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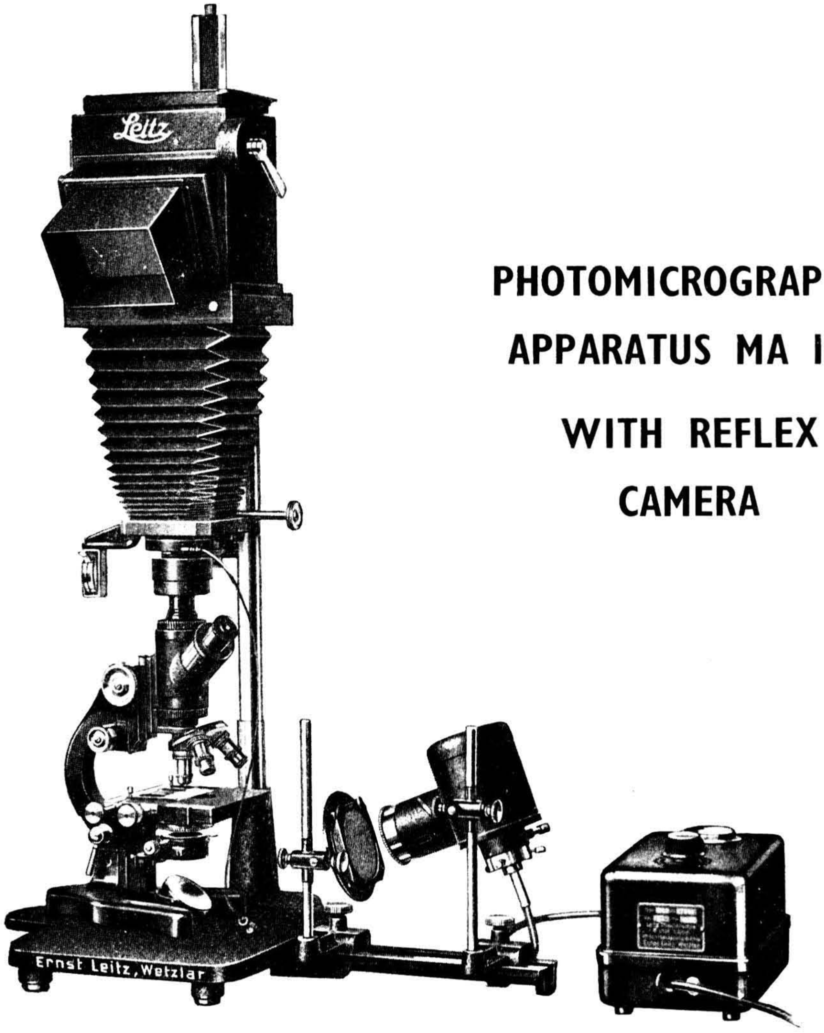
Leitz
Ernst Leitz, Wetzlar

Journal of Scientific & Industrial Research

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COVER PICTURE

The picture on the cover page is an aerial view of Dhaulagiri, the highest peak of the Central Himalayas, rising to a height of 26,795 ft. The photograph shows, in addition, the Dhaulagiri glacier on the northern flanks of the peak, and fold mountains still further north (*see* page 3).

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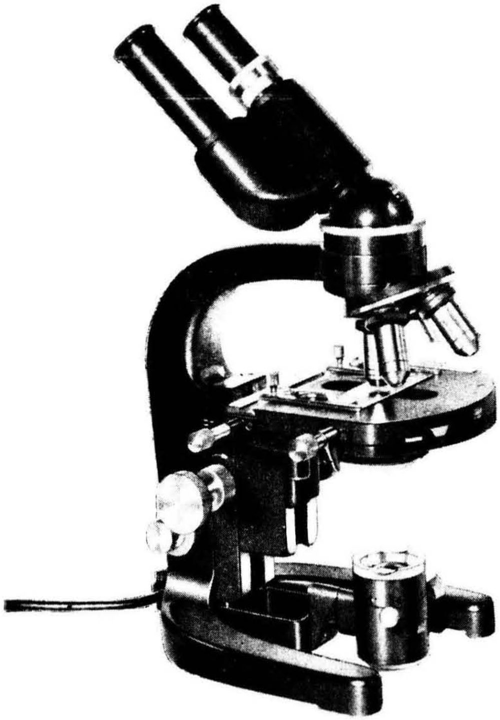

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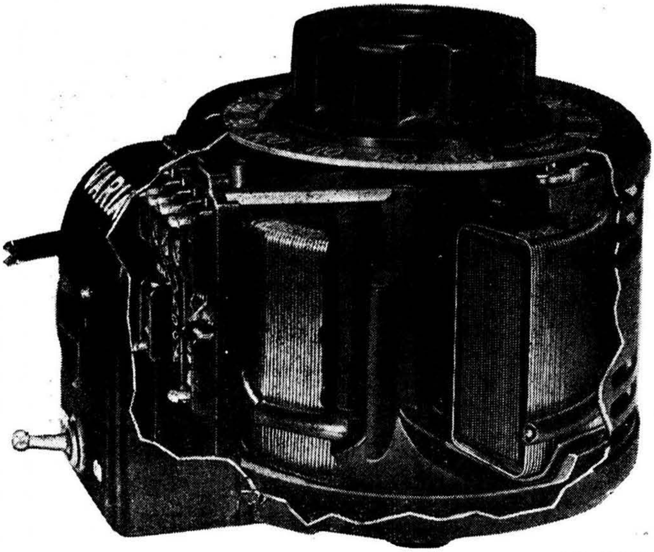
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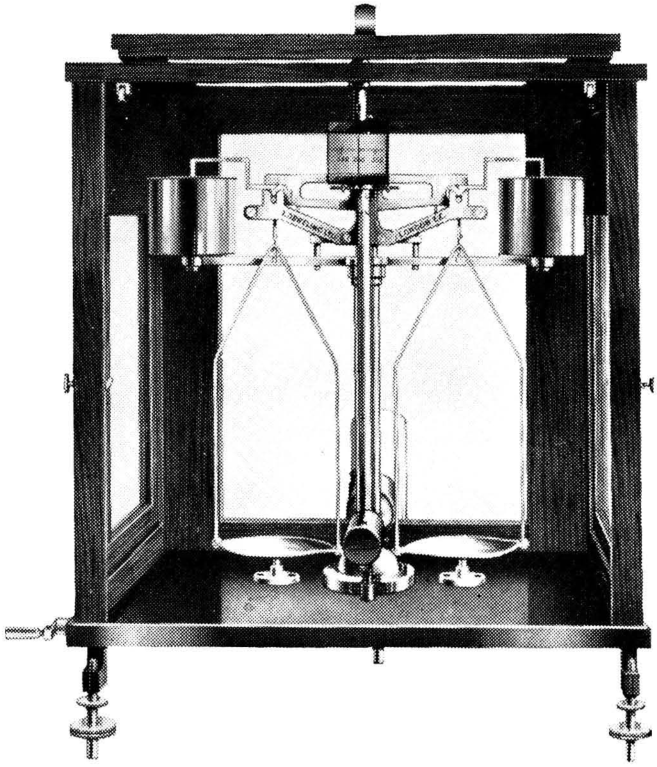

The Roorkee Engineering University

THE oldest engineering college in India, the Thomason College of Engineering, Roorkee, celebrated its centenary during the last week of November 1949. The celebration was marked by an event of unusual significance and import in the history of engineering education in this country — the elevation of the college to the status of a university. The inauguration of an engineering university with a single faculty, imparting higher instruction, setting standards for engineering education, and providing research facilities for advancing the science of engineering is a great event and a bold experiment.

The Thomason College has an impressive record of achievement in the field of technical education. Established in 1847, the College functioned as a centre of instruction in civil engineering. Three years ago the activities were enlarged to include electrical and mechanical engineering courses, and increased facilities were provided for postgraduate studies and research in engineering. The Reorganization Committee appointed in 1939 under the chairmanship of the late Raja Jwala Prasad recommended that the College should be developed as a centre for training in all departments of engineering, including aeronautical and automobile engineering, wireless, chemical and military engineering, photography, engineering economics, architecture, and industrial psychology. The Committee held the view that the College should be converted into a statutory and autonomous technical university. The Fortescue Committee appointed in 1945 gave strong support to these recommendations. A Bill was introduced in the United Provinces Legislature in 1947 to raise the College to the status of a university and was accepted. Pandit Govind Vallabh Pant, the Premier of the United Provinces, presented the Roorkee Engineering University Charter to its first Chancellor, Sir H. P. Mody, a distinguished past student of the Thomason Engineering College, and the new University was inaugurated by Pandit Jawaharlal Nehru, the Prime Minister of India. Prof. A. C. Hart, formerly Professor of Civil Engineering, University College, London, has been appointed Vice-Chancellor.

To assess the importance of a development of this magnitude in the educational field, it is necessary to appreciate that engineers trained in scientific principles and possessing practical experience in the design and carrying out of intricate schemes and plans are required in large numbers in the present context of national reconstruction. The Scientific Manpower Committee estimates the requirements of industry and the government for engineering personnel of all categories for the ten-year period 1947-57 at 25,250 senior grade engineers and the present out-turn of all the engineering colleges in India is only about 950 per year. India abounds in natural wealth. Much of it still remains potential and awaits utilization to make the life of the people rich and meaningful. The natural sciences in their diversity provide the knowledge which, if applied, can lead to their proper utilization for the industrial development of India. In an erudite note prepared by the Director of Scientific & Industrial Research for the consideration of the Reviewing Committee of the *Council of Scientific & Industrial Research*, and included in the committee's report (March 1949), attention is drawn to the rôle of the engineer in the solution of the basic problems of industry. It is pointed out that while scientific and industrial research has made substantial progress, the large-scale application of research to industry calls for the aid of the engineer, and intimate collaboration of the scientist and the engineer is an essential requirement for the successful industrial development of a country. Industrial development, it must be emphasized, does not consist in merely erecting and running of imported industrial plants which have been designed and successfully operated in other countries. However useful such industries have proved to be in supplying consumer goods, a more basic development is called for. The natural resources of the country have to be utilized through inventions and discoveries of Indian scientists and engineers, and it is through their collaborative endeavour that a lasting and progressive industrial structure can be erected. The foundation of such a structure has to be laid truly and securely by building up basic engineering industries, such as the machine tool industry, through the genius and help of engineers equipped with knowledge and motivated by the urge to contribute utmost to build a strong and prosperous India.

Engineers have contributed to progress in two decisive and spectacular directions. Firstly, they have placed at man's disposal a great store of readily utilizable energy and thereby extended his muscular power and, secondly, by providing tools in the form of precision instruments, the value and utility of man's bodily senses have been greatly extended. These extensions of man's powers, both through aids to his senses and additions to his brawn, have enlarged man's domain over Nature, and have enabled him to harness the forces of Nature to contribute to his comfort and well-being. A review of scientific advances over centuries cannot but reveal how the progress of civilization has been influenced by the number and perfection of tools designed and fashioned by the engineer, whether we consider his contributions to improving the means of transport whereby distance has been annihilated, or to the increase of readily utilizable power either by harnessing the energy latent in the tiny atom or apparent in the roaring torrents of mighty rivers, or to the production and provision of the many requirements which man needs to live and function in society. It is manifest that the engineer whose contribution has been so beneficial to progress and civilization should be sought out, trained and provided with all the facilities necessary for his optimum functioning.

The training of engineers, then, is entitled to the highest priority in any scheme of national development. It is for this reason that we welcome the inauguration of the Roorkee Engineering University. We are not here thinking of the engineer functioning in a workshop or a machine-shop and who is concerned with the production of equipment from blue-prints supplied to him, but of the creative artist whose life interest is the acquirement of new knowledge, and whose life work is the exploration of the unknown, the creative artist who makes new and radical developments possible. For his efficient functioning he needs tools, and he needs a free and congenial environment. The inauguration of the Roorkee Engineering University which meets the requirements is an enlightened recognition of the needs of the creative engineer. We are happy to learn that the laboratories and workshops of the Thomason College are being re-grouped and remodelled, and new apparatus and equipment are being installed with a view, more especially, for promoting research enterprise. A century of great achievement lies behind this great institution, and vast and exciting opportunities for constructive work are now opened out before it. The progress of the new institution would be watched with keen interest.

Geological Reconnaissance Flight Over Nepal

D. N. WADIA

AN aerial flight for geological reconnaissance purpose over the Nepal Himalaya, one of the least known regions of the Himalayan zone, was undertaken on the 18th October 1949 by Dr. Arnold Heim, the eminent Swiss Geologist, Dr. D. N. Wadia, the Geological Adviser to the Government of India and Dr. M. R. Sahni of the Geological Survey of India. By courtesy of the Government of India and the Nepal Government, permission for the flight was accorded to the party and the R.I.A.F. kindly supplied a plane provided with oxygen and other equipment needed for high altitude flying up to a ceiling of 20,000 feet.

The plane took off from Lucknow at 5 a.m. and flying for 185 miles over the plains entered the Sub-Himalayan foot-hills south of Butwal on the Nepal border and made for the Kali Gandak valley, a tributary of the Trisul Ganga, which traverses the central axis of Himalaya, right across the line of snow peaks to the Tibetan border. It flew along the valley making a steady ascent over the middle and inner Himalaya. Its route was thus flanked by bounding eminences on either side of the valley affording comprehensive bird's-eye view of the structural plan of the mountains, and even at times of the nature of their component rocks.

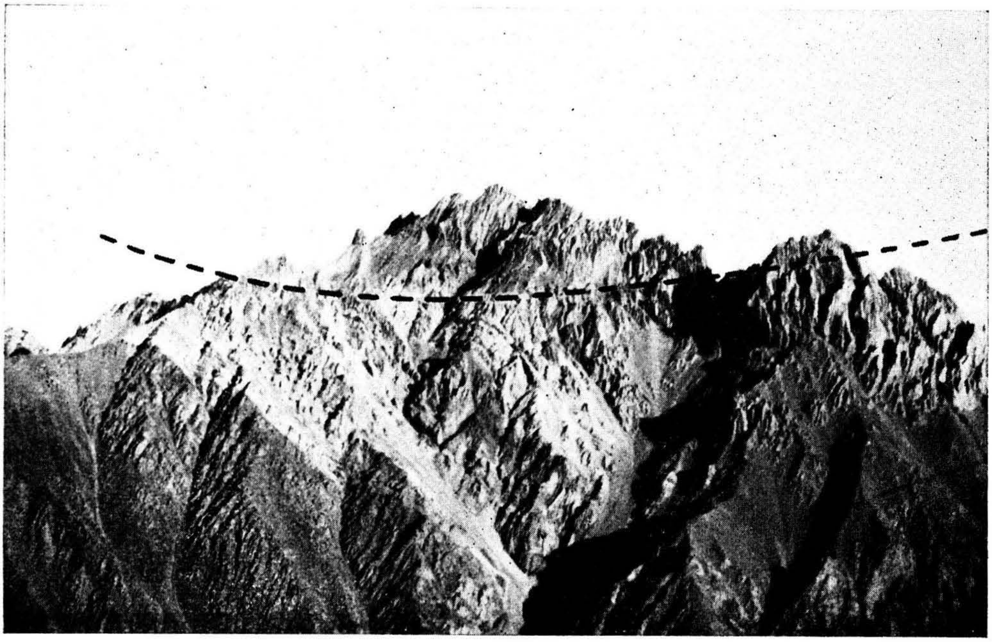

FIG. 1 — SHALES AND (?) LIMESTONES DIPPING NORTH, IN THE TIBETAN ZONE OF THE HIMALAYA. A THRUST PLANE, APPEARING AS AN ALMOST HORIZONTAL LINE SHARPLY CUTTING ACROSS THE DIP PLANES, CAN BE SEEN ABOUT ONE-FOURTH OF THE DISTANCE BELOW THE CREST. (*Photo : M. R. Sahni. View facing west*)

FIG. 2 — TIBETAN PLATEAU TYPE OF LANDSCAPE IN THE FOREGROUND. NORTH OF THE HIMALAYAN AXIS, THE PLATEAU REGION IS PROBABLY COMPOSED OF SPITI SHALES (JURASSIC). (*Photo : M. R. Sahni. View facing about south-east*)

The principal geological observations taken in by the eye of the observer as well as those captured by the camera during the 4 hours' flight are summarized below.

