Journal of Scientific & Industrial Research

V. 9, No. 12, DECEMBER 1950

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- Fourth World Power Conference
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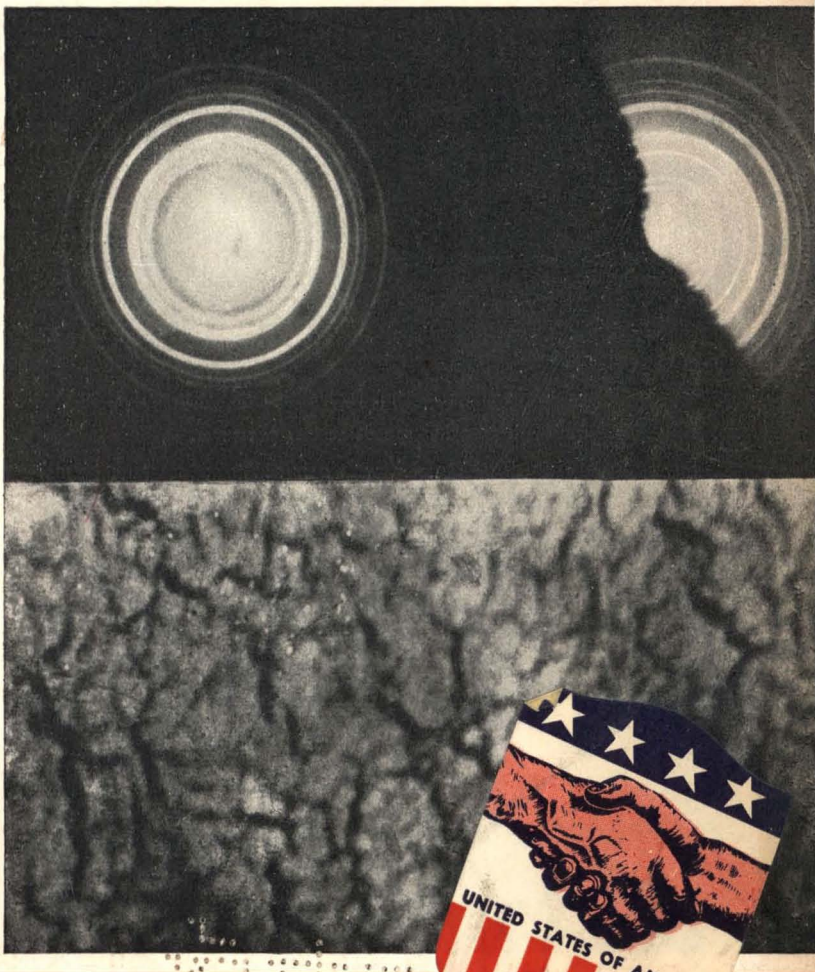

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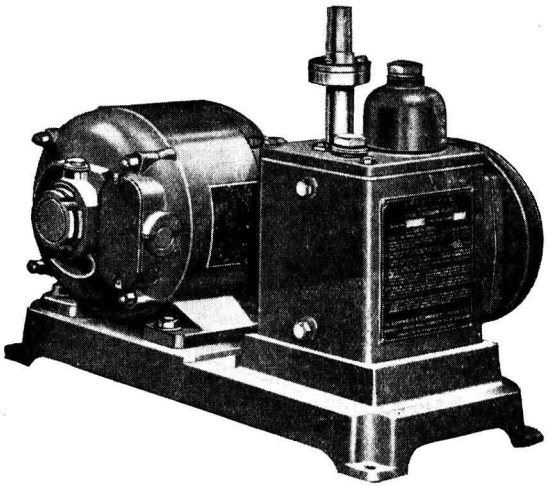

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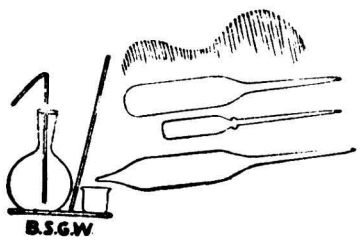

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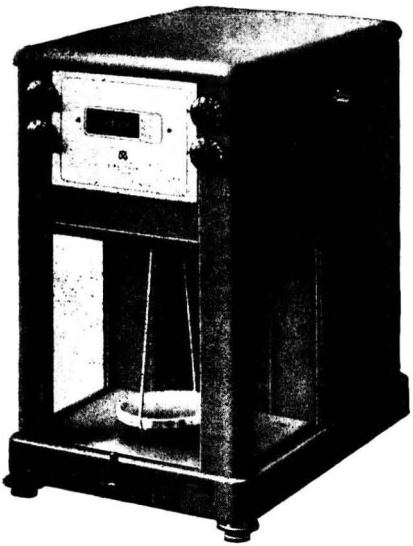

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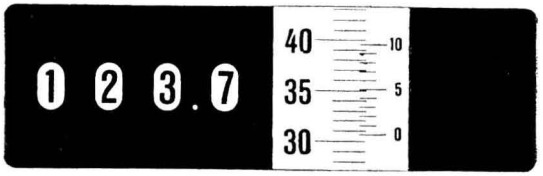

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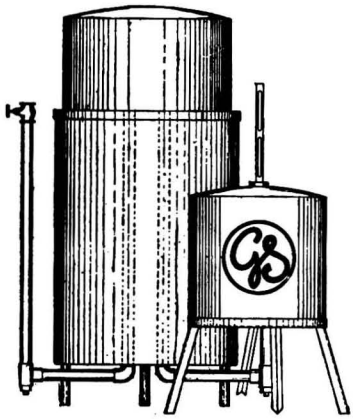

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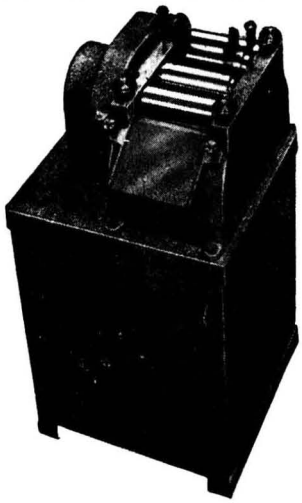

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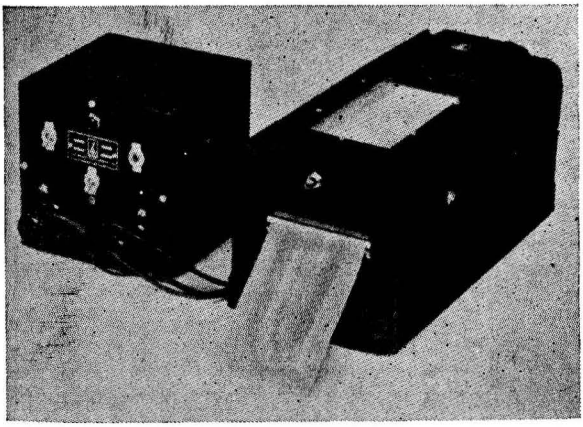

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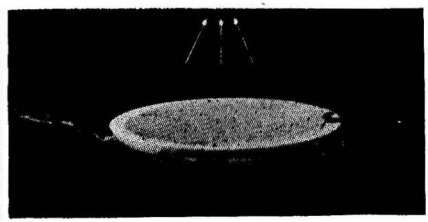

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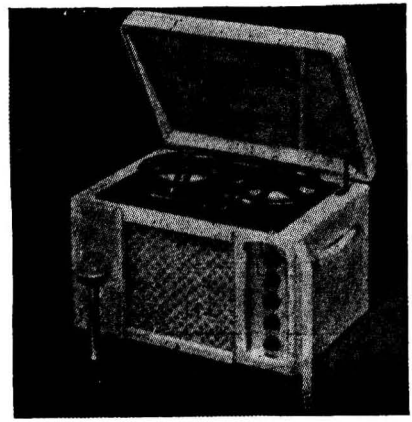

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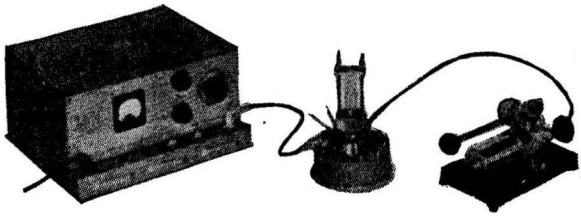

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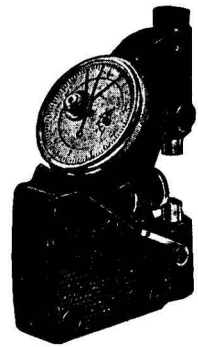

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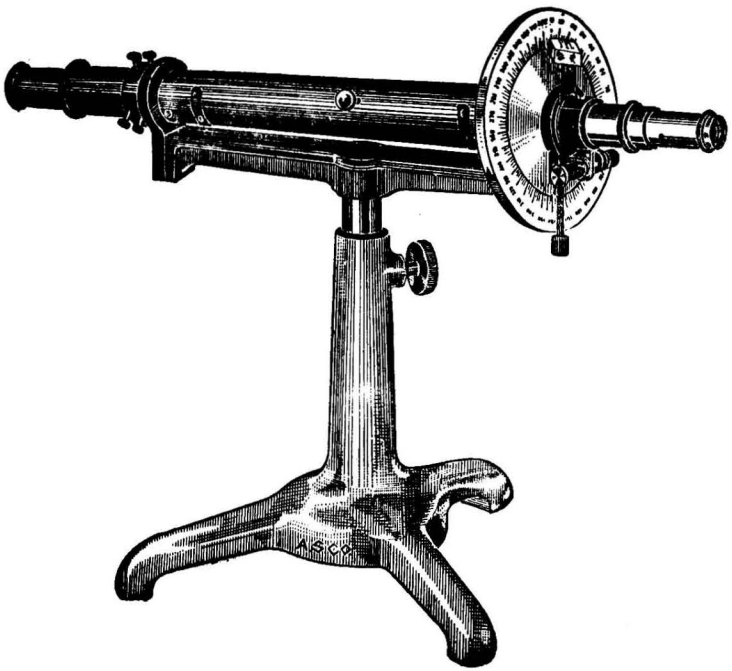

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Central Food Technological Research Institute*

AMONGST the research institutes which the Industrial Research Planning Committee, under the Chairmanship of Sir Shanmukham Chetty, suggested should be brought into being, was the Central Food Technological Research Institute. Research in this institution was envisaged to cover the field of scientific investigations connected with foods and their relationship to man. As such it embraced a large number of scientific disciplines including several branches of applied sciences and technology. When the objectives of this institute were deliberated upon by the Council of Scientific & Industrial Research and the Planning Committee, which had representatives of Industry, Science, Food and Agriculture Ministries in it, the following facts were prominently before them. A number of industries connected with the processing of food had already been established, for example flour milling, rice milling, bread and biscuit making, fruit and vegetable processing, country spirits and potable liquors, starch and vegetable oils including *vanaspati*, cocogem and margarine. The total value of factory production during the years 1946 and 1947, for which accurate data are available, was Rs. 112·68 crores and Rs. 131·07 crores respectively, the figures of individual items being :

	1946 (in lakhs of rupees)	1947 (in lakhs of rupees)
Flour milling	1,270	770
Rice milling	3.524	3,464
Biscuit making	192	244
Fruit and vegetable processing	32	21
Country spirits and potable liquors	214	188
Starch	47	26
Vegetable oils including	5,989	8,394
Vanaspati	2,056	1,655
Margarine	5	8
	11,268	13,107

In addition to the processing and production in India itself, trade in food materials forms an important feature of India's export and import trade. The volume of this trade will be apparent from the following figures which relate to the last three years, 1947-48, 1948-49 and 1949-50 :

	1947-48 (in lakhs of rupees)	1948-49 (in lakhs of rupees)	1949-50 (in lakhs of rupees)
Imports			
Fish excluding canned fish	10	15	20
Fruits and vegetables	390	585	669
Grains, pulses, flour	2,296	7,323	9,955
Liquors	210	168	108
Provisions and oilman's stores	653	705	769
Spices	363	442	354
Other foods and drinks	290	204	134
	4,212	9,442	12,012
Exports			
Fish	169	147	186
Fruits	544	610	753
Grains and pulses	12	5	4
Liquors	4	3	1
Provisions and oilman's stores	54	86	62
Spices	638	546	1,818
Other foods and drinks	49	4	107
	1,470	1,401	2,931

* From the address delivered by Dr. Shanti Swarup Bhatnagar, F.R.S., on the occasion of the opening of the Central Food Technological Research Institute, Mysore, October 21, 1950.

These figures show that the transactions at home and abroad involve an annual turnover of rupees 225 to 240 crores.

An industry and trade catering to business of this magnitude can never hope to develop and progress without the aid of research. It must have the assistance of an up-to-date technological research institute to enable it more adequately to meet the needs of our people and boldly to face the competition of other countries. To compare the functions of such a research institute with those of agricultural research institutes, which largely concern themselves with soil surveys, increasing production of crops and evolution of new varieties of resistant plants, would only be evading the issue, for there is very slender connection, if any, between research for technological processing and research for increasing agricultural production. New food industries such as the manufacture of breakfast cereals and food yeast are being established in the country and for their proper development, a Central Food Technological Research Institute is a real necessity.

During recent years, after the separation of Burma and particularly after the division of our country, the food problem has staggered us as no other problen has.... The Government has spent enormous sums of money in procuring food from abroad and in increasing food crops by utilizing all available lands. If the statistics which are available can be relied upon, we have an overall shortage of a little over 10 per cent of our total requirements of food.

Larger shortages, if any, in certain regions are due to lack of proper transport and procurement facilities. To overcome this small shortage, the Government have initiated the " Grow More Food " campaigns, the purchases outside, the procurement drive inside, and a system of rationing for principal food materials. I should not say they have neglected, but they have certainly laid much less emphasis on the more prudent utilization of our raw materials of food or reducing losses during storage and in industrial processing, and on the prevention of ravages by insect pests and fungi after crop collection. The possibilities of introducing new processed materials which can be used as food have received the least attention. All measures for increasing the growth of food, both in the vegetable and the animal kingdom, are praiseworthy. The " Grow More Food " campaign will evidently require more money and time than the aids which technology can render to food preservation and food utilization. The losses incurred in the inefficient milling of rice and flours on the large scale as well as in the making of parboiled rice and other parched, semi-parched, baked and cooked foods are pretty large and can be decreased by the aid of technical supervision and research.

We feel that by introducing substitute foods in which technological research has already shown the way, and by preventing losses of food materials during storage, science and technology can help to convert our shortage of 10 per cent perhaps into a surplus.

Today's inauguration of this Institute is the first big step which the Government of India have taken to solve the food problem by the technological as distinguished from purely biological methods.

Although work in the laboratories was started only recently, the Institute has already some useful contributions to its credit. Particular attention has been directed to the production of emergency foods to meet our urgent needs and also to utilize food materials which are now going to waste in certain seasons. The Biochemistry and the Processing Divisions have been concentrating on the production of suitably fortified grains prepared from different starch-bearing materials, pulses and seed-cakes. Till recently, the greatest difficulty was the improvement of the cooking quality, but this has recently been overcome. Other investigations relate to the possible application of lucerne, now used only for animal feeding, but which is a high class article of food, supplying practically all the food essentials which are lacking in the ordinary cereal diets. Work on the utilization of jackfruit and citrus fruits which are produced abundantly in the Malnad regions, all along the Western Ghats, is actively in progress and the industries are also taking very keen interest in the new developments. Work on the processing and preservation of juice and pulp from cashew fruit has also been carried out. Other enquiries bearing on the utilization of different seed-cakes, processing of coarse grains to render them acceptable to rice eaters, preservation of raw, sliced mango for chutney and pickling, curried vegetables, production

of good class vinegar from different sources as a cheap cottage industry, canning of meat products, new and improved methods of processing of pulses without affecting their nutritive value, production of an attractive edible milk from groundnut, etc., are in progress. The Institute has established contacts with the various food industries to whom information, advice and assistance are being given.

The National Science Foundation, U.S.A.

THE National Science Foundation has been created as an independent agency in the executive branch of the United States Government to develop a national policy for the promotion of basic research and education in the sciences.

The bill authorizing the establishment of the foundation was signed by President Truman on May 10, 1950. Described by the President as a " major landmark in the history of science in the United States ", the creation of the Foundation climaxes five years of effort to develop a sound instrument for promoting progress of science.

" We have come to know that our ability to survive and grow as a nation depends to a very large degree upon our scientific progress ", the President said in signing the bill. " Moreover ", he continued, " It is not enough simply to keep abreast of the rest of the world in scientific matters. We must maintain our leadership. The National Science Foundation will stimulate basic research and education in nearly every branch of science, and thereby add to the supply of knowledge which is indispensable to our continued growth, prosperity and security."

As provided in the bill, the National Science Foundation consists of a director and a 24-member board, all of whom are appointed by the President with the advice and consent of the Senate. Persons nominated must be eminent in the fields of basic sciences, medical science, engineering, agriculture, education, or public affairs, with their selection based solely on the basis of established records of distinguished service. The term of office of the voting board members is six years.

The general functions of the Foundation, as described in the bill, are as follows :

To develop and encourage the pursuit of a national policy for promoting basic research and education in the sciences ;

To initiate and support basic scientific research in mathematical, physical, medical, biological, engineering, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such basic scientific research and to appraise the impact of research upon industrial development and upon general welfare ;

To initiate and support specific scientific research activities, at the request of the Secretary of Defence, in connection with matters relating to national defence by making contracts or other arrangements ;

To award scholarships and graduate fellowships in mathematical, physical, medical, biological, engineering, and other sciences ;

To foster interchange of scientific information among scientists in the United States and foreign countries ;

To evaluate scientific research programmes undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programmes with those undertaken by individuals and by public and private research groups ;

To maintain a register of scientific and technical personnel and in other ways to provide a central clearing house for information covering all scientific and technical personnel in the United States, including its territories and possessions.

Four main divisions, with committees set up for each, were outlined within the Foundation: the Division of Medical Research; of Mathematical, Physical and Engineering Sciences; of Biological Sciences; and of Scientific Personnel and Education.

The bill authorizes the Foundation to co-operate "in any international scientific research activities consistent with the purposes of the Act" and to expend for such international research sums within the limit of appropriated funds. Such arrangements, however, must meet with the approval of the Secretary of State and be consistent with the foreign policy objectives of the United States.

Recipients of scholarships and graduate fellowships for scientific study will be selected by the Foundation from among United States' citizens on a basis of ability.

Commenting on the bill, Washington *Star* says the prime responsibility of the Foundation is "to mobilize the nation's brains — our richest natural resource — for a co-ordinated and continuing programme of basic research calculated to keep us from lagging behind any other country in the age of the atom and kindred good and evil wonders.... The Foundation is designed to perpetuate and enlarge upon the kind of work that was carried out with brilliant results by the temporary wartime Office of Scientific Research and Development. Once it is established and operating, however, its activities will cover far more than national defence, though that will be one of its major responsibilities. Actually it will have something to do with virtually every type of experimentation, not merely in military science but in medicine, physics, engineering, biology and similar fields, bearing upon the health and economic well-being and safety of America. Among other functions, it will serve as a clearing house for technical information, grant scholarships and fellowships to make the most of available talent and offer close co-operation — including grants and loans — to universities and other institutions engaged in fundamental studies.

"In terms of both national security and beneficent peacetime progress, such an enterprise unquestionably is full of great potentialities. Despite all that has been accomplished already, frontiers of science still remain largely unexplored. With the projected new Foundation in vigorous operation acting simultaneously as a stimulator and co-ordinator of exploratory experiments and of efforts to make practical applications of new discoveries, there will be good reason to expect rich dividends from whatever we invest in it. The sooner we have it as a going concern, the better equipped the nation will be to serve its own best interests."

Although the Foundation machinery has been established, to date the director and the board members have not been named.

U.S.I.S.

Some Basic Industrial Problems Requiring Scientific Investigation on Priority Basis

A. NAGARAJA RAO

Industries Division, Planning Commission, New Delhi

INDUSTRIAL development in India has so far been generally based on the utilization of processes developed in other countries and sometimes without adequate consideration being given to the suitability of adopting such processes to Indian conditions and/or natural resources. Planned economic development of a country necessitates a correct appreciation of the limitations of available resources and their optimum utilization.

It will be appreciated that unless the basic chemical industry is developed keeping in view our resources, particularly in respect

of raw materials, the entire superstructure would be unsound. Manufacture of mineral acids — sulphuric, hydrochloric and nitric—, soda ash, caustic soda and fertilizers, and proper utilization of our fuel resources are some aspects of the chemical industry which require careful scrutiny. Unfortunately, our sulphuric acid industry is still based on imported sulphur. Both because of insufficient knowledge and information in regard to the alternative sources of sulphur-bearing materials in the country and the reluctance on the part of *entrepreneurs* to the adoption of new processes, regarding which both they as well as the technicians of the country have still insufficient knowledge and experience, no attempt has been made to study and adopt the more recent techniques in other countries It is not only necessary to keep ourselves abreast of the times and take advantage of all scientific and technological developments in other countries for securing advantages, but also it is essential to engage ourselves on a priority basis in the development of new processes for utilizing our own raw materials as far as possible.

While the scope of fundamental scientific research having a long-term utility has to be mainly determined by the ability of the individual worker to think and plan his work, industrial investigations have to be taken up on a priority basis consistent with the immediate requirements of the country. In the long run, it is necessary for us to spend the maximum available funds for industrial research and to solve immediate industrial problems by concerted action on the part of a number of investigators interested in specific fields and allocation of the entire financial resources to specific problems on a priority basis.

Having some of these aspects in view, an attempt has been made to indicate below some of the basic industrial problems which may have to be assigned the highest priority and on the solution of which the development of some of our basic chemical industries will depend.

Sulphur Resources

(1) Recovery of sulphur from gypsum *either* by reduction to sulphur dioxide and further reduction to sulphur, *or* by reduction to calcium sulphide, generation of hydrogen sulphide and its oxidation to sulphur. (2) Use of gypsum for the manufacture of sulphuric acid. (3) Utilization of sodium sulphate for: (a) manufacture of sulphuric acid; (b) manufacture of ammonium sulphate and sodium carbonate and (c) manufacture of caustic soda by causticizing. Large sodium sulphate deposits are known to occur in Jodhpur at Didwana, and it may form a suitable raw material for this purpose.

(4) Electrolysis of sodium sulphate to recover sulphuric acid and caustic soda. (5) Use of magnesium sulphate (from sea water) for the manufacture of sulphuric acid. (6) Use of magnesium sulphate (from sea water) for producing sodium sulphate by interaction with sodium chloride.

This investigation is considered necessary to enable us to have ready information on the possibilities of producing sodium sulphate from alternative sources in the event of results under 3 and 4 proving fruitful, and the deposits at Jodhpur are considered inadequate. (7) Beneficiation of calcium sulphate occurring in the form of selenite in some parts of the Union. (8) Beneficiation of gypsum recovered from sea water; and (9) beneficiation of pyrites occurring in different parts of the country (deposits at Chitaldrug in Mysore State and others in Bihar, etc.).

Alkali Resources

(10) Recovery of sodium carbonate and sodium sulphate from Sambhar Lake utilizing bitterns left over after the manufacture of salt. It may be worth while also to take up investigations on the recovery of sodium carbonate from Chilka Lake; and (11) manufacture of ammonium chloride and sodium bicarbonate utilizing ammonia, carbon dioxide and salt.

Utilization of Chlorine

(12) Manufacture of phosphatic fertilizers, particularly dicalcium phosphate, utilizing hydrochloric acid obtained as a byproduct during organic chlorinations or by manufacturing it specially from chlorine and hydrogen in caustic soda-chlorine plants; and (13) chlorination of alcohol to obtain diverse organic chlorine compounds (solvents, plasticizers, etc.).

Phosphate Resources

(14) Beneficiation of apatite ore for use in the manufacture of phosphatic fertilizers; and (15) investigation into the conversion

of Indian phosphatic raw materials to phosphatic fertilizers without using sulphuric acid — by adoption of thermal treatment or by T.V.A. process.

Miscellaneous

(16) Generation of water gas from reactive cokes (other than hard coke) produced from low grade coals and design of suitable gas generators. (17) Improvements in plant and methods for generating producer-gas from wood or charcoal for use in transport vehicles. (18) Modification of petrol engines for trouble-free operation with pure alcohol or alcohol-petrol mixtures. (19) Comparative studies on the use of different nitrogenous and phosphatic fertilizers — ammonium sulphate, ammonium chloride, ammonium nitrate, ammonium phosphate, urea, calcium nitrate, single and triple superphosphate, dicalcium phosphate — for different crops under different soil conditions; and (20) development of processes for the manufacture of pulp for use in rayon and staple fibre manufacture, starting from different raw materials — straws, reeds, bamboo and woods — available in India.

Investigations of these problems should be continued until the completion of the pilot-plant stage and, if possible, a full-scale plant trial should be carried out after the economic possibilities of the processes are assessed by pilot-plant work.

The above list is by no means exhaustive. The writer is convinced that some of the problems indicated are of great national importance and their investigation should be given a very high priority. Valuable investigations on some of the above problems have been carried out both in India and abroad; the object, however, of raising the issue now is only to invite attention to the urgent necessity of collecting further technological data with a view to determining the economics of some of the possibilities and for facilitating the design of industrial plant and equipment for adoption in the country.

Census of Medical Men

THE SECOND IN THE SERIES OF PUBLICATIONS issued by the Council of Scientific & Industrial Research under the title *National Register of Scientific & Technical Personnel in India* to provide a continuous census of scientific manpower in the country catalogues the names of medical graduates, medical licentiates and dentists. The volume (Volume II — Medical Personnel, Part I, March 1950, Price Rs. 12) includes in brief outline, academic qualifications, postgraduate training, hospital work, specialized practice, teaching, research and administrative experience, etc., of qualified medical personnel in India. A classified statement of the number of specialists under different categories of the profession is included at the end of the volume, which also gives information on Indian doctors residing in foreign countries, teaching and research institutions in India, hospitals for the treatment of special diseases, and a brief account of the progress of medical research in the country.

Medical men who have not registered themselves so far are invited to send in their particulars and help in making the compilation exhaustive.

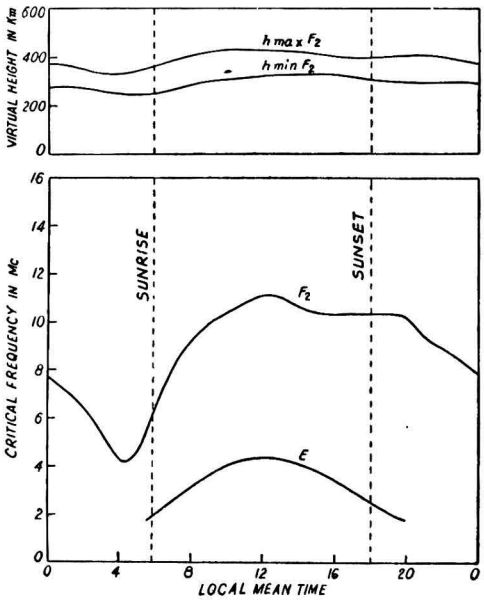
Copies of the volume are obtainable from the Chief Editor, Dictionary of Economic Products & Industrial Resources of India, 20 Pusa Road, New Delhi.

Characteristics of the Ionosphere over Calcutta (September 1950)

S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY, A. P. MITRA & R. B. BANERJEE

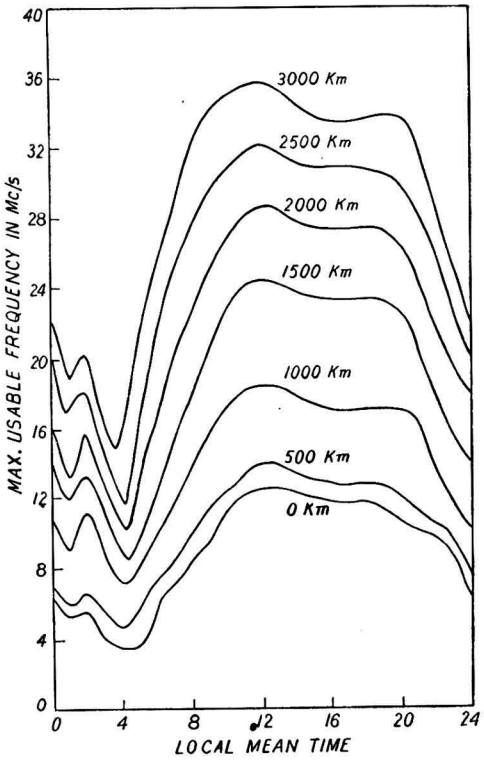
Ionosphere Laboratory, Institute of Radio Physics & Electronics, Calcutta

THE monthly average characteristics of the ionosphere over Calcutta for September 1950 have been presented in this note. Fig. 1 shows in graphical form the average diurnal variation of $f°E$, $f°F_2$, $h_{max}F_2$ and $h_{min}F_2$. Fig. 2 gives the prediction of the maximum usable frequencies which can be used for different distances of transmission by reflection at the F region over Calcutta for the month of December 1950. Table I gives the various occasions during routine observations when sporadic E ionization was observed and the corresponding values of penetration frequencies and heights.



(5 HR. 54 MIN. AHEAD OF G.M.T.)

FIG. 1 — SEPTEMBER 1950.



AT POINT OF REFLECTION.

FIG. 2 — PREDICTED M.U.F. VIA F_2 LAYER DURING THE MONTH OF SEPTEMBER 1950.

TABLE I

MONTH & YEAR	DATE	HOURS	$f°E_s$ Mc.	h_{E_s} Km.
September 1950	1	17.00	8·85	105
		18.00	6·80	105
		19.00	7·25	90
		20.00	4·20	90
		21.00	2·50	90
		23.00	6·00	90

TABLE I — *contd.*

Month & Year	Date	Hours	$f^{\circ}E_s$ Mc.	$h E_s$ Km.
September 1950	2	03.00	4·50	90
		04.00	3·25	90
	4	16.00	5·30	105
		17.00	5·25	105
		18.00	4·80	90
		22.00	4·30	90
		23.00	2·70	90
	5	00.00	4·20	90
		01.00	4·00	90
		02.00	4·00	90
		03.00	3·90	90
		04.00	3·20	90
		16.00	4·10	105
		17.00	4·00	105
		19.00	4·00	90
		23.00	4·70	90
	6	02.00	7·30	90
		03.00	8·00	90
		04.00	2·95	90
		09.00	6·00	105
		10.00	9·00	120
		22.00	8·50	105
		23.00	8·50	105
	7	00.00	6·30	105
		08.00	4·60	120
		09.00	4·85	120
		10.00	4·80	120
		11.00	5·00	135
		19.00	4·00	105
	8	18.00	4·10	105
	9	10.00	4·75	105
	12	19.00	4·00	105
		20.00	3·50	105
	13	01.00	3·50	90
		02.00	3·75	90
		03.00	3·65	90
		04.00	4·80	90
		19.00	3·50	105
	15	00.00	5·50	105
		03.00	5·00	90
		17.00	8·00	120
		18.00	6·25	105

TABLE I — *contd.*

Month & Year	Date	Hours	$f^{\circ}E_s$ Mc.	$h E_s$ Km.
September 1950	15	19.00	3·70	105
		20.00	4·00	90
		21.00	3·00	90
		22.00	2·25	90
		23.00	2·50	90
	16	00.00	3·40	90
		01.00	2.00	90
		02.00	2·00	90
		04.00	3·25	90
	18	23.00	3·10	90
	19	00.00	3·00	90
		01.00	3·30	90
		02.00	4·00	90
		03.00	3·15	90
		18.00	3 50	90
		20.00	3·90	90
	20	19.00	4 10	105
		20.00	4·10	90
	21	09.00	4·50	105
		19.00	2·30	90
		20.00	2·75	90
		21.00	2·50	90
		22.00	2·00	90
	23	04.00	3·00	90
		10.00	4·70	105
	27	08.00	4·05	105
	28	18.00	3·50	105
		22.00	5·10	90
		23.00	4·80	90
	29	01.00	4·30	90
		03.00	4·40	90
		04.00	3·10	90
		17.00	3·60	105
		18.00	3·60	90
		19.00	2·70	90
		20.00	3·75	90
		22.00	4·50	90
	30	04.00	4·25	90
		05.00	4·50	105
		06.00	3·05	105
		07.00	4·00	105
		10.00	4·95	105

Post-Doctorate Fellowships — National Research Council, Canada

THE NATIONAL RESEARCH COUNCIL OF Canada invites applications for the award of 34 post-doctorate research fellowships in the following branches of chemistry and physics in their laboratories at Ottawa: *Chemistry* — Chemical kinetics and photochemistry, surface and colloid chemistry, molecular spectra, low temperature calorimetry, alkaloids, mechanism of organic reactions, absorption spectra of organic compounds, physical properties of gases, critical temperature phenomena and liquid structure. *Physics* — Molecular spectra, molecular beams, cosmic rays, X-ray diffraction, ultrasonics and properties of matter, microwaves, optics, radiology and theoretical physics.

The fellowships, of $ 2820 each per annum, are tenable for a period of one year but may be renewed for a second year. Travelling expenses will be paid to persons coming from abroad. Applications on the prescribed form obtainable from the Secretary, Laboratories Awards Committee, National Research Council, Ottawa, or from the Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, W.C. 2, London, should reach Ottawa not later than February 15, 1951.

The Central Food Technological Research Institute, Mysore — Opening Ceremony, October 21, 1950

THE Central Food Technological Research Institute, Mysore, was declared open by the Hon'ble Sri C. Rajagopalachari, on October 21, 1950. The Rajpramukh, the Maharaja of Mysore, presided. The function, which took place in a special pandal at the Cheluvamba Mansions, was attended by eminent men of science, officials of the Central and State governments and prominent citizens.

The Institute, the fifth in the chain of national laboratories declared open this year, is housed in the magnificent Cheluvamba Mansions, which was taken over by the Government of India in April 1949.

The establishment of the Institute was recommended by the Industrial Research Planning Committee of the Council of Scientific & Industrial Research in 1945. The Governing Body of the Council sanctioned the necessary expenditure for formulating detailed plans for the Institute in February 1948. The formal agreement regarding the location of the Institute at the Cheluvamba Mansions, Mysore, was reached in December 1948, and the work connected with the planning and organization of the laboratories was entrusted to Dr. V. Subrahmanyan, since appointed Director of the Institute. The arrangements for converting the palace into a laboratory commenced in April 1949, and before the end of the year, the Biochemistry and Nutrition Divisions and a section of the Processing Division were actively functioning. Early in 1950 the Indian Institute of Fruit Technology was merged with the Institute and by July of the same year the Division of Fruit Technology was fully organized, not only for carrying out researches on the preservation and processing of fruits and vegetables, but also for conducting the All-India Postgraduate Diploma Course in Fruit Technology.

Declaring the Institute open, Sri C. Rajagopalachari paid a tribute to the work of Dr. Shanti Swarup Bhatnagar in speedily establishing the national laboratories in the country. He drew attention to the vast scope for research in solving the food problems facing the country, and suggested that scientific research and technological processes should be employed to minimize all forms of food wastage and to preserve all surplus food material. "Another field for investigation", he said, "is the elimination of the harmful constituents of non-edible materials, and the conversion of the latter into healthy and attractive food. This also is a vast and very important field of investigation in the plan of supplementing our food resources.... Closely linked up with this is the maintenance of nutritional standards by the use of staple subsidiary foods. There is again the problem of the manufacture of concentrated foods and accessories like vitamins on a large scale which would assist the maintenance of proper nutritional standards in India."

In his speech the Rajpramukh, the Maharaja of Mysore, observed that the importance of food cannot be over-emphasized in a poor under-nourished country like India. "This Institute", he observed, "is one amongst the many enterprises that are evidence of the innate constructive genius of our Nation. Our Government, since the advent of Swaraj, has been trying to liquidate the arrears of centuries in the matter of scientific, industrial and material progress. Think of the many research laboratories it has organized; of the many dams and reservoirs it has planned for the conservation of waters needed in our dry and droughty land; of the many power stations that are in the stage of planning or actually under construction for the improvement of the economic condition of our people; of the encouragement it has given to shipbuilding; and of the many research laboratories — pure and applied — it is establishing all over the country and the stimulus and support it has given to research and creative activities." Speaking of the conservative food habits of the people of

India and how the people at large are apt to be reluctant to utilize new food products, he stressed the rôle of educated and upper strata of society in setting an example by betaking to such food products.

Dr. S. S. Bhatnagar, in an illuminating address on the occasion, briefly traced the circumstances leading to the establishment of the Institute, and observed, "Today's inauguration of this Institute is the first big step which the Government of India have taken to solve the food problem by the technological, as distinguished from the purely biological, methods. New food industries such as the manufacture of breakfast cereals and food yeast are being established in the country, and for their proper development, a Central Food Technological Research Institute is a real necessity." He assured the gathering that within a year of its inauguration, the Institute will make distinct contributions towards the solution of food shortage in India. He paid a tribute to the work of Dr. V. Subrahmanyan, who has worked zealously and hard to establish, as quickly as possible, this new aid to food industry.

In his message Pandit Jawaharlal Nehru, the Prime Minister of India, referred to the scientific developments in the country during the past few years and said: "One of the remarkable developments in India, during the last three years, has been the opening of national laboratories and research institutes. We have put up some magnificent laboratories, not only impressive to look at, but I hope, the homes of productive effort and work. It is ultimately on the basis of work done in our research institutes and laboratories that we can progress in most directions. Thus far we have depended on other countries and have merely copied them or taken advantage of something that they have done. We cannot go far with this dependence. We have at least laid good and true foundations for scientific progress. It is for the young scientists of India to take advantage of the great opportunities offered to them and thus help in building up the New India.

"We have given top priority to the production of foodgrains or subsidiary foods. It is obvious that food is of the first importance and its value cannot be judged merely in money terms. We cannot depend on imports for our food and, therefore, we have laid down a target for food sufficiency. This is the 1951-1952 season. In spite of all difficulties and disasters, we still adhere to that target and are trying to work up to it. We hope to succeed. It must always be remembered that food production has the highest priority.

"How can science help in this? The primary responsibility is of our Department of Agriculture. Science can help in agriculture greatly. It can also help in various other processes. It is particularly with these other processes that this Institute will be concerned. I hope the work done in this Institute will bear fruit not in developments on paper and in scientific journals but in terms of human values and in increase of suitable food for our people."

The functions of the Central Food Technological Institute include: (1) development of improved methods of storage; refrigeration, freezing, gas storage, dehydration, canning, etc.; study of biochemical and microbiological changes accompanying spoilage; reclamation and utilization of infested or otherwise affected food materials; (2) processing of foodstuffs with a view to (a) facilitating their ready usage, and (b) improving their keeping quality; treatment of coarse materials to improve palatability, digestibility and food value; elimination of harmful and unpalatable ingredients from food materials; (3) study of new and unfamiliar sources of food materials and processing of new materials to render them suitable for human consumption; emergency foods, survey of potential food resources in different regions; (4) production of concentrated foods, vitamins and other food accessories, composite multi-purpose foods, supplementary foods, substitutes, etc.; (5) dietetics, design and demonstration of improved types of food preparations to suit the economic conditions and sentiments of people in different regions; studies on cooking utensils; improved cooking methods with a view to saving in labour and minimizing the consumption of fuel; (6) study of problems relating to food industries; provision of technological information required by industry; survey of existing industries and their technical problems and collection of factual data for development of new industries; pilot plant trials; (7) food sanitation, survey and advice on hygienic conditions for food industries; (8) food adulteration; development of new methods of detection

and quality control; and (9) food information; dissemination of general information on food and dietary problems through bulletins and technological reports.

The work of the Institute will be carried out through the following Divisions: Biochemistry and Nutrition, Processing, Storage and Preservation, Quality Control, Microbiology and Sanitation, Engineering, and Information and Statistics. A Division of Dietetics and a Section for Food Containers are also being organized.

The Institute will soon have a staff of over 200, including 70 scientific workers. As the activities develop, additional staff will be recruited. The Institute may also have to establish centres and regional laboratories which will work in close association with the Central Laboratory. The Institute is now in receipt of a recurring and capital grant aggregating to about Rs. 9 lakhs, but this is expected to increase steadily with the opening up of new Divisions and other activities.

Microstructure of Gold—Electron Microscope Studies

THE R.C.A. ELECTRON MICROSCOPE RECENTLY installed at the National Physical Laboratory is being employed for metallographic studies. This instrument, which has a special accessory arrangement, can be employed to obtain transmission, and reflection diffraction pictures of crystalline materials.

Gold is one of the few metals employed in electron microscopy for shadowing to obtain a good contrast in an electron-micrograph. The picture on the cover page relates to a few studies on gold films. The metal is evaporated under high vacuum (10^{-5} mm.) and deposited on a colloidion film. The first picture (left top) is the transmission diffraction pattern of the gold film; the second (right top) is the reflection diffraction pattern of the same at an angle of 4°; and the third (bottom) is an electron-micrograph of the film surface at a magnification of X 40,000. The gold particles are seen as discrete particles in the electron-micrograph, and the aggregation of particles at some points is due to the contraction of the colloidion film as a result of electron bombardment.

These studies are important for determining the crystalline nature of a metal surface as well as for determining the inter-atomic distances in metals. The reflection diffraction studies are important from the point of view of determining the inner potential of metals and the thermionic work functions of monovalent metals.

Fourth World Power Conference, London, July 1950

J. W. WHITAKER
National Fuel Research Institute, India

THE First World Power Conference was held in London (Wembley) in 1924 ; the second in Berlin in 1930 ; the third in Washington D.C. in 1936. Meanwhile, a number of sectional meetings of the Conference have been held to consider particular subjects : e.g. Fuels, London, 1928 ; Power Resources, Tokyo, 1929 ; Power in Industry & Transport, Scandinavia, 1933 ; Chemical Engineering, London, 1936 ; Power in Small Scale Industries, Vienna, 1938 ; and Fuel Economy, the Hague, 1947.

The object of these conferences and sectional meetings is to afford leading engineers, scientists, administrators, and economists from the various countries of the world a meeting ground where they can discuss, for mutual benefit, problems and advances connected with the generation and supply of energy for public utility. Potential resources in hydro-electric power, coal, oil, and other fuels are reviewed as well as problems connected with agriculture, irrigation, and general industry. Developments in the utilization of atomic energy are also comprised in the review in so far as they are related to the above programme.

Fifty-two countries were represented at the Fourth World Power Conference. At the opening session on July 11, the delegates were welcomed by Sir Harold Hartley who gave a brief review of the objects of the gathering and of the benefits which could accrue from the deliberations.

The subjects of discussion fell into 10 main sections and 146 papers were presented at the session. Notes on some of the leading papers are given below.

Energy Resources & Power Developments

About 30 papers were submitted dealing with the energy resources of the different countries of the world. Statistics were given showing the fuel and water power used and the estimated assets and probable developments for each country. Broadly speaking, it becomes more and more evident that those countries which have truly large supplies of natural energy in the form either of fuel (coal and oil) or of water power are not many. In other words, the natural resources of energy are unevenly distributed throughout the world. The U.S.A. seems to be particularly favoured, but the resources of Canada, U.S.S.R., U.K., and certain European countries are also great. Particulars regarding Africa are meagre, and the continent of Asia cannot be said to have been sufficiently explored as yet to permit of a true assessment. Australia is now known to have fairly large deposits of coal (brown and black), and the same is true of Canada where the bituminous shales form comparatively unusual types of deposit whose potential value is so far not decided. Pakistan would seem to have very limited supplies of fuel, and none of coking coal. The paper submitted by the Indian National Committee on the " Assessment of the Energy Resources and Their Development in India " shows India's position to be far better than that of her neighbours.

Preparation of Solid Fuels

Coal — In a paper from Great Britain, submitted by the Chief Coal Preparation Engineer, National Coal Board, on " The Problem of Coal Preparation ", the author (Grounds) first draws attention to the effects of mechanization on the quality of the coal now produced and to the fact that, while " mechanization made steady progress during the 2nd World War, improvements in coal preparation virtually came to a standstill ". In Great Britain, therefore, the National Coal Board was faced with the task of closing a gap. The work is urgent because (1) a higher proportion of dirt is now being sent to the surface with the coal, (2) the raw coal contains a greater proportion of

small coal (and particularly of fines), and (3) inferior seams are now being worked which contain large quantities of middlings and inter-stratified coal and shale. Coal washing has thus become imperative. Baum boxes (jig washers) are still the commonest type of washer in the country, and they are useful when coals of easy washing characteristics are to be treated, and/or when a separation at a specific gravity of about 1·5 or higher is required. Where appreciable quantities of middlings of specific gravities between 1·4 and 1·7 are present, however, the efficiency of separation decreases, and good separation of clean coal, middlings, and shale cannot be effected, although a crude middling fraction can be produced for crushing and re-washing. Usually in Britain the larger *sizes* of coal require to be separated at low specific gravities, and jig washing becomes notably less efficient when attempts are made to use it for separations below a specific gravity of 1·5.

Turning to dense-medium processes, Grounds gives a useful and brief review of the development of the washers of Chance, Barvoys, Tromp, Ridley and Scholes, and the American Cynamid Co. No mention is made of cyclone washers.

Summarizing, Grounds claims that the trend in Great Britain for future large coal-cleaning plant is to have (a) dense-medium washing for the large coal, say 8–1 in., (b) Baum washers for the small coal, say 1 in.–$\frac{1}{2}$ mm., and (c) froth flotation for the fines of $\frac{1}{2}$ mm.–0 in size.

A standard plant of dense-medium *cum* Baum is being developed by the National Coal Board, with standard units also for the new froth-flotation plant. Incidentally, the fines are now of greater importance than formerly: with mechanization there has been an increase in the proportion of fines, and the quantity now produced (at certain mines) is far too large to be discarded as in the past.

"In their passage through the washing plant, the natural fines become suspended in the wash water, and their quantity is increased by breakage of the raw coal during its passage through the washer and over the de-watering screens. In addition, the constant circulation of wash water leads to a still further breakdown, both of fine coal and, particularly, of soft shales. The effluent from the washing plant was formerly run into settling bays, where the solid settled out and the clarified water ran into any convenient stream. The settled solids were eventually dug out, at the expenditure of much labour, and were sometimes used for boiler firing. The *slurry* might contain up to 20 or even 30 per cent ash and about 15 per cent moisture, and was anything but an ideal boiler fuel. The hand firing of slurry was arduous work, particularly when it was produced from coking coal, for the slice-bar and poker were in continual use, thus necessitating continual opening of the fire doors and the in-leakage of excess air, with corresponding drop in boiler efficiency. The amount of ash to be handled, too, was excessive.

"The froth-flotation method of cleaning fines has, however, been adopted for larger quantities and, where coking coals are concerned, the clean fines containing, perhaps, only 9 per cent of ash, can be blended with the washed small coal, since breakage is not of any serious importance.

"With industrial coals, however, there is a limit to the percentage of fines which can be blended with the washed smalls or slack, especially if the coal is a non-caking or only slightly caking one. There is another possibility, however, namely the drying of the filter cake produced from the froth-floated fines, and the use of the dry, clean fines for pulverized-fuel fired boilers. From a dirty, almost unusable fuel a coal can thus be produced containing, say, about 8–12 per cent ash and 2–3 per cent moisture for a cost of, say, 3*s.* 6*d.* *to* 5*s.* *per ton* for froth flotation and another 2*s.* 6*d.* *to* 3*s.* *per ton* for drying. This problem of thermal drying will have to receive serious consideration in the near future, as we cannot afford to throw on the dirt heap thousands of tons of very fine coal now produced in the washeries of this country."

The above costs should be noted: larger sizes (e.g. $\frac{1}{4}$") can be washed at about one-fourth of the above rates.

The sizes of modern coal washeries are increasing — from a few hundred tons per hour in older plants to over 1,000 tons per hour in recent ones.

The general discussion of the papers in this section turned largely on coal-cleaning plants. Sir Eric Young of the National Coal Board made a plea for the reduction of capital cost of such plant, which, he said,

was now 4 or 5 times higher than the pre-war figure.

Lignite, Brown Coal, etc. — The paper submitted by F. H. Roberts on the preparation and utilization of the brown coal of Victoria, Australia, was of outstanding interest. The estimated recoverable brown coal reserves in Australia are about 37,000 million tons, whereas there is less than half this quantity, namely 15,000 million tons, of ordinary black coal. The brown coal deposits of Victoria are several hundred feet thick — sometimes 800′, covered by about 60′ of overburden. They are exploited by the State Electricity Commission and the Victorian Government Mines Department. As worked, the brown coal contains about $\frac{2}{3}$ of water, i.e. 66 per cent, but the ash is very low (less than 1 per cent) while sulphur is about 0·1 per cent (on a dry coal basis these figures become respectively 3 per cent and 0·3 per cent). The total carbon in the coal is 22 per cent in the wet coal and 73 per cent in the dry. The gross heating value of the coal, on the wet basis, is 3,710 B.t.u./lb.; on the dry basis, 12,400 B.t.u./lb. The ash is variable in composition but usually contains little silica, much iron oxide, magnesia and lime and a fair quantity of sulphates.

In spite of its low heating value, this fuel can be burnt in water tube boilers to give a net boiler efficiency of about 70 per cent. The coal has been burnt in different ways at different periods of development, e.g. in step grates using pre-drying shafts, and (more recently) as powdered coal, the grinding being relatively coarse. Even the wettest brown coals can be simultaneously pulverized and dried in suitable mills: two or three different types of such mill have been employed. Generally, however, there has been a certain amount of pre-drying of the fuel. The paper is valuable for reference. Brown coal briquettes are also produced for outside use. German practice has been the guide, both in the combustion and in the briquetting plant. Over 6 million tons of the coal are raised per annum, and it is expected that in a few years the amount will increase to about 10 million tons.

Coke — In this section, papers were submitted (a) on the preparation, properties, and utilization of metallurgical coke in Great Britain; (b) on the carbonization of coal in France; (c) on the control of the coking process in Czechoslovakia; and (d) on the improvement of quality of coke in Poland. In general there was little of striking importance. The Polish paper submitted by B. Roga gave a good review, but was largely theoretical.

Liquid Fuels

Petroleum Fractions — Among the papers in this section was a valuable contribution from W. M. Holaday on advances in petroleum refining in United States, and another by Fleming and Tait of Great Britain on the same subject.

Holaday points out that the consumption of fuel energy in the form of coal, petroleum and natural gas in the U.S.A. has practically doubled in the past 30 years, and that at the beginning of this period petroleum and gas supplied only 20 per cent of the energy requirements whereas now they provide over 50 per cent. In other words, U.S. consumption of petroleum has grown enormously in the past 3 decades. He next considers the refining techniques employed in order to obtain a proper balance among the products to be derived from the crude. In the U.S.A. the chief demand is for gasoline: this is not necessarily so in the other countries of the world.

The paper provides valuable information on thermal cracking, reforming, catalytic cracking, polymerization, alkylation, and isomerization, polyforming and hydroforming. Notes are also given on the general treatment of gasoline and on the effects of modern petroleum-refining practice in modifying the quality of the fuel oils produced. Regarding future processing techniques in America and Europe, the emphasis for some years is likely to be on improvements in gasoline quality. The United States petroleum industry is spending more than 100 million dollars (*c.* Rs. 50 crores) per annum on research and development work directed largely to this end. The following statistics for consumption of petroleum products per head of population are given:

Europe (excluding U.S.S.R.) — 22 Imperial gal. per head per year.

U.S.A. — 420 Imperial gal. per head per year.

For gasoline these figures are about 6·7 Imperial gal. and 175 Imperial gal. respectively. Doubtless Europe would probably use far more oil if it were available. The contrast with Asia is of course still more marked.

Trends in fuel utilization will require the development and application of new refining procedures to raise the anti-knock quality of motor gasolines. Possible means to accomplish this are discussed, together with alternative steps which might be taken by motor-car manufacturers to utilize more efficiently the anti-knock quality of the gasolines that can be made with currently available facilities.

In the paper "Recent Developments in Petroleum Processing", by Fleming and Tait, the oil-refining position is reviewed beginning from 1936, when practically there were only 3 basic processes, distillation, thermal cracking, and thermal reforming. Since that time, however, developments have led to a number of other processes. But there is an economic limit to the improvement in quality which can be obtained by these processes, a limit arising from the loss in yield and the formation of large quantities of gas (hitherto wasted). This stage is reached when the products from the thermal re-forming units have an octane number of about 73. The new processes comprise the following: (1) polymerization, (2) alkylation, (3) isomerization, (4) superfractionation, (5) catalytic cracking, (6) hydroforming — referred to earlier.

Diesel & Other Liquid Fuels — In this section W. Schroeder and A. Fieldner of the Bureau of Mines, U.S.A., discussed the recent advances in the Unites States in the manufacture of synthetic liquid fuels with particular reference to the work done in their laboratories. It is clear that as yet no one process has gained outstanding preference and that investigators in U.S.A. are continuing to explore the possibilities both of hydrogenation of coal (and coal-tar) and of the Fischer Tropsch (hydrocarbon) synthesis with equal interest.

A paper submitted on the highly bituminous coal of Portuguese West Africa by the Portuguese representative was heard with interest.

Preparation of Gaseous Fuels

Natural Gas — In this section there was a paper from France on natural gas. The following is quoted from the résumé:

"Natural gas is produced mainly in the south-west of France, where the Saint-Marcet gas field was discovered in 1939, and developed after 1942. The gas is produced from Jurassic dolomites, and the wells have an important open flow capacity. After being treated in the Boussens natural gasoline plant, the gas is distributed to the consumers through the most important French pipe line system, 500 miles long. The main uses are the following: Town gas (new supply or replacement); furnace and boiler heating; manufacture of fertilizers, motor fuel gas. The use of natural gas already represents a yearly saving of 420,000 tons of coal and 82,000 tons of gasoline, propane and butane." The use of bottled gas (butane) is probably capable of much development in India.

A paper from the Belgium contributors dealt with the harnessing of fire-damp from the coal mines for use as gaseous fuel.

Gas from Solid Fuels — Such gas is obtained largely by coal carbonization or producer practice: some of the papers submitted dealt with underground gasification of coal (France). There was a valuable review of modern carbonization problems in Great Britain by G. E. Foxwell, C. Johnson, J. Burns, and others. In these papers, attention is drawn to the importance of clean coal for carbonization, and to the difficulties which have been caused by using coal containing greater and greater amounts of impurities. Burns discusses the adverse effects of poor quality coal upon the results of gas manufacture and deplores the increased ash of modern coal and coke.

The French contributors submitted a paper on the use of coke-oven plant for providing industrial gas. They conclude that, if the market for the coke is assured, coke-oven plant is best installed near a populous area where there is a market for the gas, both industrial and domestic. Calcutta would seem to meet these requirements, provided that the market for the coke is assured. Other interesting papers in this section dealt with wood and charcoal producer gas for traction purposes in Sweden (1934-35) and developments in the manufacture of producer gas from British solid fuels.

Steam Power

A number of papers submitted to the Conference dealt with developments in steam turbine practice and the present trends in design. The units considered were generally of the order of 100 MW operating with steam at 1,500 lb. per sq. in. and at 1,050°F. For

the blading of these turbines, austenitic steels of 18 per cent chromium and 8 per cent nickel, stabilized with titanium or columbium, are favoured.

F. Dollin of *C. A. Parsons & Co. Ltd.*, Great Britain, in dealing with design trends, emphasized that, although improved thermal efficiency and increased output are important, a fundamental requirement is reliability. Increased pressures and temperatures are natural developments, but the saving in fuel consumption to be expected from these measures is not easy to calculate and has been the subject of several recent technical papers, recorded in the *Proceedings of Institution of Mechanical Engineers.* " As a rough indication, however, it may be stated that an increase of 100°F. (55°C.) in the initial temperature results in a fuel saving of about 3½ per cent, whatever the level of pressure and temperature." It is considered that the steam turbine will maintain its position for many years as a dominant prime-mover in the field of power generation.

Internal Combustion Engines

This section was devoted largely to trends in oil engine design and to developments in diesel engines. It is remarkable that design in this field is not yet standardized by any means, and that fresh modifications are continuously coming forward. In this section there was an unusually interesting paper by Prof. Max Serruys on " Comparative Efficiencies of the Main Types of Internal Combustion Engine ", in which he estimated the performance of each type of engine, not only on the score of overall thermal efficiency but also analytically, dealing separately with (1) theoretical thermodynamic efficiency, (2) indicator diagrams, (3) combustion efficiency, (4) mechanical efficiency and (5) a factor of performance dependent upon the fuel used.

Gas Turbines & Jet Engines

Active interest is being maintained in this field, not only in industrial and thermal power plant, but also in locomotion whether by rail or on sea or in the air. Dr. D. M. Smith in " Land Type Gas Turbines " claims that advances in cycle conditions will lead in the course of time to plant of high thermal efficiency ; with regard to coal-burning gas turbines, however, he considers that much development is still necessary for commercial success, but that such turbines will be practicable in the moderate power range. W. Karrer of Switzerland claims that overall thermal efficiencies of about 40 per cent will in due course be achieved at power stations by means of (supplementary) gas turbines. In American gas turbine practice attention is drawn to railway locomotive applications as well as to prime-powers. " The most crucial phase of gas turbine development, it is stated, has already begun in the United States. This is the operation in commercial service of a locomotive unit and several stationary units."

In " Power Plant Requirements for Future Aircraft ", F. M. Owner and G. S. Hooker of the *Bristol Aeroplane Co.* proceed to separate the thermal and propulsive efficiences of the various types of new engines.

Water Power

Under this head the resources and location of water power plant, and the design of such stations are dealt with. Papers were submitted from Canada, Norway, United States, France, Czechoslovakia, Switzerland and Italy. In Norway such power plants are often built into the rock. The advantages claimed are : (1) More efficient utilization of heads and, under difficult ground conditions, greater possibilities and freedom in the selection of design and site of the plant. Losses in head may be considerably reduced. (2) Shorter pipe lines, particularly important for plant with high heads or large pipe dimensions. Weight of pipes may be further reduced if lined pressure shafts in rock are used. (3) Protection against falling rocks and avalanches. (4) In sound and dry rock, construction details, such as columns, girders, walls, foundations. (5) Cost of maintenance and repairs, which items are frequently heavy at plants in the open, may be materially reduced. (6) The plants may be rendered invulnerable against destruction in case of war.

In France there is tendency to consider that the sizes of hydro-electric schemes have reached the limits of economic development, but in the United States the trend is towards larger units, with simplification and improvement in construction methods. " Multi-purpose river development programmes have resulted in projects of tremendous magnitude with large generating units. Load condi-

tions have given an impetus to the creation of head by dams, instead of conduits."

From Italy, Switzerland, Czechoslovakia, and Norway there were technical papers on the Kaplan, Francis and Pelton turbines dealing with their respective fields of application. There was also from France an unusually interesting paper on the possibilities of the utilization of differences of temperature between the deep and the surface water of the sea at Abidjan, Ivory Coast, West Africa. The surface temperature is 28°C. while the cold water at depth is at 8°C., thus giving the necessary thermal potential. The French Government is investigating the possibilities of harnessing this source of energy. It is stated that the problem has been solved theoretically and now remains only to be tested. Work is going ahead. The principle consists in evaporating the warm water at 28°C. under vacuum. The steam thus generated is inhaled by the condenser which is cooled by the deep cold water. On the way the energy of the steam is utilized to drive a turbine and an alternator.

Atomic Energy

Papers on the development of power from nuclear energy were submitted by Sir John Cockroft of Great Britain and by L. Kowarsky of France.

According to Cockroft, the following are the principal technical problems which will be faced in the course of the nuclear power development programme: (a) high temperature operation, (b) high heat transfer rates, (c) neutron economy and breeding, (d) long operating life, (e) development of economic chemical processing, and (f) disposal of radioactive waste.

Each of them must be solved if the programme is to succeed.

"The building of the first experimental reactors will probably occupy the next three to five years. During the following five years we may expect to gain operating experience and be designing the first full scale nuclear power producers. At least the same period will probably be needed for the necessary chemical engineering and metallurgical developments required to produce economical processes. We are unlikely therefore to embark on any large-scale development of nuclear power before at least the following decade."

Miscellaneous

Wind Power — In an unusual paper on "Recent Developments in Large Scale Wind Power Generation in Great Britain", T. G. N. Haldane and E. W. Golding analysed the economics of utilizing wind-generated energy in any electricity supply net-work, and gave estimates of generating costs. In Great Britain it is only in certain (western coastal) areas where the wind is of sufficient regularity and force to justify the installation of such plant.

Another noteworthy contribution to the Conference dealt with a unique hydro-electric project: water from the Mediterranean would be admitted to the Qattara depression in the Northern Libyan Desert (which is about 70 kilometers from the coast), the flow of incoming water being balanced by evaporation from the salt lake which would be formed. The scheme as now proposed provides for a drop of 50 m. below sea level; the area of the lake which would eventually be formed being some 13,500 square kilometers. The cost is estimated at £110 million. Power output would be 3,00,000 kilowatts, and "it is conceivable that with the creation of a vast salt lake, with fishery prospects, and the possibility of cultivation of thousands of acres around this lake, by means of electric power for lift irrigation from Nile waters, a new and vast area could be added to the cultivable area of Egypt".

A recurring theme throughout the Conference was the growth in the amount of low grade coal now being produced throughout the world. There is evidence that in many countries the coal seams of higher grade have been largely worked out and that from year to year the natural quality of the fuel being produced tends to fall due to the excessive amounts of impurities now being worked and wound with the coal. Moreover, mechanization itself (owing to the inability of machinery to discriminate) contributes to the production of rather inferior coal. Consequently, in many of the papers submitted there was abundant reference to methods of utilization of such fuel and/or to its purification prior to use. In a word, increased attention is being given to more efficient methods of treating and using *low grade coal* in the major coal-producing countries of the world.

The Mechanism of Boiling

R. S. DUBEY
Shri Ram Institute for Industrial Research, Delhi

IT is relatively within recent years that the mechanism of the formation of a bubble has received attention. This is partly because the formation of a bubble is a non-equilibrium process not amenable to thermodynamic treatment. In addition, the general prevalence of extraneous bubble nuclei in aerated liquids and on ordinary surfaces, which promote boiling and effervescence, has made the investigation of the problem difficult.

Nucleate & Film Boiling

When water is heated on a hot surface whose temperature is gradually raised, a stage is reached when "nucleate" or "bubble" boiling sets in. This is followed by " film " boiling. The " boiling curve " (FIG. 1) qualitatively illustrates the changes that occur. The temperature drop, $\triangle t$ (°F.), corresponding to the point of inflexion in the curve for flux, which marks the transition between nucleate and film boiling, is called the critical temperature difference.

The first boiling curve was given by Nukiyama[1]. Farber and Scorah[2], using electrically heated Ni, W and chromel A and C wires, found that different metals give different boiling curves for the same liquid. McAdams *et al.*[3] obtained data on heat flux

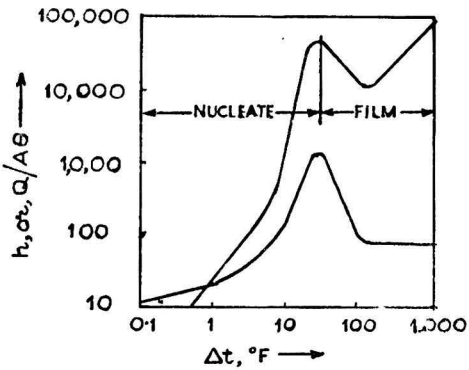


FIG 1 — BOILING CURVE.

in the film boiling range well above the maximum possible in the nucleate range. All the variables influencing the shape and the position of the boiling curve are not known but the character of the heating surface seems to be the most significant factor. The critical temperature difference has been found to be different for each surface-liquid system[4–8]. Between the maximum and the minimum points in the curve for flux, there exists " mixed boiling ", i.e. nucleate boiling on some parts of the surface and film boiling on the rest.

The insulating action of the vapour layer was first described by Leidenfrost[9]. The critical temperature drop for a given surface liquid pair is substantially independent of the boiling temperature and the corresponding flux increases with increase in boiling temperature. However, Mosciki and Broder[10], using an electrically heated wire, found the limiting temperature of the surface to be independent of the main body temperature of the liquid.

Surface Boiling

This term is applied to very high rates of heat transfer observed when sub-cooled liquids are heated by surfaces above the boiling point. This phenomenon was investigated by Knowles[11] a few years ago. McAdams *et al.*[12] made further investigations using degassed distilled water. Photographic observation showed cyclical formation of bubbles on the surface and subsequent condensation at regular intervals. Aeration of water gave higher heat fluxes at a given temperature difference. Kreith and Summerfield[13] determined heat transfer for flow of aniline, n-butyl alcohol and water. Fluxes as high as 16,00,000 B.Th.U./hr./sq. ft. were obtained. These investigators concluded that the addition of a small amount of a volatile component should be helpful in achieving the very high rates characteristic of surface boiling. In these tests, the difference of temperature from the surface to the

bulk of the liquid appeared to be one of the correlating variables. Gunther and Kreith[14] heated stagnant, sub-cooled water using a small, flat, horizontal, electrically heated strip above the boiling point and obtained pictures at the high heat fluxes. The authors concluded that the high heat transfer rates resulted from the disturbance of the surface film by periodic formation and collapse of bubbles.

Mechanism of Nucleate Boiling

Evaporation is a non-equilibrium process since heat and mass are continuously being transferred from the liquid to the vapour phase. Because of surface tension, energy is required for the formation of a liquid-vapour interface as well as for extending the surface so formed.

Larson[15] derived the following expression connecting " Contact Angle " (FIG. 2) with " Work of Adhesion " and " Work of Cohesion ":

$$\cos\theta = \left(\frac{2W_{1s}}{W_1} - 1\right) \quad \ldots\ldots\ldots (1)$$

where

$W_{1s} = \sigma_{1v} + (\sigma_{sv} - \sigma_{1s})$ = Work of Adhesion, and

$W_1 = 2\sigma_{1v}$ = Work of Cohesion,

showing that the contact angle θ depends upon the relative attraction between solid and liquid and between the molecules of the liquid itself. Fig. 3 shows the various shapes of bubbles depending upon the value of θ.

The surface energy requirement accounts for the fact that the vapour pressure inside the bubble is lower than would normally occur for the same temperature and pressure conditions of the environment. Thus

$$p_c = p_s - \frac{2\sigma}{r} \cdot \frac{\rho'}{\rho' - \rho''} \quad \ldots\ldots\ldots (2)$$

where

p_c = saturation pressure at concave surface;

p_s = saturation pressure at plane surface;

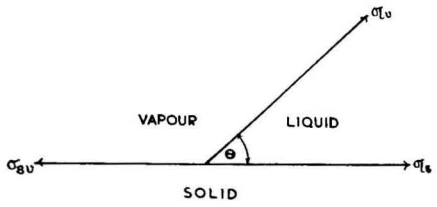


FIG. 2 — CONTACT ANGLE (θ) AND ITS RELATION TO " WORK OF ADHESION " AND " WORK OF COHESION ".

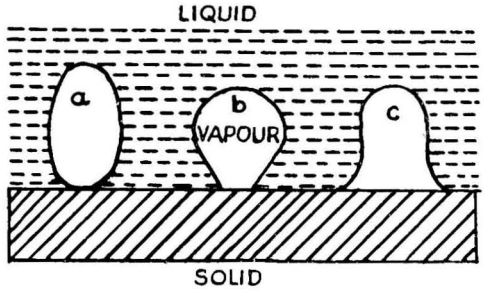


FIG. 3 — EFFECT OF INTERFACIAL TENSION ON THE SHAPE OF BUBBLES OF VAPOUR.

σ = surface tension ;

r = radius of bubble ;

ρ' = density of saturated liquid ; and

ρ'' = density of saturated vapour.

Also, for a bubble, on account of surface tension,

$$p_{in} = p_{ex} + \frac{2\sigma}{r} \quad \ldots\ldots\ldots (3)$$

where

p_{in} and p_{ex} are pressures in the interior and exterior of the bubble.

Both the above relationships require the liquid to be superheated in order that bubble formation may start and develop. The importance of this superheating was first recognized by Bosnjakovic[16]. Since the nucleus bubble is infinitely small, the formation of bubbles according to equations (2) and (3) would require excessive superheating. In fact such superheating has been observed with pure liquids[17,18]. Actually, however, there are often nuclei present, which facilitate the formation of the initial bubble. After " an explosion on a microscopic scale "[19] the bubble comes into existence and superheating provides the motive force to its development.