The foot-hill zone of upper Tertiary sediments (Siwalik series) presented the usual features of a succession of low, parallel ridges with south-facing escarpments and N'ly dip-slopes, with broad longitudinal strike valleys of the *Dun* type. To the north of this is the Mahabharat range and a broad zone of ancient Himalayan rocks — mostly pre-Palaeozoic metamorphosed sediments, slates, phyllites and quartzites, belonging to the Daling series — faulted or overthrust against the Siwaliks. This is the 50-mile wide Mid-Himalayan belt with prevailing isoclinal N. dip, composed of a bewildering plexus of ranges of irregular alignation, traversed by deep branching valleys and canöns, for the most part well cultivated and forested, succeeded by the higher ranges of snow-clad inner Himalayas, composed largely of crystalline rocks, intrusive granite and gneiss into the Daling series. These constitute the central axis of the Himalayas, the zone of majestic peaks rising above 20,000 ft. covered in perennial snow. As the plane made a steady ascent over the Kali Gandak valley, the high peak of Dhaulagiri (26,795 ft.), the fifth highest peak of the Himalayas, came into view on the west of the line of flight, with its geological structure of trough-folded strata clearly exposed on its south and east flank, closely followed by the Muktinath group of peaks on the east of the route (26,000 ft. to 21,000 ft.). The well-defined stratification-planes of the Dalings of the middle Himalayan ranges, picked out in the clear oblique light of the morning sun, enabled one to see the large granite intrusions and the dark sombre grey, brown and rusty coloured basic and ultra-basic intrusives as the inner ranges were approached. The complex folding, inversions and dislocations witnessed in this part of the Himalaya, as well as the broad characters and disposition of the rock-systems, appear to be of the same order, generally speaking, as in the better explored Western Himalayas

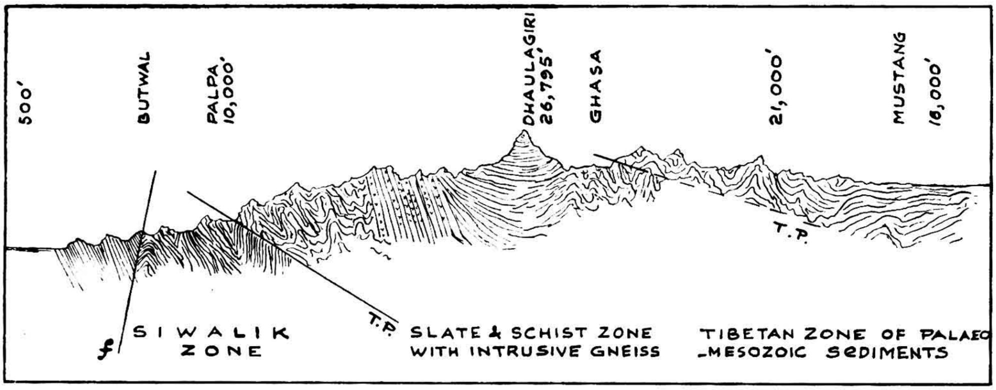

FIG. 3 — GENERALIZED SECTION ACROSS THE NEPAL HIMALAYA SHOWING BROADLY THE STRUCTURAL RELATIONS (120 MILES).

of Kashmir, Garhwal and Simla.* To the north of the central axis, however, the difference in the plan of architecture of Kashmir and Nepal Himalayas is striking. Juxtaposed against the metamorphics of the Dhaulagiri-Muktinath line of peaks, beyond Tukusha, is a faulted or mechanical junction which leads abruptly to the belt of comparatively gently folded fossiliferous sedimentary beds of Palaeozoic-Mesozoic ages — distinguished in Indian Geology as the *Tibetan Zone.* At Muktinath temple situated on the valley floor (14,000 ft.) and at Kagbeni, barely 16 miles north of Dhaulagiri, a report of a ground traverse by Mr. G. S. Lamba in the year 1942 describes occurrence of extensive outcrops of limestone crowded with *Ammonite* fossils (*saligram*). The physical aspect of the mountains, immediately the Great Himalayan Range is crossed, undergoes a profound change: the naked, snowless, barren rocks without any cover of vegetation, either forest or cultivated, look quite unlike the mountains on the Indian side of the Himalayan axis, which are green with abundance of forests and cultivation and crowned in the higher slopes by snow. Further north, as the border of Tibet is approached, well-defined rock-groups, recognizable as Permian Trias, come into view, and the topography becomes more and more subdued with flat, broad plateaus of wide expanse interspersed in the mountains. Near Mustang the country has the Tibetan aspect of far-flung, smooth, barren landscapes, treeless and without any visible signs of human habitation. The substratum of the plateau here is probably black-coloured Jurassic Spiti shales, laden under a mantle of loose sub-recent detritus.

The plane circled above Mustang and turned southwards, flying barely 200 ft. above the featureless water-shed of the Kali Gandak on the Indo-Tibetan frontier, which here makes its deepest indentation northwards, approaching within 25 miles the valley of the Brahmaputra. This low flying enabled good photographs being taken, illustrating the geology and unique topography of the country on the Indian side of the border.

The overthrust of the Tibetan zone of fossiliferous sedimentary rocks on to the central axis of the Great Himalayan Range was the best-observed feature of this aerial traverse. The photographs, thanks to the clear atmosphere and good visibility after sunrise, have picked up other tectonic features, including thrust-planes, which are being studied.

The occurrence of " exotic blocks ", an extremely interesting feature of mountain-tectonics witnessed in Kumaon, 250 miles north-west of the Kali Gandak valley, was not observed during the flight, at any rate not so strikingly as that observed by Arnold Heim and A. Gansser in 1935 during their geological traverse to Manasarover from Almora. These exotic blocks are masses of " foreign " rocks of all ages (from Permian to Cretaceous) and sizes ranging from mere boulders to whole hill-masses, that have been

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* D. N. Wadia — Structure of the Himalayas & of the North Indian Foreland, Presidential Address, Geology Section, Indian Science Congress, 1938.

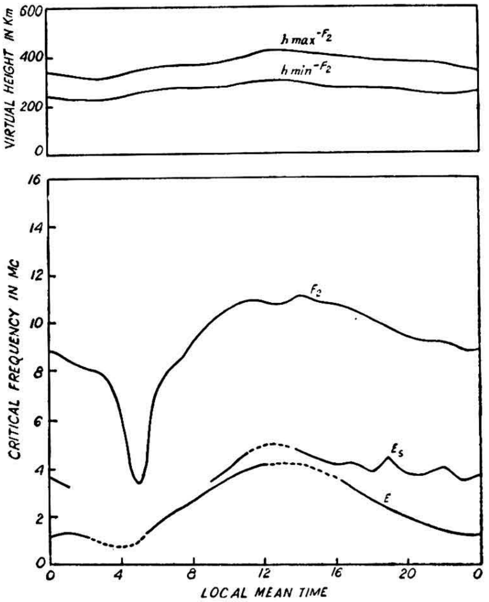
thrust southwards for many miles from their original site in upper central Tibet by powerful mountain-building forces. They are now found over-riding the indigenous rocks of Kumaon detached from their parent rock-folds. The extreme stratigraphic disorder in which these blocks occur today and the discordance of their structure and bedding-planes to the bed-rock in which they lie readily enable geologists to detect them by the eye or by aerial photographs taken at an oblique angle.

Characteristics of the Ionosphere over Calcutta (October 1949)

S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY, (MRS.) T. K. BHAR & A. P. MITRA
Wireless Laboratory, University College of Science, Calcutta

THE following are the ionospheric data observed at Calcutta for the month of October 1949.

Fig. 1 represents the mean hourly values of the penetration frequencies of the E and E_s regions and the penetration frequencies and virtual heights of region F_2 in graphical form. The figures are obtained from average values of the data taken for each hour of the day for 5 days a week. Fig. 2 gives the prediction of the maximum



(5 HR. 54 MIN. AHEAD OF G.M.T.)
FIG. 1 — OCTOBER 1949.

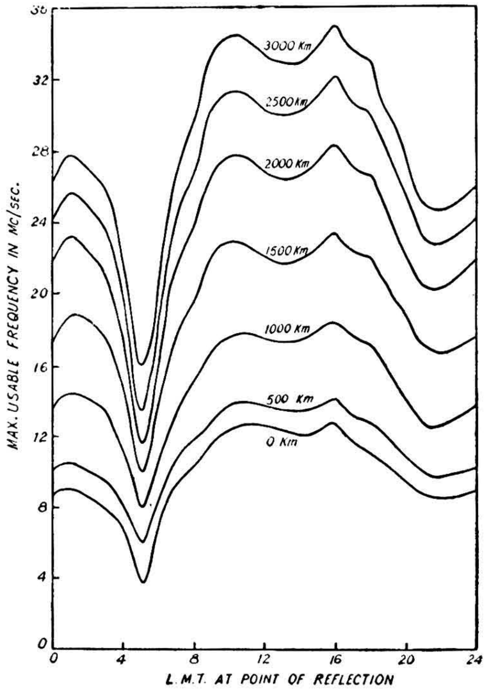


FIG. 2 — PREDICTED M.U.F. VIA F_2 LAYER, JANUARY 1950.

usable frequencies which can be used for different distances of transmission by reflection at the F region over Calcutta for the month of January 1950. Table I gives the different occasions during routine observation when sporadic E ionization was observed and the values of the corresponding penetration frequencies and heights.

Sporadic E ionization was found to occur less frequently in this month. Absorption of normal E echoes at mid-day was also less. The behaviour of region F_2 was found to be normal.

TABLE I

MONTH & YEAR	DATE	HOUR	$f^{\circ}E_s$	$^{h}E_s$
			Mc.	Km.
October 1949	4	16.00	4·35	135
		17.00	3·80	135
	8	16.00	4·70	135
	11	17.00	4·90	135
		22.00	4·80	135
		23.00	4·60	120
	12	00.00	4·00	105
	14	17.00	4·75	135
		18.00	5·00	135
		19.00	4·40	120
		20.00	4·40	120
October 1949	15	11.00	4·60	150
		18.00	3·45	135
	18	17.00	3·35	120
		18.00	3·20	120
	19	10.00	4·00	135
	20	09.00	3·45	135
		10.00	3·60	135
		17.00	3·30	135
		18.00	3·20	135
		22.00	4·60	135
		23.00	4·40	135
	21	00.00	3·20	120
		01.00	3·20	105
		20.00	3·00	120
		21.00	4·25	120
	22	14.00	4·60	135
	24	17.00	3·80	120
		21.00	3·00	105
		22.00	1·95	90
		23.00	1·30	90
	25	16.00	4·50	135
		17.00	4·50	135
		22.00	4·50	120
	28	16.00	2·50	120
		17.00	5·00	135
	31	19.00	3·40	120
		20.00	3·45	120

A Review on the Ceramic Dielectric & Insulator Materials for Low Loss & High Frequency Uses

RABINDAR SINGH
National Metallurgical Laboratory, Jamshedpur

THE rapidly growing use of short-waves and ultra-short-waves for high frequency applications confronts the manufacturer of electrical insulating materials with new problems. In high frequency circuits such as radio, radar, television, communications generally, ignition circuits, electro-medical X-rays and the like, the most important single feature determining the utility of a particular insulator structure is the power loss factor characteristics of the finished piece. The material used must meet certain definite electrical specifications in order to be useful.

Ceramic insulators are favoured because of their excellent combination of good dielectric properties, high mechanical strength, extremely permanent rigidity and refractoriness. Other dielectrics, like bakelite, resins, etc., fail at high temperatures. Normal porcelain does not have the proper dielectric properties that are necessary for high frequency work. Some dielectric materials like quartz cannot be easily fabricated, but are otherwise excellent.

The frequencies encountered vary from the common light circuit at 60 cycles/sec. to ultra-high frequencies which may be as high as 3,000 megacycles/sec.

The type of pieces made from such low loss ceramic materials include rod antenna insulators, tube socket bases, supports and spacers in vacuum and electron tubes, capacitors, switch parts, coil forms, stand-off insulators, bowl insulators, insulating washers, rheostat assemblies, automotive spark plugs, high pressure ignition plugs, etc.

The Loss Factor

The utility of an insulator depends upon the value of its power loss factor. Before going into the actual study of the ceramic materials for high frequency uses, it is desirable to have a knowledge of the loss factor and the factors causing these dielectric losses.

Any insulating material between two electrodes constitutes a capacitor. If such a condenser of capacity C is subjected to the potential E, a radio frequency field having the frequency f, a current I will flow through the condenser. If we introduce the angular velocity $\omega = 2\pi f$, then $I = E\omega C$ and energy to charge the condenser is $EI = E^2\omega C$. The energy actually used in the condenser and transformed into heat is given by the equation $N = E^2\omega C \tan \delta$, where $\omega =$ loss angle and $\tan \delta =$ dielectric power factor.

This formula shows that for a given potential and capacity, the power factor has to be extremely small in order to keep the product $E^2\omega C \tan \delta$ small, especially at high frequencies.

Effect — In a high frequency field, the energy consumed by dielectric loss is transformed into heat. If, for instance, energy is taken from the primary oscillating circuit of a receiver where amplification has not yet taken place, the quality of reception and selectivity are impaired seriously. In transmitters where high potentials are used, the development of heat through dielectric losses of the insulating material present a serious problem. A rise in temperature results in further increase of dielectric loss, and the mutual increase of temperature and power factor leads up to a point where input of heat is in equilibrium with heat radiated out. Before this point is reached, however, complete electrical break-down of the electrical insulator may have taken place.

The best insulating material for high frequency work is vacuum and air with dielectric constant of 1 and a power factor of 0. But the need is for rigid and solid insulators for supporting and separating metallic conductors.

Other factors that cause dielectric losses in ceramic insulator are :

(1) *Ohmic Resistance* — Direct conductivity through the dielectric material shows up in the form of dielectric losses. This is true both for volume and surface conductivity. For any well-vitrified insulating parts, these losses are negligible at ordinary temperatures and dry atmosphere. At elevated temperatures volume conductivity may cause complete break-down of the insulator and under humid conditions the surface conductivity may become appreciable. Because an unglazed ceramic material has a microscopically rough surface which permits moisture to settle in a continuous path, a glazed surface is desired or coating with moisture-resistant wax or varnish gives good results. The latest development in this line is of silicone varnishes, which possess a high degree of water repellancy and thereby allow the equipment to work under conditions of humidity and high temperature.

(2) *Polarization* — Dielectric losses may be caused by the dipole moment of polarized molecules in the electrical field. But these losses are not important in ceramics.

(3) *Non-homogeneity* — Non-homogeneity of the structure of the insulating material may cause dielectric losses. For ceramics the non-homogeneity may be defined as the presence of the crystalline and glassy phases in one material. A dielectric of this type has higher dielectric loss than the components of the mixture, especially if the quotient of conductivity and the dielectric constant is different for the single components of the mixture.

(4) *Oxides* — Those oxides which show excessive electrical conductivity at elevated temperatures cause dielectric losses in ceramic materials.

Requirements of a Ceramic Dielectric Material

The general properties required of ceramic dielectric and insulator materials to be classed as fit materials are as follows :

(1) *Porosity* — High or zero, as the service requires.

(2) High dielectric strength and high specific resistance.

(3) Low power loss factor, especially for service at high frequencies.

(4) High dielectric constant, especially for condensers.

(5) Nos. 2 to 4 effected by temperature changes as little as possible.

(6) High mechanical strength.

(7) Smooth surface to prevent condensation of moisture and gathering of dirt.

(8) Absolute homogeneity with respect to glass to crystal ratio and also with respect to types of crystals present. A one-component system is ideal.

(9) Accuracy of dimensions (tolerance of ±1·0 per cent in dimensions over 0·5″ are usually met without special fabrication). This entails very low shrinkage.

(10) Low thermal expansion is necessary to prevent " drift " in aircraft radios because of extreme temperature changes when they are carried from low to high altitudes, and also to prevent the drift while the radio is heating up and

(11) forming and shaping.

Ceramic Materials Used for High Frequency

Ceramic insulators can be divided under three main heads: (1) porous; (2) vitreous non-glazed and (3) glazed.

(1) *Porous* — Insulators of this type can be used only under low voltage and low frequencies and under dry conditions where moisture will not condense on the surface causing flash-over or surface leakage. High porosity[1] is requisite where evacuation must be complete and quickly accomplished, as for supports in vacuum tubes. These are generally made of refractory oxides, Al_2O_3, BeO, MgO, ZrO_2, ThO_2 and low-fired cordierite. Porous insulators have the added advantage of being able to withstand thermal shocks well.

(2) *Vitreous Non-glazed* — This type is used where high mechanical strength is necessary and where cleanliness is not an important factor. Such electrical insulators are satisfactory for service at high voltage and frequencies. They must have a smooth surface to prevent moisture condensation and many of them are waxed for this reason.

(3) *Glazed* — The porous and some of the vitreous ceramic insulators have a rough surface and must be glazed to obtain a smooth surface which will prevent moisture condensation and the collection of dirt.

Ceramic Dielectrics & Insulators

The main ceramic bodies used for this purpose are steatite, cordierite, rutile and zircon. The less important ones will be dealt with later on.

Steatite Bodies — Under this group fall the ceramic products which have talc[2] or soap-stone ($3MgO.4SiO_2.H_2O$) as the chief component and contain at least 80 per cent of Mg. silicate in the unfired mixture. These bodies are essentially mixtures of talc, clay (added to provide both green and dry strength) and feldspar as flux. Potash feldspar and not soda feldspar is used since K_2O is far less detrimental to the power loss than Na_2O[9]. The amount of flux used generally varies between 10-20 per cent. The dielectric losses of steatite bodies are found to be considerably lower than the porcelain bodies with 25-30 per cent flux in them. This is explained as steatite bodies contain 90 per cent crystalline and 10 per cent glassy phase and the porcelain 60 per cent crystalline and 40 per cent glassy phase. So, to further reduce the dielectric losses in steatite bodies, the reduction of glassy phase is attained by replacement of flux which may develop during cooling or form crystalline products by reacting with talc[4]. Fluxes of this type are found to be Al_2O_3, alkaline earth oxides and even mixtures of various oxides (Al_2O_3 in crystalline phase is beneficial but in glassy phase is harmful). Cristobalite from decomposition of talc and clay is undesirable as it gives high thermal expansion. It is largely eliminated by additions of alkaline earths to the body compositions.

The coefficient of capacitance change and power factor loss can be altered by additions of 5-10 per cent $MgTiO_3$, $BaTiO_3$, ZrO_2[5], TiO_2, BeO, fused MgO, etc. These are substances which will remain crystalline during the firing process and, therefore, effect the dielectric constant, power factor, etc. The best low loss bodies contain BeO with a BeO : BaO ratio of 1 : 22.

In the fired state, insulators of this class are predominantly clinoenstatite with a small amount of mullite and glass.

The main defect in these bodies is that the firing range is only ½ to 1 cone which causes difficulty in its manufacture.

Cordierite Bodies — High thermal expansion is an undesirable property where absolute counting of oscillating circuits has to be maintained. If, for instance. coil forms are made of a material with high coefficient of expansion, oscillations may shift by mere temperature changes due to the physical change of the size of the coil form. For such cases, the materials of low coefficient of expansion are required. Cordierite answers requirement in these bodies. Again one of the main ingredients is talc. The body composition ($2 MgO.2Al_2O_3.5SiO_2$) with theoretical proportions consists of 39·6 per cent talc, 47 per cent clay and 13·4 per cent Al_2O_3. But bodies of this composition have such a short vitrification range that it is practically impossible to manufacture them. Therefore, the amounts of Al_2O_3 and talc are reduced to get a body containing maximum amount of cordierite crystals and having adequate firing range. Sometimes ZrO_2 is also added which is said to lengthen the firing range.

These bodies cannot be glazed satisfactorily due to their very low coefficient of expansion. The unglazed products have rather rough surfaces due to the minute crystals, therefore, surface conductivity is likely to occur under humid conditions.

Sometimes self-glazing is also practised by the addition of certain fluxes like feldspar, nepheline syenite and feldspar-zinc oxide. Spodumene and feldspar and beryl and feldspar have also been tried but not with much success. Slip glazing found suitable for the bodies have the chemical compositions: SiO_2, 52·0 ; Al_2O_3, 13·5 ; MgO, 15·5 ; Be_2O_3, 3·2 ; Fe_2O_3, 9·0 and Cr_2O_3, 6·5. It gives smooth semi-mat glaze.