Jakob[19] and his associates have made a detailed study of the formation, rate of rise, and growth of bubbles, and of the distribution of the temperature above the heating surface up to the steam region. The temperature changes suddenly at the water surface, the mean superheat in water being 0·3° to 0·5°C. In the close proximity of the heating surface, the superheating of water increases greatly up to the temperature of the heating surface, indicating that a thin layer apparently exists not mixed up by convection, similar to the well-known Prandtl

boundary layer. Surface roughness is found to facilitate heat transfer.

Superheating, Supersaturation & the Role of Ebullators in Bubble Formation

The problem of the effervescence of a liquid supersaturated with gas is strictly analogous to that of bubble formation in superheated liquids or liquids under negative pressure. At a given temperature the pressure over a liquid can be reduced so that a tension develops in the liquid[20-24]. To avoid these extreme conditions, various solids called ebullators are generally used for obtaining smooth boiling.

Larson[15] attempted to explain the rôle of ebullators by correlating the adhesion-free energy ($=\sigma_{sv}-\sigma_{ls}$) of various surface liquid combinations with the ease of bubble formation. Attempts at quantitative measurement were unsuccessful. Tomlinson[25] also showed that sharp edges and points do not promote bubble formation as commonly held. Dorsey[26] pointed out that sharp edges and points that were wetted by water could not act as bubble nuclei. Dean[27] and his coworkers confirmed this conclusion whereas Cassel[28] considered surface roughness important.

Larson[15] developed a thermodynamic theory of bubble formation which led to the conclusion that the nucleus of a bubble is of molecular dimension and that surface tension may be a property of the molecule. This is contrary to the accepted theory of capillarity. An attempt was also made to explain the rôle of ebullators with the help of this theory.

According to Doring[29] bubbles survive only above a critical size. Their number varies sharply with temperature. Thus, ether may give 1 bubble/sec. at 142°C., showing that at this temperature the liquid is very unstable. This agrees with the experiments of Wismer *et al.*[18] who found that water saturated with carbon dioxide or oxygen at 14 to 30 atm., when suddenly decompressed to 1 atm., showed no immediate bubble formation, and bubble formation occurred after a few seconds only when the temperature was raised to about 70°C. With nitrogen under more than 100 atm., on decompression, bubbles formed only on the surface. These experiments strongly support the view that only at very high pressures is the spontaneous formation of bubbles possible.

Various attempts have been made to ascertain the maximum temperature to which a pure liquid may be heated without causing it to boil[15,18,30]. Eggleton and Kermack[17] have obtained data on the highest temperature and the corresponding vapour pressure maintained for 5 sec. with a number of liquids before boiling commenced. Meyer[31] found that the breaking tension of ethyl ether was at least 72 atm. Dixon[32] cooled water in a sealed tube but the liquid did not break away from the walls until the pressure inside the tube was −150 atm.

Furth[33] has investigated the empty spaces or "holes" in a liquid and developed a statistical theory according to which a liquid attains a state of complete instability when its temperature is raised. The temperature at which this just happens is taken as the maximum temperature of superheating. Also, the maximum negative pressure required to cause this instability is regarded as a measure of the tensile strength of the liquid. While applying this theory to the phenomenon of the escape of gases from a supersaturated solution, in the form of bubbles, only such cases were considered in which the vapour pressure of the liquid is so low that it can be neglected in comparison with the gas pressure.

Hatcher and Sage[34] showed that turbulence reduced supersaturation in hydrocarbon mixtures and suggested that localized regions of low pressure associated with vortices, which are widespread in turbulent motion, are conducive to the formation of small bubbles. Dean[27] extended the idea further. To explain bubble formation by mechanical shock, turbulent motion and ultrasonic waves, when active nuclei had become inactive, he suggested that free vortex motion is probably always responsible for the bubble formed. This interpretation was supported qualitatively by experiments.

Cassel[28] developed a mathematical theory of bubble formation and considered elements of surface roughness, called " conical dips " and " conical tips ", as conducive to bubble formation.

The author has made some interesting observations[35] on the boiling of liquids at atmospheric and lower pressures, under three different experimental conditions, viz. (1) boiling in a flask, (2) boiling on electrically heated platinum wire and (3) boiling of liquids in parallel flow over heated wires.

Experimental

The apparatus (FIG. 4) employed in (1) and (2) consisted of a test tube, A, about 4½ in. long by ⅝ in. o.d., in which the experimental liquid was heated electrically while surrounded by its own saturated vapours. Two leads fused into the tube carried a coil of 0·004 in. dia. platinum wire. The leads dipped into pools of mercury kept in the curved side-tubes of the neck of a 250 c.c. round-bottom flask to which a cap with a ground-glass joint and a side-tube were fitted. A thick wrought iron lead, passing through a rubber bung fitted to each of the side-tubes, and dipping into the pool of mercury, allowed external electrical connections to be made. The cap was connected to a condenser and receiver. The pressure in the system was maintained by means of a vacuum pump connected to it through pressure regulating devices. The pressure was primarily controlled by manipulating a hand-operated valve and noting the level of mercury in the manometer. For a more accurate control, an automatic electrical device described by Cryder and Finalborgo[36] was used (FIG. 5). The apparatus, made of glass with mercury in the U-bend, had two platinum leads fused into it. Its performance depends upon the response of the air enclosed in one of the limbs which was segregated from the rest of the system by means of a stop-cock, after the desired pressure had been established in the system by controlling the hand valve. Fall or rise of pressure in the system made or broke the electrical circuit, thus admitting air through the nozzle or closing the latter to the atmosphere. A large aspirator included in the assembly served as a balancing unit. The experimental liquid was also taken in the flask.

To obtain the desired pressure in the system, the vacuum pump is started and the stop-cock of the automatic control is opened to let the air in the two limbs communicate with each other. The hand-operated valve is then carefully manipulated so that the desired pressure is established. The stop-cock is then closed, after which the pressure is automatically maintained and there is no perceptible fluctuation in the level of mercury in the manometer, suggesting that the variation in pressure is less than $\pm 0{\cdot}1$ mm. of mercury.

A suitable amount of liquid was taken both in the test-tube and the flask, together

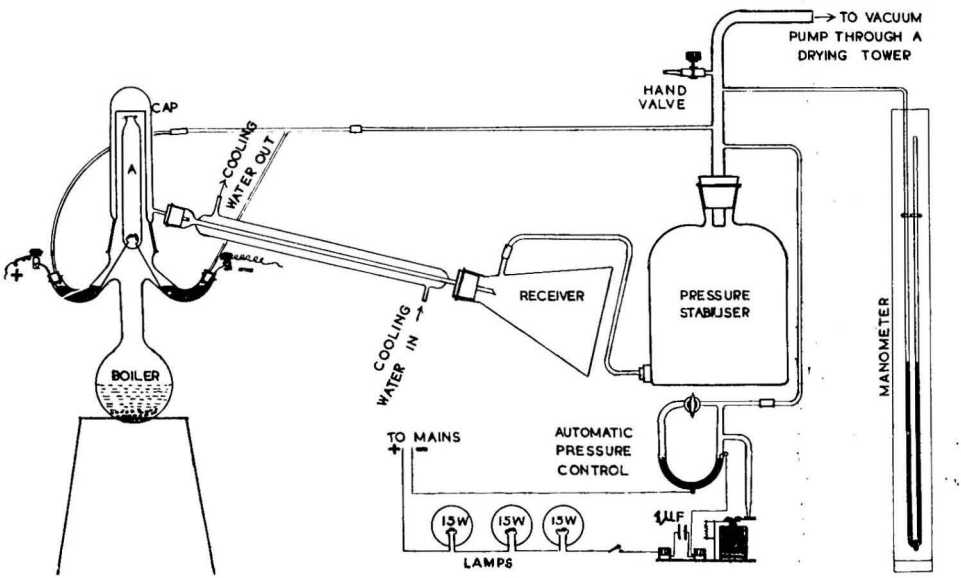


FIG. 4 — APPARATUS FOR THE STUDY OF BOILING : (1) IN A FLASK AND (2) OVER ELECTRICALLY HEATED PLATINUM WIRE.

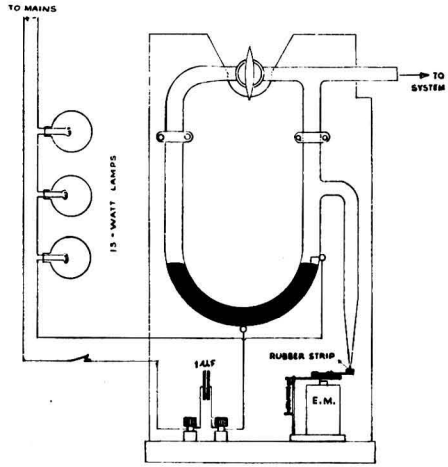


FIG. 5 — AUTOMATIC PRESSURE CONTROL DEVICE.

with the ebullator under test, the apparatus assembled and the desired pressure established. The flask was carefully heated to make the liquid boil. When the liquid in the tube A had been heated in the vapour for 15 to 20 min., the current was switched on to obtain boiling in the tube.

Boiling in the Flask

It was found that at atmospheric pressures any of the ebullators like porous porcelain, glass-wool and glass-beads was satisfactory for carrying on continued boiling over considerable periods but at lower pressures difficulty was encountered. The ebullator was found to lose its effectiveness quite quickly. When a fresh charge of ebullator was used, it initiated bubble formation without much difficulty, even at low pressures. If the liquid was now allowed to cool without disturbing the pressure and then reheated, serious bumping occurred. After a long series of trials it was found that a thick bed of glass-beads, amounting in depth to about half the radius of the flask, could be used with success for steady boiling with the following precautions :

(a) The liquid is heated slowly and cautiously and when it is about to boil a little stronger heat is applied to a spot near the edge of the glass-bead bed when bubble formation usually commences and easily spreads to the rest of the liquid.

(b) A low flame, with several thicknesses of asbestos paper between the flask and the wire-gauze, is used to heat the entire bottom of the flask. This was more satisfactory than a liquid bath.

Boiling over Electrically Heated Platinum Wire

When the test-tube was well heated and the vapours from the boiling flask began to distil over, current was switched on through the coil. For the experiment to be successful, boiling should commence immediately after switching on the current, continue boiling so long as the current is passing and should stop as soon as it is switched off.

The fresh wire gave smooth boiling for a few minutes only. When the wire had itself become inactive, various aids like small glass-beads, fine particles of porous porcelain and glass-wool proved ineffective. This suggested that it was the condition of the wire surface itself that mattered. Its surface was, therefore, coated with finely divided platinum by soaking it in a concentrated solution of platinic chloride and passing enough current to make it glow. This was repeated several times to get a good deposit. This proved quite satisfactory over considerable periods after which it had to be renewed.

Thus, boiling seems to depend upon the presence of agents which aid bubble formation either by supplying nuclei in the form of adsorbed gases or vapours in their surfaces, or by modifying conditions adjacent to the surface. In these experiments, the bubble nucleus in the ebullators quickly became inactive in vacuum due most probably to dislodgment of adsorbed gases and vapours. However, although a thick bed of glass-beads gave smooth boiling in the flask once bubble formation had been induced, it could not prevent excessive superheating in the test-tube. With glass-beads in the flask, it was seen that bubbles originating from the bottom left a trail behind them ; this trail served as nucleus for further bubble formation. The small cavities formed by the beads seemed to create a suitable condition by modifying convection as well as the manner of escape of bubbles. The fine coating on the platinum wire gave good results probably by supplying minute cavities which also acted in a manner similar to the above. It seems reasonable to suppose, therefore, that to be effective the cavities must have a curvature comparable with that of the heating surface itself.

From the above it is evident that a foreign gas in the liquid, whether in solution or adsorbed on the solid surfaces present in it, gives bubbles much more easily than the liquid vapour itself. The origin of a bubble of vapour in a saturated or superheated liquid and that of a bubble of a foreign gas inside the liquid are subject to the same laws of pressure relationships. Because of its natural attraction for its own vapour, the liquid would be reluctant to release a bubble of vapour, whereas, if it is assumed that the pressure of the foreign gas increases enormously as the temperature of the liquid is raised, the relatively easy formation of the bubble of the foreign gas inside the liquid could be explained.

The rough surface of the platinum wire might also be acting by providing conical " dips " and conical " tips " as postulated by Cassel[28]. On the basis of his thermodynamic theory of bubble formation, Larson[15] concluded that surface roughness or curvature of molecular or unit crystal magnitude helps in the formation of the nucleus bubble. From Cassel's theory also it could be deduced that the critical size of the nucleus bubble of small diameter could be obtained without excessive superheating only if the contact angle were large and the conical " dip " or the conical " tip " were minute in size, comparable with that of the nucleus bubble. Both these theories lead to the conclusion that, for bubble formation without excessive superheating, the elements of surface roughness must be small in magnitude. The finely divided platinum easily fulfils this condition. This also lends support to the observations of Sauer *et al.*[8] who found that a thin film on copper gave a better heat flux than a clean surface.

The bubbles formed in the flask were much larger than those formed in the test-tube over the coated platinum wire. In the case of simple boiling of water in a beaker, it is usually seen that large steam bubbles leave the surface. This would suggest that the size of the initial bubble largely depends upon the curvature of the surface on which the bubble originates. A smooth surface with a small curvature gives large bubbles. That a rough surface gives smaller bubbles was also noted by Jakob[19]. From the point of view of heat transfer, therefore, a rough surface is preferable. The formation of smaller bubbles leaves a larger portion of the heat transfer surface to be wetted by the liquid which quickly regains its superheated state.

Boiling of Liquids in Parallel Flow over Heated Horizontal Wires

Available literature on the subject shows that boiling on a wire surface is confined to stagnant pools of liquids. It was, therefore, decided to study boiling of liquids on horizontal wires with the liquid under forced circulation parallel to the wire. Platinum wires of 0·02 in., 0·01 in. and 0·005 in. dia. were used with water and 95·6 per cent (by weight) ethyl alcohol. The liquids were circulated at three different velocities, viz. 1, 2 and 3 ft./sec. Test sections ranged from 6·75 in. to 6·84 in. in length.

Apparatus — The platinum wires were used both as the heat transfer surfaces and as platinum resistance thermometers. The apparatus consisted of two main parts : (1) the electrical system and (2) the circulating system.

The electrical system consisted of arrangements for obtaining regulated current through the experimental wire from a bank of accumulators and for measuring the current strength and potential drop across the test section of the wire. The circuit diagram is shown in Fig. 6. Current drawn from the accumulators was regulated by a variable resistance. Its magnitude was determined by measuring the voltage drop across a semi-standard resistance made from 10 S.W.G., low-temperature-coefficient-of-resistance " Ferry " wire and calibrated against a precision resistor using a Vernier potentiometer, type 4363, supplied by *Messrs Tinsley & Co.*, London, S.E. 25. Potential drops across the semi-standard and across the

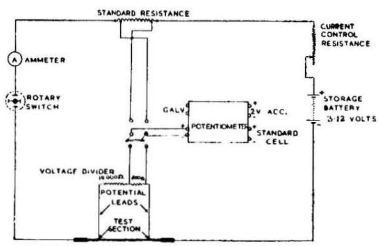


FIG. 6 — ELECTRICAL CONNECTIONS EMPLOYED IN THE STUDY OF BOILING OF LIQUIDS OVER HEATED HORIZONTAL WIRES.

test section in the actual experiments were measured with a potentiometer capable of measuring 0·01 mv. at 1 mv. The potentiometer was used in conjunction with a mirror galvanometer. Voltages were measured either directly or through a *voltage divider* depending upon their magnitude, the potentiometer being capable of measuring 1·91 volts directly.

The circulating system (FIG. 7) was assembled from a copper vessel of about 2·3 gal. capacity with a reflux condenser, a centrifugal pump, ½ in. i.d. copper tubes, an orifice flowmeter and four valves for controlling the flow. The copper vessel was seated on an electric heater inside a steel cylinder and the whole system was insulated against heat loss.

A glass U-tube, ½ in. i.d., with side-tubes, held the experimental wire (FIG. 8) and was included in the circulating system by means of short rubber tube connections. The platinum wires were C grade supplied by *Messrs Johnson Matthey*, London. Their temperature coefficient of resistance was quoted as 0·0035. The method of fixing the wire to its copper leads and mounting it in the glass tube is shown in Fig. 8. The potential leads were hammer-welded to the element at about 1½ in. from the inner end of the brass screw holding the element. The element was annealed at red-heat in air by passing sufficient current. For 0·02 in. and 0·01 in. dia. wires, 0·004 in. dia. wire was used as potential lead. For the 0·005 in. dia. wire the potential lead was only 0·002 in. in dia. The wire was mounted inside the glass tube by sealing its copper leads to the side-tubes with cold-setting " Marco " Resin No. 65C (supplied by *Messrs Scott Bader & Co. Ltd.*). The potential leads were taken out through side-tubes which were then sealed.

Experimental — The flowmeter was first calibrated for water and ethyl alcohol. The wire was next calibrated for its resistance at 0°C. and at 100°C. by passing a nominal current through it and measuring the voltage drop across the semi-standard and across the potential leads of the wire. The 0·005 in. dia. wire was calibrated at the temperature of boiling ethyl alcohol instead of at 100°C. This wire was not used with water.

The glass tube was mounted on the circulating system, the circulating pump started and the liquid made to boil at a steady, moderate rate. The valves were adjusted to give the desired rate of flow. For measurements in the nucleate boiling region, a small

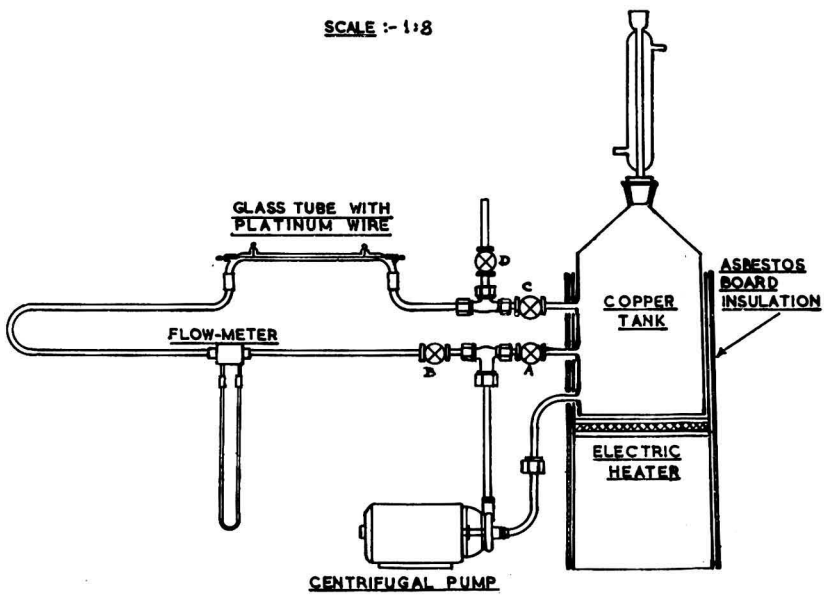


FIG. 7 — APPARATUS FOR CIRCULATING BOILING LIQUIDS OVER HEATED WIRE.

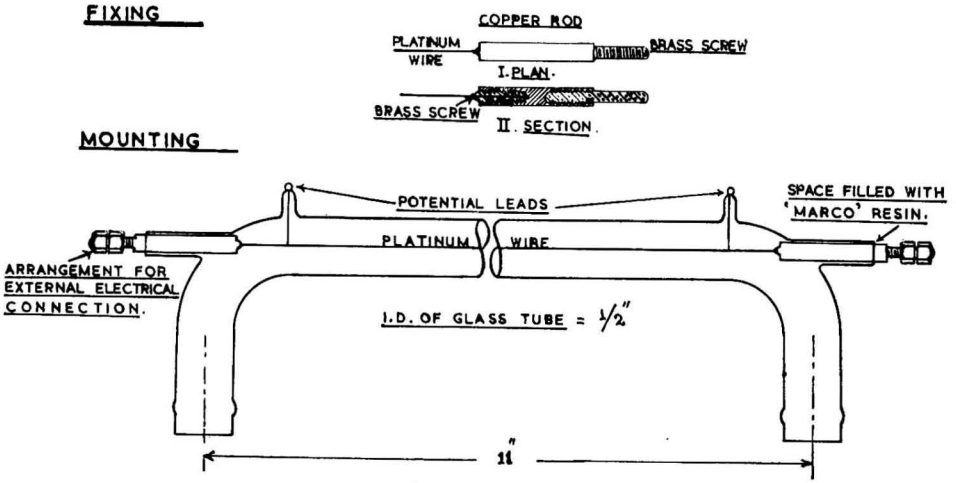


FIG. 8 — FIXING AND MOUNTING OF PLATINUM WIRE.

D.C. was now passed through the wire and potential drops were measured across the semi-standard and across the potential leads. The current was then increased by small steps to a predetermined maximum and then decreased and a series of current and voltage readings was recorded. With each liquid-wire system determinations were made at three different liquid velocities of 1, 2 and 3 ft./sec. respectively.

Some data were also obtained in the film-boiling region. To induce film boiling on the whole wire without causing it to burn out, the following procedure was adopted. To begin with, nucleate boiling was induced. The current was increased to a high value, the boiling still being of the nucleate type. Without making any further alterations, the current was momentarily switched off. On switching the current on again, film boiling set in over most of the wire and quickly spread over the rest of it. Measurements of potential drops were done in the usual way. The current was lowered in steps and readings taken at each step. When the current strength became small, boiling suddenly reverted to the nucleate type without requiring any special manipulation. The measurements were confined to the 0·01 in. dia. wire with ethyl alcohol at 2 ft./sec. and 3 ft./sec. liquid velocities respectively.

Calculations—These were made as follows:

(1) Heat load per hour, $q = 3{\cdot}415\ EI$, and

(2) area of wire, $A = \pi\ DL$

where

E = voltage drop, volts;
I = current, amperes;
D = diameter, feet; and
L = length, feet.

(3) Resistance of the wire at temperature, t,

$$R_t = \frac{E}{I}$$

(4) Wire temperatures were computed from the following relation:

$$t_p = \frac{R_t - R_o}{R_{100} - R_o} \times 100$$

For the 0·005 in. dia. wire calibrated at 78·6°C., for instance, the following relation was used:

$$t_p = \frac{R_t - R_o}{R_{78{\cdot}6} - R_o} \times 78{\cdot}6$$

For the 0·02 in. dia. wire a radial correction was applied; the surface temperature of the wire was obtained from the following relation:

$$t_s = t_p - \frac{(q/A)\ D}{8k}$$

which may be obtained by assuming uniform generation of electric heat in the platinum and constant thermal conductivity. This radial correction amounted to only a few tenths of a per cent in the case of water with the two thinner wires and in the case of all

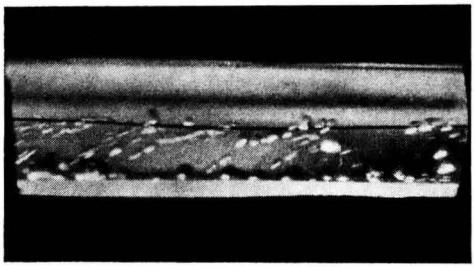


FIG. 9 — BOILING OF ETHYL ALCOHOL OVER 0·01 IN. DIA. WIRE AT A LIQUID VELOCITY OF 1 FT./SEC. UNDER A FLUX OF 15,000 B.TH.U./HR./SQ. FT.

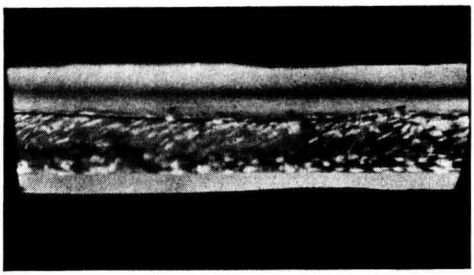


FIG. 10 — BOILING OF ETHYL ALCOHOL OVER 0·01 IN. DIA. WIRE AT A LIQUID VELOCITY OF 1 FT./SEC. UNDER A FLUX OF 38,000 B.TH.U./HR./SQ. FT.

the wires with ethyl alcohol ; as temperature measurements were not very precise, this correction was not applied in these cases.

Accuracy of Measurement — Since the flowmeter was calibrated with cold liquids, this calibration would not hold closely for the boiling liquids. A further complication was introduced by the fact that the pump tended to suck a mixture of liquid and vapour from the copper vessel and compress it into the tubes. Since the composition of this mixture varied from moment to moment, a pulsating flow was obtained as indicated by the mercury manometer. This caused a consequent unsteady temperature of the platinum wire. This was reflected in the spot of light of the galvanometer, which was seldom steady. It was, therefore, very difficult to get precise balance of the potentiometer. An error of the order of ± 20 per cent at low values of flux is possible. At the highest values of flux, this error may still be of the order of ± 10 per cent.

Observations — When the current was increased from a very small value upwards, boiling did not set in until a certain minimum flux was reached. This minimum increased with a decrease in the diameter of the wire. It also increased with increasing liquid velocity, although the difference between the two values for the two higher velocities was not considerable. Water, for the same wire and liquid velocity, began boiling under a much higher flux than ethyl alcohol. These minimum values of the flux at which boiling just commenced were found to be of the same order of magnitude for water as obtained by McAdams *et al.*[3]. At the start of boiling only two or three nuclei used to be active ; but their number quickly increased with rising flux and covered the whole wire.

With ethyl alcohol another interesting observation was made. When the flux was gradually increased, boiling did not set in until the value of the former became fairly high. Vigorous boiling would then suddenly set in over the whole wire. When the flux was increased further (for measurements in the nucleate region) and then gradually decreased, the boiling did not cease at that

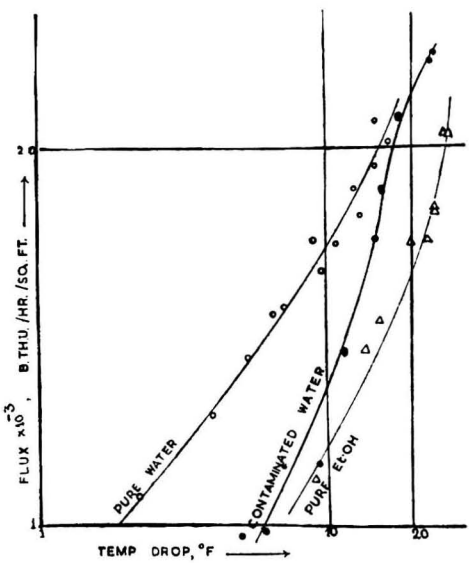


FIG. 11 — FLUX VS. TEMPERATURE DROP ; EFFECT OF CONTAMINATION AND NATURE OF LIQUID : WIRE DIA., 0·02 IN. ; VELOCITY, 1 FT./SEC.

value of flux where it had commenced. It continued down to a flux value much lower than the previous one. This would suggest a marked tendency of ethyl alcohol for superheating. With water it was found that boiling commenced and ceased at practically the same value of flux. The tendency of alcohol for superheating was greater with wires of smaller diameter.

The boiling of ethyl alcohol over 0·01 in. dia. wire at a liquid velocity of 1 ft./sec. under fluxes of 15,000 B.Th.U./hr./sq. ft. and 38,000 B.Th.U./hr./sq. ft. is shown in Figs. 9 and 10 respectively.

Results — The following notation is employed for the series of tests conducted and the results are graphically presented in Figs. 11 to 14.

Nos. 1, 2 and 3 refer to the liquid velocities of 1, 2 and 3 ft./sec. respectively.
A = 0·02 in. dia. wire ;
B = 0·01 in. dia. wire ;
C = 0·005 in. dia. wire ; and
E = ethyl alcohol ;

where A, B and C, unaccompanied with E, refer to tests with water. Numerical suffixes, 1, 2, etc., refer to repeat tests with the same liquid-wire pair at the same liquid velocity.

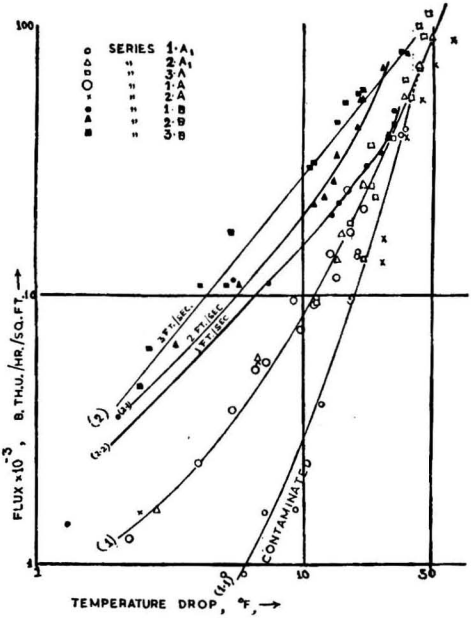


FIG. 13—FLUX VS. TEMPERATURE DROP FOR WATER; (1) AND (1·1), 0·02 IN. DIA. WIRE EMPLOYED ; (2), (2·1) AND (2.2), 0·01 IN. DIA. WIRE EMPLOYED.

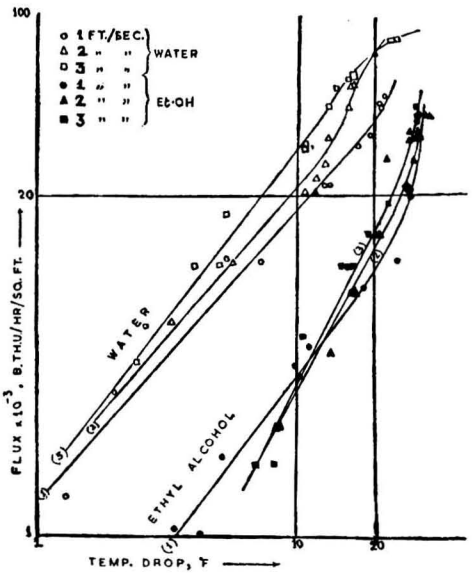


FIG. 12 — EFFECT OF THE VELOCITY OF LIQUIDS ON BOILING ; 0·01 IN. DIA. WIRE EMPLOYED.

Thus, series "1-AE$_1$" means that the tests on ethyl alcohol with 0·02 in. wire at a liquid velocity of 1 ft./sec. have been repeated once.

Discussion

The effect of the various variables on the relationship between heat-flux and temperature drop for 0·02 in. wire for 1 ft./sec. velocity for the two liquids is shown in Fig. 11.

For water, results obtained in two different series were used and the points were found to lie on two different curves. It is very probable that the wire which had been lying aside for some time before the repeat test was made became contaminated somehow and, consequently, gave less flux for the same temperature drop. This result agrees qualitatively with the observations of McAdams *et al.*[3] who found that contamination of the wire surface shifted the curve to the right.

The curve for ethyl alcohol with clean wire is still more to the right than the curve for the contaminated wire with water, showing that under similar conditions water gives a much higher flux than ethyl alcohol.

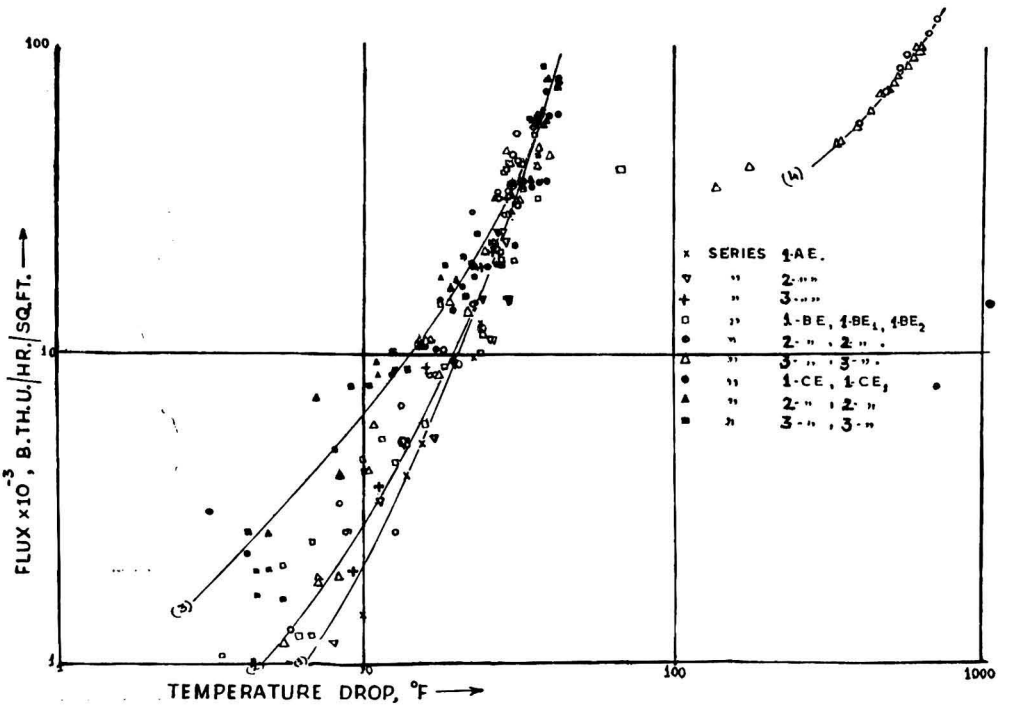


FIG. 14 — FLUX VS. TEMPERATURE DROP FOR ETHYL ALCOHOL; (1) 0·02 IN. DIA. WIRE; (2) AND (4), 0·01 IN. DIA. WIRE; (3), 0·005" DIA. WIRE.

With any given liquid-wire system, velocity of the liquid parallel to the wire does not seem to have had any considerable effect on the relative positions of the curves for the same liquid (FIG. 12 for 0·01 in. dia. wire). For water with the 0·01 in. wire, the curves for the higher velocities have a tendency to be shifted to the left, whereas for ethyl alcohol the effect of velocity, for this same wire, is not appreciable. At low and high values of temperature drop, the curves for each liquid have a tendency to merge into one another regardless of velocity. Thus for water, the curves appear to merge into one for temperature drop below 5°F. and above 25°F. For ethyl alcohol these limits appear to be 15°F. and 25°F. respectively.

The results for water and ethyl alcohol, given in Figs. 13 and 14 respectively, show that up to a temperature drop of about 25°F. the curve corresponding to a smaller diameter of wire is situated more to the left. Above this value of temperature drop, however, all the curves for a particular liquid approach one another, regardless of liquid velocity and wire diameter. In nucleate boiling range, this merging of the curves for the different wires is very distinct in the case of ethyl alcohol. Thus, so far as the effect of wire diameter is concerned, the author's findings agree with those of McAdams *et al.*[3].

In the range of film boiling, the points for two different velocities for the same liquid-wire pair lie closely on the same curve. Three points for ethyl alcohol lie between the curves for true film boiling and nucleate boiling. Their irregular disposition may be due to errors in measurement which were unavoidable considering the irregular boiling that characterizes this region.

The nature of the curve in the range of film boiling and for high values of temperature drop in the range of nucleate boiling is the same as generally accepted. However, at low values of temperature drop, well within

the nucleate range, the curves are somewhat more to the left than those obtained by McAdams *et al.*[3]. These authors found that the flux in this region was of the same order as that for simple heating of fluids by natural convection. Obviously, the forced circulation of the liquid in the present investigations markedly raised the flux in this region. In agreement with the observations of these authors, the wire diameter seems to have considerable effect on flux for values of temperature drop below about 25°F., the flux rising with decreasing wire diameter. For the same wire, the curves for water are situated higher than those for ethyl alcohol.

The superheating observed here corresponds to the superheating of liquids in a vertical tube evaporator. With the liquid moving at a fast rate, the friction head seems to prevent it from boiling below a certain minimum flux (corresponding to which, therefore, there is a minimum temperature drop). McAdams *et al.*[3] observed that at low values of temperature drop, bubbles formed only on the surface of the pool of water and not on the wire. In the present case this action might have been augmented by the effect of friction head with the result that the minimum values of temperature drop for the formation of visible bubbles on the surface of the wire ranged from 10°F. to 25°F., depending upon the nature of the liquid, its velocity and the diameter of the wire.

Summary

1. Boiling seems to depend upon the presence of ebullators which aid smooth bubble formation either by virtue of gases and vapours adsorbed by them or by creating cavities on the hot surface and thus modifying convection to give local superheating in the immediate neighbourhood of the latter.

2. In the case of liquids boiling over heated horizontal wires and moving parallel to them, end effects can be avoided by having potential leads about 1·5 in. from each end of the exposed portion of the experimental wire.

The form of the boiling curve obtained is the same as generally accepted for stagnant pools of boiling liquids. The curve is, however, placed higher in the natural convection and lower nucleate boiling regions.

3. Boiling curves for water are placed higher than those for ethyl alcohol, and those for thinner wires are placed higher than the curves for the thicker ones, for temperature drops up to about 25°F.

4. Wire contamination shifts the boiling curve to the right.

5. Above a temperature drop of about 25°F., velocity of liquid and wire diameter do not have much effect on the position of the curve.

6. Minimum values of temperature drop for visible bubble formation range between 10°F. and 25°F.

Acknowledgements

The investigations reported by the author were carried out in the Technical Chemistry Department of the Royal Technical College, Glasgow, under the guidance of Dr. F. Rumford.

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Technical Assistance to Industry

THE COUNCIL OF SCIENTIFIC & INDUSTRIAL Research has for sometime past had under consideration the question of technical assistance to industry. The following are the broad outlines of policy decided upon :

(1) The National Laboratories would not, as a matter of policy, undertake routine testing for which facilities exist in the Government Test House, Alipore, and other similar institutions, except when such routine testing forms a part of any survey or investigation being conducted in the laboratories and for testing in connection with issue of certificates of standardization. Special tests for which facilities at the existing institutions are not available may be undertaken by national laboratories provided they do not interfere with their normal work. The certificate for tests will clearly state that it relates only to the sample submitted and examined.

(2) For off-hand technical advice to industry, where no investigations need be undertaken and no written report is necessary, no fees would ordinarily be charged. Industry would, however, be required to pay the travelling expenses of the officers concerned.

(3) Fees would be charged for technical advice to industry involving minor investigations and submission of a written report, the quantum of such fees being determined by the Directors of laboratories concerned and, if necessary, after consulting the Director, Scientific & Industrial Research. In addition to these fees, travelling expenses incurred by officers would be charged to the industrial organization concerned.

(4) In the case of major problems involving regular investigations, a scheme of research would be drawn up by the Director of the laboratory concerned in consultation with the Director, Scientific & Industrial Research, and suitable provision made therein for sharing of any royalties arising out of patents, etc., which may be taken out as a result of these investigations. Any staff appointed under such schemes will be purely temporary and the salary for the same, as well as incidental charges for chemicals, apparatus, gas, water, etc., will have to be borne by industry.

REVIEWS

Seventy-five Years of Progress in Mineral Industry, Edited by A. B. Parsons (American Institute of Mining & Metallurgical Engineers), 1947, pp. 811.

THE SPECTACULAR PROGRESS IN AMERICAN mineral industry during the last 75 years is reviewed in a recent publication by the American Institute of Mining & Metallurgical Engineers. The compendium is divided into three parts, the first part dealing with the progress in mineral industry, the second section giving a brief history and evolution of the above Institute, and the third division presenting the proceedings of the Seventy-fifth Anniversary Celebration and World Conference on the Conservation of the Potential Mineral Resources. A galaxy of authorities in their respective fields of study like L. C. Graton, L. Eton, F. Taggart, F. Laist, C. D. King, Oliver Bowels, Sir Williams Fraser, Augustus Carlow, L. C. Cates and a host of others have treated a variety of subjects such as mining geology, metal mining, leaching and smelting of ores, ore dressing, non-ferrous metallurgy, ferrous metallurgy, fuels and conservation of mineral resources in an admirably interesting and instructive manner.

In mining geology, L. C. Graton, explaining the origin of metalliferous ores, expounds the intimate relationship existing between geology and mining and traces how the various reputed mining companies in U.S.A. effected a perfect co-operation and co-ordination between the two branches by appointing consulting geologists or instituting a separate department of mining geology to investigate the structural, stratigraphical and theoretical aspects of ore deposition, thereby eliminating guessing in mining enterprise involving substantial private or state funds. Realizing the importance of economic geology to mining, educational institutions have turned their researches towards the investigation of the governing principles of mineral deposition and conditions of ore formation in the various mining districts which furnished them with ample knowledge in the physico-chemical principles of mineral formation in economically profitable quantities. This co-operation between academies and industrial concerns paved the path to boom up to the peak figure the production of all strategic minerals to the tune of 9,000 million tons during the period of Second World War.

Metal mining has also shown a great progress over the earlier defective methods. Writing back from the early times, Lucien Eton has presented the development of accurate surveying and mapping of mine workings, the timely and rational use of explosives to prevent fatal injuries, the various mining methods in vogue, haulage, drainage, stoping, tunnelling, drilling, timbering, ventilation, transportation, etc., and is hopeful of further improvements in the methods and techniques of metal mining with the progress in the dissemination and application of the knowledge of principles of engineering. F. Taggart, on the other hand, entertains the reader with a wealth of information on the antique and recent processes of ore dressing under separate sub-titles, each section treating all the information in an interesting manner. Notable advances over the earlier processes of ore dressing such as milling, comminution, crushing, micronizing, and other related topics are given in a simple and intelligible way so as to enable the reader to understand every step of the process utilized for the beneficiation of the ores. A marked advance in this technique is the development of flotation process during the years between 1916-1926 (in which Prof. Taggart himself played an important part) from which time flotation machines have been built to serve in practically any set of operating conditions with diverse varieties of flotation reagents. Almost all the ores at the present time are subjected to conventional flotation procedure so as to reduce waste to a practicable minimum. Similarly, in the field of gravity concentration, the most revolutionary development since the invention of the shaking table and the application of sink float is the Humphrey's

spiral which is also finding a place in coal washing and which may ultimately replace tables in gravity concentration.

In the field of non-ferrous metallurgy, the leaching, smelting and purification of copper, zinc, gold, aluminium and magnesium merit special study. Starting with the recovery of copper, notably those which are low in impurities from the Lake Superior deposits and containing 3 per cent copper, the magnitude of the operations for the recovery of copper increased enormously since the beginning of the twentieth century as a result of the advances made in the operational techniques to cope with the discovery of new profitable geological horizons bearing copper in other regions. With the rate of increase of consumption of non-ferrous metals and their alloys, new techniques and designs have been evolved to increase the load capacity of the furnaces, converters and electrolytic baths to refine them to the desired purity. Besides, metals which were unknown or difficult to extract from their ores or are considered as museum curiosities have become of daily use, purchasable at cheaper prices than were prevailing seventy-five years ago. Ferrous metallurgy does not lag behind the non-ferrous metallurgy. This is amply illustrated by the fact that the production of steel ingots grew rapidly from less than half a million tons in 1870 to 90 million tons in 1946 of which 80 million tons are produced annually in open-hearth furnaces. Text figures depicting the improvements in the designs of blast furnaces, reverberatory furnaces and open-hearth furnaces portray clearly the achievements of the iron and steel industry.

Keeping pace with the ferrous and non-ferrous metallurgy are the researches in fuel technology — coal and petroleum. The replacement of wood charcoal and anthracitic coal in ferrous metallurgy by coke and bituminous coals increased the meagre mining of less than 50 million tons in 1870 to more than 600 million tons annually. The need for high-energy fuel for automobile and aircraft navigation during wars necessitated the investigation, development and application of the technique of thermal conversion to purify the crude oil so as to minimize waste and derive maximum energy and a host of ancillary petroleum products. The production of crude oil rose steadily from 50 million barrels to more than 1,700 million barrels annually after the Second World War and still the market for petroleum and its products is expanding.

In the field of production of non-metallic minerals such as building materials, ceramic materials, glass-making minerals, abrasives, raw materials for chemical industries, the value of minerals mined rose from 56 million dollars to more than 1,000 million dollars. With the rapid advances in construction and structural engineering, the demand for cement and its subsidiary products finds an important place in the world markets. Similarly, the shifting of fertilizers from organic to inorganic, the source of potash from sylvite instead of wood ashes, and the recovery of phosphate from phosphate rocks have enlarged the industrial potential of U.S.A. to such an extent as to have a virtual monopoly and domination in the non-metallic mineral products.

The grave situation developing as a consequence of the rapid depletion of the irreplaceable mineral resources of the world in general, and U.S.A. in particular, necessitated the holding of a conference to discuss the problem of conservation of the natural resources and to reduce and/or completely avoid waste in the mining operations. The chapters on the international atomic control and the rôle of engineer and technologist in atomic energy are interesting as they furnish a fine example of co-ordination in scientific work in the development of atomic energy.

The volume abounds in factual data and the material presented by the authors is exceptionally good as it brings to light the present-day position and progress in the diverse fields of mineral industry, and the importance of co-ordination in research and technology for the economic development of the country is emphasized throughout. The account is stimulating to the industrialists, to the teacher and to the research worker alike.

E. VENKAYYA

Electronic Valves, Book II & III — Data & Circuits of Receiver & Amplifier Valves (N. V. Philips Gloeilampenfabricken, Eindhoven, Netherlands), pp. 427 (with 532 illustrations) and 220 (with 267 illustrations) respectively, 1949.

THESE TWO BOOKS ARE DEVOTED ENTIRELY to giving comprehensive descriptions of a

large number of receiving and amplifying valves as well as full technical data and characteristics of nearly all such valves manufactured by Philips. Details are also furnished on current and voltage regulators, stabilizers, cathode-ray tubes, photocells, etc. Representative circuits of A.C., A.C./D.C. and battery receivers are given as also of gramophone amplifiers. Descriptions of various test gear of Philips design add to the usefulness of these volumes.

Book II includes all the valves and circuits developed by Philips during 1933-39 while Book III covers the period 1940-41.

Those using equipment manufactured by Philips will find these books useful.

N. B. BHATT

Practical Applications of Spectrum Analysis, by Herbert Dingle (Chapman & Hall Ltd., London), 1950, pp. ix + 245. Price 40*s.* net.

THIS BOOK HAS BEEN WRITTEN BY AN AUTHOR who has been a close associate of the late Professor A. Fowler at the Imperial College, London, during the years when the foundations of science of line spectra were being laid. In this period, various avenues of applying this branch of spectroscopy to problems of analysis were being explored and the present book forms a record of the author's experiences. It is primarily addressed to readers who would like to possess working knowledge of spectroscopy from the point of view of its applications to analysis.

In order to make the book understandable even to persons not familiar with spectroscopy, an introductory chapter, " General Principles ", discussing Bohr's theory, etc., is included. This is followed by a description of " Sources of Luminosity " which deals with the usual methods of exciting spectra. In the succeeding two chapters the principles of taking spectra with prism and grating spectrographs are discussed somewhat in detail.

The above four chapters cover 65 pages, which is nearly half the book. The most instructive chapter is on " Qualitative Spectrum Analysis ", pages 74-122, which describes fairly fully the peculiar problems which arise in identifying individual metallic elements, including the rare earths. There is then, only a brief reference to " Quantitative Spectrum Analysis ".

The utility of the book is considerably enhanced by eight tables in the appendix which include wavelengths of iron arc lines, raies ultimes and identification lines on plates I-XIX.

W.M.V.

Vegetable Crops, by Homer C. Thompson (McGraw-Hill Book Co. Inc., New York), Fourth Edition, 1949, pp. 611. Price $ 6.00.

THIS WELL-KNOWN BOOK WAS FIRST PUBlished nearly 3 decades ago to serve as a guide to the principles and practice of vegetable culture and marketing, particularly to students of horticulture in the U.S.A. That the book has served its purpose successfully and has enjoyed sufficient popularity with its users is illustrated by the fact that it had already undergone three editions and is now appearing as a fourth edition, in a new and revised form. The last edition was published nearly 10 years back and the opportunity has been well taken to bring the matter fully up to date. As in previous editions the earlier chapters of the book deal with the general outline of the principles and methods of vegetable culture ; classification and preparation of soils ; use of manures, fertilizers and irrigation ; control of weeds, pests and diseases ; and problems of storage and marketing, all in a remarkably comprehensive manner. The later chapters of the book, which form the bulk, is devoted to a systematic treatment of the history and taxonomy, culture and harvest, storage and marketing of each one of the leading vegetable crops in the U.S.A. The crops are classified under 12 groups based mainly on their methods of culture, viz. as perennial crops, pot herbs or greens, salad crops, cole crops, root crops, bulbs, potato, sweet potato, beans and peas, solanaceous fruits, cucurbits and miscellaneous crops.

In this edition, the general arrangement of the subject-matter remains practically unaltered, although considerable portions of the book have been revised and in many places rewritten to include all the results of recent researches in the U.S.A. Chief among the new inclusions are : statistics regarding *per capita* consumption of vegetables in the U.S.A. ; recent advances in the knowledge of nutritional value of vege-

tables; importance of minor and major elements in plant nutrition; weed control by the use of chemicals; control of pests and diseases by new types of insecticides and fungicides and their application by aeroplanes; and advances made in handling and packing of vegetables, particularly the use of transparent films in consumer packaging. Mention is also made of the marked development of roadside marketing of produce, coinciding with the great expansion of travel by automobile. In the chapters dealing with individual crops, many of the topics have been completely revised and in some places new ones added in order to include all the recent advances in the knowledge of the respective crops. The list of literature cited has also been enlarged and includes references right up to 1948.

The book is primarily intended for students of horticulture in American universities and its outlook, scope and application are, therefore, purely American. Further, it deals mostly with temperate vegetable crops and does not include even such tropical crops like taros and dasheens (*Colocasia esculenta*), yams (*Dioscorea* spp.), cassava (*Manihot utilissima*), etc., even though they have been long introduced in America and grown to a certain extent in the southern States of the U.S.A. Unfortunately even the literature cited, though extensive, is confined mostly to American publications and hardly any work outside U.S.A. finds mention, with the result that the usefulness of the book outside U.S.A. is somewhat restricted. But, in spite of these limitations, the book is valuable, as it contains a mine of information regarding the underlying principles of vegetable culture, marketing and storage which do not materially differ from what is current in most countries, including India. To Indian students it is particularly useful, since it gives a lucid and comprehensive account of what results can be expected by an application of scientific methods to vegetable culture and marketing. It is needless to state that vegetable culture in our country is still primitive and far from scientific and even so our methods of marketing and transport. In recent years our acreage under vegetable crops is reported to have progressively declined and with the increase of population our present output is hardly sufficient to meet the growing demands, especially in the face of serious shortage of foodgrains. If a substantial increase in output and use of vegetables in our country is contemplated, a good deal has to be learnt and applied of such scientific advances as have been made in the U.S.A. and other countries, particularly for increasing the yield per acre and successfully marketing and transporting them to consuming centres without undue deterioration and damage. The book under review will serve as a useful introduction to such principles and methods.

The present edition, like its predecessors, appears under the well-known format of its publishers. It contains a number of new illustrations besides the old ones, most of which have been slightly enlarged or improved to show the details more clearly.

K. R. RAMANATHAN

The Science of Chemistry, by Watt & Hatch (McGraw-Hill Book Co. Inc., New York), 1949, pp. viii + 567. Price $ 4.50.

THE BOOK HAS BEEN PRIMARILY WRITTEN as a text-book to meet the requirements of students taking the terminal courses in chemistry, and to serve as a guide to teachers who have to give these courses. The authors consider that the aim of these terminal courses is not to prepare students for any further study for becoming potential chemists but to impart to them sufficient knowledge of the fundamental principles of chemistry so that they may have a thorough and proper grasp of the scientific method and also be prepared to conduct laboratory work. The book is really a comprehensive text. The various chapters cover most of the important properties of matter in solid, liquid, gaseous and colloidal states, deal with radioactivity and atomic energy and give an account of the chemistry of important metals and non-metals. The authors have succeeded in giving also a good account of theoretical organic chemistry to biology, medicine, agriculture and industry. A novel feature of the book is the inclusion of the chapter on industrial chemical products and processes which describes the various stages in industrial research, such as research stage, pilot-plant stage, plant-scale operations and others.

The book has been very well written and is well illustrated. Its main feature is the distinctive style of the presentation of the various important chemical topics, which is clearly different from the method adopted

by the authors of the usual text-books in chemistry. The book deserves a place in all college libraries and is commended for general reading to students of chemistry.

M.P.

Engineering Economic Analysis, by Clarence E. Bullinger (McGraw-Hill Book Co. Inc., New York), 1950, pp. xii + 397. Price $ 4.00.

THIS BOOK (REVISED EDITION OF THE one issued in 1942) is a very valuable addition to the literature available on engineering economics. For engineers and engineering students in India, books of this type have a special significance, because with the advent of freedom, nationals of India assume full responsibility for organizing all production enterprises and services. This book, coming as it does from a reputed author, heading the department of industrial engineering of a well-known American university and which has been tried out as a text-book in the same institution, must prove a very valuable addition to engineering libraries in India as well as in technical institutions.

The book examines in detail, organized engineering effort to produce goods and services to satisfy human want. Engineering effort is divided and analysed as a number of steps arranged in proper sequence from research, invention, planning organization, promotion, design, operational supervision, etc., to the sale of finished product. Engineers at every stage of their work are called upon to make decisions requiring the study and analysis of the technical and economic aspects of each of the foregoing steps. The ordinary training in a technical college and engineering works provide the engineer the necessary technical knowledge; but for properly assessing and evaluating the economic aspects special training is necessary. In India we have very little facility to provide for this particular line of training. It is in this aspect that the present book is of inestimable value, in as much as it deals thoroughly with the technique of engineering economic analysis.

The subject is discussed in its three essential phases, viz. the economic analysis, the financial analysis and the intangible analysis. In addition, the book also deals with the inter-relationship of the several analyses as well as long-term and short-term aspects.

In any enterprise, either for organizing production of goods or for supplying services, the final and ultimate decision is taken not by the engineers themselves, but by the executive authorities like the members of the board of directors, etc. These authorities weigh their decisions and judgements on the materials prepared and presented to them by engineers, influenced, of course, by their own knowledge and experience of current problems as well as by the sum total of current market trends. It is of paramount importance that engineers, to whom is assigned the rôle to study facts, methods, operations, costs and standards of efficiency attainable that will warrant the investment and execution of projects and services, equip themselves with the latest knowledge and current practices of engineering economics obtaining in the most advanced countries of the world. This book goes a very long way to serve this specific purpose.

A. VISWANATH

Publications Received

STRUCTURAL CHEMISTRY OF INORGANIC COMPOUNDS, I, by Walter Huckel, Cleaver-Hume Press Ltd., $ 9.00

NEW ATOMS, by Otto Hahn, Cleaver-Hume Press Ltd., 12*s.* 6*d.*

HANDBOOK ON DESIGNING FOR QUANTITY PRODUCTION (Second Edition), by Herbert Chase, McGraw-Hill Book Co. Inc., $ 7.50

RADIO ENGINEERING HANDBOOK, by Keith Henney, Mc-Graw-Hill Book Co. Inc., $ 10.00

MAN IS A MICROCOSM, by J. A. V. Butler, Macmillan & Co. Ltd., 10*s.* 6*d.*

PLASTICIZERS, by D. N. Buttrey, Cleaver-Hume Press Ltd., 18*s.*

HIGH-SPEED COMPUTING DEVICES, by W. W. Stifler, Jr., McGraw-Hill Book Co. Inc., $ 6.50

DIRICHLETS PRINCIPLE CONFORMAL MAPPING AND MINIMAL SURFACES, by R. Courant, Interscience Publishers Inc.

LEHRBUCH DER THEORETISCHEN PHYSIK, by Walter Weizel, Springer-Verlag O.H.G., Gottingen (Germany)

NOTES & NEWS

Field-emission Electron Microscope

AN INSTRUMENT FAR SIMPLER IN design and operation, the field-emission microscope, has been designed at the Kaiser-Wilhelm Institute, Berlin, and has been successfully employed for the study of structure of molecules. The phthalocyanine molecule which has been studied is 50 times smaller than the smallest molecule so far seen with the standard electron microscope. The above fact points to a new means of investigating physical and chemical phenomena visually and in greater detail than has hitherto been possible. The microscope consists of a tungsten wire with a fine tip mounted inside a thoroughly clean and evacuated glass bulb. The tip of the wire has a very small radius of curvature. The application of a positive voltage to the surface of the bulb produces a field on the surface of the tip of the wire, large enough to attract electrons out of the wire tip even when its temperature is lower than that used in the thermionic emitting filaments. The electrons proceed in straight lines until they reach the inner surface of the bulb, which is covered with a phosphor which glows when electrons impinge on it. Certain regions of the surface related to the crystallographic axes emit electrons more easily than others and the electrons moving out in nearly straight lines from these parts of the surface give rise to brighter regions on the bulb. Magnifications of the order of one million times can be obtained and the image brightnesses are quite adequate for visual and photographic work. Resolving power is also high.

Muller has found that if a few phthalocyanine molecules are evaporated on the tungsten point, then they locally increase the electron emission. A pattern of brighter spots is now superimposed upon the original broader pattern due to tungsten above. On closer examination these are seen to consist of four segments each corresponding to a benzene ring and tallying with the structure of the molecule deduced by chemical and X-ray diffraction.

The method has its limitations. While Muller's microscope is a simple inexpensive structure, it cannot be opened to change the specimen as is done in the standard electron microscope. The vacuum conditions are very exacting and the microscope does not work in a demountable vacuum system. The molecules to be studied must be sufficiently stable not to decompose when they are evaporated over to the tungsten point. While the resolution and contrast detailed by Muller are far higher than that which can be attained with the standard electron microscope in the study of chemicals of this kind, the resolution is not sufficient to show the detailed internal structure of the molecules (*Discovery*, 1950, **11**, 274).

New Atomic Particles

THE DISCOVERY OF TWO NEW large meson particles — V-particles — was announced by Prof. Blackett at the annual conference of the British Association for Advancement of Science, held recently at Birmingham. Though the lifetime of the particles has not been estimated, photographs have confirmed that the particles decay spontaneously into charged particles, i.e. the pi-mesons which are familiar in cosmic radiation. One is neutral and decays into two charged particles; the other is positive and decays into a positive and a neutral particle. The masses of the new particles have been estimated to be between 250 and 400 electron masses larger than the sum of the masses of particles into which they decayed (*Chem. Age*, 1950, **63**, 355).

Silver & Platinum Catalysts

SOME OF THE RECENT APPLICATIONS of silver and platinum catalysts in German industry are described (*Chem. Age*, 1950, **63**, 291).

The relatively high cost of industrial catalysts from noble metals is more than offset by their greater efficiency and long service life. The high percentage purity of platinum and silver for catalysts and process equipment has minimized the chances of poisoning of the catalysts by traces of certain materials used in industrial processes. Most high pressure plants now use gauze woven from 10 per cent rhodium-platinum wire arranged in multi-layer catalyst pads of 20 to 30 individual nets. Pure platinum is an effective catalyst over a wider range of conditions than the rhodium-platinum alloys. Most of the modern sulphuric acid plants are supplied with nitrogen oxides by a small oxidation unit with a built-in heat exchanger and fitted with a pad of 4 rectangular platinum gauzes mounted vertically. Platinum is also used extensively as a hydrogenation catalyst in organic synthesis dispersed on pumice or charcoal or used directly in the form of platinum black without a support. In Germany palladium was used for direct hydrogenation of acetylene to ethylene. The process consisted of passing acetylene and an excess of hydrogen and steam over palladium in silica gel at 270°C. and ordinary pressure. The consumption of the catalyst amounted to 1 kg. of palladium per 1,600 to 1,800 tons of ethylene produced. Palladium also finds limited use as a catalyst for the purification of oxygen and hydrogen and for the removal of residual oxygen from atmospheres required for bright annealing and other operations where complete freedom from oxygen is necessary.

Silver has almost universally replaced copper in the catalytic vapour-phase dehydrogenation of methyl and ethyl alcohols. In most existing installations the catalyst is either a thick pad of many layers of silver gauze or a shallow bed of crystalline silver which is prepared by electrodeposition under conditions regulated to produce hard crystals. In the manufacture of formaldehyde by the *I.G. Farbenindustrie* plants at Ludwigschafen and Leverkusan, methanol is oxidized and dehydrogenated with a granular silver catalyst. The silver catalyst is produced by the electrolysis of a silver nitrate solution containing 3 per cent $AgNO_3$ and 0·1 per cent HNO_3.

Silver is a useful catalyst in the aerial oxidation of ethylene to ethylene glycol avoiding the chlor-

hydrin stage. The silver-on-pumice catalyst is made by impregnating pumice with silver oxide and subsequently reducing this product in a silver-lined reactor, using a nitrogen-hydrogen mixture at 200°C. The life of the catalyst is estimated to be one year.

Amalgam Metallurgy

AMALGAM METALLURGY HAS RECENTLY been applied to solve some important and complex problems of the metal industry. A few selected techniques are reviewed (*Research*, 1950, **3**, 407).

Extraction of Aluminium from "AlFeSi" — The process makes use of the principle of filtration as applied to metallurgy. The method first developed in Germany during the war is based on the solubility of aluminium in mercury at high temperatures and on the insolubility of iron and silicon. On cooling, aluminium crystallizes out. Energy consumption is very low as compared with the usual electrolytic method.

Extraction of Metallic Sodium — One of the processes is based on the removal of mercury by distillation and the other by electrolysis in an auxiliary electrolyte of molten salt (which is not used up), the sodium being transferred from the amalgam on to a solid cathode on which it is deposited in molten metallic form. In the distillation process, sodium is displaced from the amalgam by metallic calcium which has an even greater affinity for mercury than sodium and, therefore, displaces the sodium without mixing with it even at high temperatures. Calcium can be easily recovered by distillation of the mercury. The anodic transfer electrolysis makes use of a molten electrolyte with the lowest possible melting point, e.g. sodium bromide, sodium hydroxide. Metallic sodium is deposited on an iron wire net cathode and rises to the surface.

Amalgam electrolytic process using molten electrolytes may also be applied for the extraction of aluminium.

Processing Zinc Alloy Scrap — Regenerated metal obtained from scrap, though cheaper, is of poorer quality than metal obtained from ores. Amalgam metallurgy techniques make it possible to obtain zinc in a pure and in a readily usable form, starting from scrap alloy. Degreased scrap is dissolved in mercury in the presence of dilute sulphuric acid. The aluminium reacts with the water and is finally recovered in the form of pure aluminium sulphate crystals; other alloy metals do not react with the water. The iron and copper contained in the alloy are not dissolved in mercury and can be separated from the liquid zinc amalgam by filtration; they are obtained in the form of iron-zinc amalgam and copper-zinc amalgam. The former being magnetic, the two can be separated. The alloys are obtained in powder form by the distillation of mercury. The less reactive accompanying metals such as tin, lead and cadmium are gradually accumulated in the zinc amalgam. The zinc is obtained by electrolysis in an acid zinc sulphate solution (which is not used up), the amalgam being the anode. The cathodes are of aluminium and the deposited zinc is of 99·99 per cent purity. The main features of the cell are the slowly revolving iron discs of 2 m. dia. half plunged into the amalgam pool and half into the electrolyte. Passing through the amalgam, the discs are amalgamated and this gives to the anodic amalgam the vertical position necessitated by the vertical cathodes. The energy consumption is about 0·35 kWh. per kg. zinc, i.e. about one-ninth of the consumption usually needed for electrolytic zinc.

Extraction of Zinc from Purple Zinc Ore — The lyes from the calcination process can be electrolysed after preliminary treatment as a neutral zinc chloride solution, the zinc being transferred as zinc amalgam on to mercury cathodes. The cells used are of the chlorine alkali electrolysis process.

Extraction of Electrolytic Lead from Low Grade Zinc Ores — The lead chloride solution obtained by treating low grade lead-zinc ore is not electrolysed directly as is done in other methods. Instead, it is brought into intimate contact with zinc amalgam when lead replaces zinc in the amalgam which passes into solution. The solution from which lead has thus been extracted, passes on to two consecutive electrolytic cells with mercury cathodes; the first serves to replenish the zinc content of the amalgam used for the lead extraction, the second to extract zinc amalgam from which the zinc is then extracted in metallic form in a third cell. The lead is also extracted in metallic form from its amalgam by a blocking electrolysis in a fourth cell using a lead salt electrolyte of high purity and high conductivity which is not consumed. The phase exchange reaction between lead and zinc is instantaneous if the contact area is made sufficiently large and if the contact zinc is strongly agitated. The lead obtained is of electrolytic purity.

Extraction of Rare Zinc Satellite Metals: Concentration Transforming Process — An aqueous solution of the satellite elements is brought into intimate contact with zinc amalgam prior to the electrolysis proper; due to the phase exchange reaction the rare earths displace the zinc from the amalgam and accumulate in it. If no atmospheric oxygen or other oxidizing substance which can corrode the amalgam are present in the aqueous solution, the phase exchange occurs stoichiometrically and zinc satellites are obtained in a pure form. The disadvantage, however, is that gallium is lost. The method can be employed not only for the extraction of zinc satellites such as cadmium, indium and thallium, or of lead satellites such as silver and bismuth, but also for processing of various other exhausted or dilute solutions obtained in mining and metallurgical processes.

Continuous Separation of Multimetallic Mixtures — Alkaline solutions of rotary kiln oxides containing equal parts of lead oxide, tin oxide and zinc oxide are made to circulate inside a revolving drum divided by transverse partitions into many narrow chambers; the partitions are so arranged that the solution is forced to change direction at every partition, flowing inwards in one chamber and outwards in the next. The other phase is zinc amalgam which is contained in small chambers on the periphery of the drum. These amalgam chambers are separated from the inner part of the drum by porous partitions. The amalgam contained in a chamber which is brought to the top by the rotation of the drum percolates through the porous partition, falls through the aqueous solution in the form of minute droplets and collects at the bottom where it percolates again through the porous partition and back into an amalgam chamber. The amalgam is introduced at one end of the

drum as pure zinc amalgam. Part of it is continuously removed near the middle of the drum as pure tin amalgam and the rest is continuously removed at the far end as pure lead amalgam; these two amalgams are then processed separately for the extraction of tin and lead. The original plumbite-stannite-zincate solution introduced into the drum leaves it at the far end as a pure zincate solution which can be electrolysed to obtain zinc amalgam.

Manufacture of Pure Manganese Alloys — The amalgam metallurgical process producing pure manganese alloys in powder form is by indirect electrolysis in which a sodium amalgam is used for a phase exchange with an aqueous multi-metal saline solution containing all the components of the desired manganese alloy. The alloy is precipitated from the amalgam circuit. The mercury is removed by distillation in an oven. This method of mixing alloy components in aqueous metal saline solutions is useful for low grade ores and eliminates all intermediary stages of the usual manufacturing processes.

The exceptional efficiency of the amalgam metallurgical processes and quality premium it brings in, make it possible to counter-balance the higher capital costs of low grade ore exploitation. The equipment and functioning of an amalgam metallurgical factory do not depend on the particular alloy produced. Different low grade ores can be worked in the same plant.

Rapid Determination of Uranium

A RAPID METHOD OF DETERMINING uranium is described. The method depends on measuring the intensity of yellowish-red colour produced when a uranyl salt is treated with hydrogen peroxide in the presence of excess sodium carbonate (*Industr. Chemist*, 1950, **26**, 375). Molybdenum and tungsten in small amounts do not interfere, but large amounts must be separated as they give a faint yellow colour.

Aluminium and uranium are separated together by double precipitation with ammonia; the solution of these elements is then treated with dry hydrochloric acid gas and aluminium is precipitated as $AlCl_3 . 6H_2O$. Uranium is determined in the filtrate; small amounts of aluminium do not interfere. Iron is separated by hydrogen peroxide-sodium carbonate precipitation; copper is also carried down in this treatment but traces left in solution do not interfere. Cobalt, nickel and cerium are also removed with iron. Fluorides do not interfere up to 10 mg. per 100 c.c. but with high concentrations slight bleaching of the colour results; phosphates do not interfere up to 140 mg. per 100 c.c. or silicates up to 60 mg. per 100 c.c. but chromium and vanadium do interfere. Chromium is separated by precipitating uranium with ammonia, the chromium being in the form of chromate, while vanadium is determined by suitable means and allowance made for it in the final measurement of uranium.

The colour reaction conforms with the Beer-Lambert law and the method can be applied to amounts of uranium varying from 0·2 to 85 per cent of U_3O_8, the average error not exceeding 2 or 3 parts in 100.

Nitrate Determination

A MODIFIED BRUCINE METHOD FOR the determination of small amounts of nitrate in biological material is described (*Can. J. Res.*, 1950, **28**, 280).