This glaze layer fits the body as its thickness is only between 0·001″-0·002″ and is intimately connected with the body by cordierite crystals extending from the body into the glaze.

Power factor values of cordierite lie between those of electrical porcelain and the steatite and vary slightly with composition. It has been found that the feldspar content of the glazed articles has some effect on the power factor.

Rutile Bodies — For high frequency application, condensers with low dielectric losses and concentrated capacities are desirable ; in other words, condensers of high capacity but of small size. Mica is used for this purpose but it has the defect of having variations from piece to piece and warping with age and moisture. Steatite has been suggested but they are comparatively bulky and cannot be easily used in radio constructions where space is limited.

Rutile has been found to possess a dielectric constant value of 183[6] parallel to its crystal axis and 89 perpendicular to the axis. A crystal mixture gives an average value of 110 dielectric constant[7]. By adding certain fluxes like titanite ($CaO.TiO_2.SiO_2$), alkali-free titania glasses or MgO titanate, BeO titanate, ZrO_2 titanate, etc., it is possible to produce vitrified ceramic bodies which consist chiefly of rutile crystals with dielectric constant not much less than 110.

The power factor of such bodies is low and within the limits of low loss ceramic materials at high frequencies. At low and audio frequencies, however, the power factor increases considerably.

It shows a negative temperature coefficient of dielectric constant, that is in bodies with high dielectric constant, increase in temperature decreases the dielectric constant. As this negative property is the physical property of rutile, temperature-independent dielectrics can be made only by reducing the TiO_2 content considerably and, therefore, at the same time lowering the dielectric constant. Bodies with dielectric constant between 10-20 are practically independent of temperature.

Zircon Bodies[16] — Considerable research has been done to develop ceramic insulator bodies having the dielectric properties of low loss steatite bodies, but having a longer firing range. Work along this line has been done by *Titanium Alloy Manufacturing Co.*, Niagra Falls (N.Y.), U.S.A. They found that mixtures of zircon and zirco-silicates of barium, calcium, magnesium bonded by clay would produce a body having an unusually long firing range. Such bodies were reported to have a firing range of about 300°F. before maturity. The defect with zircon bodies is that as the material is very abrasive it eats away the dies in extrusion and dry pressing.

Minor Ceramic Materials

(1) *Glass*[8]— Soda-lime glass has low specific resistance, a low dielectric constant and large coefficient of capacitance with temperature change. Pyrex and special alkali-free glasses are much better, but have high dielectric losses at elevated temperatures and at high frequencies. Rapid change in

dielectric properties with temperature variations prevent its use in many applications.

(2) *Clear Fused Quartz* — Fused quartz has a very high volume resistivity and very high dielectric constant. It has the lowest loss of any dielectric.

(3) *Porcelain :* (i) *Normal* — The clay-flint-spar porcelains contain from 40 to 60 per cent of glass containing alkali ions and, therefore, have a rapid change in electrical properties with temperature variations. They also have large power loss at high frequencies. (ii) *Mullite*[2]— This class is particularly well suited for spark plugs because of its high thermal conductivity. It contains little glass but exhibits high power losses at high frequencies.

(4) *Al_2O_3, MgO, BeO, etc.*— The porous refractory oxides are usually bonded with a small amount (2-5 per cent) of clay or talc. All have very high dielectric strengths at high temperatures. For giving the green strength a paste of flour, ammonia and water is generally used.

(5) *Alsifilm* — Dried montmorillonite films impregnated with polystyrenes and resins for pliability have been developed to replace mica in flat irons, toasters, etc. The dielectric constant is about 4-6.

(6) *Lava* — This type of electric insulator is cut from steatite rock, machined and drilled and then fired to 1,000°C. There is little or no linear firing shrinkage. The fired product is mostly clino-enstatite with some cristobalite. The coefficient of thermal expansion is $9{\cdot}0\times10^{-6}$ and the dielectric loss is 1·5 per cent, a fairly high value. Its greatest use is in making " first models " before making expensive dies. It is also used for vacuum tube spreaders.

(7) *Mycalex* — Fine-grained mica is formed (with pyro-plastic at 750°C.) at 5,000 lb. per sq. in. by using either potassium iodide or lead borate bonds, which are soft at this temperature. Both the compression and injection processes are used. These insulators begin to soften at 450°C. but are machinable like unfired lava at room temperature. The dielectric losses are fairly low and the dielectric constant is about 8·0.

(8) *Pyrophyllite* — Pyrophyllite insulators have been made with over 94 per cent pyrophyllite and 6 per cent " plastic flux " and fired to cone 14. These have been found to be superior to porcelain but inferior to steatite.

Properties of Ceramic Insulators & Dielectrics

(1) *Dielectric Constant* — Rochelle salt is reported to have a dielectric constant of about 20,000 in one crystallographic direction at −18°C. and at +24°C. Rutile has a mean dielectric constant of 110-114. The titanates have a dielectric constant of 20-30 and ZrO_2 has a dielectric constant of 18.

Mixtures of TiO_2 with other crystalline substances closely obey the equation :

$$\text{Log } e = X_1 \log e_1 + X_2 \log e_2$$

where e_1 and e_2 represent the dielectric constants and X_1 and X_2, per cent components by volume. This equation is approximated by other dielectric materials especially if all components are crystalline.

Porcelains have a dielectric constant of about 6-8 and all steatite products have a slightly lower value of 5-6.

As a rule Na_2O and Al_2O_3, especially when in glassy phase, lower the dielectric constant. K_2O and Li_2O are less detrimental than Na_2O.

(2) *Dielectric Loss & Power Factor* — A high dielectric constant and a high volume resistivity do not often indicate a low power factor and low dielectric loss. For example, rutile may have a dielectric constant of 100 and a loss of 0·2 per cent while vitreosil has values of 3·5 and 0·06 respectively. Vitreosil has the lowest loss factor of all the common materials, followed closely by low loss steatite and mica. Steatite, normal porcelain and pyrex have slightly higher losses.

Glasses containing " free ions " and dipole components have large losses. The ideal dielectric material has zero power factor and consequently zero dielectric loss.

(3) *Coefficient of Capacitance Change* — To have a constant amount of energy stored in a condenser with temperature variation, the capacitance of the dielectric must remain constant. Porcelain has a large positive coefficient of capacitance change ($5{\cdot}0\text{-}7{\cdot}0 \times 10^{-4}$/°C.) while rutile has a large negative coefficient ($-7{\cdot}0\text{-}7{\cdot}4 \times 10u^{-4}$/°C.). Porcelain has a dielectric constant of about 8 at 25°C. and increases to 63 at 100°C. The dielectric constant of rutile decreases from 100 at approximately the same rate. Steatite and cordierite are remarkably stable. Combinations of positive and negative dielectrics are incorporated in aircraft radios so that the total capacitance change is zero with temperature change.

Rutile can be mixed with positive dielectrics (ZrO_2 for example) to produce condensers of constant capacitance change.

(4) *Coefficient of Thermal Expansion* — Vitreosil has the lowest coefficient of thermal expansion among the insulators, being 0·5 × 10^{-6} per cent/°C. This is followed by the theoretical cordierite at 0·53 × 10^{-6} per cent/°C., and commercial cordierite at about 1·5-2·0 × 10^{-6} per cent/°C. (FIG. 1).

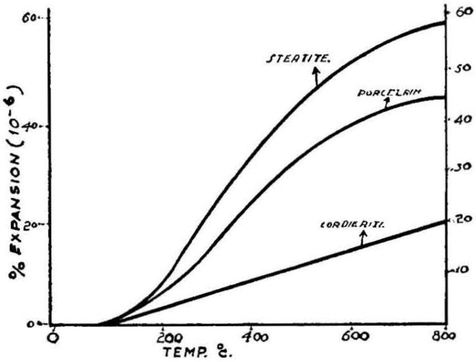


FIG. 1

The thermal expansion is important from two stand points: (i) constancy in induction coils and (ii) resistance to thermal shocks. Cordierite has its greatest application for coil forms where constancy of inductance is necessary and where dielectric loss is the determining requisite. Soda-lime glass, lava and rutile have the highest coefficient of expansion (about 9 × 10^{-6} per cent/°C.). Steatite and normal porcelains have coefficients of expansion slightly lower than lava. As a rule, porous bodies are much more resistant to thermal shock than denser bodies even though the coefficient of expansion may be higher.

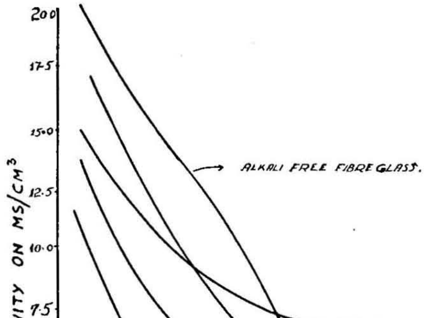


FIG. 2

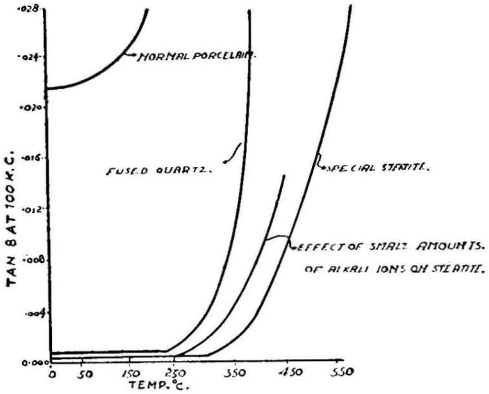


FIG. 3 — EFFECT OF TEMPERATURE ON POWER LOSS.

(5) *Mechanical Strength* — The steatite insulators are only next to zircon insulators in strength. The compressive strength goes up to 1,00,000 lb. per sq. in. Rutile and porcelain sometimes go higher, up to 1,20,000 lb. per sq. in. The porous cordierite insulators are noticeably weak, especially when the composition approximates to the theoretical value.

Steatite bodies have an unusually high tensile strength and this, combined with its compressive strength, produces great toughness. It is presumed that the strength of the steatite bodies is due to the nature of the clino-enstatite crystals.

(6) *Thermal Conductivity* — The combination of high thermal conductivity and mechanical strength give steatite good resistance to thermal shocks in spite of its high coefficient of thermal expansion. Glass, porcelain and others have rather low thermal conductivities.

(7) *General Effects of Temperature on Frequency* — The power factor and power loss factor, as a rule, increase with rise in temperature. The volume resistivity and dielectric strength decrease with increase in temperature in dielectrics containing glass

TABLE I — ELECTRICAL PROPERTIES OF INSULATORS AT ROOM TEMPERATURES

TYPE OF INSULATOR	VOLUME RESISTIVITY ohms/cm. cube	COEFF. OF EXPANSION 20°-100°C.$\times 10^{-6}$	DIELECTRIC CONSTANT AT 1 MC.	DIELECTRIC LOSS FACTOR % AT 1 MC.	COEFF. OF CAPACITANCE CHANGE $\times 10^{-4}$
Rutile	X	7·9	30-100	0·1-0·4	—(7·0-7·4)
Lava	10^{6}	9·0	5·2	1·5	X
Mica	10^{17}	...	4·0-8·0	...	X
Mycalex	10^{16}	8·0	7·5-8·5	0·2-2·0	X
Steatite	10^{14}	6·4	5·0-6·5	1·2	X (1·2-1·6)
Low loss steatite	10^{15}	6·3	6·0	0·04-0·17	X (1·2-1·6)
Porcelain	10^{15}	4·0	6·0-8·0	1·7-2·5	X (5·0-6·0)
Soda-lime glass	10^{12}	8-10	3	5-7	X
Pyrex	10^{18}	3-5	5	0-7	X
Vitreosil	10^{19}	0·5	3·5	0·08-0·05	X
Cordierite	10^{15}	0·53-1·8	5·2	2·0	X

and free ions of K^+ and Na^+. Soda-lime glass may have high resistance at room temperature, but becomes a conductor at 150°C. Crystalline Al_2O_3 is remarkable in its high volume resistivity of about 5,000 ohms/cm. cube at 1,600°C., when practically all the common dielectrics would melt. Because of its high heat conductivity, refractoriness and resistivity at high temperature, vitreous Al_2O_3 is much favoured for aircraft spark plugs. MgO, BeO and ThO_2 are of the same class.

The power factor and dielectric constant decrease as the frequency is increased. The dielectric loss at high frequencies is sufficient to cause heating of the dielectric. The power factor becomes quite constant at about 2-3 megacycles and above.

REFERENCES

1. WELLS, T. : *J.A.C.S.*, 1923, **5**, 675.
2. Idem. : ibid., 1933, **16**, 293.
3. THURNAUER : *Review of Ceramic Materials for High Frequency Insulation.*
4. RIGTERINK & GRISDALE : *J.A.C.S.*, 1942, **25**, 439.
5. STEVENS : ibid., 1933, **21**, 330.
6. " Composition & Properties of Some High Titania Ceramic Bodies ", *J.A.C.S.*, 1941, **24**, 148.
7. BERBERICH & BELL : *Jour. App. Phys.*, 1940, **11**, 681.
8. THURNEAUR & BADGA : "Dielectric Loss of Glass at High Frequencies ", *J.A.C.S.*, 1940, **23**, 9.
9. KRAUER & McDOWELL : ibid., 1925, **8**, 626.
10. RIGTERNIK : *Rev. Sci. Instruments*, 1941, **12**, 527.
11. ANON : " Low Shrinkage Insulators with Preroasted Tetaina ", *Cer. Ind.*, 1939, **33**, 48.
12. NAVIAS : *J.A.C.S.*, 1941, **24**, 148.
13. THIESS : ibid., 1937, **20**, 311.
14. McDOWELL : *Cer. Age*, 1939, **33**, 10.
15. *J.A.C.S.*, 1943, **36**, 98, 389.
16.
17. SEARLE : *Encyclopedia of Ceramic Materials*, Vol. A-E, p. 352.
18. PARMELEE & THURNEAUR : *Am. Cer. Soc.*, 1935, **14**(2), 69.
19. Publications of *Titanium Alloy Company*, Niagra Falls (N.Y.), U.S.A.
20. " Ceramic Dielectric & Insulator Materials for Radio & Radar Instruments", by R. L. STONE, *Bull No. 25, North Carolina State College Publication.*
21. *A.S.T.M.* : *Standards on Electrical Insulating Materials*, prepared by Committee D. 9.

The Use of Wetting Agents in Acidizing of Oil Wells

S. S. BHATNAGAR & MOHAN LAL KHANNA

Council of Scientific & Industrial Research, Delhi

THE acidizing of oil wells is a well-established practice[1] for improving production, particularly of those wells which have passed through the normal process of decline. Hydrochloric acid of 15 per cent concentration is usually employed, and 1,000 gallons of acid dissolve 1,800 lb. or 11 cu. ft. of limestone[2]. The acid concurrently attacks metallic equipment and piping at $\frac{1}{1000}$ to $\frac{1}{100}$ the rate of attack on limestone. This action is of serious consequence, especially if the acid remains in the well for some time. It is, therefore, customary to add inhibitors to prevent or greatly minimize metallic corrosion while the dissolution of the limestone proceeds unaffected.

It has been observed that acidizing in many instances produces little or no beneficial effect on production. This has been attributed to the presence of the oil layer covering the limestone face and the capillaries which prevent the acid from coming into contact with the rock. In such cases the addition of wetting agents has proved helpful.

Wetting agents were used at Dhulian oilfields with marked improvement in the rate of production. " Calsolene H.S. Oil ", an *I.C.I.* product, was used in dilute aqueous solution for the wetting operation. " Fixanol " was added to the acid. The latter, in addition to lowering of surface tension, acted as a corrosion inhibitor. During the early years of World War II, when the supply of chemicals from U.K. to India became uncertain, the indigenous production of wetting agents from the raw materials available in India became a matter of urgent necessity.

Preparation of Wetting Agents

The main structural feature of effective wetting agents appears to be that they consist of molecules in which polar and non-polar groups occur in a balanced proportion[3]. Recent work has shown that polar bodies possessing hydrocarbon chains of not more than 12 carbon atoms in length possess wetting characteristics, while those with longer chains exhibit dispersing and emulsifying properties[4]. Vegetable oils provide useful raw materials for the production of a variety of such reagents. Of these, coconut oil has the most favourable composition[5] (TABLE I). The utilization of coconut oil for preparing suitable wetting agents thus suggested itself.

TABLE I

ACID	NUMBER OF C ATOMS	%
Caproic	6	2
Caprylic	8	9
Capric	10	10
Lauric	12	45
Myristic	14	20
Palmitic	16	7
Stearic	18	5
Oleic	18	2

160 gm. of fatty acids from coconut oil were stirred with 60 gm. of chlorosulphonic acid, the temperature of the mixture being maintained below 22°C. Stirring was continued for 8 hr. The mixture was allowed to stand overnight and excess acid was removed by repeated washing with ice-cold sodium chloride solution. A solution of sodium hydroxide was then added until *just* alkaline.

Evaluation of Wetting Agents

Draves' method[6] was employed for the evaluation of wetting powers of the preparations. 3-ply unboiled cotton yarn was used. As the type of yarn used has a profound influence on the sinking time, a sufficient supply from one particular stock was obtained. " Aerosol O.T. dry ", an extremely active wetting agent, was included for comparison. The results obtained are summarized in Table II and are graphically represented in Figs. 1, 2 and 3.

TABLE II

Temperature 25°*C.*

WETTING AGENT	% CON.	SOLVENT	SINKING TIME sec.	*p*H
Aerosol O.T. dry	0·025	Distilled water	5	6·85
	0·025	15% HCl solution	239	...
	0·010	Distilled water	17	...
	0·005	,,	40	...
	0·100	15% HCl solution	32	...
Calsolene H.S.	0·10	5% ,,	210	...
	0·10	Distilled water	10	6·4
	0·02	,,	55	...
	0·01	,,	96	...
Sulphonated coconut fatty acids	0·10	,,	14	7·2
	0·10	5% HCl solution	287	...
	0·02	Distilled water	83	...
	0·01	,,	190	...
Fixanol	0·10	,,	43	...
	0·02	,,	173	...
	0·01	,,	270	...
	0·10	5% HCl solution	11	...
	0·10	15% ,,	8	...
	0·05	,, ,,	18·5	...
	0·025	,, ,,	34·5	...
	...	Distilled water	613	...

Though surface-tension characteristics cannot be taken as a definite indication of wetting power, yet it provides an indication of its suitability as a test material. Surface tension was determined by the Donnan pipette method. The results obtained are summarized in Table III.

Corrosion Inhibitors

The inhibiting properties of various arsenic compounds and Fixanol on the corrosion of mild steel by sulphuric acid were studied and the results obtained are summarized in Table IV.

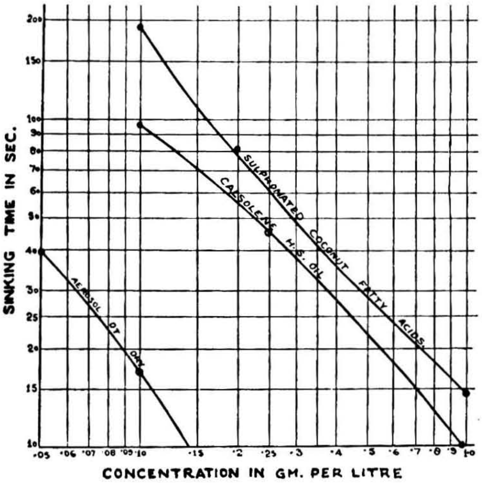


FIG. 1 — SINKING TIME VERSUS CONCENTRATION FOR THE THREE WETTING AGENTS AT *p*H 7.

TABLE III

Temperature 25°C.

WETTING AGENT	% CON	DENSITY	SURFACE TENSION (Dynes/cm.)
Aerosol O.T. dry	...	0·9975	71·97
	0·025	0·998	38·78
	0·10	0·998	30·07
Calsolene H.S.	0·10	0·998	43·84
Sulphonated coconut fatty acids	0·10	0·999	42·07
Fixanol	0·10	1·002	36·92

Discussion of Results

Surface-tension determinations (TABLE III) show that " Aerosol O.T. dry " is exceptionally effective in lowering the surface tension. The results of Draves' test show that the sulphonated fatty acids from coconut oil constitute as good a wetting agent as " Calsoline H.S." and that its wetting power is considerably decreased when the *p*H is increased to 3. On the other hand, the wetting power of dilute solutions of " Fixanol " at *p*H 7 is inferior to any other wetting agent studied in the present investigation. A surprising improvement is recorded when the product is tested in 15 per cent HCl solution. It has decidedly greater wetting power than " Aerosol O.T. dry " when tested in the same medium.

The corrosion inhibiting properties of the various substances studied show (TABLE IV) that sodium arsenite is the best.

TABLE IV

Temperature 25°C. ; *acid* 10% H_2SO_4 (*by vol.*)

INHIBITOR	% CON.	TIME OF REACTION	% LOSS IN WT.
	...	24 hr.	18·9
As_2O_3	0·5	"	7·0
Sodium arsenite	0·5	"	0·23
Fixanol	0·5	"	12·54

In evaluating a wetting agent for use in acidizing operations, it appears that a distinction should be made between the treatment of a new well which merely consists in cleaning the rock face, and the operations intended to revitalize an old well by enlarging the capillaries of the limestone. In the latter case, the acid should penetrate the capillaries, overcoming, if necessary, the gas blocking or " jamin " effect which resists the penetration of the acid. It has been contended that a wetting agent helps to bridge the gas locks and so enables deeper penetration of acid than would otherwise be possible. Obviously, in such cases, the wetting agent is introduced along with the acid and the

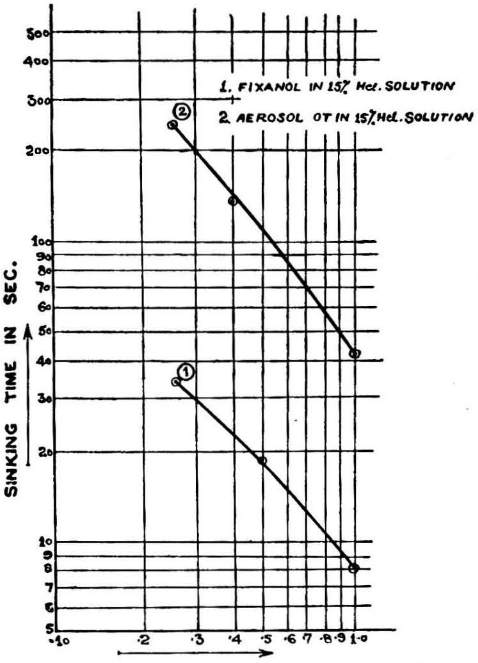


FIG. 2 — SINKING TIME VERSUS CONCENTRATION IN 15 PER CENT HCl SOLUTION, FIXANOL AND AEROSOL O.T. DRY.

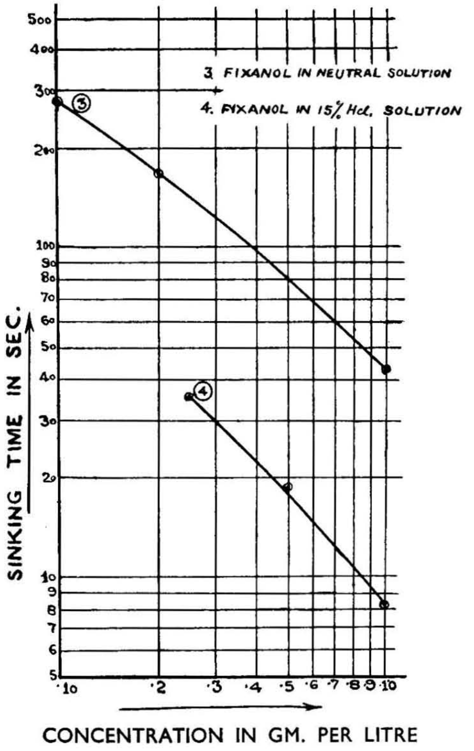


FIG. 3 — SINKING TIME VERSUS CONCENTRATION FOR FIXANOL IN 15 PER CENT HCl AND NEUTRAL SOLUTIONS.

activity of the wetting agent in a strongly acid medium becomes important. The results of " Calsoline H.S." and coconut oil sulphonation product in 5 per cent HCl show that these agents are not suitable for such work. Fixanol, being active in acid medium, assists the acid reactivity and, therefore, should be particularly effective where the enlargement of limestone capillaries in oil wells is desired.

Naik and Desai[7] have studied extensively the sulphation and sulphonation of Indian vegetable oils using sulphuric acid, oleum and chlorosulphonic acid as sulphonating agents. They have not tried either coconut oil or its fatty acids. Venkataraman and his collaborators[8] have recently synthesized a large number of compounds, particularly the sulphonic acid derivatives, from the common Indian vegetable oils for use in the textile industry. With the exception of lauric acid all other acids yielded poor wetting agents. Lauric acid furnished highly efficient surface-active compounds. When similar compounds were prepared by condensing coconut oil without the isolation of lauric acid, they were comparable with those obtained from lauric acid only at higher concentrations but were less effective in dilute solutions. The results of the present investigation clearly support the above findings.

The result of this investigation were made available to *Messrs Attock Oil Co. Ltd.*

REFERENCES

1. CHAMBERLAIN, Jr., L. C. & BOYER, R. F. : *Ind. Eng. Chem.*, 1939, **31**, 400.
2. *Acidizer* (*Trade publication of Dowell, Inc.*) 1936, Nov., No. 4 ; CHAPMAN, M. E., *Oil Gas J.*, 1938, **32(21)**, 10.
3. CARYL, C. R. : *Ind. Eng. Chem.*, 1941, **33**, 731.
4. CARYL, C. R. & ERICKS, W. P. : ibid., 1939, **31**, 44.
5. ELSDON : *Analyst*, 1913, **38**, 8 (From JAMIESON, G. S. : *Vegetable Fats & Oils*, Reinhold Publishing Corporation, New York, 1943, p. 148 ; cf. HILDITCH, T. P. : *The Chemical Constitution of Natural Fats*, Chapman & Hall Ltd., London, 1947, p. 202).
6. DRAVES : *J. Am. Dyestuff Rep.*, 1939, **28**, 425.
7. NAIK, K. G. & DESAI C. M. : *J. sci. industr. Res.*, 1948, **7B**, 193.
8. VENKATARAMAN, K. *et al.* : *J. Soc. Dyers Col*, 1938, **54**, 465, 520 ; 1939, **55**, 125 ; 1941, **57** 41 ; *J. sci. industr. Res.*, 1944, **3**, 193, 290.

Cotton Seed Oil Industry

M. N. KRISHNAMURTI
Volkart Brothers, Bombay

THERE is a widespread prejudice against the crushing of cotton seed in India, and milch cattle are still fed with whole cotton seed. This is wasteful ; a large part of the fat in the seed is not assimilated by the animals and is excreted[1]. Feeding experiments in western countries have revealed that for the nutrition of milch cattle only small quantities of certain unsaturated fatty acids are required. In the case of oil cakes which are unsuitable for animal feed and are used as fertilizers, the lesser the oil content of the cake, the better the value as a fertilizer. It is, therefore, evident that cotton seed cake which still retains a small quantity of oil is rich in protein and is eminently suitable both as a cattle feed and as a fertilizer.

Recent investigations at the Cotton Cess Committee's laboratories at Lyallpur on the nutritive quality of cotton seed cake reveal that of all the oil seed cakes employed as cattle feed, cotton seed cake is the cheapest from the point of view of starch equivalent and assimilable proteins[2]. Cotton seed cake flour is finding increased use in human dietary. Under the trade name " Alison flour " it is used in admixture with wheat flour, and the combination is 25 times as nutritious as an equivalent quality of potato flour, 5 times as nutritious as corn meal and 4 times as nutritious as oats meal.

The *per capita* consumption of oils and fats in India has been estimated by the Food Ministry of the Government of India at 8 lb. per annum, as against the normal nutritional requirement of 45 lb. If the *per capita* consumption of fat is to be raised, it is necessary that efforts should be made to increase the production of edible oils by crushing oil seeds such as cotton seed which are now being wasted.

India produces at present over 2 million tons of cotton seed per annum ; out of this quantity 3 lakh tons are crushed for oil and 2 lakh tons are used for planting. A part of the remaining quantity is exported and the rest fed to cattle. If all the available cotton seed is crushed, the production of vegetable fats can be increased without having to bring more land under oil seed cultivation. In California, where cotton seed processing is a major industry, the oil is refined and used for the manufacture of margarine. Cotton seed oil is also largely used in soap manufacture.

If the cotton seed oil industry is to be established in India on a commercial scale, the processing should be economical and the products should conform to the trade standards. In case the residual cake after the extraction of oil is not accepted as a cattle feed, it will have to be utilized as manure and sold at a low price[3].

The toxic phenolic substance, gossypol, present in cotton seed cake and its removal have formed the subject of a great deal of research. It has been suggested that cooking of cotton seed meal renders gossypol inactive, and the resulting meal is suitable for animal and human consumption.

The China Vegetable Oil Company, Shanghai, is producing petrol and Diesel oil from cotton seed oil. From 100 lb. of oil, 24 lb. of motor fuel and a large quantity of lubricant are produced.

The storage of cotton seed demands particular attention. The cotton ginning season is comparatively short, and the seed collected has to be stored for the rest of the year. Investigations on storage and respiration show that cotton seeds with a high moisture content (exceeding 8 per cent) respire vigorously, develop free fatty acids and deteriorate rapidly[4]. Seeds intended for storage should be dried, and temperature and humidity conditions in storage sheds should be controlled. Commercial seed conditioners and dryers for controlling the moisture content to the required degree are available.

Processing of cotton seeds for oil extraction involves, as the first step, cleaning of seeds in a combined pneumatic and mechanical cleaner for separating dirt, sand and other impurities. The closely adherent fibrous coat is removed by a carver or other type of delinting machine of modern design. The seeds are decorticated or hulled and the kernels separated from hulls with the help of shaker screens and aspirators. The kernels are coarsely ground in a roller mill and crushed in an Anderson expeller provided with a cooling system. The residual cake contains less than 4 per cent oil.

During the past few years solvent extraction processes have been employed in the United States of America for obtaining cotton seed oil. Direct solvent extraction, however, presents many serious difficulties, and processing by the combined use of expeller and solvent extraction has proved not only advantageous but also economical.

In planning a cotton seed oil mill it is essential to consider a number of factors which influence both its design and operation. Included among these are optimum capacity, supply of raw material, transportation facilities, power and water supply, and storage space. Plant economies dictate the necessity for continuous operation of a minimum of 300 days per year. Full-time operation is especially desirable since trained and competent operating personnel cannot be had on a part time or seasonal basis. The economy of a 75-ton capacity cotton seed oil mill by the expeller process can be gauged readily from the estimates given below :

ESTIMATES FOR A 75-TON COTTON SEED OIL MILL ON 24-HOUR DAY BASIS

A. CAPITAL

	Rs.	a.	p.
1. Oil mill machinery, viz. cleaning, delinting, crushing, with ancillary units	9,00,000	0	0
2. Oil refining plant	2,00,000	0	0
3. Auxiliary plant, viz. steam, power and water-cooling towers, pipe line, etc.	2,00,000	0	0
4. Erection, etc.	2,00,000	0	0
TOTAL	15,00,000	0	0

B. COST ESTIMATE

	Rs.	a.	p.
1. *Raw Materials* —			
75 tons cotton seeds at Rs. 25 per ton	18,750	0	0
2. *Utilities* —			
(a) 75,000 lb. process steam equivalent to about 5 tons of coal at Rs. 40 per ton	200	0	0
(b) 12,000 kWh. of electricity at 1 anna per unit	750	0	0
(c) 35,000 gallons water	35	0	0
(d) 3 cwt. of caustic soda at Rs. 33/- per cwt.	100	0	0
(e) 4 cwt. of Fullers earth at Rs. 35/- per cwt.	140	0	0
(f) 2 cwt. of activated carbon at Rs. 70/- per cwt.	140	0	0
3. *Labour, Supervision and Overhead Charges*	300	0	0
4. *Amortization value* at 10 per cent over Rs. 15,00,000/- capital equipment at 300 working days per year	500	0	0
5. *Amortization value* at 5 per cent over Rs. 5,00,000/- over building and godown	80	0	0
6. *Mill stores, repairs and maintenance* at 2 per cent over capital cost of machineries	100	0	0
TOTAL EXPENSES PER DAY	21,095	0	0

CREDIT FOR SALES PROCEEDS

	Rs.	a.	p.
1. 10 tons refined oil at 13 per cent overall recovery at Rs. 1,500/- per ton	15,000	0	0
2. 0·75 tons soap stock at 1 per cent yield at Rs. 400/- per ton	300	0	0
3. 1·5 tons linters based at 2 per cent yield at Rs. 400/- per ton	600	0	0
4. 30 tons hulls based at 40 per cent yield at Rs. 60/- per ton	1,800	0	0
5. 28 tons cake based at 37 per cent yield at Rs. 170/- per ton	4,760	0	0
TOTAL	22,460	0	0
PROFIT PER DAY	1,365	0	0

REFERENCES

1. BOATNER, C. H., HALL, C. M., O'CONNOR, R. T., CATILLON, L. E. & CURET, M. C. : " Processing of Cotton Seed ", *J. American Oil Chemists Soc.*, 1947, **24**, 97.
2. AFZAL, MOHAMMED : " The Cotton Seed Oil & Cake ", *The Indian Cotton Growing Review*, October 1948.
3. SWIFT, CLIFTON E. : *J. American Oil Chemists Soc.*, 1947, 412.
4. BILBE, C. W. : " A Year of Cotton Seed Solvent Extraction ", *Oil Mill Gazetteer*, July 1948.

REVIEWS

Elastomers and Plastomers, Part II: Manufacture, Properties and Applications, edited by R. Houwink (Elsevier Publishing Co. Ltd., New York, Amsterdam, London, Brussels; Cleaver-Hume Press Ltd., London), 1949, pp. xvi + 515. Price 50*s*.

THIS VOLUME FORMS PART II OF ELSEVIER'S comprehensive treatise on "Elastomers and Plastomers" of which Part III was recently reviewed in this Journal (Vol. VIII, p. 194, 1949). It contains, besides a detailed table of contents and an exhaustive index, thirteen chapters, one on each of the following topics: phenol formaldehyde resins (including aminoplasts), synthetic resin ion exchangers, urea and melamine resins, polymers from ethylene derivatives including allyl compounds, cellulose derivatives, protein plastics and fibres, synthetic polyamides, silicone polymers, alkyd resins, natural resins and their derivatives, derivatives of natural rubber, synthetic rubbers, and asphalts, which thus cover the whole field of natural and synthetic high polymers.

The topics are treated in a comprehensive and authoritative manner in respect to their chemistry, industrial preparation, properties and applications. The chapter on phenolics may serve to illustrate the point. It begins with the industrial production of the raw materials (phenol, cresols, aniline and aldehydes) and then deals, in succession, with the chemistry and reaction kinetics of condensation polymerization as applied to phenolics, with resins for varnishes, paints and lacquers giving individual preparations, properties and applications, with resins used for adhesives, moulding compositions including resins for jet moulding, and finally with resins for laminating purposes, the whole treatment being based on sound theoretical principles and accurate technical details of facts illustrated with tables, diagrams and photographs; a list of references at the end completes the chapter. A more or less similar procedure is adopted in the remaining chapters.

Each chapter is written by one or two chemists of the research laboratory of the industrial company which is specializing in the production of the particular plastomers or elastomers in question. Thus the chapter on urea and melamine resins is by two chemists of *Ciba Ltd.*, Switzerland, which produces several of these resins and has done original work in the field. The chemists of the Protein Research Division of *British Plastics Ltd.*, and of *Courtaulds Ltd.*, England, contribute the chapter on protein plastics and fibres. A chemist of *Rohm & Haas Co.*, U.S.A., writes the chapter on polymers of ethylene derivatives, and this company is not only producing acrylic and other vinyl resins, but has also done pioneer work in these plastics. Silicones are treated by a chemist of *General Electric Co.*, Schenectady, which first produced these resins. It is natural that a chemist of *Du Pont de Nemours* should write about synthetic polyamides (nylons). Dr. Houwink who has to his credit several books and articles on high polymers not only writes with authority on phenolics but is the editor of the three parts of this series on elastomers and plastomers.