The reagents used are: (1) brucine reagent consisting of 10 gm. of brucine dissolved in 80 c.c. of 95 per cent ethanol, 3 c.c. of distilled water made to 100 c.c. with 95 per cent ethanol; (2) concentrated sulphuric acid, reagent grade, free from nitrates; (3) sulphuric acid (1*N*) and (4) urea, 10 per cent solution.

10 c.c. aliquot of the solution to be analysed containing 50 to 250 μgm. of sodium nitrate are placed in a 50 c.c. volumetric flask, 2 or 3 drops of 1*N* sulphuric acid and 1 c.c. of urea solution are added, the mixture boiled for 5 min. On cooling 1 c.c. of brucine reagent followed by 20 c.c. of concentrated sulphuric acid is added and thoroughly mixed. On further cooling in a cold water bath for 20 min. another 20 c.c. of concentrated sulphuric acid are added and contents mixed thoroughly. Blanks are run with a second aliquot of the sample and with distilled water. The light transmittance of the sample is measured in a photoelectric colorimeter and the nitrate content determined by reference to a previously prepared standard curve.

Sugar Analysis

THE AMMONIACAL SILVER NITRATE spray used for the detection of sugar on paper chromatograms involves careful control of the heating step, requiring special apparatus. A modified procedure based on a test given by Feigl for reducing sugars, which eliminates the heating step, is described (*Nature*, 1950, **166**, 444). The method has proved reliable and easy to handle.

The dried, developed paper chromatogram strip is first passed rapidly through a reagent solution, prepared by diluting 0·1 c.c. of saturated aqueous silver nitrate solution to 20 c.c. with acetone, and adding water dropwise, with shaking, until the silver nitrate which separates on addition of acetone has dissolved. Spreading of the spots is limited on account of the sparing solubility of sugars in acetone (0·014 per cent at 23°C. for crystalline glucose). The dry paper is sprayed with a 0·5*N* solution of sodium hydroxide in aqueous ethanol, made by diluting saturated aqueous sodium hydroxide solution with ethanol. Brown silver oxide is immediately produced, the colour facilitating even spraying. Reducing sugars form dense black spots of silver more or less rapidly at room temperature. When reduction is complete, excess silver oxide is dissolved by immersing the strip for a few minutes in 6*N* ammonium hydroxide, after which the paper is washed for at least 1 hr. in running water, and dried in an oven. Black or dark-brown spots on a white background are obtained, except when phenol has been used as the developing agent, when the background is greyish. The spots can be rendered jet black by momentary exposure to hydrogen sulphide. A feature of the method is that substances other than reducing sugars are detected. Thus glycerol reacts at room temperature after a much longer period of contact with the reagent than is required for reducing sugars. Under the same conditions, trehalose reacts faintly; but the spot can be intensified by heating.

A similar technique for the detection of sugars has been employed, using triphenyltetrazolium chloride which, in alkaline solution, is reduced to the insolu-

ble intensely red, formazan compound. This property has been used in the analysis of reducing sugars. A 0·5 per cent solution of triphenyltetrazolium chloride in chloroform is applied as above and, after evaporating the solvent at room temperature, the strip is sprayed with an alcoholic solution of sodium hydroxide. After standing overnight, reducing sugars develop intense red spots against a pink background, fructose and xylose reacting readily. The excess reagent is easily removed by washing with water. If rapid reaction is required, the strip may be heated for 5 min. at 100°C. in an oven in a moist atmosphere. Non-reducing disaccharides do not react.

Determination of Free Carbon in Rubber

A SIMPLE AND RAPID METHOD FOR the determination of free carbon in vulcanized rubber stocks is described (*Anal. Chem.*, 1950, **22,** 1002). The method is sufficiently accurate for control purposes and has been successfully applied to the analysis of natural rubber, GR-S, Butyl rubber and neoprene.

The method makes use of the fact that rubber containing ethylenic double bonds is oxidatively cleaved by *tert*-butylhydroperoxide in the presence of osmium tetroxide. The sample is softened in gently boiling *p*-dichlorobenzene and then treated with *tert*-butylhydroperoxide in the presence of osmium tetroxide catalyst. The mixture is filtered through a Gooch crucible. The carbon on the filter is washed with benzene and then with dilute nitric acid and water to dissolve inorganic fillers. The filter is dried at 350°C., cooled and weighed. The carbon is burnt off at low red heat and the crucible is cooled and reweighed. The loss in weight represents the amount of carbon originally present. No empirical correction is required and no difficulties are encountered in the filtration of carbon black.

Micro-analysis of Gas Mixtures

AN APPARATUS FOR THE MICRO-analysis of gas mixtures containing (i) carbon monoxide and an inert gas or nitrogen and (ii) oxygen and an inert gas or nitrogen is described (*J. Sci. Instrum.*, 1950, **27,** 224). The apparatus has been used for analysing samples of the order of 10 mm. at N.T.P. with an accuracy of 1 per cent.

A MacLeod gauge with two capillary inlets of 1·50 mm. bore tubing for the introduction of the sample and oxygen and a platinum filament just above the bulb comprise the apparatus. The volume of the bulb is about 200 c.c. and that of the combustion tube about 3 c.c. An important feature of the apparatus is that the mercury in the analyser need never come into contact with tap grease, nor with the less pure mercury from the burette and sampler.

The mixture for analysis is expanded from the sampler into the bulk, the mercury raised into the closed capillary and the pressure and relative volume of the sample measured using a cathetometer. The mercury is lowered to its former level, a small excess of oxygen expanded from the burette into the bulb, the mercury raised and the pressure and volume again recorded. To effect combustion of carbon monoxide, the level of mercury is again lowered to the desired level and the mercury adhering to the filament volatilized off. The gas is then compressed by raising the mercury level and the filament flashed for 10 sec. at red heat. Finally the mercury is raised into the closed capillary and the resultant pressure and volume measured.

Mixtures containing oxygen and an inert gas or nitrogen may be analysed by reversing the procedure, i.e. by adding a small excess of CO to the sample to be analysed. The oxidation of mercury is eliminated because CO is in excess.

Magnetic Stirrers

EFFICIENT MINIATURE MAGNETIC stirrers have been designed for carrying out potentiometric titrations and conductometric experiments. Three models were exhibited at the recent annual general meeting of the Microchemistry Group of the Society of Public Analysts & Analytical Chemists held in London (*Chem. Age*, 1950, **63,** 296).

The general purpose bench model is 5″ long, 3¾″ wide and 3¼″ high. The top or titration platform is of white Perspex, $\frac{1}{16}$″ thick, and a ¼″ thick panel of the same material carries the switch and speed controller. The connecting leads are detachable, an accumulator or other external battery being used only when long runs are required. For ordinary work, energy is drawn from an internal flash-lamp battery. Small but powerful type M. 4776A magnets in the form of short slotted cylinders with central holes are mounted directly upon the motor spindle. The light weight and small height greatly contribute to freedom from vibration and long life of the motor. The assembly spins freely and the poles of the magnet describe a circle in a plane parallel to the Perspex top. A variable resistor (maximum resistance 10 ohms), mounted adjacent to an on-off switch, controls the speed. Operation at low speeds gives excellent stirring, minimizes current consumption and enables long runs to be undertaken without overheating the motor. The stirring action is vigorous at the bottom of the liquid and splashing is avoided even at high speeds. Using small beakers or conical flasks it is possible to perform conductometric titration of samples less than 1 c.c. If required, as in Karl Fischer method of moisture determination, the titration vessel can be hermetically sealed and stirring continued.

Another model is designed for use on a retort stand. The cylindrical body slides freely into a retort ring of suitable size and the whole unit is firmly secured by four small Terry spring clips. A third low-built stirrer consists of a pair of 2¼″ dia. bakelite caps placed mouth-to-mouth. Controlling resistor and motor assembly are retained in position by partially imbedding in sealing wax.

Liquid Level Gauge

A DEPTH GAUGE OPERATED BY A continuous air purge for measuring the liquid head in a vessel is described (*J. Sci. Instrum.*, 1950, **27,** 223). The instrument is operated by passing a steady flow of air through a variable orifice, the variation being effected by a change of level of a liquid-air interface, so that a small change in level produces a large percentage variation in effective orifice area. These changes produce changes in the differential pressure across the orifice. The static pressure in the system is then a measure of the head of the liquid in a vessel.

A supply of compressed air passes down a dip pipe of the open-

ended type, with an inverted V-notch cut in the bottom. This is surrounded by a second open-ended pipe, cut square, and extending a short distance below it, but clear of the bottom vessel. In operation, the interface between the air in the pipe assembly and the liquid contents of the vessel partially seals the V-notch. The air passes through the triangular orifice bounded by the notch and the interface and up through the outer tube. It then enters a chamber of a relay assembly and passes through a needle valve to atmosphere or into the vapour space above the vessel contents. The needle may be sized to have an orifice equivalent to $\frac{3}{16}''$ when in the fully open position. This is equivalent to a minimum measurable depth of vessel content of 1″ when the purge rate is 15 cu. ft. per hr. of free air. If the available ratio of areas of the valve is 12 : 1, the instrument will measure up to a total vessel content of 12′ head of water with an accuracy of ± 1 per cent.

Uranium Oxide Films

A MODIFICATION OF THE PYRIDINE method for depositing uniformly thin films of uranium oxide used for investigations into the nuclear properties of uranium is described (*J. Sci. Instrum.*, 1950, **27**, 230).

The method was originally used to prepare layers of 1 to 10 sq. cm. area but by slight variations uniform films covering an area of 100 sq. cm. can be made. Normally platinum foil is used and is washed with nitric acid and distilled water, followed by ignition.

The area to be covered is defined by painting the perimeter with a solution of nitrocellulose in ether-alcohol or in acetone. For films of small area (1 to 10 sq. cm.), a concentration of 10 mg. of uranyl nitrate per 1 c.c. of pyridine is used; for films of larger area (100 sq. cm.), a solution consisting of 500 mg. uranyl nitrate and 1 c.c. of concentrated nitric acid (sp. gr. 1·42) made up to 250 c.c. with reagent grade pyridine has been found satisfactory. To prepare a film up to 10 sq. cm. in area, the platinum foil is cleaned and ignited to constant weight. The pyridine solution is applied at the rate of 0·02 to 0·05 c.c. per sq. cm. by means of a capillary pipette and allowed to evaporate. The foil is gently heated to drive off residual pyridine and to destroy the nitrocellulose boundary and then heated strongly to bright red heat to convert uranium salts to oxides. On cooling, the whole procedure is repeated until a film of required thickness is obtained. For a film covering an area between 10 and 100 sq. cm., the solution is applied at 0·02 c.c. per sq. cm. and the area is wetted by rocking the foil gently on a glass plate, the motion being continued during evaporation of the solvent so as to keep the boundary edges wet. The crystalline film is allowed to stand for 10 min., then gentle heat from a Bunsen flame is applied rapidly and evenly and continued more strongly and finally to a bright red heat for a few minutes. Films of a thickness of 0·3 mg. per sq. cm. have been prepared by repeating the procedure.

The technique would not be suitable for thorium and highly α-active uranium preparations because of radioactive dust hazards.

Sulphate-reducing Bacteria

INVESTIGATIONS ON THE COMMERCIAL production of sulphur from sulphates employing micro-organisms are in progress at the Chemical Research Laboratory of the D.S.I.R., London.

About 100 tons of sulphur is formed by bacterial activity each year in certain lakes in North African deserts for every half a million gallons of lake water. The bacteria swarming in the waters convert sulphates to sulphides which is reduced to finely divided sulphur by other micro-organisms. Experiments are in progress to see whether natural waters rich in sulphates such as waste from sewage works might be utilized and whether bacteria could be made to multiply on relatively large surfaces provided by lumps of coke or asbestos. Attempts are being made to obtain highly active strains of bacteria. Cultures of sulphur bacteria procured from the North African lakes and from other parts of the world are being investigated and their growth rate on various kinds of nutrients is being studied.

The most promising types of organisms are the purple and green sulphur bacteria, photosynthetic bacteria, which abound in nature and sometimes proliferate in enormous numbers. For maximum development they require hydrogen sulphide, aerobic or anaerobic conditions and sunlight. All these requirements are satisfied in polluted pools and it might be possible to create such conditions that hydrogen sulphide produced by the sulphate reducers is consumed as it is produced.

Another aspect of the problem investigated at the laboratory relates to the method of controlling the growth of sulphate-reducing bacteria. The addition of acid to the water decreases their numbers enormously.

Black Rootrot in Tobacco

STUDIES ON THE BLACK ROOTROT fungus *Thiela viospsis basicola* (Berk. and Br.) Ferraris undertaken to elucidate the complex relationships between host, parasite and the soil environment are reported (*Canad. J. Res.*, 1950, **28**, 445).

The fungus exists in two distinct forms, grey and brown wild types. The wild types do not remain stable on media which support abundant saprophytic growth but give rise to and are crowded out or replaced by mutants. The wild type can be maintained with a minimum of variation in soil, soil agar or roots.

The brown wild type of fungus is usually the predominant form. The grey wild type is less pathogenic and is more poorly adapted than the brown to withstand long dormant periods. The latter mutates to the grey in the soil, host and in artificial culture whereas the grey wild type mutates to the brown only in association with host and not in culture, thereby suggesting a directive influence being exerted by the host parasite relationship. Root invasion by *Thielavia basicola* was common only in association with another fungus *Thielaviopsis basicola*, which suggests a commensal relationship between the two fungi.

New Insecticide

PRELIMINARY INVESTIGATIONS ON the insecticidal and miticidal potentialities of antimycin A (the crystalline antibiotic isolated from cultures of an unidentified species of Streptomyces) are described (*Science*, 1950, **112**, 172).

The antibiotic caused mortality to insects which ingested the material rather than by contact action of the substance on the exo-skeleton. The common housefly *Musca domestica L.*, sprayed

with 10 p.p.m. of antimycin A, showed no adverse effects whereas 38 per cent of the flies allowed to feed on a ball on absorbent cotton saturated with 10 p.p.m. of antimycin A dispersed in water were killed in 24 hr. Similar results were obtained with the large milkweed bug *Oncopeltus fasciatus* (Dall.). To determine the specificity of action, the standard test wool fabric was immersed in a water dispersion containing 10 p.p.m. antimycin A and offered to larvae of the webbing clothes moth, *Tineola biselliella* (Hum.), and the black carpet beetle, *Attagenus piceus* (Oliv.). The larvae of the webbing clothes moth ate the test swathes with impunity while duplicate test pieces inhibited the feeding of the black carpet beetle. Further tests were conducted with this beetle comparing antimycin A with sodium aluminium silicofluoride which is a widely used fabric protection against insects. The standard wool fabric was immersed and saturated with test subjects, aired, dried and tested in accordance with the method set forth by ASTM. Data showed that antimycin A will afford the same degree of fabric protection at 1/100th the concentration of sodium aluminium silicofluoride, compared with methoxychlor (1, 1, 1-trichloro-2, 2-bis (*p*-methoxyphenyl) ethane), which is at present used for the control of second instar Mexican bean beetle larvae; antimycin A used at the rate of 25 p.p.m. was as toxic as 500 p.p.m. of methoxychlor.

Antimycin A is also efficacious for the control of red spidermite, *Tetranychus* sp. On the basis of LD_{50} readings, it is three or four times more effective than DMC (di *p*-chlorophenyl) methyl carbinol.

Paper from Hemp Waste

PRELIMINARY INVESTIGATIONS ON the suitability of Manila hemp fibre obtained from the leaf-stalks of *Musa textilis* Nee are reported (*Philippine J. Sc.*, 1950, **78**, 355). The fibre is available in large quantities as a rope factory waste in the Philippines.

2 lb. fibre (moisture free) was digested with cooking liquor; the ratio of the volume of the cooking solution to the moisture-free weight of the fibrous material was 7 to 1. The digesters were rotated throughout the cooking period at 1 r.p.m. Pulping abaca waste for 2 hr. at a maximum temperature of 150°C. with 12 to 16 per cent caustic soda on the weight of the raw material gave satisfactory pulps of good bursting, tearing, folding and tensile strengths. The colour of the unbleached pulps obtained under these conditions has a brightness of 22 to 29 per cent.

The rate of hydration of soda pulp from abaca waste is relatively fast. The pulp is sufficiently hydrated in 20 min. to give a Schopper-Riegler freeness within the range of 550 to 700 c.c. and an average bursting strength of 1·33 points per lb. per ream. The lightest coloured pulp had a brightness of 36·4 per cent. The colour of most of the pulps was similar to that of kraft pulps made from wood.

New Road Surfacing

THE ADDITION OF 5 PER CENT OF *Mealorub* — flocculated natural rubber latex — to the aggregate mix has been found to considerably improve road surfaces and to make them skid-proof. Several strips of *Mealorub* surfacing laid before the war and subjected to heavy military traffic emerged after seven years with the quality of an average B-road whereas the non-rubber road surfaces were worn off completely. The June 1950 issue of *Rubber Developments* is devoted entirely to the subject of rubber in road surfacing.

Efficient Production & Utilization of Steam

FACTORS AFFECTING THE EFFICIENT production and utilization of steam and the importance of boiler testing, fuel analysis, treatment of boiler feed water and cooling water for condensers are discussed in an informative pamphlet published by the Shri Ram Institute for Industrial Research (*Efficient Production of Steam* by R. S. Dubey). The publication contains valuable practical aids and hints on boiler maintenance.

Modern trend in the efficient utilization of steam is to employ compact high pressure boilers generating superheated steam. Most of the new British boilers are designed for two standard conditions: 600 lb. per sq. in., 850°F. and 900 lb. per sq. in., 900°F. In America, boilers are run on steam pressures as high as 1,800 and 2,000 lb. per sq. in. and many are designed for steam production at 1,050°F. These new developments make possible the use of power cycles of higher thermodynamic efficiencies.

India's coal resources being meagre, the need for efficient utilization of coal is of great importance. Mining, transport, storage and utilization of coal are also important considerations while selecting a boiler plant; attention has to be given to the pressure required, the fuel available, the space requirement of the boiler, the disposition of the plant, the maintenance resources of the factory and the purpose for which steam is to be used. Modern methods of cleaning the boiler plant like soot-blowing, water-lancing, steam-soaking, or spray-soaking minimize draught loss and give increased heat transfer.

The pamphlet is available from the Director, Shri Ram Institute for Industrial Research, University Road, Delhi.

Marketing of Mustard & Rapeseed in India

VARIOUS ASPECTS OF PRODUCTION and marketing *sarson* (colza), *toria* (rapeseed), *rai* (mustard) and *taramira* (*Eruca sativa*) are dealt with in a report issued by the Agricultural Marketing Adviser to the Government of India (*Report on the Marketing of Rapeseed & Mustard in India*, 1950, Manager of Publications, Delhi, price Rs. 2 or 3*s*.). The main botanical species of these seeds commonly grown in India are: *Brassica campestris* var. *sarson*, *Brassica campestris* var. toria and *Brassica juncea* corresponding to colza, rapeseed and mustard respectively. The commercial seeds are, however, a mixture of varying proportions of *sarson*, rapeseed and mustard. Besides, two other species, viz. *Brassica juncea* var. *rugosa* and *Brassica nigra*, are also found to a limited extent and are generally known as *pahadi rai* and *benarsi* or *asli rai* respectively.

Next to China, India is the world's largest producer of rapeseed. Exports to U.K. and continental countries amounted to 23 per cent of the entire produce before World War I, but have been steadily declining (the present figure being 3 per cent of the production) due to fall in demand from the importing countries and

simultaneous increase in requirements in India where the oil is primarily used for edible purposes.

The total area under rapeseed and mustard in undivided India (1943-44) was about 58 lakh acres yielding about 11 lakh tons of the seed, of which U.P. accounted for 44 per cent, Bengal 16 per cent, Bihar 12 per cent, Punjab 12 per cent, Assam 6 per cent and Sind, N.W.F.P. and Central Provinces 5 per cent. The post-partition figures are not included. The average yield per acre is about 377 lb. as against 557 lb. in China, 1,000 lb. in Japan, 1,600 lb. in Germany, 939 lb. in France, 830 lb. in Poland and 803 lb. in Russia. Steps to investigate the cause of low yields in India and to develop high-yielding strains are recommended. The report has outlined a scheme for regulating the production of different types of oil seeds in the *Brassica* group in compact areas on the lines of cotton cultivation and standardized classification and grading. This would also avoid confusion in the use of botanical and local names to the various types of rapeseed and mustard grown in the country, result in uniformity of production types and reduce heterogeneous number of varieties and trade descriptions. Commercial grading of these varieties could be possible on the basis of (1) number of seeds per gm. (bold, medium and small); (2) oil content; (3) correlation between size of seed and oil content; (4) moisture content; (5) percentage of mixtures of other whole seeds and (6) percentage of impurities and non-*Brassica* seeds. This would also lead to a more uniform price structure and avoid appreciable variations in prices due to differences in their qualities. In Okara (Punjab), during the six seasons (1934 to 1939), a variation 4·7 to 27·8 per cent between the prices of different lots varying in quality sold on the same day was recorded.

The prices of rapeseed and mustard in India have been on the increase since 1933-34, rising from Rs. 3-10-0 in 1933-34 to about Rs. 16-0 per md. in 1944-45. The world prices (at London) for the corresponding period were £ 9 per ton and £ 39 8*s*. per ton respectively.

Institute of Animal Genetics & Nutrition

THE FOUNDATION STONE OF THE Mangalal Goenka Institute of Animal Genetics & Nutrition was laid in October by the Hon'ble Dr. Rajendra Prasad, President of the Indian Union, At Anand.

Speaking on the occasion, Shri K. M. Munshi, Food and Agriculture Minister, Government of India, stressed the need for the application of scientific and technical resources for the improvement of animal nutrition and genetics.

The Institute, which was started with the generous donations of Seth Mangalal, and other Government and private support, now has a farm, a dairy, a school and a college of agriculture with hostels, a postgraduate department of animal husbandry and genetics. The Central Government has leased its dairy building and equipment to the Institute and the Indian Council of Agricultural Research proposes to utilize the Institute for a tobacco research centre.

The Institute has three substations: (a) animal genetics, animal nutrition and dairy science section at Anand; (b) animal breeding farm at Chharodi; and (c) animal breeding farm at Surat. The research work that is being carried out at the Institute has been mainly confined to metabolic studies on cows and buffaloes fed on different rations.

A 5-year scheme for the establishment of a Regional Sub-station for Animal Nutrition submitted by the Institute has been accepted by the Indian Council of Agricultural Research. Work is already in progress at the Institute on artificial insemination of cattle to improve their milk yields under a scheme sanctioned by the Bombay Government.

The Institute has been recognized by the Bombay University for training in postgraduate studies in animal husbandry and dairying, animal nutrition and dairy science, and plant breeding and agronomy.

Indian Standards

Radio Components — A DETAILED Indian Standard Specification for Fixed Paper — Dielectric Capacitors has been drawn up by the Sectional Committee of the Indian Standards Institution prescribing requirements for material, workmanship and marking, besides other mechanical tests. Comments on the draft (copies can be had on application) should reach the Director, Indian Standards Institution, University Road, Delhi, by January 10, 1951.

Announcements

Board of Agricultural Research — The Government of India have set up a board to plan and coordinate agricultural research in the institutes under the Ministry of Agriculture, the Indian Council of Agricultural Research, Commodity Committees and the State Governments. The board will work for maximum utilization of the existing research facilities and supervise the scientific publications issued by the Ministry of Agriculture and the I.C.A.R. The board will consist of Hon'ble Shri K. M. Munshi, Chairman, Shri M. D. Chaturvedi, Dr. S. Datta, Shri W.R. Nater, Dr. B. P. Pal, Shri K. L. Punjabi, Dr. S. Ramanujam, Dr. K. Ramaiah, Dr. S. C. Ray, Dr. K. C. Sen, Sardar Datar Singh and Dr. B. Viswanath.

Statistical Education Centre — An International Statistical Education Centre will be established at Calcutta under the auspices of the UNESCO and in collaboration with the Central Statistical Institute, Calcutta. The centre will provide instruction in the theory and practice of statistics to a restricted number of students belonging to Middle, South and Far East countries. Further information may be had from Prof. K. B. Madhava, Honorary Administrator of the International Statistical Education Centre, C/o Indian Statistical Institute, Presidency College, Calcutta.

Progress Reports

PATENTS IN INDIA

THE REPORT ON THE WORKING OF THE PATENT Office in India covering the period 1942-1948 gives a comprehensive survey of the trend of inventions during the war and the post-war periods. The number of applications for patents increased from 681 in 1942 to 2,610 in 1946 and thereafter dropped to 1,921 in 1948, presumably due to post-war unsettled conditions. The number of applications originating in India recorded a steady increase from 252 in 1942 to 361 in 1948, Bengal and Bombay making a substantial contribution.

During the war, a large proportion of applications filed related to armament industries, aircraft and other appliances concerning the prosecution of the war. The activities in the armament industries related to better detonating arrangements for ammunition and in the improvement of cartridges and their cases, explosive mixtures and blasting compositions, automatic weapons and recoilless guns, safety devices and optical devices for range finding. Attention was also directed to improved designs of shock absorbers and air filters for aircraft engines. Attempts were made to utilize gas turbine engines for the jet propulsion of aircrafts; some of these applications related to construction of air compressors for such turbine units. With increased activity in the field of aeronautics, there was also an increase in the number of inventions in wireless engineering, e.g. radio beacons for aircrafts, direction finding receivers, measuring distance by electromagnetic waves, radio glide path systems, multi-channel signalling by time-modulated electric pulses and directive antenna systems for microwaves, radar and television aids to navigation. A number of inventions were also made in line communication engineering relating to line equipment for multi-channel carrier wave signal transmission systems, automatic telephone exchange circuits, particularly in the inter-exchange equipment and in the use of discharge devices like thermionic valves and cathode ray tubes in telephone exchange circuits for various types of indications and identification purposes in line circuits. Other fields covered related to photo-electric methods of telegraph transmission and reception.

In addition to armament and aeronautical industries, there was considerable activity with regard to metal working, building construction, road and aerodrome runway construction, erection of bridges and special steels and alloys. Most of the inventions in the field of metal working related to devices for mass production of metal tubes, pipes and rods of different shapes in a single operation and turning, forging and welding of metals. In the metallurgical field, inventions mostly related to copper base and magnesium base alloys besides special alloy steels.

Warfare in the east, in swampy woods and forests, has been responsible for a number of inventions relating to insecticidal compositions, anti-malarial drugs and other preparations for tropical diseases. A large number of such compositions related to the use of DDT (dichloro-diphenyl-trichlor-ethane) in the form of emulsions.

Indian inventors devoted their attention to problems arising out of the scarcity of raw materials such as fuels for internal combustion engines, mineral oils and others for lighting purposes. A large number of inventions related to charcoal producer-gas plants. Use of substitutes or waste materials such as paper substitutes from plant leaves, paper pulp from bagasse, sizing materials from tamarind seeds, moulding products from jute and jute waste, and use of coir for reconditioning or making new tyres engaged a number of inventors. Extraction of vitamins from fish oils, dehydration of foods and manufacture of tea and coffee also figured prominently.

Just before the cessation of the war, there was a considerable increase in inventions in various branches of electrical industry, viz. vacuum discharge apparatus and cathode ray tubes, electric discharge devices, condensers of metallized paper rolls, electric switches, coupling devices, junction boxes, eddy current machines, fluorescent lamps and materials, layer type of dry batteries and controlling devices used in traction and lifts. At the close of the war a number of applications relating to earth-working machines, bull-dozers and agricultural tractors were filed and almost all of them originated from the U.S.A.

The number of applications for registration of designs filed during the years 1942 to 1948 remained practically constant with 414 in the year 1942 and 494 in 1948, except for a rise to 731 in 1943. A major portion of the applications filed related to textile designs and more than 90 per cent originated in India.

During the period under review an exhibition of Indian Patents and Designs was organized for the first time in India at the Lord Reay Maharashtra Industrial Museum, Poona. The exhibits have become a permanent feature of the Museum known as the Patents Section.

INDIAN INSTITUTE OF SCIENCE BANGALORE

THE UTILIZATION OF OIL SEED CAKE AS A BASIC raw material for the production of subsidiary foods which would contain all the essential nutrients is one of the interesting problems investigated in the Department of Biochemistry. Various oil cakes, groundnut, sesame, etc., are being investigated. The best method of removing the residual oil from the cake and the optimum amount of oil that can be left in it without affecting its keeping quality are being worked out. To improve the palatability and the nutritive value of the protein foods, dehydrated onions, spices, salt, yeast and calcium in suitable proportions is recommended.

A number of useful investigations are in progress in the Communication Engineering Department of

the Institute. A manually operated pulse apparatus operating directly off the a.c. supply mains is being developed to measure the penetration frequencies and virtual heights of the different layers of the ionosphere. For the first time in India, studies in frequency modulation have been started at the Institute with the aid of a 250-watt frequency modulated transmitter working on 100 megacycles per sec. and a frequency modulated receiver recently purchased from America. Field strength and signal to noise ratio in and around the Institute are being studied. Investigations into the response of electrical circuits to steady state pulses have been taken up and the necessary equipment consisting of a pulse generator, a time base generator, etc., is being developed.

An electronic type of ringing current generator for use in telephone exchanges to substitute the existing motor generator and magneto-generator sets has been developed. The new generator can work directly from the a.c. supply mains and involves no moving or rotating parts. Another line of research in progress in this connection is the development of a new type of key sender based on electronic principles to replace the present mechanical and electrical devices used in trunk exchange.

A new method to connect a large number of circuits to a single source has been devised. The method is based on the switching technique used in automatic telephony and enables the circuits to be connected to the source one at a time and in any desired order by depressing a set of plunger keys corresponding to the desired circuits.

CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, KARAIKUDI

THE CONSTRUCTION OF THE CENTRAL ELECTRO-Chemical Research Institute, Karaikudi, whose foundation stone was laid on the 25th July 1948 by the Hon'ble Shri Jawaharlal Nehru, is expected to be complete by the end of 1951.

The problem of adequate water supply has now been successfully got over. Three bore-wells have been sunk yielding 70,000 gal. in a 12-hr. working day.

The main building of the Institute will have a floor area of about 60,000 sq. ft. The Library, the Director's office and the Laboratories will be situated on the first floor and certain sections will be air-conditioned. Besides the usual laboratory services such as gas, water and electric supply, certain sections of the workshop, the pilot plant and heavy investigation laboratories will be furnished with steam, compressed air, vacuum and D.C. supply lines.

The total estimated cost of the Institute is Rs. 10 lakhs for building and Rs. 25 lakhs for equipment, stores and library. The annual recurring expenditure for the first three years is estimated at Rs. 2·5 lakhs per year.

FOUNDRY SAND TESTING AT THE NATIONAL METALLURGICAL LABORATORY

A FOUNDRY SAND TESTING SECTION EQUIPPED with up-to-date equipment has been established at the National Metallurgical Laboratory, Jamshedpur, to provide facilities for the study of moulding sands available in India. The Laboratory will serve as a central research and control station and will offer full facilities to the Indian foundry industry for foundry sand testing. Besides, the Laboratory has the following functions assigned to it : (1) to prepare a suitable bibliography on the subject of moulding materials ; (2) to review the sources of Indian moulding materials and report on their suitability for general foundry practice for steel, cast-iron and non-ferrous metals and alloys ; (3) to study the fundamental characteristics which are of importance in the bonding power of clays ; (4) to specify the properties of naturally bonded and synthetic sand mixtures for moulding ; and (6) to explore new sources of moulding sands and silica sands in collaboration with the Geological Survey of India.

The problem of finding a suitable bond for synthetic sand mixtures is being investigated at the Laboratory. The Indian bentonites, being of a calcium base, possess less swelling power and bonding capacity and cannot readily replace the sodium-base imported bentonites. However, the calcium base Indian bentonite can be converted into sodium-base product through base exchange to serve as a substitute for the imported bentonite. The following are a few of the problems planned for investigation at the Laboratory : (1) the relation of the bond in naturally and synthetically bonded sand to stripping, burning on, etc. ; (2) investigations on the behaviour of synthetic bonds with clean high silica sand and weak clay-bonded sand ; (3) effects of milling as affecting the properties of moulding sands ; (4) investigations on the specific surface of sands as affecting the strength properties of sand-clay mixtures ; (5) relation between the specific surface of sands as regards angularity and grain shape ; (6) sintering phenomenon of moulding sands including the study of incipient fusion ; (7) effect of pressure on the sintering point of moulding sands and " Compos " ; (8) volume changes in moulding sands and " Compos " up to 1,400°C. ; (9) effect of thermal conductivity of the moulds on the castings for the preparation of insulating sand mixtures for feeder heads ; (10) study of the various types of clay and organic bonds for moulds and cores including artificial resins and other suitable hydrophilic compounds ; and (11) effect of washes and paints on stripping and casting.

INDIAN PATENTS

The following is a list of a few of the Patent Applications notified as accepted in the *Gazette of India*, Part II, Section 1, for September and October 1950.

Inorganic Chemicals

43081. Manufacture of anhydrous caustic soda: *Passing a gas stream up through caustic soda particles at* 200°-300°*C.*— I.C.I. LTD.

42232. Method for preparation of very fine aluminium trihydrate and uses thereof: *Hydrolysing sodium aluminate solution by the Bayer's process at less than* 50°*C. in presence of alumina gel* — COMPAGNIE DE PRODUITS CHIMIQUES ET ELECTROMETALLURGIQUES ALAIS, FROGES ET CAMARGUE

Organic Chemicals

43408. Purification of aureomycin: *Add to an acid solution of aureomycin of pH less than* 4, *a salt and an organic solvent for aureomycin* — AMERICAN CYANAMID CO.

40753. Preparation of new biguanide compounds: *Reacting p-chlorophenyl-guanido-carbothiolethylimide with isopropylamine* — GUHA & GUHA

42542. Dyestuff intermediates and their manufacture and use: *Reacting phthalic acid with cobalt salts under usual conditions for producing phthalocyanines but at a lower temperature* — WILLIAMS

42848 & 42854. New vat dyestuffs: *Condensing* 1 *molecular proportion of* 4 : 10-*dihalogeno-anthanthrone with* 2 *molecular proportions of a mono-aminoacedianthrone; condensing aminoacedianthrones or halogeno-acedianthrones with aromatic amines* — I.C.I. LTD.