The book certainly gains much from the international character of the collaborating group of authors, but suffers a little, just as any composition of composite authorship, from lack of uniformity in the manner of presentation. Thus, in certain chapters like those on polyamides and silicones, the details of industrial production of the materials concerned are not too abundant, maybe due to lack of published information or simply due to the tendency on the part of the authors to gloss over them. The language of the non-English authors is, at times, not too clear or sufficiently idiomatic as in the following cases: " . . . the conception to which the aniline formaldehyde resins contain globular molecules has gained support" (p. 17); "the products that form distinguish themselves from . . ." (p. 7); "the surprising moment was the fact . . ." (p. 112); "a far too driven condensation" (p. 58); "herefore" (p. 57); "at the time being" (ibid.)

and so on. A little careful retouching could have eliminated these mistakes.

The printing is good and the paper, too, is equally good. But some typographical mistakes have been noted which are rather uncommon in Elsevier's publications. These minor defects do not, however, detract in any way from the main value of the book which is a mine of carefully assorted scientific and technical data of wide variety and scope concerning high polymeric materials of industrial importance and which, along with Part I (General Theory) and Part III (Testing, Analysis : Tabulation of Properties), would make an excellent and up-to-date reference set. The book should find a ready welcome at the hands of all who are interested in the scientific and industrial aspects of plastics, fibres and rubbers.

L. M. YEDDANAPALLI

Tablet Making, by Arthur Little & K. A. Mitchell (Northern Publishing Co. Ltd., Liverpool), 1949, pp. 121. Price 15*s*.

TABLET MAKING IS AN IMPORTANT AND AN indispensable feature of the modern pharmaceutical industry as tablets have become most popular owing to their elegance for single dose dispensation of solid medicines. This device which is nearly a century old has now been perfected with the aid of the modern automatic tabletting machines which can turn out compressed tablets in great speed and in various sizes, shapes and colours. There has been, however, very little information published so far by those who possess the " know how " of the process of tablet making and the present volume is, therefore, to be welcomed as a valuable publication on the subject.

Little and Mitchell have written their book well and have adequately illustrated it. The book furnishes detailed and comprehensive information on all aspects of tablet making including granulating, drying, compressing, colouring and coating. It seems to have been written with an idea of giving practical guidance to those who wish to take up the manufacture of tablets and as such contains several useful " tips " in every process of tablet making. Furthermore, the inclusion of a formulary giving the composition of about 25 typical tablets should also prove very useful in practice.

Although there are possibly many other industries where the tabletting machines could be used, just only a mention has been made in the book of such possible uses. This is because at present it is only the pharmaceutical industry which is making the compressed tablets on a very large scale and the other industries are yet to develop this line.

On the whole there is no doubt that the book is a very useful practical handbook on tablet making and, therefore, should prove valuable not only for students of pharmacy but also to manufacturers of tablets in the pharmaceutical industry.

H.B.S.

Proceedings of the Rubber Technology Conference, London, 1948 (W. Heffer & Sons Ltd., Cambridge), 1949, pp. xxxii + 523 + xix. Price £ 3/3.

RUBBER TECHNOLOGY HAS ONLY RATHER recently received the recognition that has been its due for a long time. The second Rubber Technology Conference of which the " Proceedings " is the record was the focal point for rubber technologists from various corners of the globe. The information contained in this admirably edited " Proceedings " forms a very valuable contribution to the knowledge of rubber technology.

The papers presented in this volume deal with the work done on various aspects of rubber during 1938-48. During this decade, as in practically every other realm of science, there has been unusual activity in the field of rubber technology. Rubber industry can boast of substantial progress made during the war years. It was the stress of war that accelerated the advent of synthetic rubber. Although there has been a general tendency to brush aside synthetic rubber as a " war baby ", many rubber technologists realize that the synthetic rubber industry has come to stay. This realization is reflected in the " Proceedings " because the first session of the Conference was devoted to " Synthetic Rubbers ".

In this first section all the more common synthetic rubbers — GR-S, Butyl, Buna N, Neoprene and Silicone — find their place. Synthetic rubber is still in its youth, if not in its infancy, and as such we may expect to hear a lot more about these polymers.

GR-S is the most common commercial synthetic rubber and perhaps the largest amount of work in synthetic rubber chemistry and technology has been done with reference to this polymer. Yet Dinsmore, a veteran in this field, says in the first paper in which is given a comprehensive comparison between natural rubber and butadiene-styrene polymers, that " nothing could be more misleading than to create the impression that the quality of GR-S had reached a static position or we were fully informed as to how to use the material to the best advantage ". This, in fact, summarizes the present status of synthetic rubber.

Silicone is an interesting new-comer in this field. " Unknown in 1938, Silicone rubber appeared in the American market in 1944 " — that is how Bass introduces Silicones in his paper. The ability of this elastomer to retain its resilience and flexibility over a wide temperature range of −70°F. to over 400°F. has made it specially suitable for a variety of uses in electrical and other industries where resistance to extremes of temperature is required.

Some of the information contained in this paper as also in the other four subsequent papers in this section has already been published in technical journals. However, as reviews of work done on the various elastomers the papers are useful.

The section on the chemistry of rubber gives some of the latest concepts regarding rubber-sulphur combination during vulcanization, and the action of oxygen on both raw and vulcanized rubber. The structure of the rubber vulcanizate has been the subject of investigation right from the early days of the discovery of vulcanization. Recently it has been shown that during vulcanization, sulphur can combine with rubber either by intramolecular cyclization or by intramolecular cross-linking. Bloomfield has attempted in his paper to show the point of attachment of sulphur in these combinations. According to the evidence so far obtained from experiments with olefines, the sulphur atom appears to be located between the α-methylenic carbon atom and a tertiary saturated carbon atom.

An elegant technique developed by the Institut Francais du Caoutchouc for the measurement of the rate of oxidation of rubber is described in this section. Some of the results of this investigation such as the variation in absorption of oxygen by different samples of the same rubber but purified by different methods require further clarification. The most interesting aspect of the work is probably the portion dealing with the influence of three selected negative catalysts — phenyl-β-naphthyl amine, α-tocopherol, and zinc salt of mercaptobenzothiazole. The first two anti-oxidants slow down the rate of oxidation of the rubber whereas the zinc salt of MBT shows a quite different behaviour — the sample containing this behaves almost as purified crepe rubber containing no anti-oxidants. The explanation of this will have to await further experimental work.

The rôle of oxygen in the mastication of rubber has been the subject of controversy for some time. Direct determination of the oxygen content of a rubber sample would be valuable in following the action of oxygen. For this purpose a method originally developed by Unterzaucher has been adapted by Chambers. By combustion the oxygen in the sample is converted first into carbon monoxide, and then into carbon dioxide. The latter conversion is effected using I_2O_5 and the iodine liberated in the process is estimated. A relative accuracy of 2 per cent is claimed for this method.

The section dealing with the physics of rubber is of considerable interest in several ways. The study of the crystallinity of rubber has recently thrown much light on the tensile strength of vulcanized rubber. Tensile strength is attributed mainly to the ability of the rubber to form crystallites when stretched. Further work in this field combined with investigations on the nature of sulphur linkage in vulcanized rubber may prove to be of value in improving the methods of vulcanization.

Many of the ideas regarding the physical properties of vulcanized rubber are changing. Permanent set is now stated to be " not permanent at all ". It entirely depends on the orientation of the filler particles when rubber is stretched.

Rilvin's paper is sufficient to vindicate, if any vindication is necessary, the pursuit of fundamental research as applied to rubber. In this paper is discussed the application of the elastic theory to many practical engineering problems.

Testing and analysis of rubber appears to have received only a cursory attention. This is all the more surprising when viewed against the fact that a great deal of development in this field occurred during the past decade, and that most of the methods so developed have not yet seen the light of publication. The paper on the meaning of test results included in this section gives the impression that in spite of the significance of the interpretation of test results, this is becoming a rather over-preached topic.

Rubber latex is generally described as an emulsion of rubber globules in aqueous serum. But the isolation of a yellow fraction which is referred to as " lutoids " in a paper presented in the section devoted to latex changes the above conception. The study of this yellow fraction assumes great significance because this fraction seems to be responsible for variability of latex, and also for its spontaneous coagulation. Variability of latex has been a constant worry of latex goods manufacturers, and now there seems to be a possibility of eliminating the very cause of this trouble. The drop in viscosity of latex observed on addition of ammonia is explained as due to the dissolution of the yellow fraction in ammonia. It looks as though many more of the perplexing problems connected with latex are much nearer solution now. As such, the importance of this paper cannot be over-emphasized.

Most of the information contained in the papers on the coagulation of latex by sodium silicofluoride and the control of viscosity increases of compounded latex has been the subject of two similar papers read at the latex symposium held in Manchester in 1947.

The development of synthetic rubber has given a great impetus to work on modifications of the natural rubber hydrocarbon. In order to achieve the latter end, it is essential that the properties of the pure rubber hydrocarbon must be studied. From this point of view, the paper on the " Preparation and Properties of Highly Purified Rubber " is an important contribution. A new method by which rubber hydrocarbon of nearly 99·9 per cent purity can be obtained without resorting to any drastic chemical or mechanical treatment of the rubber is described.

Of the two sections dealing with compounding ingredients, one section is devoted entirely to carbon black. There has been no lack of theories on filler reinforcement of rubber. It is now suggested that modulus type of properties of loaded rubber are determined mainly by the shape and concentration of the filler, whereas tensile-type properties are dependent on the size and surface characteristics of the filler particle.

It has been generally agreed that the reinforcing ability of carbon black depends to a great extent on the surface activity of the carbon black particle. The study of the surface characteristics is, therefore, important. In a paper devoted to this subject it is stated that the electron microscope examination of the emission spectra of groups desorbed from carbon black has shown the presence of aldehyde, carboxyl, hydroxyl groups and many other chemical complexes. The extension of this work may throw more light on the mode of carbon black reinforcement of rubber.

The next section dealing with developments in factory processes since 1938 when the first Rubber Technology Conference was held is mainly concerned with the use of rayon as tyre cord. High-tenacity viscose rayon is superior to cotton because rayon shows higher fatigue resistance, smaller tyre drag and better tensile characteristics at elevated temperatures. Nylon and steel are also mentioned as tyre cord materials. Although both these have been used in the construction of tyres, not much headway has been made. One ply of steel cable is equivalent to about three plies of rayon fabric, and as such tyres made with steel cable are much thinner ; and because of this such tyres show less tyre drag which depends, among other things, on the thickness of the rubber in the tyre.

It is of interest to note that a tyre made of 100 per cent GR-S shows a rolling resistance 50 to 60 per cent higher than that of a typical tyre made of natural rubber.

The " Proceedings " ends with an open discussion on certain physical properties of vulcanized rubber. It is stated that the discussions were held to help drawing up of international standards. It may not be too much to hope that the I.S.O. would succeed in reconciling some of the conflicting views expressed during the course of the discussion regarding the methods of test and the presentation of results, and in bringing out standard specifications which would be acceptable to a large majority, if not all, of the rubber technologists.

As pointed out in the foreword to the " Proceedings ", there is a paucity of papers dealing with aspects of rubber manufacture in which field a considerable progress was made during the war years. This is attributed to " the brief time available for their preparation, and the proximity to the cessation of hostilities ". Whatever be the reason, it must be admitted that the absence of such papers has, to a certain extent, decreased the usefulness of an otherwise valuable volume. Even with this detraction in its value, it can still serve as a very useful companion to rubber technologists.

G. T. VERGHESE

Welding Technology, by F. Koenigsberger (Cleaver-Hume Press Ltd., London), 1949, pp. viii + 280. Price 21*s*.

" WELDING TECHNOLOGY " BY F. KOENIGSberger is undoubtedly a very comprehensive work on the subject. It is evident from the author's point of view that in these days of specialization, one finds it hard to draw the line of demarcation between one subject and another. For example, a welding engineer is called upon to have a general background of other branches of engineering such as mechanical engineering, electrical engineering, metallurgy, production engineering, etc. Though, primarily, it is the business of the structural engineer to see that the welded structure has the required strength, the welding technologist cannot ignore this fact. For, he should see whether the process involved in welding yields the desired result or not. He should keep his mind alert on various problems cropping up from other branches of engineering in his day-to-day work.

The author deals exhaustively with arc welding, gas welding and resistance welding. The treatment of the subject has been thorough and systematic. Having at his back years of industrial experience supported by good academic training, the author has brought home in this volume the many points that a welding technologist usually misses in his work. The author has dealt the subject of welding under two heads, viz. fusion welding and forge welding. The former covers only that process involving additional filler metal, and in this process, the heat is generated invariably either by electric arc, or by gas or by chemical reaction. In the case of forge welding, no additional filler metal is used, but the operation takes place under pressure and the heat is generated by ordinary blacksmith furnace, or by gas flame or electric current.

The subject-matter is presented in seventeen chapters and a chart is also included at the end of the book for identifying the metals to be welded. In the first three chapters a comprehensive survey of various types of welding is made, while in the subsequent chapters the welding of ferrous and non-ferrous metals is outlined.

The chapters on plant and equipment for oxy-acetylene welding, arc welding and also for resistance welding are exhaustively treated, though an ordinary welder need not know these details. But, after all, it is the duty of those connected with welding to put the welding machines and plant in working order when there is a break-down. Hence the author is justified in treating this part of the subject in these chapters in the way he has done. Flame cutting and gouging have also found a place in this volume, wherein he has outlined the technique on which the author claims to have some experience.

In the last seven chapters of the volume, the author has included various topics which are directly or indirectly connected with welding technology as, for example, the chapter on " Design Principles " and " Drawing Office Procedure in Connection with Welding ". At first sight it would seem as though this chapter can hardly find a place in a book like this, but when one goes through the book, it only shows the complete and thorough understanding of the subject by the author and the presentation of the subject is such that the reader would be fully convinced that there is not a word extra or superfluous in this volume other than the essential material.

The author is extremely lucky to draw his knowledge from his father to whom he has paid homage. The whole work looks as though the trait has been inherited.

The reviewer feels that this book should be a valuable addition to the desk of any one, be he an apprentice or a professional welder or a foreman or an engineer ; to the college student and an industrialist it should fill the place of a reference book.

V. CADAMBE

Engineering Metals and Their Alloys, by Carl H. Samans (Macmillan & Co., London), 1949, pp. xiii + 913. Price 37*s*. net.

THIS IS AN ADMIRABLE BOOK FOR STUdents of engineering and metallurgy. Its unique feature lies in the classification of alloys based on their application rather than on their composition. There is a happy blending of information valuable alike to the engineer and the metallurgist.

It opens with a chapter on the general characteristics of the metallic and engineering materials. All the mechanical properties have been discussed and the standard tests including the magnaflux, radiographic, supersonic methods and fluorescent penetrants, etc., are described.

In the next chapter, the structure of the pure metal has been discussed. The author has enunciated the fundamental principles and has made this subject very lucid — especially the conception of grain size, space lattice, recrystallization and effects of hot and cold work on metals and alloys.

The author has then dealt with the production of metals and alloys. The production of pig iron and steel has been given briefly and the reader is not burdened with too much detail in this particular branch.

The production of certain non-ferrous metals has, however, been very well dealt with. A number of processes for the manufacture of magnesium has been described — the important ones being the Dow chlorine process, the electron process, the oxide process, Hansgirg process, Pidgeon ferrosilicon process, etc.

In the case of aluminium, in addition to the common Bayer process, two more processes like the kalunite process for alunite and the Ancor process or lime-sinter process have been described.

In the case of zinc also some modern methods have been discussed. One is the *St. Joseph Lead Company's* electro-thermic process used for the electro-thermic reduction of zinc and the other Waelz process in which residues containing a very small quantity of zinc are profitably and efficiently recovered by volatilization in a rotary kiln.

The production of other metals has been discussed and information as given by other standard books has been incorporated.

The most impressive chapter in the book is the chapter on the theory of alloys. It has been ably written and amply illustrated with instructive diagrams. The binary system has been dealt with at length and the ternary system which is receiving increasing attention in recent years has also been dealt with. The author has explained in simple language the facts and phenomena which ordinarily are not readily understood by the beginner. The structures, wherever necessary, are illustrated with microphotographs.

One chapter has been devoted to the heat treatment of metals and alloys. Various important treatments given to ferrous and non-ferrous alloys have been discussed and the theories of age-hardening have been given with modern views thereon.

The chapter on shaping and forming the metallic materials has been dealt with systematically under various heads such as casting, extruding, hot working, adding or joining metal by means of soldering, brazing, welding, rivetting, flame cutting, machining, grinding, etc.

Finally, the book deals with the most important alloys, both ferrous and non-ferrous. They have been classified according to their applications. Those alloys which can be easily fabricated like the brasses are dealt with first. Then come aluminium alloys, gun metal, alloys having heat resistance, high strength, ductility, and finally are described tool alloys, like the high-speed tool steels. The author has described these alloys under the various heads of manufacture, composition, properties, metallographic structure, effect on heat treatment and, finally, their industrial uses.

The book is an excellent guide for those interested in metallurgy and the use of metallic materials. As already pointed out, all the matter has been discussed both from the metallurgical and the engineering points of view.

D. SWARUP

Patented Inventions of the Council of Scientific & Industrial Research

CONTAINERS FROM PLASTIC SHEET MATERIAL

Indian Patent No. 32,824; British Patent No. 6,26,963; U.S.A. Patent No. 24,84,656

B. N. SIKKA, G. SINGH & L. C. VERMAN

LAMINATIONS made out of cotton cloth, jute cloth, paper or like fibrous sheet material are impregnated with resin and pressed in a mould by means of a plunger having within it a spring-loaded secondary pilot plunger which pushes the laminations into the mould cavity prior to the entrance of the main plunger (FIGS. 1 and 2). To the spring-loaded secondary plunger is attached an arrangement for locking the plunger after the mould is closed and also an arrangement for unlocking the plunger when the mould is opened. The spring-loaded secondary plunger pushes the laminated blank ahead into the cavity in the mould before the confining edge of the main plunger comes into contact with the blank and thus the shearing of the blanks is avoided. The clearance between the main plunger and the mould is varied by providing tapers in the main plunger and in the mould, the taper in the main plunger being kept at a minimum, while the taper in the mould is made larger to accommodate the excess gathering of the pressed material at the top of the article.

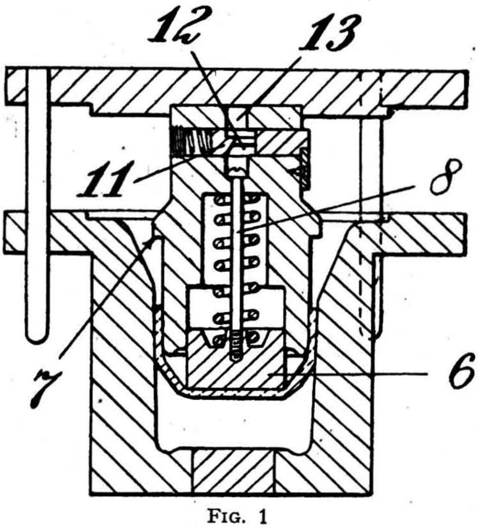


FIG. 1

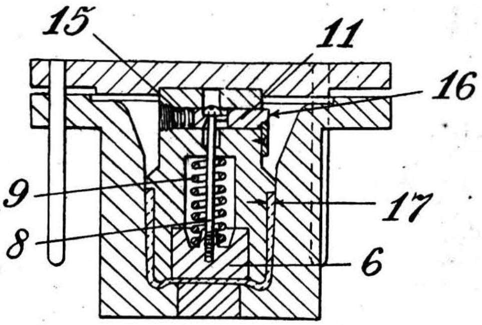


FIG. 2

Fig. 3 shows an alternative construction wherein the spring-loaded secondary plunger is provided in the mould part.

The method is specially suited for the manufacture of cigarette containers, ash trays, ceiling rose covers, cups and the like deep mouldings.

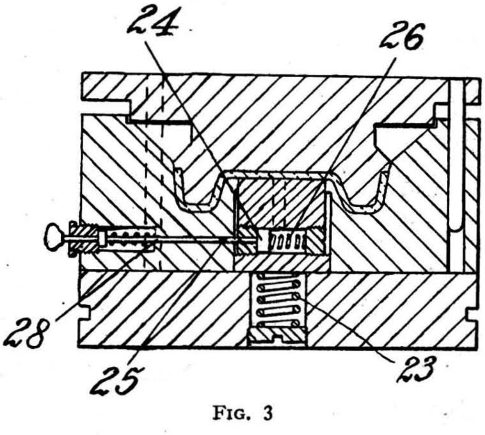


FIG. 3

Some Aspects of the Finnish Glass Industry

K. D. SHARMA

Central Glass & Ceramic Research Institute, Calcutta

THE Finnish glass industry, as a whole, is not strictly comparable with that of the U.K. or the U.S.A. The demand for bottles and containers being limited to the home market, the industry has specialized in the manufacture of cut and engraved glass and high-quality table ware. Both automatic and semi-automatic methods are used in their manufacture.

Of the four well-known glass works, the factories at Karhula and Riihimekki produce pressed and blown ware, various types of container ware, building blocks and decorated glass; the factory at Iittala makes table ware and art glass, while the Lahti Glass Works have a Fourcault sheet-glass plant. The present article deals with some of the production practices employed at the Karhula Glass Works.

Karhula Lasitehdas

The factory produces container ware of colourless and amber glass by automatic and semi-automatic machines, building blocks and cheap table ware by semi-automatic presses, glass wool by centrifugal process, and high-class decorated cut and engraved ware from potash and crystal glasses. A few artists possessing outstanding ability and originality in the field of designing have made the Finnish glass industry famous and have earned a name for themselves. Most of the first quality handmade glass is at present exported to the U.S.A.

Raw Materials

There are no suitable deposits of glass-sands in Finland. Sand required for colourless glass is mainly imported from Holland and Belgium. For amber glass, a mixture of Finnish and Dutch sands is used.

Glass-house pots and some of the refractories are made in the factory from German clays, though most of the refractories for tank furnaces are imported from the U.K. and the U.S.A.

Batch Mixing

Mixing is effected in small mechanical batch-mixers. Batch is usually mixed dry but at Lahti a little moisture is added to it. The dry batch is charged into the mixer which revolves for about a minute; a little water is then sprinkled on to the batch and the mixing carried on for another minute or two. This is reported to give better mixing and prevent segregation of different-sized particles during handling; it also permits a dust-free charging into the furnace.

Furnace & Fuels

Pot furnaces are mostly of Siemen's regenerative type or Teisen's recuperative type. Open pots are used for melting colourless, opal and coloured glasses from soda-lime and lead-potash batches. Tank furnaces are small, melting from 12 to 20 tons of glass per day per furnace. The recuperative furnaces are mostly fitted with Teisen patent recuperative tubes. Thermocouples are inserted in the crown over the melting, refining and working zones. Temperature measurements of the incoming producer-gas, preheated air and waste gas at the base of the chimney are recorded. Analyses of fuel gas and waste gas are carried out regularly.

As there are no coal deposits in Finland, producer-gas made from wood is the chief source of heat supply for the glass industry. When imported coal is available, a mixture of coal and wood chips constitutes the charge in gas producers which are water-sealed and are of the stationary or revolving type. There is no clinkering when wood is used. The gas is free from oxides of sulphur and allows melting of even full crystal glass in open pots.

The wood used at the sheet-glass factory contained 30 to 35 per cent moisture which lowered the temperature of the issuing gas to 160° to 200°C. To enrich the gas, a little fuel oil was allowed to drip in the gas producer. The calorific value was about 1300 cal. per cu. m. of gas.

Melting by Electricity

Finland has plenty of cheap hydro-electric power and much of the glass melting at Karhula is done by electricity.

There are 2 recuperative tank furnaces for melting colourless glass which are heated by oil-electric and gas-electric combinations, while a third one heated by electricity melts amber glass for bottles.

The electric furnace has a definite advantage over combustion furnaces because of its higher efficiency on smaller tonnage and better performance for coloured glass. The resistance of glass is taken advantage of, and heat is injected directly into the body of glass. There are no chimney and regenerator losses and the throughput of the tank is not limited by the amount of heat that can be passed by radiation from the crown and the flame into the glass. Current consumption per kg. of glass is usually less than one kWh. In a tank furnace using gas or oil in combination with electricity, the melting rate is about 30 per cent higher than in a tank of the same dimensions using only gas or oil. In addition, there is better temperature control and the glass produced is more homogeneous and of better quality.

A new Cornelius patent electric furnace under construction at Karhula is designed to produce about 20 tons of amber glass per day. The electrodes are of soft Swedish iron containing less than 0·05 per cent carbon and are made large so that the current density is low. There are 3 sets of electrodes in the melting end of the furnace. Each set consists of 3 electrodes, one on each side of the tank and the third placed centrally dipping into molten glass. The flux line of the tank is made of Corehart blocks. No crown is needed over the melting end as the glass batch which is fed from the top covers the melt uniformly like a blanket and prevents heat loss. The working end has an insulated roof and is provided with an oil burner to heat up the surface layers of glass when necessary.

Experience at Karhula shows that whereas colourless glass can be melted satisfactorily in the electricity *cum* oil or gas tank, it is difficult to thoroughly fine and decolourize glass in a tank running only on electricity. The quality of amber glass and undecolourized glass, however, is definitely superior to glass melted in a combustion furnace.

Hand-blown Ware

All decorative ware, crystal ware, good quality table ware, wine glasses, lamp shades, etc., are hand-blown. Wooden moulds are generally employed for the production of quality goods. Paste moulds are also used but are not common.

The output per chair is considerably higher than that in the U.K. A team consisting of 3 men and 3 boys blows about 1200 thin tumblers of 10 oz. capacity during a shift of 7 hours, while 4 men and 2 boys make about 600 wines with stem in the same time. In the chair making wines, the headman puts the stem on and the footmaker puts the foot on. Each worker — blower, headman and footmaker — has his own gatherer.

Tumblers are finished by burning off in a French single-head machine in which the article is held by a chuck in the inverted position. The article is lowered in a revolving ring-burner with a number of jets. One machine is sufficient to handle the production of at least two chairs. As no town-gas is available, the fuel used is hydrogen and oxygen contained in cylinders.

Grinding is carried out on 3-head horizontal machines using carborundum powder. A drilling machine fed with carborundum powder bores holes in lamp shades and globes.

Decoration of Finished Ware

(a) *Cutting* — Heavy fluting is effected by the old method of steel mill and stone using different grades of carborundum powder and water. Artistic designs are cut by small carborundum wheels of various sizes.

(b) *Polishing* — A felt wheel and pumice are used for an article with a shallow design, while a cork wheel with pumice is employed for a ware which has been cut to a deeper and sharper surface. For acid polishing, a mixture of hydrofluoric and sulphuric acids contained in lead pans is used. Little or no sulphuric acid is necessary for high lead glasses ; a 1 : 1 mixture is used for lime glasses. The mixture is maintained at about 40°C. and the time required to obtain a good polish is about a minute.

(c) *Engraving* is effected with copper wheels of different sizes. Linseed oil and emery powder are fed to a revolving wheel and the article is pressed against it.

Production on Semi-automatic Machines

Various types of phials and bottles are made on Schiller-type suction and blow semi-automatic machines, and jars on press and blow machines. These machines show a definite improvement on the original models and are light and easy to operate. The workman attains high speed by a repetition of the same article, the production per machine being higher than seen anywhere else. 2200 to 2400 pint beer bottles per shift is the usual output for a machine fed by two gatherers.

Tumblers, dishes and building blocks are pressed in a multiple mould press machine which is rotated by a motor but is fed and worked manually. The articles made are usually fire-polished before annealing. The production is 4000 eight oz. tumblers per shift.

Cheap quality jugs are made in a single mould press. After the article is taken out of the mould, it is attached to a punty and softened a little to make the lip. The production is about 2000 jugs per press per shift.

Production on Automatic Machines

Along with the semi-automatic machines are installed, around the working end of the same tank, a few Riorant machines of B and F types. These machines are suitable for small-scale production of high-grade bottles. They are simple and do not require large space or costly equipment for installation and operation. One operator can easily look after 3 or 4 machines. No automatic feeders are required as the machines are of the suction type. The machine-head carrying the blank mould enters the furnace and sucks the required quantity of glass. The ware formed is accurate in weight and capacity. The production varies from 3 to 4 bottles per minute depending upon the size of the bottle.

The Riorant machine is now also made with double-mould head, i.e. the head carries two moulds, thus increasing the output by 100 per cent.

The trend of production at Karhula, as anywhere else, is now towards employing fully automatic machines for the manufacture of containers and pressed ware. A new "4-head Hartford I.S. machine" and a "12-mould PBL press and press and blow machine" are under installation. These machines are useful only for large production and capital costs are high. In addition to the cost of machines, moulds, feeders and forehearths, a well-equipped workshop manned by skilled and specially trained operators is essential. Because of the large and continuous production, a regular and rigid check on the quality of raw materials, furnace operation, wear and tear of moulds and other equipment, annealing of ware, and homogeneity of metal has to be maintained for successful production of the glassware.

Manufacture of Building Blocks & Glass Wool

Glass building blocks are made by pressing shallow, rectangular boxes on a semi-automatic press and then sealing pairs of these together to form the hollow block. Flutes and prisms are

(*Continued on p.* 35)

NOTES & NEWS

Peptide Synthesis

THE REACTION OF ACYLPHOSPHATE (the phosphoric group of which is bound in an ester linkage) with the amino group of a free amino acid at 37°C. in aqueous solution of *p*H 7·4 to form the corresponding acylated amino acid is made use of in the synthesis of some true peptides (*Nature*, 1949, **164**, 576).

Phenyl carbobenzoxyglycylphosphate has been prepared by the reaction of carbobenzoxyglycyl chloride with disilver phenylphosphate. Phenyl carbobenzoxyglycylphosphate reacts very rapidly with amino acids, forming the corresponding carbobenzoxyglycylpeptides, from which the free peptides can be obtained by catalytic hydrogenation. Up to the present, glycylglycine, glycyltryptophane and glycylglycyltryptophane have been prepared in this way.

An unusual feature of this method is that it permits the synthesis of oligopeptides without isolation of the intermediary products (dipeptide, tripeptide, etc.) by alternately adding the phenyl carbobenzoxyaminoacylphosphate and hydrogenating the resulting carbobenzoxypeptide. All the operations are carried out in aqueous solution at 37°C. and *p*H 7·4 ; the yields are high, even in M/100 concentration of both the reacting substances.

From the biochemical point of view, the reaction provides a model of peptide synthesis, the interest of which is due to the fact that acylphosphates are believed to play an important part in peptide-bond formation within the living cell. It is to be noted that the reaction takes place under physiological conditions of *p*H, temperature and concentration.

Synthesis of Chromones & *Iso*flavones

THE INTERACTION OF *o*-HYDROXYphenyl benzyl ketones with ethyl orthoformate in boiling pyridine containing a little piperidine gives *iso*flavones. Thus *a*-naphtha*iso*flavones is obtained from 2-phenylacetyl-1-naphthol, and 7-hydroxy*iso*flavone from 2 : 4-dihydroxyphenylbenzyl ketone in excellent yields. The ethyl orthoformate condensation can also be effected in acetic anhydride and zinc chloride but, under the conditions so far examined, yields are poor. With 2 : 4 : 6-trihydroxyphenyl benzyl ketone, ethyl orthoformate gives deeply coloured, complex condensation products. With 2-acetyl-1-naphthol, naphthachromone is obtained, together with a bright-yellow by-product, m.p. 160°C. (*Curr. Sci.*, 1949, **18**, 373).

Vanadium Pentoxide Sols.

THE PREPARATION OF RELATIVELY pure vanadic acid system from ammonium vanadate (than that obtained by the usual method, involving addition of an acid to ammonium vanadate), by ion exchange method is described (*J. Franklin Inst.*, 1949, **248**, 251).

Two exchange resins, Amberlite IR-100H and Dowex-50, are employed in the preparation of the sols. In sol. I a weighed amount of C.P. ammonium vanadate, 1·497 gm., was mixed with 10 c.c. of water and 15·0 gm. of air-dried amberlite IR-100H. The paste was stirred until it acquired a deep-red colour. This occurred in about 5 min. 190 c.c. of water was added with rapid stirring. The system had the deep colour characteristic of vanadium pentoxide sols. It was filtered and analysed for ammonia and vanadium. In sol. II a weighed amount of ammonium vanadate, 21·1688 gm., was mixed with 1 litre of water and 300 c.c. of wet Dowex-50. The system was stirred for 1 hr., filtered and the sol. analysed. The coagulation data revealed that the particles were negatively charged. An excess of resin was required for the production of a stable sol. Calculated amounts of reactants yielded a precipitate because of the coagulating action of ammonium vanadate present in the equilibrium system. Excess resin, however, contributed to the low yield of vanadium pentoxide in the sol. Other factors influencing the low yield of vanadium pentoxide in sol. II were : the absorption of pentavalent vanadium and the greater exchange capacity of Dowex-50.

Separation of Fatty Acids

A NEW FRACTIONAL DISTILLATION plant for the separation of fatty acids has been recently erected in a Lancashire factory (*Chem. Age*, 1949, **61**, 410). The technique is very similar to that of petroleum fractionation and takes place in fractionating towers constructed of stainless steel which give off 4 fractions containing an overhead fraction including odour and unsaponifiable matter, acids of medium boiling point, acids of high boiling point and a residue. The plant is heated by Dowtherm and is controlled by an elaborate system of instrumentation. High vacuum and close control of the heating ensure that the products are not decomposed at the high temperatures involved.

The process will produce fatty acids ranging from C-8 to C-22 of up to 90 per cent purity. The unsaturated products will, in some cases, be mixed, since the process does not separate acids of the same carbon chain length.

Removal of Oxygen from Gaseous Mixtures

A CONVENIENT APPARATUS FOR removing traces of oxygen from gaseous mixtures is described (*Canadian J. Res.*, 1949, **27**, 299).

A pyrex glass tube (No. 172), about 70 cm. long, 16 mm. inside, 20 mm. outside diameter, is drawn at one end to a tip suitable for connection to rubber tubing. The tube is well packed with copper oxide wire fragments which are held in place by rolls of copper gauze. The greater part of the length of the tube is wrapped with two layers of thin asbestos paper and then wound evenly, 3 to 3·5 turns per cm., with nearly 40 ft. of nichrome wire, 2 ohms per ft. The tube is further protected with more asbestos layers. One or two turns of the nichrome wire and asbestos cord are spaced widely, and the layers of asbestos paper are cut away except under the wire, before applying the asbestos paste to the remainder of the tube. This provides spaces which enable the condition of the copper in the tube to be examined. The apparatus can be used with 110 volts d.c. or a.c. power source and temperatures of the order of 650° to 700°C. are attainable. To reduce the copper, hydrogen mixed with a carrier stream of nitrogen or inert gas is passed through the hot tube and this is continued until the tube has cooled down.

New Industrial Viscometer

A NEW TYPE OF VISCOMETER FOR industrial use has been devised for the rapid determination of viscosity of a wide range of liquids (*Br. Sci. News*, 1949, **2**, 345).

A constant air pressure is developed in the instrument which forces the liquid under examination from a container into a horizontal glass capillary tube, open to the air at its far end. The time taken for the liquid to pass between two points is proportional to the viscosity.

The constant air pressure is produced by a dead weight gauge operating under conditions of low friction and producing a pressure (of the order of 60 cm. of water) far below the lower limit at which conventional dead weight gauges can operate satisfactorily. Pressure is maintained constant to ± 2 per cent.

Each determination is carried out using a clean, dry, calibrated capillary tube, 12 in. long, which is inserted into the viscometer head. The cup containing the liquid is fitted into the viscometer head. The cup containing the liquid is fitted into the taper on the other side of the head. A " Snorkel " tube is then fitted to the capillary, at the end remote from the container, to prevent ingress of water and to allow exit of air when the viscometer is laid horizontally in a bath.

To take a reading, the piston is released and the time in seconds for the liquid in the capillary to pass the first to the second mark is recorded.

The viscosity of very small samples can be determined using this new viscometer. The volume of liquid used need not be known, and no density determinations are necessary. The instrument is equally effective with clear or opaque liquids, and is suitable for viscosity measurements of volatile liquids. The viscometer has a range of 50 centipoises upwards.

Mosquito Larvae Mounts

AN EASY AND RAPID METHOD OF making permanent mounts of mosquito larvae in a simple medium prepared from indigenous materials has been evolved at the *Malaria Institute of India* (*Ind. J. Malariology*, 1949, **2**, 283).