43520. Production of *meta*-benzene disulphonic acid: *Preparing mono sulphonate by benzene vapour phase sulphonation and reacting with oleum* — DE DIRECTIE VAN DE STAATSMIJNEN IN LIMBURG, HANDELEND VOOR EN NAMENS DEN STAAT DER NEDERLANDEN

42847. Vat dyestuffs: *Nitrating acedianthrone in presence of sulphuric acid, reducing the nitro compound and acylating the amino compound with* 1-*amino or* 1-*nitro-anthraquinone-2-carboxylic acid* — I.C.I. LTD.

42912. Tapping liquid slag from pressure gas producers: *Tapping the slag notch connected to the gas producer* — METALLGESELLSCHAFT AKTIENGESELLSCHAFT & DANULAT

Miscellaneous Chemicals

42922. Anti-bacterial compositions: *Mixing streptomycin, polymyxin and bacitracin* — CHAS. PFIZER & CO. INC.

Lumber & Wood Products

42273. Tanning skin with zirconium compounds: *Tanning in a liquor prepared by heating a zirconium mineral with sodium carbonate and a mineral acid and containing silica gel from* 0·1 *to* 2 *mols per mol of* ZrO_2 — SOCIETE DE PRODUITS CHIMIQUES DES TERRES RARES

Machinery (Except Electricals) : Miscellaneous

41437. Sectional electrolytic cells of the diaphragm type: *Frames by which cell units are laterally enclosed and division plates separating vertically adjacent units and clamped between said frames* — THE INTERNATIONAL ELECTROLYTIC PLANT CO. LTD., WOOD & BOWEN

Metals & Metal Products

41249. Cold pressure welding of metals: *Pressure for welding obtained by the release of stored energy, welding being effected by impact pressure* — THE GENERAL ELECTRIC CO. LTD.

43115. Tubular articles of light alloys adapted to withstand high mechanical stresses, such as handle bar shanks and sockets for cycles: *A steering column of cycle made up of two semi-tubular parts coupled together and united* — COMPAGNIE GENERALE DE VILVORDE "COGEVIL" SOCIETE ANONYME

Textile & Textile Products

42162. Manufacture of textile materials: *Treating textile materials with a solution of sodium benzoate and drying the material* — THE BRITISH JUTE TRADE RESEARCH ASSOCIATION

Miscellaneous

43052. Catalytic hydrogenation of carbon monoxide: *Iron catalysts impregnated with alkali salts of a non-volatile acid and synthesis gases containing acetylene are used* — RUHRCHEMIE AKTIENGESELLSCHAFT & LURGI GESELLSCHAFT FUR WARMETECHNIK M.B.H.

43128. Oxidation with chlorite solutions: *Immersing the material in a solution of chlorine in an organic solution prior to immersion in the chlorite bath* — SOLVAY & CIE

42996. Containers for electric batteries: *Provided with a vent having a plurality of outlet apertures afforded between elements of absorbing and dissipating assembly* — I.C.I. LTD.

43654. Refining lubricating oil of power-operated engines: *Comprising means for heating the oil, for removing volatile impurities from the oil and means for returning the purified oil to the engine* — COMERFORD-BAILEY

IMPROVEMENTS IN INTERNAL COMBUSTION ENGINES

Patent No. 35646

K. A. NAIR & L. C. VERMAN

THIS INVENTION RELATES TO AN AIR CLEANING AND crank-case ventilation system for internal combustion engines. The object of the present invention is to produce a simple and efficient device which will perform the functions of an air cleaner and crank-case ventilator. Such a device would also serve as a crank-case breather by relieving the pulsating pressure set up inside the crank-case.

The composite air cleaning and crank-case ventilation system (FIGS. 1 and 2) consists in connecting the atmospheric air intake attached to the carburetter (11) and the crank-case breather opening (15) to a common passage or reservoir (3) containing clean, dust-free air at a pressure slightly below the atmospheric pressure. The clean air may be supplied to the passage by an oil bath (16) or other type of cleaner, but it is preferable to use a porous fabric bag (3), the interior of which is at a pressure slightly below the atmospheric pressure and the air passing through is freed from atmospheric dust before entering the carburetter (11). The flow of crank-case vapour (arrow 6), which

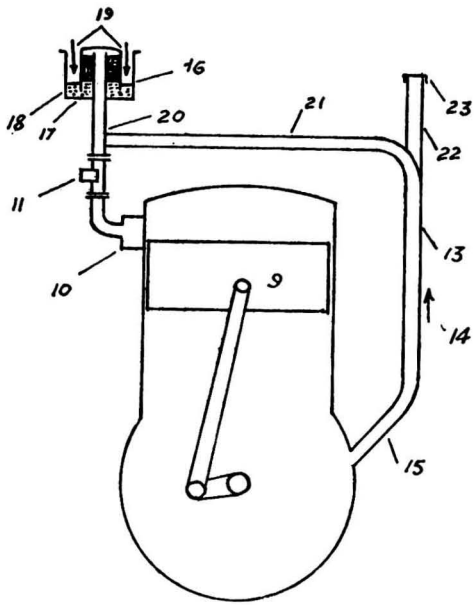


FIG. 2

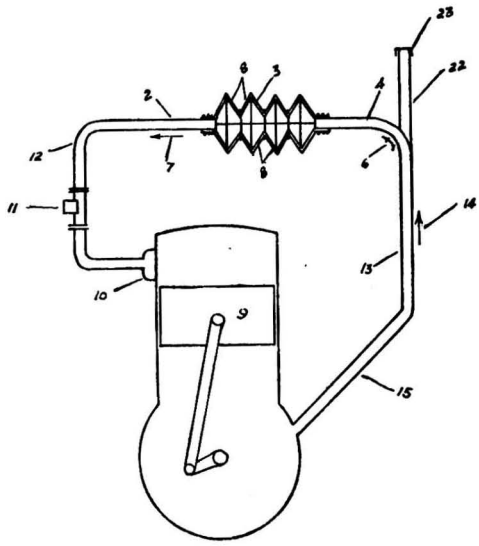
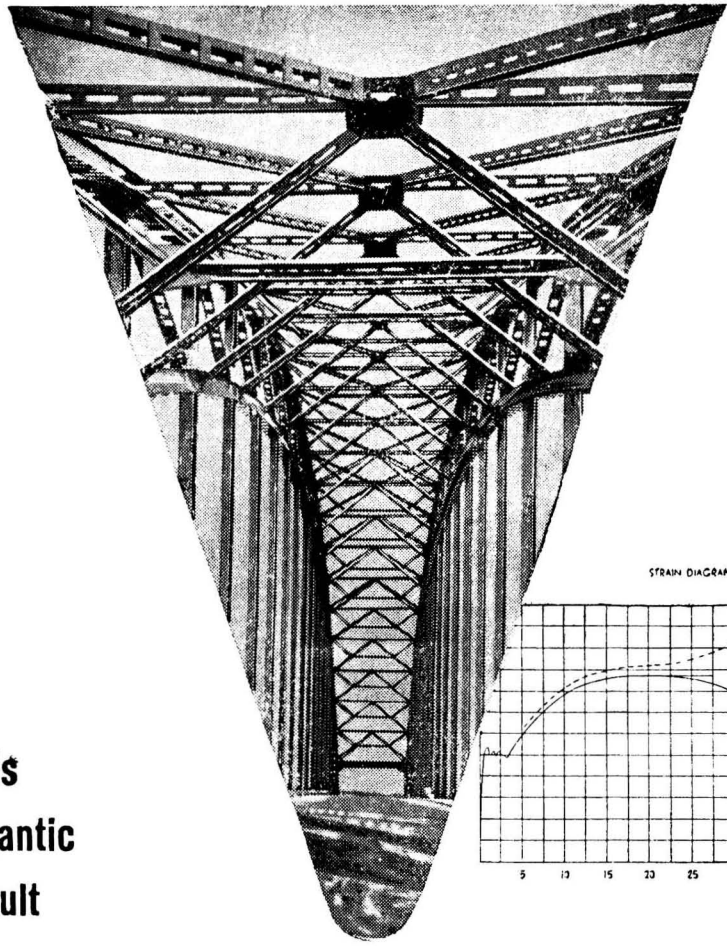


FIG. 1

is controlled by the low pressure in the passage, is steady and no metering arrangement is necessary to control it. The filter bag (3) is made of fabric having a pore size which would arrest dust particles and is of such an area as to cause only the small pressure drop inside the bag necessary to induce the crank-case vapour to flow into it. The pressure inside the cloth bag (3) is controlled by the resistance to flow of air through the fabric and fluctuates but little for a given fabric bag.

The crank-case opens directly into the reservoir or low pressure passage and has no other opening to the atmosphere. The low pressure in the reservoir or passage causes the crank-case vapour to flow into it and thence to the engine by the engine suction. Inevitable minute leakage past the pistons keeps up the pressure inside the crank-case and assists the flow of vapours from the crank-case to the reservoir and ensures automatic and effective ventilation of the crank-case.

The device combines in a simple way all the functions of a carburetter intake air cleaner, crank-case breather, crank-case ventilator and air cleaner. The cost of construction of the device is only a small fraction of the cost of the four devices put together.



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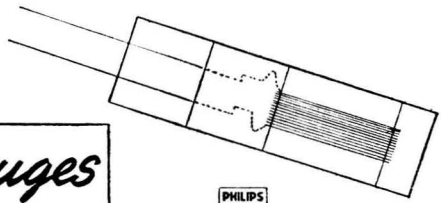

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GEODESY : Universal instruments, microscope theodolites, levelling instruments, levelling rods, heliotropes, sag meters for overhead lines, comparators, standard gauges, cathetometers, reading telescopes.

GEOPHYSICS : Pendulum apparatus, torsion balances, magnetometers, seismographs, magnetic standard and portable theodolites.

VIBRATIONS : Vibrographs recording cantact vibrographs, accelerometers.

PHOTOGRAMMETRY : Photographic recording theodolites, cinematographic recording theodolites, zenith cameras.

OCEANOGRAPHY : Current meters, deep sea sounding apparatus, remote transmission sounding apparatus, tide predicting machines, deep sea thermometers.

MATHEMATICS : Prism derivators, differential integraphs, geophysical integrometers, circular slide rules.

B. HEAT & PLANT ENGINEERING

MEASURING INSTRUMENTS : Pressure gauges and meters for gases, air, steam and liquids, liquid level gauges with remote transmission, measuring balances, water-gauge micromanometers, calibrating balances, compressed air meters, long distance gas supply metering stations, tele-thermometer installations, mine statoscopes.

REGULATORS : Automatic regulators for industrial plant, furnace regulators, water-level regulators, temperature regulators, mixture regulators, blast-furnace regulators, paper moisture regulators, gas-works regulators.

C. AERONAUTICS, METEOROLOGY, NAVIGATION

AERONAUTICS : Complete instrument boards, steering, navigating and bearing compasses, curve compasses, distant-reading compasses, compensation bearing discs, altimeters, altitude recorders, statoscopes, variometers, air-speed indicators, air-speed recorders, measuring nozzles, venturi nozzles, pitot tubes, turn and bank indicators, horizons, directional gyros, air supply apparatus, instrument board clocks, fore-and-aft levels, optical communication apparatus, calculating instruments, map instruments, instruments for the supervision of engines, tachometers, charging pressure gauges, apparatus for measuring stocks of fuel and other working media, pressure gauges, flexible hoses, testing and calibrating installations, automatic control devices, optical multiple recorders, training and instructing apparatus, compensation instructional models.

METEOROLOGY : Balloon theodolites for visual and recorded observations, instruments for measuring wind direction and velocity, station barographs, radio-meteorographs, cloud altitude meters.

NAVIGATION : Compasses, compass housings, sextants, logs, compass and sextant testing apparatus, map instruments.

D. PHYSICS, OPTICS, CINEMATOGRAPHY

PHYSICS, OPTICS : Spectrometers, spectrum apparatus, spectroscopes, polarization apparatus, glass strain testers, refractometers, sensitometers, interferometers, instruments for testing optical equipment, optical benches, interference apparatus.

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ALKALOIDAL CONSTITUENTS OF THE BARK OF *Berberis aristata* (RASSAUT) **306**
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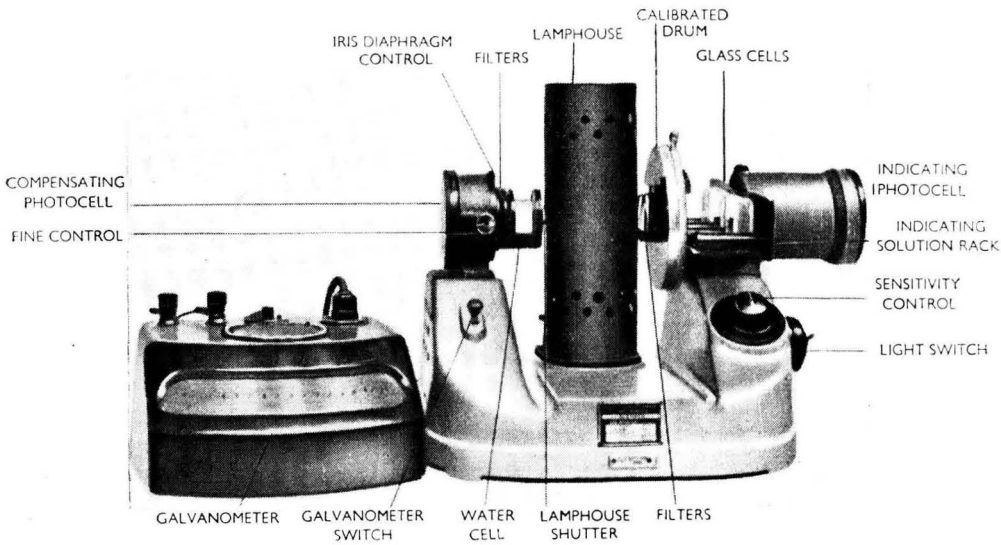

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Co-occurrence of the Positive & Negative Joshi Effect

D. P. JATAR

Chemical Laboratories, Banaras Hindu University, Banaras

Joshi effect in iodine vapour under sleeve excitation has been investigated. Current oscillograms obtained in the dark and in light reveal the co-occurrence of the positive and negative Joshi effect.

DURING work on the potential variation of Joshi effect, an almost instantaneous and reversible photovariation ($\pm\Delta i$) of the discharge current (i), some suggestive results were obtained when current measurements were made with systems charged with various vapours and gases in dark and in light, using *simultaneously* more than one detector. They were particularly significant in the case of iodine vapour excited by external sleeve electrodes connected to the secondaries of an H.T. transformer. The current (i) was observed with a mirror galvanometer actuated by a diode; and also with a cathode ray oscillograph connected serially with the former in the tube circuit. Table I records one typical series of results. The relative Joshi effect, $\%\Delta i = 100\Delta i/i_D$ where i_D is the current in dark and Δi its change (usually though not invariably decrease) on irradiation. Joshi[1], using h.f. discharges in chlorine, Tewari[2] and Deshmukh[3] using commercial frequency discharges in iodine vapour observed a fairly pronounced positive effect at low potentials and its inversion by increasing the potential; the familiar Siemens' ozonizer constituted the discharge tube in their experiments. The present results using sleeve excitation show the production of a large positive Joshi effect just near the threshold potential, viz. about 0·4 kV. On increasing the applied potential by 0·07 kV., i.e. by about 17 per cent, it is remarkable to see the effect changing sign and yielding about 66 per cent negative Joshi effect. This last increases (numerically) to a maximum, about 73 per cent, for the same rise in applied potential and then diminishes progressively.

TABLE I — JOSHI EFFECT IN IODINE VAPOUR

kV.	i_D	i_L	Δi	$\%\Delta i$
$0{\cdot}4_0$	8	21	+ 13	+162·5
$0{\cdot}4_4$	98	33	− 65	− 66·3
$0{\cdot}5_3$	143	38	−105	− 73·4
$0{\cdot}6_4$	173	46	−127	− 73·4
$0{\cdot}7_1$	190	53	−137	− 72·1
$0{\cdot}8_4$	208	58	−150	− 72·1
$0{\cdot}9_4$	218	63	−155	− 71·1
$1{\cdot}0_7$	220	66	−154	− 70·0
$1{\cdot}1_7$	218	70	−148	− 67·9
$1{\cdot}3_3$	228	76	−152	− 66·7
$1{\cdot}6_0$	231	89	−142	− 61·4
$1{\cdot}8_7$	231	100	−131	− 56·7
$2{\cdot}1_3$	230	110	−120	− 52·2
$2{\cdot}4_0$	230	113	−117	− 50·8
$2{\cdot}6_7$	203	113	− 90	− 44·3

A study of the wave-form of the discharge current i_D, and that under light, i_L, was next undertaken. Fig. 1 is a representative group of oscillograms obtained in dark and in light for the potential range 0·4 to 1·0 kV. when the relative Joshi effect, $\%\Delta i$, varies appreciably. Oscillograms corresponding to large applied potentials (not shown) differed from those in Fig. 1 chiefly in one respect: The number of high frequency (h.f.) pulses increased markedly rapidly and tended to be crowded with increased applied potential. As the value of the discharge current was low and the regime markedly unstable, the corresponding current structure on the C.R.O., at potentials less than 0·4 kV., was too flickering for delineation. It was seen, however, that at

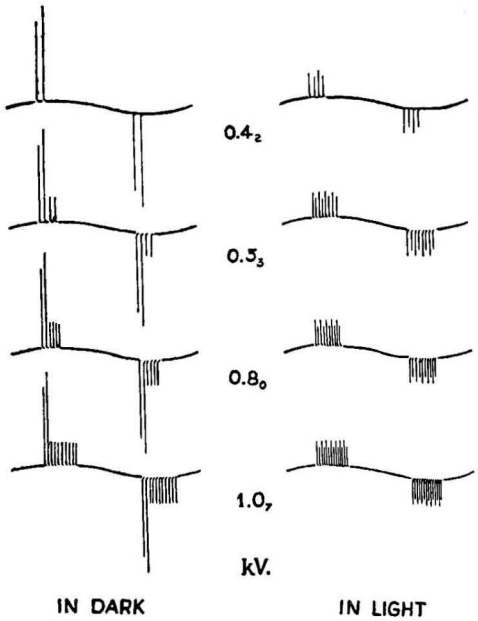

FIG. 1 — OSCILLOGRAMS IN THE DARK AND IN LIGHT FOR THE POTENTIAL RANGE 0·4 TO 1·0 KV.

these low potentials, causing the positive Joshi effect, the influence of irradiation was chiefly to stabilize the h.f. pulses. It is now seen that as the potential is increased, the number of high frequency pulses (say, in dark) increases ; their amplitudes, however, remain sensibly unaltered. A diode measures the overall current whose magnitude depends almost entirely on the number and the amplitude of these h.f. pulses. It is instructive to observe that the effect of light investigated in various visible spectral regions is to cause two *simultaneous* changes, both instantaneous and light-reversible : (a) a decrease in the amplitude of some of these h.f. pulses but (b) increase in their total number. An examination of a number of oscillograms, of which Fig. 1 is typical, undertaken to obtain more information about (a) has revealed that the amplitude reduction on irradiation is apparently linked with alternate h.f. pulses, which is suggestive. The amplitude reduction (a) has been observed in these laboratories and elsewhere in numerous system showing $-\Delta i$. Now, $-\Delta i$ would be reduced (numerically) due to the co-occurrence of (b), which *per se* should cause the positive Joshi effect. The net influence of light under any given circumstances would, therefore, depend on the resultant of (a) and (b). Essentially similar results have been observed in a number of other media and markedly in hydrogen under sleeve excitation over a fairly wide range of operative conditions. With an ozonizer discharge in chlorine and using as a current detector a special nine-valve amplifier connected to a loudspeaker, a small positive effect was observed by Joshi and Lad[4] just above the threshold potential V_m, which inverted precipitously to the apparently more familiar negative effect due to a very slight increase of the applied potential. In a chlorine-filled semi-ozonizer, Joshi[5] observed within a limited range of conditions, in the anti-phase half-wave positions of the oscillograms, a simultaneous production of the positive and negative Joshi effect. The ready inversion $+\Delta i \rightleftharpoons -\Delta i$ and their co-occurrence now observed as a methodic feature of a fairly wide range of conditions under sleeve excitation, have an obvious interest from the standpoint of a general theory of this phenomenon, e.g. Joshi's theory[5] of its surface photoelectric origin. Subsequent studies have shown that compared with other type discharges such as that using an ozonizer, which has almost invariably been used during earlier work in this field, this *simultaneous* production of $\pm\Delta i$ is more widespread, easier of detection and entails a simpler technique under sleeve excitation. Presumably this is because at low field strengths, which are favourable for the co-occurrence of this phenomenon, sleeve excitation produces chiefly a surface as distinct from volume conductivity. This is illustrated by the general finding that both the magnitude and the above-mentioned characteristics (a) and (b) of the Joshi effect become more pronounced by increasing the number of sleeves.

My grateful thanks are due to the Council of Scientific & Industrial Research for a grant and to Professor S. S. Joshi for his valuable advice and guidance throughout the progress of this work.

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Preparation & Properties of β-dextrin from Arrowroot Starch

R. VISWANATHAN
University Biochemical Laboratory, Madras

The preparation of β-dextrin from soluble starch (arrowroot) has been described. Four samples have been analysed for their phosphorus content, iodine number and copper reducing power. The rate of hydrolysis of dextrins by paddy malt amylase is influenced by the phosphorus content and iodine and copper numbers of the dextrin and is appreciably slow when these values are high.

The dextrins can be fractionated into two components by cold water extraction.

A modified iodometric method has been described for determining the copper reducing power of starches and dextrins.

AMONG the controversial aspects of the chemistry of β-dextrin[1] may be mentioned the functional significance of the dextrin-phosphorus[1-3] and the homogeneity of the dextrin itself[1,2,5,6]. A reinvestigation of these and allied problems requires as an essential preliminary the characterization of β-dextrin obtained under varied conditions of starch hydrolysis. These aspects are dealt with in the present communication.

Experimental

Hydrolysis of Starch — Lintner soluble starch from arrowroot was used as the substrate. Three different preparations of amylase were employed: (i) "Aqueous" amylase was obtained by stirring up ungerminated wheat flour with five times its weight of water and a few c.c. toluene for 10 hr. at 31°C. The suspension was then centrifuged, filtered and the filtrate preserved under toluene at 5°C.; (ii) for the preparation of "alcoholic" amylase, the wheat flour was extracted with twice its weight of 20 per cent (v/v) alcohol for 30 min. at 31°C.; (iii) a third extract was prepared by dialysing the stock "aqueous" amylase for 48 hr. against distilled water under toluene at 5°C. The concentration of the amylase (expressed in terms of its gm. equivalent of wheat flour) was 0·42 per cent of the total volume of the reaction mixture in experiments I-IV.

Expt. No.	*Starch conc., per cent*	*Amylase extract*
I	2·1	aqueous
II	8·4	aqueous
III	2·1	aqueous (dialysed)
IV	8·4	alcoholic

The hydrolyses were carried out at 38°C. in acetate buffer (*p*H 4·6, final concentration 0·01 molar) with the addition of a few drops of toluene. For following the course of starch hydrolysis, aliquots of the reaction mixture were withdrawn at definite intervals of time. After heat inactivation of the enzyme by keeping in a boiling water bath for 5 min., the maltose in the aliquots was estimated by copper iodometry[7].

The results of experiments I-IV (FIG. 1) correspond to typical hydrolysates and refer to ash and moisture-free substrate. The percentage hydrolysis of starch was calculated as 100x (apparent maltose/theoretical maltose), the equation for the theoretical value being 1 gm. starch = 1·055 gm.

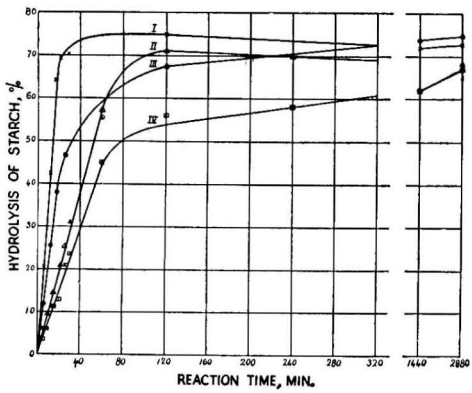

FIG. 1 — HYDROLYSIS OF STARCH BY β-AMYLASE.

maltose. It will be observed that the limit values reported here are considerably higher than those considered typical for β-amylase action by Blom, Bak and Braae[8], namely 53 per cent. Among the factors influencing the extent of starch hydrolysis by β-amylase are the nature and method of preparation of enzyme and substrate[9,11-13]. It is relevant, therefore, to refer to the high limit values associated with the use of crude wheat amylase[10,14] as also to the peculiarities of arrowroot amylopectin[15].

Precipitation of β-dextrin — In each of the experiments I-IV, two digests were used for following the course of starch hydrolysis and two others for the preparation of β-dextrin. At the end of 48-hr. reaction time (by which period the hydrolysates were found to have approached the limit stage), three volumes of 96 per cent alcohol were added to the latter two digests. The dextrin which precipitated was removed by centrifuging, stirred into suspension in 10 c.c. water (in experiments I and III) or in 20 c.c. water (in experiments II and IV) and reprecipitated by the addition of five volumes of 96 per cent alcohol. The dextrin was once again separated by centrifuging, washed twice with 96 per cent alcohol and dried at 60°C. overnight. The yield of the dextrin was 0·3 gm. (in experiments I and III), 1·3 gm. (experiment II) and 1·5 gm. (experiment IV) from a reaction mixture of total volume 72 c.c. These yields of β-dextrin were found to suffice for the determination of total phosphorus, iodine number and dextrin content.

Analysis of Dextrins

One per cent solutions of the dextrins in hot water were prepared. For the estimation of dextrin content, 10 c.c. of the dextrin solution were hydrolysed in N/2 hydrochloric acid for 3 hr. in a boiling water bath. The acid hydrolysate was neutralized with strong alkali, the solution made up to known volume and the glucose in aliquots estimated by copper iodometry. The glucose value was multiplied by 0·90 to get the dextrin equivalent.

Iodine number and total phosphorus of dextrin were estimated by the methods of Samec[16] and King[17] respectively.

An iodometric adaptation of the technique of Richardson, Higginbotham and Farrow[18] was used for estimating the copper reducing power of the dextrins. 5 c.c. of Somogyi's copper reagent[19] and 1 c.c. of 0·1 per cent glucose solution were added to 4 c.c. of the dextrin solution contained in a lightly stoppered 8″×1″ Pyrex boiling tube and kept immersed in a boiling water bath for 3 hr. The boiling tube was then plunged into water at room temperature (31°C.) and maintained therein for 20 min. 2. c.c. of 2·5 per cent potassium iodide were run down the walls of the Pyrex tube without stirring or agitation. 2 c.c. of 20 per cent sulphuric acid were dropped direct into the solution from a wide-mouthed pipette with simultaneous agitation so as to mix the contents thoroughly. Complete dissolution of the cuprous oxide was ensured by stirring up the sedimented reaction products with a glass rod and washing out the tip of the rod into the solution. Titrations were carried out against standard N/200 sodium thiosulphate solution. Blanks were run to allow for the thiosulphate equivalent of the added glucose and the reagents.

The values reported are the averages of those obtained with two separate preparations of each dextrin.

Hydrolysis of Dextrins

For hydrolysis studies a malt preparation from paddy was used. Paddy was allowed to germinate for 3 days and the sun-dried malt was extracted with five times its weight of water and a few c.c. toluene for 10 hr. at 31°C. The procedure for following the course of dextrin hydrolysis was the same as that employed in the case of starch. The reaction mixture was made up of 20 c.c. 1 per cent dextrin solution, 2 c.c. acetate buffer (pH 4·6, 0·1 molar) and 2 c.c. malt extract (= 0·1 gm. malt). Fig. 2 gives the

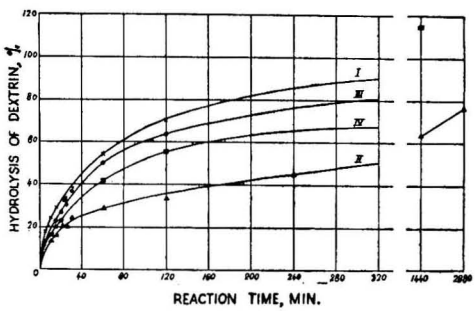

FIG. 2 — HYDROLYSIS OF β-DEXTRIN BY MALT AMYLASE.

results of the hydrolysis experiments on dextrins I-IV. It is seen that the initial rates of hydrolysis as well as the final equilibrium values are of the same order as those obtained by Hopkins, Bailey and Dolby[2] and much higher than those of Tychowski and Masior[10] who used unbuffered reaction mixtures at *p*H 6·0 and could get a final split of only 28 per cent on a typical dextrin. The limit values of maltose obtained in the present case often exceed 100 per cent and point to considerable liberation of glucose[2].

Table I gives the properties of the dextrins and their rates of hydrolysis by malt amylase.

TABLE I — ANALYSIS OF DEXTRINS

Dextrin No.	Phosphorus*, %	Iodine number	Copper number†	% dextrin hydrolysed in 30 min.
I	0·18	7·40	46·5	38·4
II	0·22	7·41	49·8	24·6
III	0·18	6·81	45·1	37·1
IV	0·26	7·41	48·9	28·8

* Phosphorus content of arrowroot soluble starch, 0·06 per cent.

† Copper number refers to mg. of copper reduced by 1·0 gm. starch or dextrin, 1·055 gm. maltose or 1·111 gm. glucose. The values for glucose, maltose and arrowroot soluble starch were 2702, 1279 and 30·43 respectively.

The phosphorus content, iodine number and copper value of dextrins II and IV are slightly higher than those of dextrins I and III. Correspondingly, the rates of hydrolysis by malt amylase are somewhat lower in the case of dextrins II and IV. The differences between the two groups of dextrins are probably related to the differences in activity of 1,6-α-glucosidases of the type mentioned by Myrbaeck and Ahlborg[20]. Decreased activity of 1,6-α-glucosidases at 8 per cent starch concentration might lead to the formation of β-dextrin with a comparatively higher content of anomalous linkages. The possibility has been suggested that phosphorus might be involved in such linkages[1] and it is hence interesting to note that dextrins II and IV prepared from higher substrate levels of starch are relatively richer in phosphorus than dextrins I and III which were prepared from a lower level of starch concentration.

Solubility Determination & Fractionation of β-dextrins

The solubility data reported here refer to dextrins II and IV which were prepared from 50 gm. lots of soluble starch. In the final drying of the dextrins, it was found convenient to use acetone. The yield was 15 gm. of dextrin II and 20 gm. of dextrin IV from 50 gm. of air-dry soluble starch.

Varying amounts of dextrin were mechanically agitated at 31°C. with 10 c.c. water in test-tubes fitted with rubber stoppers. After 30-min. agitation the suspensions were filtered. It was observed that even with the lowest amounts of dextrin used, a significant portion of residue could be recovered on the filter paper. 2 c.c. of the filtrate were used for the determination of dextrin by acid hydrolysis. " Total dextrin " was estimated in hot water solutions of the dextrin. In Fig. 3, the dextrin in 2 c.c. of cold water extract is plotted against total dextrin.

Fig. 4 shows the percentage of dextrin in solution when 100 mg. of dextrin were extracted for 30 min. at 31°C. with 10 c.c. of sodium sulphate solution of varying strength.

For the fractionation of dextrins II and IV, 500 mg. of dextrin were extracted with 50 c.c. water for 30 min. at 31°C. The suspension was then filtered. 5 c.c. of the filtrate were used for the determination of iodine number, 4 c.c. for the determination of copper reducing power and 2 c.c. for acid hydrolysis followed by the determination of iodine number. Another 500 mg. lot of dextrin was similarly fractionated and 37·5 c.c.

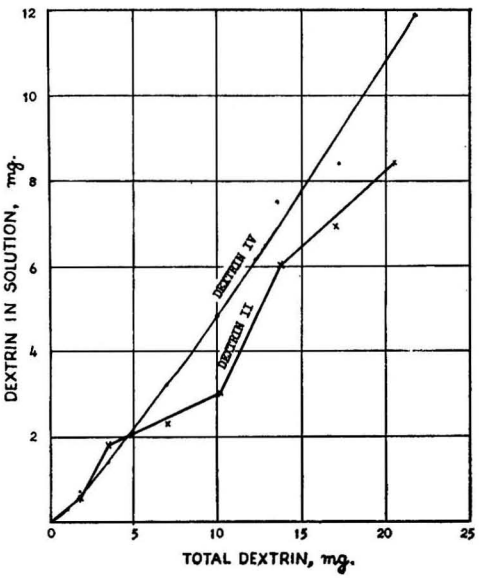

FIG. 3 — SOLUBILITY OF β-DEXTRIN IN WATER AT 31°C.

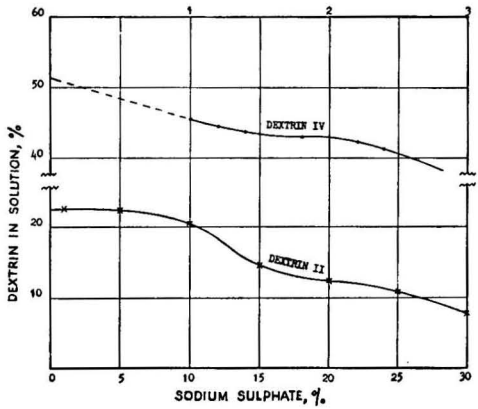

FIG. 4 — SOLUBILITY OF β-DEXTRIN IN SODIUM SULPHATE SOLUTION AT 31°C.

of the filtrate were mixed with 12·5 c.c. of 20 per cent sodium hydroxide for the determination of optical rotation. Values read off from Fig. 3 were used for calculating the properties of the cold water soluble fractions of dextrins II and IV, reported in Table II.