The medium is prepared by dissolving at room temperature 50 gm. of crystalline pine rosin in 75 c.c. of eucalyptus oil in a stoppered bottle. The time required to dissolve the rosin completely is reduced from 48 hr. to 2 hr. by placing the container in an automatic shaker. The solution is allowed to stand for a few hours and then decanted, after which it is ready for use. For preparing the mount, the larvae are killed in hot water and put into 90 to 95 per cent alcohol, or they may be directly killed in alcohol. The specimens are transferred to fresh alcohol, absolute or 95 per cent, and kept in it for 15 to 20 min. While under alcohol, it is preferable to prick the larvae in the thoracic region in order to prevent their getting distorted or shrunk when mounted. One larva at a time is placed in the centre of a slide and any excess of alcohol removed with a piece of blotting paper. A few drops of medium are then placed and the specimen covered with a cover-slip after arranging it in the desired position with the help of a needle. In half an hour a transparent mount is obtained.

The method obviates prolonged treatment of specimens for dehydration and other disadvantages in the use of Canada balsam and chloral gum as mounting media. The refractive index of the improved medium described (1·497) is comparatively lower than that of Canada balsam (1·524) with the result that even the very fine colourless structures like the retractile thoracic notched appendages of the Anopheline larvae, mounted laterally, are clearly visible. This medium acts as a clearing as well as a mounting agent which sets hard by itself within 2 to 3 days, without the slides being placed in an incubator. It is not necessary to seal the edges of the mounts with any cement. The medium has been found to be equally useful for unstained as well as stained objects and the larvae need not be completely dehydrated before they are mounted.

This medium has been found useful for other insects such as fleas, ticks, lice, etc. Its consistency can be varied by adding more eucalyptus oil but it is advisable not to increase the percentage of rosin in the solution as the latter is apt to crystallize if the slide is heated for quick drying.

Alkali Lignin

AN ALKALI-SOLUBLE LIGNIN DERIVATIVE, free from sulphur, has been

INDUSTRIAL TARGETS FOR 1950

The following targets of production for the year 1950 have been suggested by the Ministry of Industry and Supply, Government of India, for 15 basic chemical and consumer industries. These targets have been communicated to the various industries for consideration and implementation by production committees which have been set up for each industry.

Industry	*Target for* 1950
Coal	31 million tons
Steel	1·0 million tons
Cloth	45,000 million yards
Sugar	12 lakh tons
Sulphuric acid	1 million tons
Superphosphate	50,000 tons
Aluminium	3,500 tons
Cycle tyres and tubes	6 million sets
Motor tyres and tubes	1 million sets
Power alcohol	10 million gallons
Paper and paper board	110,000 tons
Glass	100,000 tons
Refractories	225,000 tons

obtained as a by-product from the sulphate pulping of *Eucalyptus regnans* (*Aust. J. Sci. Res.*, 1949, **2**, 117).

From the dioxan-ether mother liquors obtained in the isolation and purification of thiolignin from crude lignin (200 gm.), the last traces of thiolignin were removed by concentration and precipitation with ether. After removal of the precipitate (a mixture of thiolignin and alkali lignin, 32 gm.) and working up the filtrate, alkali lignin (38 gm.) was obtained as a fine light-buff powder. Concentration of the mother liquors and precipitation yielded a second crop, darker in colour (9 gm.). This was combined with (32 gm.) mixed alkali lignin and thiolignin and refractionated, yielding a further crop of thiolignin (24 gm.) and alkali lignin (8 gm.). After purification from chloroform-ether to petroleum ether the purified alkali lignin was obtained (40 gm.). This was found to have a minimum molecular weight of 1760 and is in agreement with the empirical formula $C_{92}H_{104}O_{34}$ (1754). The molecule contains 14 methoxy and 8 hydroxy groups. Of the latter, 6 are sufficiently acidic to react with diazomethane, and consist of 1 carboxyl, at least 1 enol, the remainder being presumably phenolic. There are 2 alcoholic hydroxyls, 1 primary and 1 tertiary.

The alkali lignin is a fine powder with a lower softening point (112°C.) than thiolignin (239°C.). It is much lighter in colour, yellow when freshly prepared, and fading, on standing, to a light buff. It is also higher in methoxyl content, 24·7 per cent, compared with 21·1 per cent methoxyl for thiolignin. Potentiometric titration gives a curve of the same type as that obtained with thiolignin, having two points of inflexion — occurring at *p*H 7·0 and 6·5 — and showing an equivalent weight of 863 compared with the value of 665 found for thiolignin.

New Coking Process

THE DISCOVERY OF 2 NEW METHODS for producing high-grade coke has made possible the full exploitation of 8,000 million tons of Norwegian coal on Spitsbergen (*Chem. Age*, 1949, **61**, 491).

When thawed for coking with the traditional methods, the coal disintegrates (on account of the prevailing low temperatures), making it unsuitable for firing. One new method is to crush the coal to a fine powder and then make it into briquettes under heavy pressure. The other method is to bind the coal together by means of concentrated sulphite-lye from the cellulose factories. The latter method has the advantage that the coal need not be crushed so finely, and consequently pressing machines of simpler construction can be used.

It is estimated that a plant processing 1·5 million tons of coal can produce 7,00,000 tons of ashless coke briquettes, 1,30,000 tons of low-temperature tar, and 70 million gal. of petrol plus diesel oil. This would require 3,00,000 kW. of power a year. The high-temperature coke thus produced is very strong and far more reactive than ordinary high-temperature coke. It can be used with great advantage both as a reducing material in all kinds of metallurgical processes and as a smokeless fuel for domestic heating. The by-products of coking, tar and gas, are both readily usable in industry. The gas can be used for chemical synthesis, especially of motor fuel.

Extrusion Method of Butter Manufacture

A UNIQUE METHOD OF MANUFACTURING butter is being tried in Australia with a new Australian machine (*Agri. Newsletter*, Australia).

The method involves the use of extreme cold extrusion instead of churning. Milk is handled in the usual way until after it passes through a separator. Then the cream is piped to a special cream separator, which divides it into 80 per cent butter fat and 20 per cent butter fat skim. Butter fat is carried to a vat which standardizes it for salt and moisture content. During the process a portion of the skim is fed back into the butter fat. Then, under vacuum pressure, the butter fat enters the extruder where, in a brine solution at a temperature below zero, it is transferred into butter. The butter comes out of the machine at 30°F.

Suppression of Radio Interference

The British Electrical & Industries Research Association have reported in a recent pamphlet work relating to the suppression of radio interference from electrical appliances and motor vehicles. An interference field-strength measuring equipment developed by the Association has been accepted as a provisional standard for interference measurements.

Interference to radio reception from motor vehicle comes entirely from the ignition system. The layout and design of the system has been modified and effective suppressors with resistors inserted in the high-tension leads have been designed on economical lines. A single resistor of 5,000 to 10,000 ohms in the lead from the ignition coil to the distributor and with the coil mounted on the engine block has been found to give satisfactory interference suppression in the majority of cases. Additional suppression can be achieved by insertion of resistors of similar value at the sparking plugs. Where, however, the maximum degree of suppression is required as, in the case of military vehicles and aircraft carrying very sensitive radio equipment, screening of the ignition system may be essential. Controlled tests have shown that, in general, resistors of values very much higher than those envisaged for suppression have no effect on engine performance and petrol consumption of the average motor vehicle.

Apart from interference from motor vehicle accessories, the studies cover power-operated domestic appliances, industrial and high-frequency equipment.

Welding of Thermocouples

THE USUAL THERMOCOUPLES CONSISTING of copper, constantan, nickel and nichrome cannot be used on engine pistons because of the high incidence of breakage on account of low elasticity of these materials. Even the best couple consisting of annealed steel and constantan for temperature measurements of high-speed Diesel engines (1,500 r.p.m.) makes the welding difficult in an ordinary voltaic arc, as the steel oxidizes. The essential features of a simple and suitable apparatus invented in Russia for use on engine pistons are described (*Science*, 1949, **110**, 308).

One of the poles of the source of current (d.c. is preferable) is connected to the terminal through a fuse, knife-switch and resistance. The other pole is connected to a wire dipped into a vessel containing mercury and oil. To weld the couple, the ends of the wires are twisted into a knot, the free end of one of the wires being connected to the terminal. The knot is then dipped into the mercury and rapidly withdrawn. For an instant an arc is formed between the mercury and the wire knot while the latter passes through the oil, and this arc welds the tips of the wires together. An excellent joint is produced as the process takes place in a complete absence of air. Wires of 0·05 to 2·0 mm. diam. can be welded by this method.

Prevention of Corrosion

A NEW METHOD OF INHIBITING corrosion effects of hydrogen sulphide produced by anaerobic bacteria is described (*Chem. Age*, 1949, **61**, 494).

During studies on substances which might prove satisfactory inhibitors, consideration was given to dyestuffs which were likely to be non-corrosive and possibly effective in very small concentrations. Tests on the resistance of mixed cultures of sulphate-reducing bacteria to a large variety of dyestuffs showed that dyes of the flavine type are very effective. Some derivatives of 3 : 6-diamino-acridine were prepared by *I.C.I.*, and the dye, known as *I.C.I.* 914, proved extremely efficacious for the inhibition of such bacteria. Experiments conducted to estimate the concentration of dye required to inhibit the growth of sulphate-reducing bacteria in varying degrees of infection, and practical use of the dye show that 1 lb. of the dye per 100 tons of water is usually sufficient to control anything but the heaviest infections if used on successive occasions, the number of dosages being a function of the degree of infection.

These investigations indicate that while control of the distinctive results of bacteria-produced hydrogen sulphide is not generally practicable in open systems (ships' condensers, etc.), protection can now be secured in many closed systems containing limited quantities of water.

Preservation of Biological Specimen

THE DEVELOPMENT OF A CRYSTAL-clear resin, bioplastic, has greatly simplified the technique of preserving and studying biological specimens as pig embryo, jelly fish, human foetus and cross-section of human body. The specimens can be studied from any angle with the naked eye and under the microscope and can be preserved indefinitely.

To prepare the mounts, the specimens after being stained and treated with chemicals, if necessary, are placed in rows in a dish containing two layers of plastic, liquid on top, hard on bottom. Specimens sink through liquid upper layer which soon solidifies, surrounding them with a hard, transparent covering. The dish is placed in an oven for 3 hr. to allow the plastic to set. Blocks are then cut out with a fine-toothed bandsaw, each containing a single specimen. These blocks are sanded and polished.

Saffron Thistle Oil

OIL SUITABLE FOR USE AS A substitute for linseed oil in paint manufacture has been found in the saffron thistle in Australia. The thistle yields 20 gal. of oil to a ton of seed (*Technical Newsletter*, Australia).

Indian Standard for Plywood

THE DRAFT STANDARD PRESCRIBES the requirements for 4 grades of commercial plywood and does not include plywood for special purposes such as aircraft, marine-craft, tea-chests, etc. It lays down definitions of terms used in the trade, species of timber that are to be used for the different grades of plywood, the requirements of adhesives, method of manufacture, and dimensions and finish of the various grades. Tests for moisture content, for adhesion, and for resistance to moisture, and mycological test have been included. Methods of marking, stamping and delivery of plywood are also given.

Comments on the standard will be received by the Director, Indian Standards Institution, till February 12, 1950.

Central Research Laboratory, Hyderabad

THE FOUNDATION-STONE OF THE *Central Laboratory for Scientific & Industrial Research* was laid on 6th November 1949. The Laboratory will work in close collaboration with the National Research Laboratories of the *Council of Scientific & Industrial Research*, and will devote attention to urgent regional problems of Hyderabad. The plan of the Laboratory has been drawn upon the basis of the National Research Laboratories in India and other countries, taking into consideration the special regional requirements of the Hyderabad State.

The buildings will consist of a main block and a few auxiliary units. The main block will house the offices of the Director and his administrative staff, general laboratories and special laboratory units, library, lecture hall, stores, common room and refectory. In addition to the laboratory units, the main building will have a museum.

The work of the Laboratory will be under 4 divisions — fuel, oil, analytical and general research.

The annual recurring expenditure is estimated at Rs. 3,75,000.

Radio Research Laboratory

PLANS FOR THE ESTABLISHMENT of an up-to-date radio laboratory attached to the Engineering College, Poona, costing over 2 lakhs of rupees, is expected to be ready by June 1950. Two similar laboratories are functioning at the Indian Institute of Science, Bangalore, and the Guindy College of Engineering, Madras. The laboratory will have a separate control room, studio, transmitting and receiving stations, with facilities for television and frequency modulation. The line communication section of the laboratory would have an automatic telephone exchange and equipment for picture transmission by wire, while the testing laboratory for carrying out standard tests of equipment used in line and radio communication would have all instruments according to the requirements of the Institute of Radio Engineering for British Standards. A special ultra-high and micro-wave laboratory forms another important feature of the laboratory where research work on radio location would be carried out.

Sugar Research Foundation Award

THE $25,000 GRAND PRIZE OF the Sugar Research Foundation Inc. will be awarded on or about March 15, 1950. Following the awards of 1946, 1947, 1948 and 1949, established by the Foundation to stimulate scientific studies of sugar as a food and as industrial raw material which may lead to its greater usefulness, the Grand Prize will be given for the most significant discovery of the preceeding five years.

Central Advisory Board on Forest Utilization

The Board has been reconstituted with a view to co-ordinating research on forestry with the needs of industry and agriculture and to ensure closer and more active liaison with public opinion. The reconstituted Board will provide representation for industry, agriculture and consumers. Its functions will be : (i) to advise on the assignment of priority to various items of research conducted at the Institute ; (ii) to co-ordinate research with the needs of industry, agriculture and the general public ; and (iii) to link research with the needs of the producer and the consumer.

Indian Showroom in San Francisco

To stimulate exports of Indian manufactured articles, especially to hard currency areas, it has been decided by the Government of India to open a showroom for Indian goods in San Francisco. Attached to the Indian Consulate-General, the showroom will, in the first instance, accept only Indian handicrafts and cottage-industry products. Interested Indian manufacturers should contact the Director of Exhibitions, Ministry of Commerce, 96 Council House, New Delhi, for details.

Trade Exhibition in Japan

A Foreign Trade and Industries Exhibition will be held in Kobe from March 15 to June 15, 1950. The Indian Chamber of Commerce (Japan), Kobe, has advised that it would be advantageous for Indian manufacturers of commercial goods to take part in this exhibition. Intending exhibitors are advised to contact the Indian Chamber of Commerce (Japan), Post Box 393, Kobe, Japan, for details concerning terms and conditions.

The Government of India will arrange for issue of the required export licences to intending exhibitors, who should communicate with the Director of Exhibitions, Ministry of Commerce, Government of India, 96 Council House, New Delhi, for this purpose.

Announcements

Edwards A. Deeds Fellowship — The Secretary, University College, Dundee (*University of St. Andrews*), invites applications by 31st March 1950 for the Edward A. Deeds Fellowship for research in Physical Science, viz. Engineering, Metallurgy, Chemistry, Physics, Mathematical Physics, or any cognate subject. The Fellowship which is tenable for 3 years is of the value of £750-1050 per annum according to qualifications and carries membership of the Federated Superannuation System for Universities. The Fellow will have the status of a University Lecturer and may be required to do a limited amount of advanced teaching.

Prof. T. M. Harris, Professor of Botany and Dean of Faculty of Science, Reading University, England, has taken charge of the Palaeobotanical Research Institute at Lucknow. Prof. Harris will act as an adviser on the future activities and research in the Institute.

Journal of Experimental Cell Research — The International Society for Cell Biology is sponsoring a new journal — *Experimental Cell Research*. 4 issues will be published annually and will include studies in experimental analysis, the organization, structure and activity of the cell and its sub-units, including work on viruses and new methods in the field of experimental cytology.

A New UNESCO Publication — *Impetus*, has replaced the *Reconstruction Newsletter*. The magazine, a monthly, will be the forum for presenting opinion and exchanging views on educational, scientific and cultural development and reconstruction. A new feature is the monthly award of an international book coupon worth $10 for the best discussion in the field.

The American Society for Testing Materials will hold its Committee week and spring meeting in Pittsburgh from February 27 to March 3, 1950. The 53rd Annual Meeting will be held in Atlantic City from June 26 to 30, 1950.

Publications Received

A Chemistry of Plastics & High Polymers, by P. D. Ritchie, Clever-Hume Press Ltd., 1949, pp. 271, price 25*s*. net.

Chemistry of Perfumery Materials, by R. W. Moncrieff, United Trade Press Ltd., pp. 344, price 30*s*.

Canning Practice & Control, by Osman Jones, Chapman & Hall, 1949, pp. 322, price 36*s*. net.

Modern Methods for the Analysis of Aluminium Alloys, by G. H. Osborn & W. Stross, Chapman & Hall, 1949, pp. 144, price 13*s*. 6*d*.

Industrial High Frequency Electric Power, by E. May, Chapman & Hall, 1949, pp. 355, price 32*s*. net.

Indian Science News — Brochure on Penicillin, by Dr. S. L. Bhatia, Government College, Ludhiana, 1949, pp. 71, price Rs. 1/8.

The Swelling of Wood under Stress, by W. W. Barkas, His Majesty's Stationery Office, 1949, pp. v + 103, price 6*s*.

Modern Synthetic Rubbers, by Harry Barron, Chapman & Hall, 1949, pp. xix + 636, price 45*s*. net.

Colloid Science — II, by H. R. Kruyt, Elsevier Publishing Co., 1949, pp. xix + 753, price 77*s*. 6*d*.

Ionization Chambers & Counters : Experimental Techniques, by Hans H. Staul & Bruno B. Rossi, Mcgraw-Hill Book Co., 1949, pp. 243, price $2.25.

Chemical Engineering Plant Design, by Frank C. Vilbrandt, Mcgraw-Hill Book Co., 1949, pp. 608, price $6.00.

Mechanics Statics & Dynamics, by Merit Scott, Mcgraw-Hill Book Co., 1949, pp. 394, price $4.50.

The Technique of Radio Design, by E. E. Zepler, Chapman & Hall, 1949, pp. 394, price 25*s*.

Analar Standards for Laboratory Chemicals, The British Drug Houses Ltd., 1949, pp. 302.

Technology of Light Metals, by Alfred Von Zeerleder, Elsevier Publishing Co., 1949, pp. xiv + 366, price $7.50.

Physical Principles of Oil Production, by G. P. Hernwell, Mcgraw-Hill Book Co., 1949, pp. xv + 922.