TABLE II — PROPERTIES OF DEXTRINS II & IV & THEIR COLD WATER SOLUBLE FRACTIONS (CWSF)

PROPERTIES	DEXTRIN II	CWSF FROM DEXTRIN II	DEXTRIN IV	CWSF FROM DEXTRIN IV
Iodine number	7·41	19·48	7·41	10·97
Increase in reducing power on acid hydrolysis of dextrin, %	1731	701·5	1522	1140
Copper number	49·77	164·2	48·88	119·0
Specific rotation in 5% aq. NaOH, D line, 31°C.	+161·1°	+181·1°	+166·1°	+226·6°
* n_{BM}	16	6	16	11
† n_{Samec}	18	8	16	12

* n_{BM} = chain length calculated from iodine number according to formula of Bergmann and Machemer[21], i.e. $n_{BM} = 2000/(17 \cdot 11 \times \text{iodine number of dextrin})$.

† n_{Samec} = chain length calculated according to Samec[18] from data on iodine consumed by dextrin before and after acid hydrolysis.

The data presented here on the solubilities of dextrins are not sufficiently extensive to warrant any conclusions on the number of components in the dextrins; still they are enough to show that the dextrins are not chemically homogeneous. The results of the fractionation experiments strikingly confirm the heterogeneity of the dextrin preparations used. The cold water soluble fraction possesses a much higher copper reducing power and iodine number than the original dextrin in both the cases (TABLE II). The specific rotations of the original dextrin and the cold water soluble fraction are also widely different. This is a clear evidence that each of the limit dextrins investigated is a mixture of at least two distinct polysaccharide components. The more soluble component is of lower molecular complexity as judged from its reducing power. A similar relationship between solubility and molecular weight has been reported of starches by Richardson *et al.*[18].

It is also pertinent to note that Haworth and co-workers[5,6] have recorded experimental observations regarding dextrins prepared by them which definitely point to the heterogeneity of their specimens; but they do not appear to have stressed their significance. Thus, depending on the method of acetylation, one or two acetates could be obtained from the same and apparently homogeneous dextrin[5]. Further, the dextrins would not give clear aqueous solutions in the cold. The possibility of fractionating β-dextrin with cold water has been demonstrated in the present work; it would, therefore, seem to be more appropriate to investigate the question of homogeneity by physico-chemical techniques than to place absolute reliance on the methylation method of end group assay.

Summary

1. Four specimens of β-dextrin have been prepared from arrowroot starch under different experimental conditions. Their phosphorus content, iodine number, copper reducing power and rates of hydrolysis by malt amylase have been determined. Of the four dextrins studied, two with the higher phosphorus content, iodine number and copper number were hydrolysed more slowly by malt amylase than the other two.

An iodometric adaptation of the technique of Richardson *et al.*[18] has been described for the determination of copper reducing power of starches and dextrins. The values obtained by this method are consistent with that given by determination of iodine number.

2. Two different preparations of β-dextrin have been studied in regard to their solubility behaviour. Each of these preparations has been separated into two distinct components by fractionation in cold water. In both the

cases the more soluble component has been shown to be of relatively lower molecular complexity.

Acknowledgements

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Utilization of Castor Seed Cake

N. R. KAMATH & R. K. KULKARNI

University Department of Chemical Technology, Bombay

Conditions for the extraction of castor seed proteins from defatted cake have been standardized. Extraction of cake (1 part) with 0·20 per cent sodium hydroxide solution (20 parts) at 60°C. for 30 min. and precipitation of proteins by acetic acid or sulphur dioxide gives a product suitable for the preparation of distempers, oil-bound water paints, adhesive compositions and moulded products.

INDIA produces 64,00,000 tons of oil seeds annually (1944), of which 1,14,000 tons are castor seeds. The oil seed cakes are mostly used as fodder or fertilizer. Castor seed cake, whose production is estimated as 66,000 tons per annum, cannot be used as fodder due to the poisonous constituents present in it, and is, therefore, mainly used as a fertilizer for sugarcane and other crops. Unlike other oil seed proteins, castor cake proteins have not been investigated to any great extent. An excellent review of the castor seed cake and its uses has been given by Jones[1]. The average analysis of defatted castor meal shows 12·4 per cent globulins, 3·85 per cent proteoses, 1·5 per cent toxalbumin ricin and 1·8 per cent pentose proteins.

The suitability of castor cake proteins for the production of distempers, plastics, adhesives and fibres has been investigated and the results are presented in this paper.

Isolation of Proteins

Analysis of Cake — Castor seed cake was first crushed to 4 mesh in a jaw crusher and then disintegrated in a laboratory Raymond screen mill. The cake powder had a bulk density of 0·7 gm./c.c. and gave the following proximate analysis: moisture, 11·25 per cent; fat, 6·2 per cent; ash, 6·27 per cent;

and nitrogen, 4·582 per cent. As the various fractions obtained by the screen analysis of the powder gave the same values for the amount of nitrogenous material peptized by 0·2 per cent NaOH (76·98 per cent), the whole unfractionated cake powder was used in this investigation.

Defatting of the Cake Powder — The relative efficiency of benzene, benzene-methyl alcohol azeotrope, industrial methylated spirits and *n*-hexane for defatting the cake was investigated. Benzene was found to be the ideal solvent for the purpose, as it causes the least denaturation of proteins as indicated by the extraction values by 10 per cent sodium chloride (62·14 per cent N) and is readily available in India. Analysis of the benzene extract was: acid value, 145·1 mg. KOH/gm.; sap. value, 184·0 mg. KOH/gm.; hydroxyl value, 145·2 mg. KOH/gm.

Extraction of Proteins — The defatted cake powder was air dried for 18-24 hr. and all traces of residual benzene were removed under vacuum. The extraction of proteins by sodium chloride, sodium bicarbonate, sodium sulphite, borax and sodium hydroxide solutions was studied in detail. Good yields were obtained by extracting the cake powder with 0·2 per cent sodium hydroxide (20 c.c. per gm. of powder). The optimum temperature and time of agitation are 60°C. and 0·5 hr. for the maximum extraction of protein (88·86 per cent of the total nitrogen). The sodium hydroxide solutions are extremely slow to filter and a systematic investigation showed that the rate of filtration can be considerably enhanced, without in any way diminishing the yield of proteins, by diluting the solution with three times its volume of water; alternately, the decanted solution together with washings can be clarified by centrifuging.

Precipitation of Proteins — The proteins in solution were precipitated by adding dilute acid and adjusting the *p*H to the isoelectric point. Acetic acid and sulphur dioxide were found suitable for the purpose. Proteins obtained by precipitation with alcohol do not easily go into solution in different peptizing agents. The properties of proteins isolated by different methods are given in Table I.

The viscosities of the various protein samples in 0 2 per cent carbonate-free sodium hydroxide solution at 25°C., using standard Ostwald viscometer[2], were determined. The specific viscosities and reduced viscosities at various concentrations were calculated and plotted against concentration, as shown in Figs. 1 and 2. A sample of commercial acid casein, purified by repeated washing with water and separation from extraneous matter by decantation and dried by the usual method, has been included for comparison.

It is seen from Fig. 2 that the specific viscosity of castor cake proteins varies almost linearly with concentration below 1 per cent. The intrinsic viscosity is, therefore, given by the slope of the specific viscosity-concentration curve. At concentrations higher than 1·0 per cent, however, the straight-line relationship does not hold good, although it does in case of casein (FIG. 1). Castor cake protein No. 7 has an intrinsic viscosity of the same order as that of acid casein indicating the possibility of obtaining a castor cake protein fraction having properties comparable with those of acid casein.

It is interesting to note that Staudinger's equation,

$$\eta_{sp} = KMC$$

where η_{sp} = specific viscosity; M = molecular weight; C = concentration in gm./100 c.c.;

TABLE I — PROPERTIES OF ISOLATED PROTEINS

No.	Peptizing agent	Precipitating agent	Yield, %	Nitrogen content, %	Ash content, %	Intrinsic viscosity, 100 c.c./gm.
1	10% NaCl	Alcohol	15·0	14·27	6·79	Partly insoluble
2	do	Acetic acid	10·2	15·91	0·615	0·128
3	do	Sulphur dioxide	10·0	15·63	0·500	0·260
4	do	Acetic acid at *p*H 5·5	2·0	15·34	...	0·145
5*	do	Acetic acid at *p*H 4	4·0	15·23	4·52	0·142
6*	do	Acetic acid at *p*H 3	4·0	15·03	...	0·125
7	0·2 % NaOH	Acetic acid at *p*H 7	16·0	15·63	1·63	0·312
8	do	Acetic acid at *p*H 3	18·2	14·63	2·53	0·197
9	do	Sulphur dioxide	18·0	15·07	1·89	0·160
10	0·4 % Na_2SO_3	do	10·5	14·94	0·5	0·140

* Sample No. 5 is obtained by acidification of the filtrate and washings from sample No. 4 while sample No. 6 is similarly obtained from No. 5.

K = constant, holds good at concentrations below 1 per cent. Hence the determination of viscosity at any one concentration below 1 per cent is needed to determine the molecular weight of the protein fraction, provided the constant K has been previously determined.

Application of Castor Cake Proteins

Coating Compositions — Work done in this laboratory on the raw materials easily available in India, for use in coating compositions, has shown that a mixture of pigments consisting of 48 per cent whiting, 32 per cent barytes, 16 per cent china clay and 4 per cent asbestine (with a small quantity of body pigments for the adjustment to standard whiteness) gives on the whole a better performance than the usual composition for a distemper based on casein. This improved formulation of pigments is used throughout the work with castor cake proteins in coating compositions.

Castor seed cakes, either in the finely powdered form or its fractions passing through (200 mesh screen), were found unsuitable for producing a good grade distemper. The alkali extracts of the cake powder were likewise unsuitable for direct use.

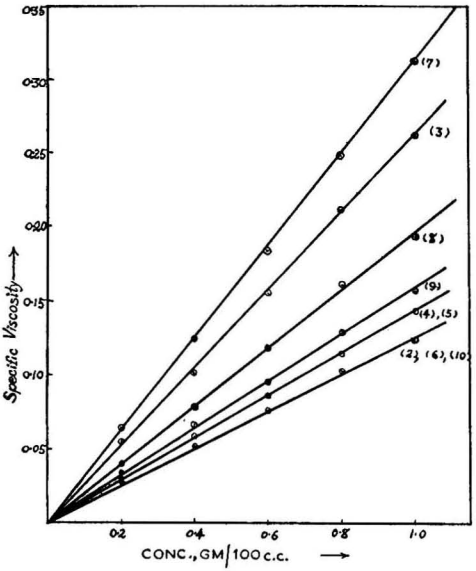

FIG. 2 — VARIATION OF SPECIFIC VISCOSITY WITH CONCENTRATION OF CASTOR PROTEIN SAMPLES (2)-(10).

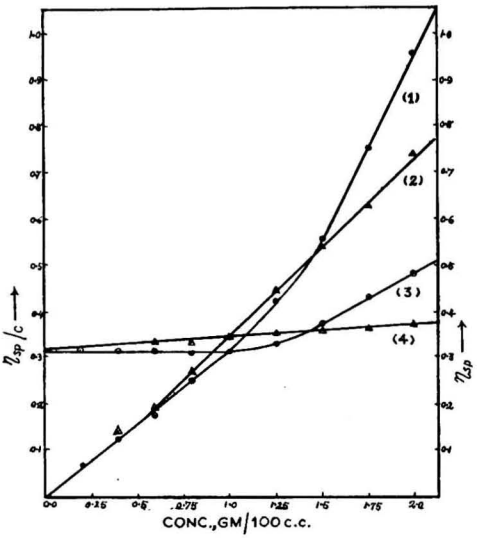

FIG. 1 — VARIATION OF SPECIFIC VISCOSITY AND REDUCED VISCOSITY WITH CONCENTRATION OF CASEIN AND CASTOR PROTEINS (SAMPLE NO. 7); (1) AND (2), η_{sp} *vs.* CONCENTRATION; (3) AND (4), η_{sp}/C *vs.* CONCENTRATION; Δ, CASEIN; O, CASTOR PROTEINS.

The following general procedure was adopted for the preparation of distempers. The proteins in the wet state (10 per cent solids) were dissolved in aqueous sodium hydroxide (5 per cent) and ground with the above pigment mixture along with small quantities of phenol as preservative and turpentine as foam inhibitor.

Two coats of the various distemper samples were applied to a previously prepared wall surface at intervals of 1 hr. The brushability of the distemper while applying, colour, smoothness, uniformity, durability, rub resistance, washability and water resistance of the coating, and failures such as checking, chalking, cracking, etc., were recorded in each case.

The performance of the distempers from proteins obtained from undefatted and defatted cake powder were of the same order. The addition of small quantities of aluminium sulphate was found to enhance the smoothness, durability, water resistance and non-chalking characteristics of the coatings. But chromium salts, effective in insolubilizing

glue films and lime, and particularly useful in hardening casein films, were found to have no appreciable effect on castor cake proteins; on the other hand, lime produced inferior coatings with enhanced chalking. The distemper coatings, which were ordinarily "off-coloured", could be adjusted to standard whiteness by the addition of appropriate quantities of body pigments like titanium dioxide, lithopone, zinc oxide, etc. The amount of body pigments could be reduced to nearly half when sulphur dioxide was used as the precipitant for the proteins instead of acetic acid. The final formula adopted for distempers from castor cake proteins is as follows:

	Parts
1. Whiting	42·2
2. Barytes	19·4
3. China clay	14·1
4. Asbestine	3·5
5. Titanium dioxide	7·9
6. Zinc oxide	0·9
7. Castor cake proteins	10·0
8. Caustic soda	1·0
9. Phenol or other preservative	0·2
10. Turpentine or other foam inhibitor	0·3
11. Aluminium sulphate	0·5

The wet proteins isolated by the caustic soda-sulphur dioxide method, pressed to remove excess of water, was dissolved in a given quantity of caustic soda (5 per cent solution), ground with phenol, turpentine and aluminium sulphate, with the minimum amount of water. The dry blend of pigments were then ground with the above solution to a thick paste, which can be marketed as such in closed containers, or used by thinning it with the requisite quantity of water.

The distempers in the paste form have good keeping qualities; they have been stored for more than a year without any appreciable deterioration. They give dead-white, smooth, non-chalking coatings having good resistance to dry rubbing, moderate washability, durability, but only limited resistance to wet rubbing.

"Tempera" or oil-bound distempers prepared from castor cake proteins give excellent performance. Stand oil with 0·02 per cent cobalt was found to give better results than raw or boiled linseed oil. 50 per cent of oil on the dry weight of proteins gave good results, but twice the above quantity was necessary to give sufficient resistance to water for outdoor use. The fully developed formula was as follows:

	%
1. Proteins	10·0
2. Sodium hydroxide	1·0
3. Phenol or salicylic acid	0·25
4. Pine oil or turpentine	0·60
5. Linseed oil Stand oil of viscosity 4-7 p. with 0·02 per cent cobalt	10·0
6. Aluminium sulphate	0·5
7. Gum tragacanth	0·25
8. Whiting	37·10
9. Barytes	17·30
10. China clay	12·40
11. Titanium dioxide	6·70
12. Zinc oxide	0·80
13. Asbestine	3·10

The wet proteins are dissolved in a minimum quantity of water and phenol, turpentine, and aluminium sulphate and gum tragacanth are added and thoroughly mixed. The oil is then added and the mixing continued until a homogeneous emulsion is obtained. The emulsion is then gradually added to the dry blend of pigments in a pug mill or other suitable mixer; for better dispersion and homogeneity it may be necessary to grind the paste by passing it once through a triple roller or stone mill. The "tempera" so prepared have the same properties as the distempers in use with the added advantage of improved resistance to water and wet rubbing.

The dead-white distempers or "tempera", prepared as above, may be adjusted to any shade of colour by incorporating alkali-resistant inorganic or organic pigments, but when the organic pigments are to be used, lithopone or zinc oxide should be preferred to titanium dioxide because of the blanching effect of the latter.

Plastic Compositions — The production of resinoid plastics using castor cake powder, either defatted or otherwise, with phenol-formaldehyde resins was not encouraging, as the mouldings produced were very brittle and do not take high polish. The proteins, however, could be used along with resins and wood-flour to produce mouldings having good

TABLE II — PROPERTIES OF PLASTIC MOULDINGS FROM CASTOR CAKE PROTEINS

No.	Method of preparation of proteins	Water soluble, %	Water absorption, %		
			24 hr.	48 hr.	20 days
1	0·2% NaOH and acetic acid	4·128	13·7	20·06	23·4
2	0·2% NaOH and $Al_2(SO_4)_3$	3·058	11·38	16·67	22·03
3	0·2% NaOH and SO_2	5·035	13·17	18·93	19·86
4	0·2% NaOH and SO_2 for 24 hr.	5·109	12·18	17·81	18·30
5	0·2% NaOH and SO_2*	5·230	38·95	45·63	46·27

NOTE : The mouldings showed a uniform shrinkage of 9·6 per cent.
* Moulded along with 5 per cent hexamethylene tetramine instead of formalin treatment.

resilience and toughness ; but the surface crazing and high water absorption of the moulded products make them unsuitable for the manufacture of plastic products and electrical accessories. Plastic products from castor seed cake proteins were similar to those prepared from casein. The protein curd, dried to a moisture content of 30 per cent, was moulded under 500 p.s.i. at 95°C. The moulded pieces were steeped in a 5 per cent formalin bath at *p*H 5 for 7 days and dried at 95°C. The shrinkage and water absorption[3] of some samples are given in Table II.

Attempts to harden the mouldings *in situ* with hexamethylene tetramine were unsuccessful and there was a considerable decrease in cohesion when proteins were pretreated with formaldehyde. Proteins obtained from defatted or undefatted cake produced mouldings with like properties. A slight reduction in water absorption was observed when aluminium sulphate was used as a precipitant for proteins instead of sulphur dioxide or acetic acid. The mouldings produced were almost dark in colour and only slightly transluscent ; but thorough blending of the proteins while wet with 10 per cent titanium dioxide and 10 per cent glycerine improved the colour to a great extent, showing the possibility of tinting the plastics to any required shade.

The plastic compositions possess low cohesion and cannot be extruded into rods and tubes like casein. The material can, however, be made into sheets by pressing in frames between hot plates at 500 p.s.i. and 95°C. Buttons and dress ornaments can be punched from the sheet while still wet either before or after treatment with formaldehyde. These treated and dried mouldings have nearly the same resilience, toughness, shrinkage and water absorption as those of casein and, with a judicious modification of the processing technique, can be employed, at least partly, to replace casein plastics.

Attempts to improve cohesion of the plastic compositions by treatment with either alkalies or acids were unsuccessful ; the proteins after such treatment showed a marked tendency towards warping during drying.

Wood Adhesives — Work carried out at the Indian Forest Research Institute, Dehra Dun[4], has shown that the " lime-silicate-casein " formula (cold pressing) evolved at the Madison Laboratories, and Smith and Max formula for soyabean proteins (hot pressing) give suitable adhesive compositions with castor seed cake proteins. This work relates to the use of proteins from the undefatted castor seed cake. The present investigation, however, shows the amount of improvement in the adhesive strength obtainable by defatting the cake.

The dried castor cake proteins not being readily dispersible, the wet protein curds were used in the usual formulations as indicated below.

I. Lime-silicate Formula

1. Proteins	100 parts (dry basis) / 400 parts (wet basis)
2. Lime (CaO)	32
Water	100
3. Sodium silicate ($Na_2O : SiO_2 = 1 : 3{\cdot}25$)	70 parts
4. Copper sulphate	3 parts
Water	30 parts

The wet proteins were ground with milk of lime, and sodium silicate and copper sulphate were further incorporated. The composition was diluted and applied to box-wood (pine) pieces, which were pressed at 200 p.s.i. at room temperature for 18-20 hr.

II. Smith & Max Formula

1. Proteins	100 parts (dry basis) / 400 parts (wet basis)
2. Trisodium phosphate	10 parts
3. Ammonia (0·88)	32 parts
4. Formaldehyde (37% ; neutral)	100 parts

The wet proteins were dispersed in 10 per cent solution of trisodium phosphate and ammonia was added. Formaldehyde was incorporated carefully with agitation. The boxwood (pine) pieces joined with the adhesive were pressed at 135°C. under 300 p.s.i. for 15 min.

The shear strengths of the glue joints were determined using the standard Dillon tester. The shear strengths obtained for various adhesives based on castor cake proteins, along with that for standard acid casein, are given in Table III.

The above results indicate that a good deal of improvement in adhesive strength can be obtained when the cake proteins leached with 0·25 per cent $NaHCO_3$ solution are used. The leaching process removes the residual fats *which are already hydrolysed.* As this avoids the costly and involved process of defatting the cake with a solvent, the loss of 5 per cent of the proteins during leaching will not materially affect the cost to any great extent. The Smith and Max formula (hot pressing) gives consistently high values of adhesive strengths. Thus castor cake proteins isolated from the undefatted cake powder after a preliminary leaching with sodium bicarbonate solution can be recommended in the formulation of wood adhesives by the Smith and Max method.

Fibres — The proteins isolated in the wet state from the defatted castor seed cake by the sodium hydroxide-sulphur dioxide method were directly used in the preparation of fibres. A good grade of commercial acid casein was used for comparison. 10 per cent solution of the proteins in 0·25 per cent aqueous sodium hydroxide, with 1 per cent oleic acid and 1 per cent sodium aluminate, was prepared and, after ageing and removal of air bubbles, it was extruded through a fine orifice into a coagulating bath containing 2 per cent sulphuric acid and 15 per cent sodium sulphate. The extruded fibres were thoroughly washed and then treated with 5 per cent formaldehyde solution. The fibres so obtained were comparable with those made from acid casein under similar conditions, apart from their brownish shade. Although the castor cake proteins show promise as a potential raw material for the manufacture of textile fibre, investigations on a pilot-plant scale have to be carried out before any final recommendation can be made.

Summary

1. Benzene is suitable for defatting the commercial castor seed cake. Proteins from the defatted as well as undefatted cake are best extracted with 0·2 per cent sodium hydroxide, at 60°C. for 0·5 hr. Either acetic acid or sulphur dioxide can be used for the precipitation of proteins. Under suitable conditions it is possible to isolate proteins having the same intrinsic viscosity as that of acid casein.

2. Excellent distempers and oil-bound water paints can be formulated from castor seed cake proteins.

3. The proteins in the wet state with 10 per cent titanium dioxide and 10 per cent glycerine can be employed to produce plastic products, having properties similar to casein plastics.

4. Superior wood-adhesives can be prepared from proteins of castor seed cake.

5. Castor seed cake proteins show promise as a source of textile fibres.

TABLE III — SHEAR STRENGTH OF GLUE JOINTS

No.	Protein used	Lime-silicate formula (cold pressed)			Smith & Max formula (hot pressed)		
		Dry strength, p.s.i.	Wet strength, p.s.i.	Wet strength, % of dry	Dry strength, p.s.i.	Wet strength, p.s.i.	Wet strength, % of dry
1	Acid casein	434 (5)	150 (3)	34·56	...	...	...
2	Proteins from undefatted cake powder	242 (5)	90 (3)	37·18	329 (4)	92 (3)	27·97
3	Proteins of the cake powder leached with 0·25% $NaHCO_3$	255 (4)	110 (2)	43·14	462 (4)	155 (3)	33·55
4*	do	290 (4)	120 (4)	41·38	550 (3)	177 (2)	32·18
5	Proteins of the cake defatted with benzene	— †	— †	— †	462 (3)	137 (2)	29·66

Note — (1) The figures in brackets show the number of specimen samples tested.
(2) For finding out the wet strengths, the test pieces were boiled vigorously for 4 hr. in water, cooled and tested.
* The proteins were precipitated with hydrochloric acid in this case. In all other cases acetic acid was used.
† The samples prepared opened out due to defects in the wood not detected beforehand.

The castor seed cake powder has got a characteristic action on the human respiratory system and due precautions have to be taken in the handling of castor cake powder, particularly during disintegration.

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Studies on Calcium Gluconate: Part I—Production from Dextrose

S. BALASUNDARAM, R. K. HIRANI & V. SUBRAHMANYAN

Department of Biochemistry, Indian Institute of Science, Bangalore

An electrolytic process for the production of calcium gluconate from dextrose has been described. The following operating conditions have proved satisfactory: size of electrolytic cell, 20″×20″×12″; 6 pairs of graphite electrodes, 12″×7″×¼″, separated by ¾″ wooden separators; dextrose, 28 lb. in 60 litres of water; sodium bromide, 3 lb.; calcium carbonate, 8 lb.; current, 25 amp./5V.; temperature, 30° to 35°C.; time, 58 to 60 hr. A yield of 80 per cent on the weight of sugar is reported.

A NUMBER of chemical methods are available for the preparation of gluconic acid and calcium gluconate by mild oxidation of dextrose or materials which yield dextrose on hydrolysis. Gluconic acid was first prepared by Hlassiwetz and Haberman[1] using chlorine as the oxidizing agent. Of the earlier workers Kiliani[2] and Herzfeld[3] used bromine, Haberman and Hoenig[4] used cupric hydroxide and sodium hydroxide, Tarugi and Nicchiotti[5], alkaline ferricyanide. More recently Herzfeld and Lenart[6] developed an improved method using bromine. Kiliani[7] and Pichon[8] have suggested further improvements. Goebel[9] studied the oxidation of glucose in alkaline solutions of iodine and also the preparation of hexonic acids[10] by the oxidation of aldoses with barium hypoiodite. Hoenig and Ruzicka[11] used barium hypobromite for oxidizing *d*-glucose to gluconic acid. Sandoz[12] obtained several patents for the manufacture of calcium gluconate by the oxidation of glucose with chlorine in the presence of potassium bromide and alkaline earth carbonates. Bert[13] prepared gluconic acid by the oxidation of glucose with yellow oxide of mercury. Van der Lande[14] obtained a patent for oxidation of glucose with mixtures of bromides and chlorates in an acid medium and Max Busch[15] for oxidation of dextrose with oxygen in the presence of palladium as catalyst. Hoffman-la-Roche[16] patented a process for the preparation of *l*-gluconic acid by the catalytic hydrogenation of *d*-glucuronic acid in the presence of nickel as a catalyst. Pasternack and Brown[17] obtained a mixture of calcium-*l*-gluconate and *d*-gluconate by hydrogenation of calcium-5-keto-gluconate.

Loeb[18] first attempted the electrolytic oxidation of glucose in sulphuric acid medium but obtained mostly oxalic acid as the final product. Isbell and Frush[19-21] developed an electrolytic process for the oxidation of glucose and other aldoses in which the bromine used for oxidation was continuously regenerated during electrolysis. Fink and Sumners[22] studied the same method in somewhat greater detail. *Rohm & Haas Co.*[23] patented the use of insoluble anodes for electrolysis. Kiliani[24] considered that potassium bromide gives better results than potassium chloride. Szware[25] gives the optimum conditions for maximum yield of calcium gluconate as low temperature (10°-15°C.) and a current density of 3 amp./sq. dm.

The production of calcium gluconate from raw materials hitherto unexplored has been systematically examined and the various practical and theoretical aspects of manufacture are discussed in this paper.

Electrolytic Oxidation of Dextrose — Electrolytic oxidation of dextrose has a great advantage over chemical methods in that a small amount of oxidizing agent present in the electrolyte is continuously regenerated by electrolysis. Usually, a solution containing dextrose (to be oxidized) and potassium bromide is electrolysed at a voltage of 4 to 6 volts using graphite electrodes. The bromine evolved oxidizes the dextrose to gluconic acid and gets itself converted to potassium bromide, which in turn generates bromine on electrolysis. Thus a small amount of potassium bromide in solution is repeatedly utilized for the oxidation of the glucose.

Experimental

All laboratory experiments were carried out in a 3-litre glass container fitted with two pairs of Acheson graphite electrodes, $8'' \times 4\frac{1}{2}'' \times \frac{1}{2}''$. A glass stirrer with wooden upthrust vanes was employed. Pure anhydrous dextrose, potassium bromide and calcium carbonate were used.

In all the runs 450 gm. of pure dextrose were dissolved in water and the solution made up to a volume of 2·5 litres and 125 gm. of calcium carbonate added. A total current of 150 amp./hr. was passed in each case. The temperature of the cell was kept constant by external cooling. The source of current was a 6-volt storage battery which was continuously charged from the D.C. mains. The results are summarized in Tables I to IX.

TABLE I — EFFECT OF ELECTROLYTE (KBr) CONCENTRATION ON THE YIELD OF CALCIUM GLUCONATE

Current density, c. 1·3 amp./sq. dm.; temp. of the cell, 26°C.; distance between electrodes, $\frac{3}{4}''$

KBr, %	Volts	Cal. gluconate formed, %	Cal. gluconate crystallizing out, %
0·5	20	73·3	51·6
1·0	9·5	77·0	52·5
1·5	7·2	82·5	54·1
2·0	6·0	88·3	55·0
3·0	5·0	88·3	54·1
5·0	4·2	88·3	50·8
10·0	2·4	87·6	40·9

TABLE II — EFFECT OF ELECTROLYTE (KBr) CONCENTRATION ON BROMIDE LOSS

Current density, c. 1·3 amp./sq. dm.; distance between electrodes, $\frac{3}{4}''$; temp., 26°C.

Initial conc. of KBr, %	Final conc. of KBr, %	Bromide lost, %
10	9·6	4·0
5·0	4·61	7·8
3·0	2·60	13·5
2·0	1·63	18·5
1·5	1·15	23·3
1·0	0·69	31·0
0·5	0·20	60·0

TABLE III — EFFECT OF VARIATION OF DISTANCE BETWEEN ELECTRODES ON THE YIELD OF CALCIUM GLUCONATE

KBr concentration, 2 per cent; current density, c. 1·3 amp./sq. dm. temp., 26°C.; Acheson graphite electrodes employed

Distance between electrodes, in.	Voltage	Cal. gluconate formed, gm.	Yield, %
$\frac{3}{4}$	4·7	470	78·3
$\frac{7}{8}$	5·5	505	84·2
$\frac{3}{4}$	7·0	530	88·3
1	8·4	525	87·5
$1\frac{1}{8}$	10·0	530	88·3
2	12·0	522	87·0

TABLE IV — EFFECT OF TEMPERATURE ON THE YIELD OF GLUCONATE & LOSS OF BROMIDE

Distance between electrodes, $\frac{3}{4}''$; KBr concentration, 2 per cent; current density, c. 1·3 amp./sq. dm. Water was circulated in the outer jacket at the desired temperature and the temperature in the cell did not vary by more than 1°C. from the desired temperature

Temp., °C.	Yield of cal. gluconate, %	Final conc. of KBr, %	Bromide lost, %
20	87·8	1·70	15·0
30	89·4	1·60	20·0
40	86·9	1·52	24·0
50	83·5	1·43	28·5
60	80·2	1·30	35·0
70	78·6	1·10	45·0

TABLE V — CURRENT DENSITY & YIELD OF CALCIUM GLUCONATE

KBr concentration, 2·0 per cent; average cell temp., 28°C.; total current, 150 amp./hr. Current density was varied by altering the voltage across the cell

Current density, amp./sq. dm.	Voltage	Cal. gluconate formed, gm.	Glucose consumed, gm.	Yield of cal. gluconate, %
0·8	3·7	535	450	89·2
1·3	6·0	530	450	88·3
2·0	9·0	525	443	87·5
3·0	13·5	510	450	85·0
5·0	22·3	470	460	76·6
6·5	29·0	410	460	68·3

TABLE VI — EFFECT OF REVERSAL OF CURRENT AT INTERVALS

Time between reversals, min.	Cal. gluconate formed, gm.	Yield of cal. gluconate, %	Bromide lost, %
5	530	88·3	18·0
30	525	87·5	20·0
60	522	87·0	20·0
180	525	87·5	21·2
360	530	88·3	21·6

TABLE VII — RATE OF STIRRING & YIELD OF CALCIUM GLUCONATE FORMED & CRYSTALLIZED

Total current, 150 amp./hr.

R.P.M.	Cal. gluconate formed, gm.	Cal. gluconate crystallizing out, gm.	Yield of cal. gluconate, %
60	350	120	58·3
120	410	215	68·5
300	520	335	86·6
700	530	340	88·3

TABLE VIII — EFFECT OF REPEATED USE OF MOTHER LIQUOR ON CALCIUM GLUCONATE YIELD

Glucose, gm.	Cal. carbonate, gm.	Sodium bromide, gm.	Yield of recrystallized cal. gluconate, gm.	Remarks
450	125	45	260	...
300	90	20	250	M.L. I
250	70	18	236	M.L. I & II
250	70	18	232	do

M.L. = Mother liquor.

TABLE IX — EFFECT OF INITIAL SUGAR CONCENTRATION ON THE YIELD OF CALCIUM GLUCONATE

Current density, 1·3 amp./sq. dm.; temp., 26°C.; KBr, 2 per cent; volume of solution, 2·5 l.

Initial glucose conc., %	Total amount of glucose, gm.	Total current passed, amp./hr.	Cal. gluconate formed, gm.	Yield of cal. gluconate, %
5	125	40	148	88·1
10	250	80	290	86·4
15	375	120	442	87·0
20	500	160	600	89·2
30	750	240	760	74·0

The yield of calcium gluconate is unaffected by the initial concentration of the sugar. However, with higher concentrations of glucose (above 20 per cent), there is a marked lowering in the yield of calcium gluconate (Table IX). With a 30 per cent solution of glucose, calcium gluconate started crystallizing out from the electrolytic medium long before all the sugar was oxidized. The bulky nature of the salt rendered efficient stirring difficult and the lowering of yield was perhaps mainly due to local over-oxidation near the electrodes. Thus, a concentration of 18 to 20 per cent glucose appears to be best suited to large-scale practice.

The following operating conditions for semi-large-scale production of calcium gluconate have been employed by us with satisfactory results over a period of five years.

(i) Dextrose concentration at the start of electrolysis, *c.* 18 per cent.
(ii) Initial KBr concentration, *c.* 1·8 per cent.
(iii) Temperature of the cell during electrolysis, 30° to 35°C.
(iv) Current density, 1 to 1·3 amp./sq. dm.
(v) Distance between the electrodes, 15 to 20 mm.
(vi) Voltage across the cell, 4 to 6 volts.

Semi-large-scale Production — A wooden cell, 20″ square and 14″ tall, fitted with a wooden stirrer with upthrust blades and 6 pairs of Acheson graphite electrodes, 12″ × 7″ × ½″, was used. The electrodes were separated by wooden separators, ¾″ thick. The cell was charged with 60 litres of tap water, 28 lb. of anhydrous dextrose, 3 lb. of sodium bromide and 8 lb. of calcium carbonate. Sodium bromide was substituted for potassium bromide on a large scale in view of its lower cost, and considering the fact that only the bromide ion is concerned in the oxidation of glucose. A current of 75 amp. at about 5 volts pressure was passed. The glucose was oxidized; electrolysis was allowed to proceed for 58 to 60 hr., after which the contents of the cell were allowed to crystallize, the crystals spun and washed in a centrifuge and the crude calcium gluconate recrystallized from hot water. The calcium gluconate thus obtained conformed to the B.P. specification. That the salt obtained by electrolytic oxidation was calcium gluconate and no other was verified by preparing the phenylhydrazide of the acid. The calcium gluconate prepared using the same mother liquor over and over again gave consistent values for the melting point of the phenylhydrazide, indicating that the glucose was directly oxidized to gluconic acid.

The mother liquor and washings were always returned to the cell and calcium gluconate yields of over 80 per cent on

the weight of sugar employed have been obtained over a period of several months.

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Effect of Heat on Vegetable Oils

MAHARAJA M. BHASIN & J. S. AGGARWAL

National Chemical Laboratory, Poona

Changes in the physical and chemical properties of coconut, castor, groundnut, mustard, safflower and linseed oils brought about as a result of heating the oils under varying experimental conditions have been quantitatively determined. The oils were heated for 4 hr. at 125°C., 200°C. and 300°C. under (1) ordinary conditions, (2) blowing air and (3) blowing carbon dioxide.

THE changes which fixed oils undergo when heated to different temperatures are important in the manufacture of varnishes, paints, printing inks, linoleum and lubricants. Coconut, castor, groundnut, mustard, safflower and linseed oils have been heated under different experimental conditions and the changes occurring in their physical and chemical properties are reported in this paper.

Experimental

500 gm. samples of alkali-refined oil were heated in a flask for 4 hr. at 125°C., 200°C. and 275°-300°C. under the following conditions : (1) ordinary conditions, (2) by blowing air or carbon dioxide at the rate of 10 litres an hour through the oils. A distillation head was provided for flasks when the oils were heated at 275°-300°C. The physical and chemical characteristics of the various samples are recorded in Tables I-VI.

Discussion

Very little loss in the weight of oils was observed when they were heated at 125° and 200°C. while losses were observed in the oils heated at 275°-300°C. Greater losses in weight are observed with coconut and castor oils which may be due to the presence of lower fatty acids in the former and due to dehydration of ricinoleic acid chains in the latter. There is definite increase in the depth of the colour of the oils as the heating temperature and the period of heating are increased.

The increase in specific gravities and viscosities of the oil samples are highest when

TABLE I — EFFECT OF HEAT ON COCONUT OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	398·0	399·0	397·0	396·0	395·0	396·0	386·0	350·0	353·0
Colour (Lovibond)	0·1*	0·1*	0·15*	0·2*	2·0*	1·0*	3·0*	30·0*	80·0*	40·0*
	...	...	...	...	...	...	0·8†	2·0†	25·0†	7·0†
Sp. gr., 40°C.	0·9170	0·9170	0·9183	0·9170	0·9228	0·9209	0·9182	0·9162	0·9284	0·9232
Viscosity, 40°C. (centistokes)	31·77	32·69	33·16	32·57	34·94	36·1	34·66	41·94	48·65	41·87
Ref. ind., 25°C.	1·454	1·4542	1·4543	1·4540	1·4545	1·4545	1·4547	1·4535	1·456	1·4540
Peroxide val.	4·26	19·83	46·95	20·48	2·43	17·93	10·23	0·98	2·51	6·12
Acid val.	0·35	0·37	0·74	0·46	0·5	1·178	1·073	27·68	16·68	7·92
Sap. val.	259·4	267·4	258·0	262·0	268·9	261·7	265·0	267·1	267·3	267·2
Iodine val. (Wijs)	9·32	9·79	8·72	8·34	9·18	8·53	8·53	9·02	7·5	7·93

* Yellow † Red

TABLE II — EFFECT OF HEAT ON CASTOR OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	395·0	396·0	399·0	397·0	393·0	393·0	344·0	330·0	338·0
Colour (Lovibond)	0·3*	0·4*	0·5*	0·6*	0·5*	1·4*	3·0*	15·0*	...	2·0*
	...	...	...	...	...	0·3†	0·4†	1·8†	...	0·3†
Sp. gr., 40°C.	0·9603	0·9572	0·9547	0·9562	0·9585	0·9563	0·9562	0·9508	Gel formation took place	0·9445
Viscosity, 40°C. (centistokes)	280·16	295·6	311·6	312·7	322·9	347·4	336·8	933·6		337·7
Ref. ind., 25°C.	1·478	1·4782	1·4780	1·4781	1·4785	1·4782	1·4783	1·4840		1·483
Peroxide val.	1·8	1·45	6·14	2·2	2·15	2·72	2·50	1·16		1·80
Acid val.	2·63	2·44	2·73	2·36	2·44	1·99	2·1	17·97		20·72
Sap. val.	183·5	186·6	184·1	186·8	186·2	185·1	187·9	210·0		199·1
Iodine val. (Wijs)	86·9	86·7	85·17	85·66	80·66	85·9	87·1	92·94		113·4
Acetyl val.	147·6	144·2	147·0	145·5	145·8	145·2	144·3	37·39		18·1

* Yellow † Red

TABLE III — EFFECT OF HEAT ON GROUNDNUT OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	398·0	398·0	398·0	396·0	393·0	395·0	392·0	365·0	380·0
Colour (Lovibond)	0·2*	0·3*	0·25*	0·25*	0·5*	0·5*	0·5*	10·0*	16·0*	3·0*
	...	...	...	...	...	...	...	1·2†	3·1†	0·6†
Sp. gr., 40°C.	0·9071	0·9073	0·9080	0·9079	0·9102	0·9130	0·9103	0·9105	0·9234	0·9229
Viscosity, 40°C. (centistokes)	42·75	45·04	48·63	46·72	52·94	62·21	50·69	66·75	171·2	88·68
Ref. ind., 25°C.	1·466	1·466	1·4663	1·466	1·467	1·467	1·4665	1·4665	1·471	1·470
Peroxide val.	12·82	10·37	28·48	17·64	8·69	10·57	8·27	3·02	2·82	4·06
Acid val.	0·41	0·56	0·55	0·44	0·77	0·63	0·55	0·74	7·34	3·22
Sap. val.	193·7	193·3	193·6	193·4	194·9	193·6	194·4	192·0	202·0	200·4
Iodine val. (Wijs)	95·7	94·7	95·06	94·95	93·0	94·3	91·24	92·19	82·56	79·16

* Yellow † Red

TABLE IV — EFFECT OF HEAT ON MUSTARD OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	398·0	397·0	397·0	396·0	397·0	395·0	396·0	398·0	382·0
Colour (Lovibond)	0·8*	2·0*	2·4*	10·6*	9·0*	11·0*	8·0*	60·0*	80·0*	50·0*
	0·2†	0·2†	0·6†	2·0†	1·8†	2·0†	2·0†	5·0†	10·0†	3·6†
Sp. gr., 40°C.	0·9040	0·9039	0·9089	0·9076	0·9057	0·9122	0·9105	0·9123	0·9295	0·9229
Viscosity, 40°C. (centistokes)	51·62	52·94	58·06	55·18	60·4	72·79	59·64	128·8	336·6	180·5
Ref. ind., 20°C.	1·469	1·469	1·4692	1·4697	1·4692	1·470	1·4705	1·471	1·4745	1·4733
Peroxide val.	13·58	11·58	15·29	30·27	7·01	8·67	8·80	1·77	7·4	5·0
Acid val.	0·36	0·56	0·65	0·43	0·90	0·97	0·65	18·75	12·6	6·18
Sap. val.	174·0	173·6	174·1	177·2	174·1	175·7	177·0	177·0	180·0	179·8
Iodine val. (Wijs)	99·02	102·0	96·0	100·7	101·5	102·5	104·1	98·63	79·47	89·69

* Yellow † Red

TABLE V — EFFECT OF HEAT ON SAFFLOWER OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	399·0	397·0	399·0	398·0	395·0	398·0	396·0	370·0	375·0
Colour (Lovibond)	0·3*	0·4*	0·8*	0·8*	1·1*	7·0*	6·0*	2·3*	23·0*	60·0*
	...	...	0·3†	0·5†	0·2†	1·7†	1·4†	0·5†	4·6	6·0†
Sp. gr., 40°C.	0·9162	0·9171	0·9174	0·9166	0·9195	0·9203	0·9192	0·9278	0·9502	0·9423
Viscosity, 40°C. (centistokes)	34·38	35·51	40·59	38·47	41·91	48·09	45·43	124·0	1257·1	380·1
Ref. ind., 25°C.	1·4740	1·4740	1·4745	1·4745	1·4745	1·4755	1·4752	1·4772	1·4845	1·482
Peroxide val.	20·2	12·2	43·55	41·0	11·0	12·5	20·00	3·1	2·89	4·56
Acid val.	0·21	0·24	0·55	0·60	0·27	1·01	0·91	8·4	10·07	4·58
Sap. val.	193·6	195·9	193·8	191·0	196·7	192·5	196·1	197·3	195·4	201·3
Iodine val. (Wijs)	143·3	145·0	141·0	141·2	145·0	138·0	139·4	130·7	104·3	118·7

* Yellow † Red

TABLE VI — EFFECT OF HEAT ON LINSEED OIL

Characteristics	Original oil	Oil heated at 125°C.			Oil heated at 200°C.			Oil heated at 275°-300°C.		
		Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown	Ordinary conditions	Air blown	CO_2 blown
Weight, gm.	...	399·0	399·0	398·0	398·0	398·0	396·0	390·0	370·0	370·0
Colour (Lovibond)	3·0*	2·0*	3·0*	2·6*	4·4*	5·4*	3·7*	10·0*		15·0*
	0·3†	0·3†	0·3†	0·5†	0·5†	0·6†	0·6†	1·0†	Gel formation took place after 3-hr. heating	2·0†
Sp. gr., 40°C.	0·9244	0·9256	0·9266	0·9241	0·9304	0·9307	0·9265	0·9509		0·9603
Viscosity, 40°C. (centistokes)	32·9	34·42	37·94	33·09	46·44	56·1	39·61	511·2		1694·2
Ref. ind., 25°C.	1·4777	1·4780	1·4805	1·4805	1·4807	1·4787	1·4820	1·4850		1·4898
Peroxide val.	28·8	10·0	16·3	13·2	7·81	11·75	12·31	2·2		1·7
Acid val.	0·35	0·39	0·47	0·40	0·73	0·75	0·68	6·3		3·3
Sap. val.	193·8	196·6	194·1	194·8	206·1	195·4	196·0	195·4		198·2
Iodine val. (Wijs)	178·2	181·6	180·5	180·4	178·1	176·2	176·6	142·5		119·8

* Yellow † Red

heated at 275°-300°C. The change in the refractive index has been very little in all cases but there is slight increase in the case of castor oil and linseed oil heated at 275°-300°C. The acid and saponification values of the samples increase as the temperature of heating is raised while the iodine value follows the reverse order. These changes are greatest at 275°-300°C. and may be due to oxidation, cracking and polymerization of the oils.

Peroxides, being unstable bodies, break down at higher temperatures and no inference can be arrived at from this value.

The air-blown oil samples show high specific gravity and viscosity and this is more marked in the case of castor and linseed oils. In several cases lower values for specific gravity and viscosity and high acid values have been obtained for oils heated under ordinary conditions at 275°-300°C. than when air or carbon dioxide is blown through. This may be due to some of the cracked products of low molecular weight remaining in the oil.

From the data presented in Tables I-VI it can be concluded that oils with high iodine value should not be employed for lubricating purposes. The use of coconut oil and castor oil for lubrication in steam cylinders or in heavy internal combustion engines where high temperatures are encountered may lead to their decomposition and polymerization. Groundnut and mustard oils appear to be quite satisfactory for lubricating purposes.

Effect of Salts on the Physical Properties of Soils

L. C. JAIN
Building Research Unit (C.S.I.R.), Roorkee

The effect of sodium and calcium salts on the physical properties of Roorkee soil (30 per cent clay and 45 per cent sand) has been investigated. Sodium salts reduce and calcium salts enhance the liquid and plastic limits and linear shrinkage values of the soil. The density of compaction is not significantly influenced by sodium silicate, lime or calcium carbonate, unless the salts are present in high concentrations.

THE physical properties of soils can be modified by the addition of salts. The effects of salts on the bearing capacity of soils — an important consideration in laying the foundations of a structure — have been investigated by Asghar and Sain[1]. The effects of salts on liquid and plastic limits, optimum density and moisture content and linear shrinkage have been investigated in this laboratory with a view to correlate the influence of these factors on the ultimate bearing capacity of soils. The results obtained are reported in this paper.

Experimental

Roorkee soil containing 30 per cent clay and 45 per cent sand was employed in these studies. Samples containing varying amounts of calcium and sodium salts were prepared by mixing salt, soil and water, air-drying the mixture and then sieving through a 40-mesh sieve.

The liquid and plastic limits and the plasticity index were determined according to A.S.T.M. methods D423 and 424 — 39[2,3]. The method recommended by the U.S. Bureau of Public Roads was adopted for the determination of the linear shrinkage. Optimum moisture content and the density of the soil were measured by compacting the soil in a cylinder (3″ × 2·5″ dia.); the soil was compacted in one layer, a hammer (6·6 lb.) being allowed to drop 25 times through a height of 10″. The compacting effort in this case was the same as that obtained in the standard Proctor method.

The results of the tests are presented in Tables I and II and Figs. 1 and 2.

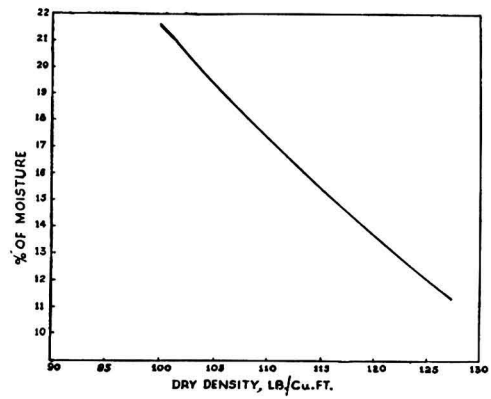

FIG. 1 — RELATION BETWEEN OPTIMUM MOISTURE CONTENT AND OPTIMUM DENSITY OF ROORKEE SOIL AS AFFECTED BY THE ADDITION OF SALTS.

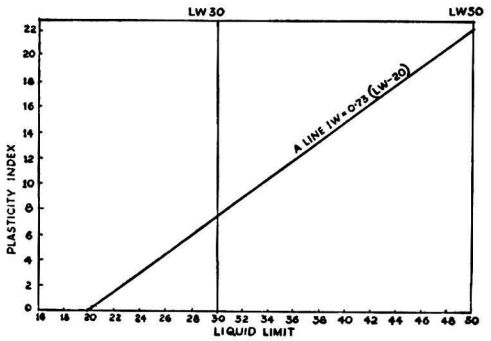

FIG. 2 — INFLUENCE OF SALTS ON THE RELATION BETWEEN THE LIQUID LIMIT AND PLASTICITY INDEX OF ROORKEE SOIL.

Discussion

Liquid Limit — The progressive addition of sodium silicate to the soil first decreases the liquid limit up to a salt concentration of 2 per cent and then the value rises (TABLE I). Similar effects are noticed when sodium carbonate is added to the soil. Sodium sulphate and sodium chloride reduce the value slightly while calcium salts increase it. Sodium soils have a lower liquid limit than calcium and hydrogen soils (TABLE II). These results indicate that it is not the exchangeable bases alone that control the liquid limit of a soil but the presence of salts also affects the value.

The variations in the liquid limit brought about by the addition of salts to the soil may be due to increased dispersion of the

TABLE I — EFFECTS OF SALTS ON ROORKEE SOIL

SALT	% OF SALT ADDED	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	OPTIMUM MOISTURE	OPTIMUM DENSITY	LINEAR SHRINKAGE
Sodium silicate	None	38·4	18·4	20·0	13·3	121·0	12·3
	0·5	23·3	16·1	7·2	13·5	121·8	4·9
	1·0	21·5	16·5	5·0	14·5	119·3	3·9
	2·0	21·0	16·8	4·2	16·4	113·6	2·8
	3·0	27·5	21·0	6·5	20·0	104·5	4·2
	4·0	33·3	24·2	9·1	24·7	98·7	4·8
Sodium carbonate	0·0*	35·0	18·4	16·6	15·9	113·8	11·6
	0·5	26·2	16·4	9·8	14·2	118·7	6·5
	1·0	25·0	15·7	9·3	14·4	117·3	6·0
	2·0	30·4	17·3	13·1	14·8	117·0	8·7
	3·0	33·0	17·9	15·1	14·6	117·6	9·4
	4·0	33·5	17·9	15·6	14·8	117·4	9·7
	5·0	...	...	...	...	...	...
Sodium chloride	0·5	34·5	18·4	16·1	14·8	117·0	10·8
	1·0	34·1	18·0	16·1	14·2	118·0	10·5
	2·0	32·3	18·0	14·3	14·7	117·2	9·6
	3·0	33·2	18·5	14·7	15·1	116·9	9·7
	4·0	33·4	18·5	14·9	15·2	116·7	9·8
Sodium sulphate	0·5	33·8	17·7	16·1	15·1	116·2	9·2
	1·0	31·8	17·4	14·4	14·8	116·8	8·5
	2·0	32·6	17·3	15·3	14·9	117·2	8·7
	3·0	33·0	17·3	15·7	14·9	117·2	8·7
	4·0	33·0	17·5	15·5	15·0	117·0	8·7
Calcium chloride	0·5	35·8	18·9	16·9	14·9	117·4	12·6
	1·0	36·3	18·9	17·4	15·0	116·8	12·6
	2·0	35·4	18·2	17·2	14·9	117·2	12·6
	3·0	35·0	17·9	17·1	15·0	117·2	12·6
	4·0	34·9	18·2	16·7	15·1	116·9	12·6
Calcium sulphate	0·5	35·6	18·5	17·1	15·4	115·0	11·6
	1·0	37·1	19·6	17·5	15·7	114·2	12·1
	2·0	36·9	19·5	17·4	15·4	114·8	11·9
	3·0	36·8	19·2	17·6	15·7	114·3	12·3
	4·0	36·7	18·9	17·8	15·6	114·5	12·4
Calcium carbonate	0·5	35·6	19·0	16·6	15·7	114·3	11·3
	1·0	36·8	19·5	17·3	14·9	115·1	11·2
	2·0	36·6	20·1	16·5	15·1	114·6	11·0
	3·0	36·6	20·3	16·3	15·9	113·7	11·0
	4·0	36·8	20·4	16·4	16·5	112·4	11·0
Calcium oxide	0·5	35·0	18·8	16·2	16·1	114·6	11·6
	1·0	34·9	19·8	15·1	16·2	114·1	9·4
	2·0	35·0	23·5	11·5	17·5	107·5	6·7
	3·0	34·9	24·8	10·1	18·8	105·0	5·5
	4·0	35·4	26·0	9·4	20·4	102·0	4·7

* Untreated Roorkee soil.

TABLE II — EFFECT OF EXCHANGEABLE BASES ON ROORKEE SOIL

SOIL	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	OPTIMUM MOISTURE	OPTIMUM DENSITY	% OF CLAY BY DISINTEGRATION*	% OF CLAY (SHAKING 15 MIN. IN HORLICK'S SHAKER)
Sodium soil	29·0	15·3	13·7	14·8	117·5	26·5	28·5
Calcium soil	34·4	18·0	16·4	15·0	116·8	3·5	9·85
Hydrogen soil	35·4	19·2	16·2	16·1	112·9	4·2	9·9
Sodium soil + 2% sodium chloride	34·8	16·9	17·9	14·6	117·8	19·5	22·5
Calcium soil + 2% calcium chloride	35·3	18·9	16·4	15·0	116·7	2·25	4·75
Untreated soil	35·0	18·4	16·6	15·9	113·8	...	...

* The soil was allowed to remain in contact with water for 24 hr. and the percentage of clay was determined by the pipette method.

soil particles. When sodium carbonate and sodium silicate are added to a soil in small concentrations, they act as deflocculating agents and decrease the value of the liquid limit. In larger amounts they favour flocculation and increase the value. Calcium salts coagulate the soil particles in suspensions and increase the value of the liquid limit.

The plastic limit is controlled both by the exchangeable bases and salts present in the soil. Sodium salts depress the plastic limit to a greater extent than calcium salts. In general, sodium soils have a lower plastic limit than calcium and hydrogen soils. Addition of lime enhances the plastic limit to a significant degree.

The linear shrinkage of soils is influenced by added salts in the same manner as the plasticity index. Addition of small quantities of sodium carbonate and sodium silicate causes the soil compacts to warp. Bricks made from Roorkee soil containing 0·5 per cent added sodium carbonate develop cracks when dried in the sun.

The density of compaction is not significantly affected by the addition of salts. Sodium silicate, lime and calcium carbonate lower the density when added in large amounts to the soils (TABLE II). The density of compaction of a soil is controlled by the thickness of the water film surrounding the clay particle. In the case of soils containing exchangeable bases, in concentrations sufficient to saturate the soil, the thickness of the film around the clay particle is low and the density of the soil is high. Sodium and calcium soils have a higher density of compaction than untreated and hydrogen soils.

The Atterbergs's limits and optimum moisture content of a soil are reported to increase when the density of soil falls[4]. Our results are not in accordance with this observation. Addition of 2 per cent of sodium silicate decreases both the density and the liquid limit of the soil. Similarly, addition of lime decreases the density of the soil but has practically no effect on the liquid limit. The increase in the density of the soil is accompanied by a decrease in the optimum moisture content. The relationship between the optimum moisture content and the optimum density is shown in Fig. 1. The influence of salts on the relation between liquid limit and plasticity index of Roorkee soil is represented in Fig. 2.

The method of classifying soils on the basis of grain size distribution does not give a correct picture of the physical properties of different types of soils. Fine-grained soils having the same particle size distribution can differ widely in physical properties. The limitations of textural classification of soils have been indicated by the work of Casagranade[5]. The results reported (TABLES I and II) indicate that the physical properties of a soil are influenced by the addition of salts.

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Letters to the Editor

LOCATION OF UNDULATIONS IN THE F_2 REGION OF THE IONOSPHERE

IT HAS BEEN REPORTED IN A PREVIOUS COMMUNICATION[1] that the abnormal or anomalous multiple reflections from the F_2 region of the ionosphere, observed by pulse transmissions at vertical incidence, appear to be very intimately connected with the undulations in the ionosphere. As these undulations may at times substantially affect the reception of radio signals, it would be useful to collect the detailed information regarding their formation and other characteristics. These undulations generally occur in the evening hours and are associated with rapid fluctuations and general increase in the intensity of the reflected pulses from the ionosphere. It should be mentioned that these undulations may be fairly extended in space as their effects have often been observed in our fading records for transmissions from Delhi and at the same time they were found to be present in the pulse observations at vertical incidence at Banaras. They may, however, at times be localized in the ionosphere and their duration of existence may vary from several minutes to a few hours. The present communication is intended to show the effects of these undulations on the variations of intensity of short-wave radio signals received at oblique incidence and to find their possible positions in the ionosphere.

For the above purpose, the observations of fading of received signals from three different transmitting stations, viz. Delhi, Calcutta and Karachi, on 31-metre band were recorded at the same time. For the sake of convenience the various stations with lines of shortest distances between the transmitting stations and the receiving centre at Banaras are shown in Fig. 1. The dots on these lines indicate the approximate positions of the projections of the points of reflections in the ionosphere for singly and doubly reflected rays. They are represented by D_1, D_2, D_3, etc., in which the letters indicate the names of transmitting stations and suffixes 1, 2 and 3 represent the points of single reflection, the

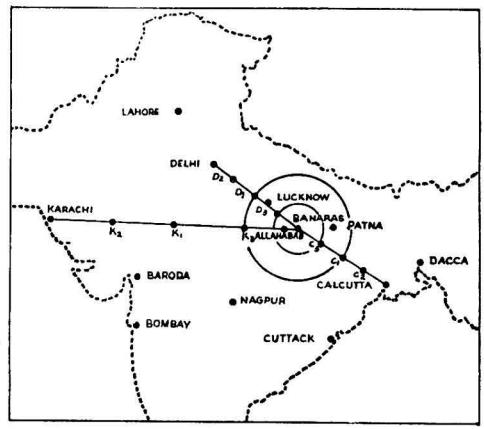

FIG. 1 — THE LINES OF SHORTEST DISTANCES BETWEEN THE TRANSMITTING STATIONS AND THE RECEIVING STATION AT BANARAS.

first and second points of double reflection respectively. The two circles around the receiving station at Banaras are drawn to show the equidistant points of reflection from the receiving centre.

Figs. 2 and 3 represent the fading patterns obtained for the receptions from Calcutta and Karachi respectively. It will be observed that these patterns indicate slow random variations of intensity superimposed with ripples caused by double reflection associated with the vertical movement of the layer, as observed by Banerjee and his collaborators[2,3]. The possibility of double reflection is corroborated by the reception of signals from Delhi on 25 and 19-metre bands

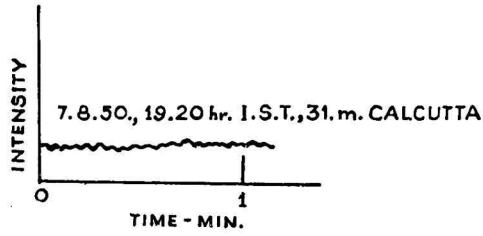

FIG. 2 — FADING PATTERN FOR THE RECEPTIONS FROM CALCUTTA.

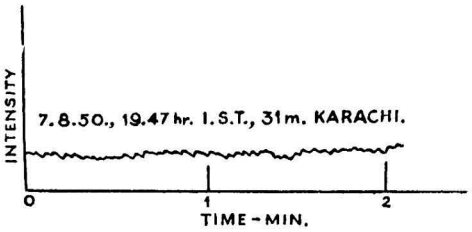

FIG. 3 — FADING PATTERN FOR THE RECEPTIONS FROM KARACHI.

as the average electron densities required for double reflection from Delhi on 31-metre band and for single reflection on 19-metre band are $0{\cdot}82\times10^6$ electrons/c.c. and $1{\cdot}50\times10^6$ electrons/c.c. respectively. The types of fading, as shown in Figs. 2 and 3, are the normal patterns obtained on such occasions when the intensity of singly reflected signal is much greater than the doubly reflected one. Fig. 4 shows the effect of anomalous variations of such reflected waves on the fading patterns obtained for transmissions from Delhi. It would be seen that the amplitudes of the ripples have very much increased due to the increase of intensity of doubly reflected wave compared to the intensity of singly reflected one. It should be mentioned, however, that prior to the appearance of the undulations, the fading pattern for the above transmission from Delhi on 31-metre band was of the normal type as represented in Figs. 2 and 3. The absence of undulations in the fading patterns for Calcutta and Karachi shown in Figs. 2 and 3 and their presence in the reception of

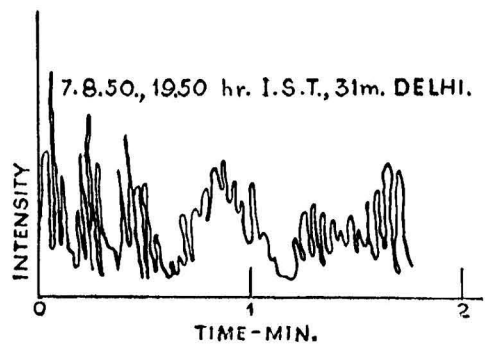

FIG. 4 — EFFECT OF ANOMALOUS VARIATIONS OF REFLECTED WAVES ON FANG.

signals from Delhi suggest the possibility of locating the positions of the undulations in the ionosphere. From preliminary considerations it can be shown that they are not present in the west and south-east directions from Banaras. From the amplitudes of the ripples and average intensity of the received signal from Delhi shown in Fig. 4, it can be inferred that the anomalous variations in the fading pattern are due to doubly reflected signals from Delhi. Thus the undulations may be at the points in the ionosphere over D_2 or D_3 shown in Fig. 1. The vertical incidence pulse transmissions over Banaras at the time of the above observations and on the same frequency band showed the absence of undulations. This indicates that the undulations may be situated over D_2 and not over D_3 (FIG. 1), and thus it may be possible to locate the position of the undulations in the ionosphere. Further work in this direction is in progress and the results of detailed investigations will be published shortly in this journal.

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S. S. BANERJEE
R. R. MEHROTRA

Section of Radio & Electrical Communications
Engineering College
Banaras Hindu University
Banaras
August 21, 1950

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STUDIES IN THE SYNTHESIS OF QUINOLYL-TRICHLORO-ETHANES

IN VIEW OF THE ANTI-TUBERCULAR ACTIVITY of 1, 1, 1,-trichloro-2, 2,-bis-(*p*-aminophenyl)-ethane[1] and also in consideration of the bactericidal properties of 8-oxyquinoline, it

was thought of interest to synthesize and study the physiological activity of quinolyl-trichloro-ethanes in which the lipid solubilizing trichloro-ethyl group is attached to 8-oxyquinoline.

As a result of the present investigations, 1, 1, 1,-trichloro-2, 2,-bis-(8-oxy-x-quinolyl)-ethane, $C_{20}H_{13}O_2N_2Cl_3$, colourless prismatic rods, m.p. 240°C. (decomp.) has been synthesized by condensing chloral hydrate with 8-oxyquinoline in the presence of concentrated sulphuric acid. The intermediate mono-condensation product, 1, 1, 1,-trichloro-2-hydroxy-2-(8-oxy-x-quinolyl)-ethane, $C_{11}H_8O_2NCl_3$, colourless plates, m.p. 130°C., as well as 8-oxyquinoline-5-sulphonic acid, light-yellow needles, m.p. 320°C., have also been obtained from the reaction mixture. Further work in this line is in progress.

K. K. CHAKRAVARTI

National Chemical Laboratory of India
Poona
September 14, 1950

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ALKALOIDAL CONSTITUENTS OF THE BARK OF *BERBERIS ARISTATA* (RASSAUT)

AS A RESULT OF FRACTIONATION OF THE initial crystallizate obtained from the alcoholic extract of the bark of *B. aristata*, Chakravarti, Dhar and Siddiqui[1] reported the isolation of three alkaloidal chlorides melting at 220°C. (decomp.), 204°C. (decomp.) and 165°C. (decomp.) respectively. The chloride, m.p. 220°C. (decomp.), was shown to be identical with berberine chloride ; from the mother liquors of the initial crystallizate, berberine and palmatine were isolated through their respective chloride and iodide.

A further study of the naturally occurring salt, m.p. 204°C. (decomp.), mentioned above, through the preparation, analyses and comparison of melting points and mixed melting points of its various salts, has established its identity with palmatine chloride. On catalytic reduction the chloride yields tetrahydro-anhydro-palmatine (m.p. 147°C.), identical with that obtained from an authentic sample.

The chloride melting at 165°C. (decomp.) on reduction gave a mixture of tetrahydro-anhydro-berberine and tetrahydro-anhydro-palmatine and is a mixture of palmatine and berberine chlorides.

K. K. CHAKRAVARTI

National Chemical Laboratory of India
Poona
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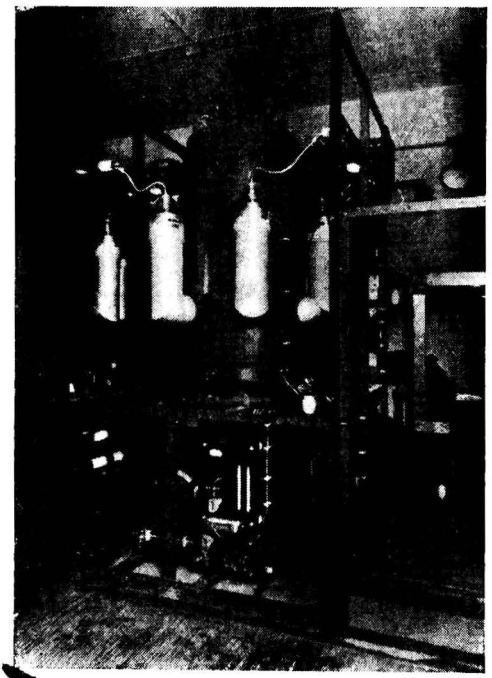

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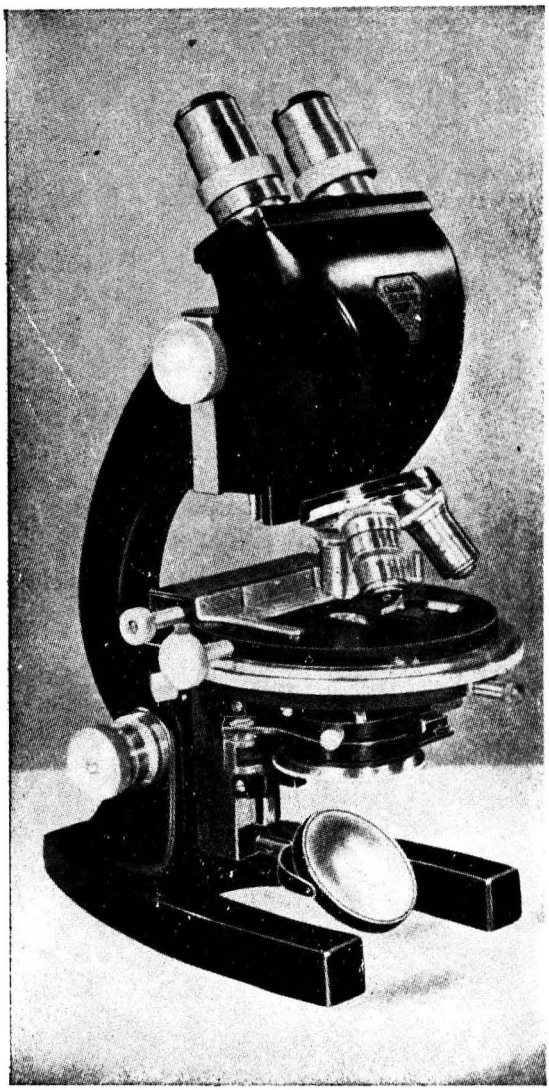

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