Multi-Enzyme Systems, by Malcolm Dixon, Macmillan & Co., 1949, pp. 101, price 7*s*. 6*d*. net.

INDIAN CENTRAL COTTON COMMITTEE, 27TH ANNUAL REPORT (1948-49)

THE RESEARCH ACTIVITIES OF THE COMMITTEE'S technological laboratory and research stations in various provinces and states during the year under review show steady progress and valuable results have been reported in many fields.

Improved strains of cotton have been developed with a greater yield per unit area and better quality of the lint. A micro-spinning technique suitable for evaluating the spinning quality of small quantities of lint (12 oz.) has been worked out, thus, making it possible to select suitable strains which have been cultivated on a small scale.

A standard ginning technique evolved for testing samples has been recommended for use at several cotton-breeding stations. A balance of the steelyard type, which could be used for the rapid determination of the ginning percentage of small samples, was designed and constructed at the laboratory. A modified type of Bardoli gin, in which seed crushing is practically eliminated, was fabricated during the period under report. A new gin of the Macarthy type, which could be used at cotton-breeding stations for ginning small samples, is being designed at the laboratory.

Tests were carried out on *Vijay* grown at different centres; on hybrids to replace *Jarilla*; on *Gaorani* 6 of different generations grown with different doses of manure; and effect of exposure of cotton seeds to X-rays.

Technological Research — Causes of abnormal spinning performance of certain Indian cottons having longer staple but spinning lower were investigated. A study of optimum conditions for partial acetylation of cotton fibres to render them highly resistant to mildew and rotting, without any appreciable loss in strength from micro-organisms, indicated the following optimum concentrations of chemicals: glacial acetic acid (75 per cent) 72 per cent; acetic anhydride, 25 per cent; sulphuric acid, 3 per cent. In addition, several batches of chemical cotton were prepared from linters by the method specially evolved at the laboratory. Many lengths of cellulose sheets had been produced by the viscose method and efforts are being made to make them fully transparent. Besides, work is in progress on the spinning quality of mixings of Indian cottons with special reference to their fibre properties, effect of agronomical factors on the physical properties of the cotton fibre and on the use of air permeability apparatus for determining the fineness of cotton. The work of the scheme on the survey of cellulose-bearing materials in India, financed by the *Council of Scientific & Industrial Research*, was continued and a paper on the investigations on some promising cellulose-bearing materials (other than cotton) for the manufacture of rayon has been published. A suitable standard technique for halolength determination is being evolved for adoption at all breeding stations.

Fundamental research during the year dealt with the causes of chlorophyll deficiencies in cotton plants, lintless genes, evolution of substrains with uniform fuzz colour, effect of agronomic factors on the yielding capacity of the seed, vernalizations of seeds (prior to sowing). Agronomical investigations were connected with the study of the effect of crop rotation, nitrogenous manuring with inorganic and organic manures and addition of phosphate on soil fertility. Nitrogen increased the yield significantly, although the difference in yield due to different sources of nitrogen was not quite significant. Ammonium sulphate gave the best result followed by groundnut cake and farm-yard manure. Phosphate applied in addition to nitrogen increased the yield significantly beyond the average of the yield from nitrogen and phosphate, applied singly. Soaking of seeds in nutrient solution before sowing increased the yield of cotton over the control in all varieties although the effect is somewhat greater in indigenous varieties than in the American varieties. Treatment with ammonium sulphate followed by mono-potassium phosphate (KH_2PO_4) shows the highest increase. Inter-specific hybridization is being carried out at Surat to obtain hybrids from Asiatic and American cottons, with useful agronomic characters.

Physiological Research — Field trials were conducted at Indore to study the effect of molybdenum, boron, copper, magnesium, iron, zinc, manganese and chromium on the growth and yield of cotton. The crops treated with zinc, manganese and chromium were greener in appearance than the crops under other treatments, and recorded an increase in yield varying from 20 to 25 per cent over the control. The inter-relationships of sowing time, spacing and manuring on the growth and yield of cotton were determined on two soil types, viz. (1) soils that become water-logged during monsoon and (2) well-drained deep soils. The optimum sowing period was found to be between 25th May and 10th June for water-logged lands and 1st June to 20th June on well-drained lands. Sowing on water-logged lands gave poor yields. Spacing of cotton was found to be an important factor in increasing the yield per acre. ½ sq. ft. per plant equivalent to 9″ between rows and 8″ between plants or 12″ between rows and 6″ between plants has been found to be the optimum spacing. The relation between sandiness of a soil and the magnitude of the response to manuring has been established. The results with one exception indicated that wherever the soils contained more than 50 per cent of sand in the first 2 ft., a good response to the fertilizer was obtained.

Cotton Research in Provinces — The area under improved varieties of cotton, mainly of medium and long staple types, was 51,48,000 acres or 47 per cent of the total cotton area as compared with 52,49,000 acres or 45 per cent of the total area in the previous year. The proportion of cotton of staple length ⅞″ and above to the total production increased from 30 per cent in the quinquennium 1922-27 to 64 per cent in the quinquennium 1942-47. The proportion of cotton of staple ⅞″ and above (now termed as long staple) to the total production formed 18 per cent during the year under report as against 19 per cent in the previous year. The Committee has recommended the adoption of improved varieties of cotton on a larger scale and has put into operation 13 seed distribution and extension schemes in various provinces. Additional benefit thus accruing to the growers is estimated between Rs. 5 to 5·5 crores.

Experiments were conducted during the year at Government Farm, Raichur, under the scheme for investigation of " small leaf " disease of cotton. Transmission of virus by several sucking insects was tested to see whether they were responsible for the transmission. A sub-committee appointed to examine the question of cotton production in the country, in view of the partition, has recommended the establishment of permanent cotton research stations in all the main cotton tracts of the country. These stations would carry out a survey of the areas to see that only the most suitable cotton strains are grown in those tracts and to ensure a proper supply of pure seed. An increase of 4 million acres under medium and long staple varieties in the various provinces has been recommended which raises the area under cotton from 11 million acres to 15 million acres.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Cattle Breeding & Animal Nutrition

A COMPREHENSIVE POLICY REGARDING CATTLE-breeding in India was recommended at the annual meeting of the Animal Breeding, and Livestock and Milk Committees of the *Indian Council of Agricultural Research* held in November 1949. Special attention will be given to animals of the non-descript type with a view to upgrading both their milk and draught-resisting capacity. The Committee on Animal Nutrition recommended the establishment of the first regional Animal Nutrition Centre at Anand in Bombay province where all aspects of work on nutritional problems of livestock including research on grasses and fodder crops are proposed to be carried out on a regional basis.

Soil Conservation

The Scientific Committee on Agronomy and Development considered a new scheme on soil conservation in Himachal Pradesh. The protection of the area which constitutes the catchment areas of the rivers Jumna, Sutlej, Beas, Ravi and Chinab is essential on account of the Bhakra Dam Project and for the cultivation of fruits and vegetables. The scheme considered by the Committee aims at the introduction of suitable trees and grasses and to find a suitable technique for preventing soil losses from cultivation. A co-ordinated scheme of weed eradication by the application of synthetic chemicals was considered and approved. The scheme will operate in Madras, Bombay, U.P. and West Bengal.

The Committee has approved of a scheme for the trial of wind-mills for irrigation purposes at Allahabad, Ahmedabad, Belgaum, Travancore, Poona and Pusa to determine on a field scale the possibilities of harnessing wind power for irrigation of crops in areas having favourable wind velocities.

Fruit Research Station

The establishment of a Fruit Research Station at Simla with two sub-stations at Bushair and Solan has been recommended by the Scientific Committee on Fruits and Vegetables. The proposed sub-station at Bushair will be used for cultivation of grapes and pomegranates. The dry and cold climate of Bushair is favourable for these fruits. The Committee also recommended that the Central Institute of Fruit Technology of the Ministry of Agriculture should be put on a permanent basis and should be properly equipped for giving technical assistance and advice to the fruit industry.

Various schemes of production of tuber crops were considered and among the new schemes approved by the Committee was one for breeding of high yielding types of tapioca and sweet potato in Travancore and Madras.

Cultivation of Medicinal Plants

The Medicinal Plants Committee has recommended commercial-scale cultivation of medicinal plants in India. Fifty important plants have been selected for cultivation on an experimental basis in different regions of the country. Six regions have been selected and, in each, one centre in the plains and another on a higher altitude are proposed. The centres suggested are : the Simla Hills in Himachal Pradesh, Gurdaspur and Manali in East Punjab, Coimbatore and Nilgiris in Madras, Poona and Panchgani in Bombay, Darjeeling in West Bengal and Jorhat and Shillong in Assam.

The work under the scheme consists of trying the plants in the various centres in order to find out what particular varieties, climatic conditions and soil types would give the maximum yield of the active principle. On the basis of this information plantations will be developed for commercial cultivation.

COLONIAL PRODUCTS RESEARCH COUNCIL ANNUAL REPORT 1948-49

THE OPENING OF THE COLONIAL MICROBIOLOGICAL Research Institute at Trinidad devoted to fundamental research in microbiology was an important event in the Council's activities during the year. The Institute forms a part of Commonwealth scheme for the establishment of culture collections of micro-organisms which will be made available to other microbiologists.

Work on the re-use of rum distillery waste liquors in the preparation of fresh wort by treating the wash with 1 per cent superphosphate and neutralization during ebullition has led to the development of pure culture fermentation of molasses worts, and successful distillery trials have been made. Studies on the types of organism growing in the cocoa pulp during fermentation to determine their role in the development of cocoa flavour and chemical changes of pigments in cocoa bean during fermentation have been successfully followed up. 3 new anthocyanins, 2 leuco anthocyanins and a catechin have been isolated from the fresh Forestro bean. Soil antibiotics, related to litamacidin produced by certain actinomycetes, have been isolated from *Fusarium* infected soils. An actinomycete collected from Jamaica and Trinidad soils has been found to produce an antibiotic which arrests the growth of *Fusarium oxysporum cubense* and other fungi in dilutions less than 1 part per million.

Carbohydrates — One of the main items of the Council's research programme has been to find further industrial uses for sugar and starch. A large number of pyridazone derivatives prepared from levulinic acid (from sucrose) are being examined for their therapeutic value. Since the anhydrides of mannitol and sorbitol appear likely to be of value for the preparation of substances suitable for use in plastics industry, attention has been directed to a study of the structure of certain by-products which are formed in the dehydration of the two hexitols, and pyrolysis of mannitol and sorbitol formates. One of the products of pyrolysis is 2-vinyldihydrofuran. The interesting observation has been made that diallyl itaconate, in admixture with polymethylmethacrylate, yields a plastic which is superior in abrasive properties to that made from polymethylmethacrylate alone when used in the manufacture of dentures. New and rapid methods have been devised for the isolation of 2 important *P* and *Q* enzymes. Purified *Q* enzyme converts amylose to amylopectin. This may prove to be of industrial value since it provides a method for the conversion of industrial starches into the non-retrograding starches of the waxy-maize type. Another important investigation is the action of ultra-violet light on starch. A solution of starch exposed to ultra-violet light is completely decomposed to give carbon dioxide. Since other carbohydrates, such as cellulose, behave similarly and the reaction is obviously connected with the deterioration of carbohydrate material on exposure to sunlight, the course of this photo-oxidation is being studied.

Vegetable Oils — Important studies on vegetable fats and oils have been conducted in Prof. Hilditch's laboratory at Liverpool. An oil with an iodine value of 205 to 207 and free fatty acid content of 0·9 to 1·6 per cent has been expressed from heat-treated conophor seeds (*Tetracarpidium conophorum*) from Nigeria. Heat treatment of the nuts checks the development of free fatty acids.

The dispersion of about 1 per cent of rubber in the rubber seed oil expressed by usual methods has been removed by precipitation with acetone indicating thereby that rubber seed oil for industrial use will have to be solvent extracted with acetone and not expressed. As in conophor nuts, the heat treatment of rubber seeds also effects a check on the development of free fatty acids apart from facilitating their decortication when whole seeds are treated. The component acids of the glycerides of groundnut, niger seed, safflower and tobacco seed oils have been examined.

The Turkish tobacco seed, having 35 per cent oil content, yielded an oil resembling safflower seed oil in its high (73 per cent) linoleic acid content. It is considered possible to roll the seed and solvent extract the oil. The presence of α-elaeostearic acid (30 per cent) in the fat of fresh *Parinarium laurinarium* seeds from Fiji has been confirmed and parinaric acid (51 per cent) has been shown to be octadeca — 9, 11, 13, 15 — tetraenoic acid.

An accurate method for the estimation of ricinoleic acid in castor oil has been worked out.

The determination of the chemical constitution and component glycerides of conophor, *Argentine* linseed, Australia and Hong-Kong candlenut and rubber seed has been completed. This knowledge will enable paint manufacturers to obtain drying oils suitable to their requirements and to utilize them more economically.

Medicinal & Insecticidal Plants — Two triterpene acids, centoic and centillic acids, have been isolated from the Ceylon variety of *Hydrocotyle asiatica.* From the Assam variety also 2 triterpene acids have been separated. One of these is closely related to, but differs from, centoic and centellic acids ; it gives a crystalline methyl ester and contains an *a*-glycol system. The second acid present in the plant occurs in combination with a polysaccharide system, just as does centellic acid in the Ceylon plant, but the identity of the latter has not yet been established. A number of west African plants have been investigated. The alkaloid rhynchophylline has been isolated in small amounts from the bark of *Mitragyna inermis.* A triterpene acid has also been isolated and identified as quinovic acid, the acid present in cinchona bark. This is of some interest as mitragyna and cinchona belong to the same natural order (*Rubiaceae*). In seeking better sources of mitragyna alkaloids, *Mitragyna rubrostipulacea* and *Mitragyna ciliata* have been examined. The former proved to be an excellent source of mitraphylline, which is apparently the simplest member of the series of mitragyna alkaloids ; both bark and leaves were found to contain about 5 gm. per kg. of alkaloid. The isolation of rotundifoline from this source is noteworthy. The only other source of rotundifoline is *M. rotundifolia,* from which it was isolated together with rhynchophylline.

The essential oil from *Brachylaena hutchinsii* has been found to contain 2 dicyclic sesquiterpenes derived from cadalene, a sesquiterpene alcohol, and a sesquiterpene ketone.

Gums — The gum from *Sterculia setigera* has been found to resemble in its properties gum tragacanth and gum karaya. It is a partially acetylated polysaccharide and on hydrolysis gives rise to the sugars l-rhamnose, d-galactose, d-galacturonic acid and d-tagatose. The presence of the last-mentioned sugar is of interest since it is for the first time its occurrence in nature has been reported. A preliminary examination of *Khaya senegalensis* has shown it to resemble very closely gum acacia.

A relatively rich source of saponin has been found in the wood of *Mora excelsa* which contains up to 10 per cent of the saponin. The wood of the related species, *M. gonggrijpii,* also contains a saponin.

SOME ASPECTS OF THE FINNISH GLASS INDUSTRY (*Contd. from p.* 27)

formed by the plunger on the inside so that the finished piece transmits light but no vision.

The sealing process as carried out at Karhula is as follows. The two halves of the block are lifted from the semi-automatic press by a specially designed tool and held in an electric furnace containing molten aluminium. They are removed after the aluminium has adhered to the edges, placed upon each other and pressed together to complete the seal. The block is then annealed. The edges are given a water and alkali-resistant coating which also assures a permanent bond between glass and mortar.

Glass wool is manufactured by the centrifugal process. A thin stream of glass at a constant temperature flows from an orifice on to a specially designed refractory disc revolving at a speed of about 4000 r.p.m. The disc accomplishes the centrifugation and the fluid glass is thrown out into thin threads.

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 November 1949.

Organic Chemicals

39888. Catalytic hydrogenation process for the production of hexamethylenediamine : *Heating 1 : 4 dicyanobutene with hydrogen in presence of cobalt hydrogenation catalyst at 75° to 200°C.*— I.C.I. Ltd.

39958. Leuco sulphuric ester derivatives of vat dyestuffs and intermediates : *Treating with a salt of chlorosulphonic acid* — I.C.I. Ltd.

39964. New wool dyestuffs of the xanthene series : *Sulphonating 3 : di-90- or p-cyclohexyanilino-fluorans* — I.C.I. Ltd.

40986. Pyridinium salts and the preparation thereof : *Reacting a 3-pyridol with a carboxyl halide and then quaternizing the product* — William R. Warner & Co.

41311. Preparation of phenols : *Heating sulphonic acids with alkaline earth hydroxides to 350° to 450°C. in presence of inert gas and thereafter in the presence of steam* — De Directi Van de Staatsmijnen in Limburg

39028. Production of a pigment from a pigmentry anthraquinone vat dyestuff : *Admixing anthraquinone vat dyestuff with aniline and separating the components* — Bernier

39847. New vat dyestuffs : *Comprises acylating 4 : 8-diamino-1-aroylamino-anthraquinone with acylating derivative of anthraquinone 2-carboxylic acid carrying an amino group in 1-position* — I.C.I. Ltd.

39965. Wool dyestuffs of the anilinofluoran series : *Sulphonating 3 : 6-di-(o- or p-dialkyl anilino) fluoran containing two sulphonic acid groups per molecule* — I.C.I. Ltd.

Drugs & Pharmaceuticals

40638. Process for the preparation of a non-aqueous, homogeneous therapeutic gel : *Aluminium stearate homogeneously dispersed in a non-rancid vegetable oil to form a gel for injecting penicillin and its salts* — Sharp & Dohme, Incorp.

41182. Preparation of vitamin B_{12} : *Subjecting a liver preparation or streptomyces griseus elaboration product to the action of activated material and recovering the vitamins in purified forms* — Merck & Co. Inc.

Metals & Metal Products

39203. Alloy steels : *Comprising carbon ·05 to 6·0 per cent, manganese ·1 to 2·0 per cent, silicon ·1 to 2·0 per cent, nickel ·0 to 40 per cent, chromium 10 to 30 per cent, cobalt 20 to 60 per cent, molybdenum and/or tungsten ·05 to 6 per cent. iron ·5 to 25 per cent* —William Jessop & Sons Ltd.

41639. Decarburization of iron or iron alloy castings : *Comprising heating castings to 850°C. to 1100°C. in a gas-tight furnace, circulating gaseous products which is burnt to raise steam in a steam generating unit* — Birlec Ltd.

40793. Magnesium base alloys : *Consisting of at least 85 per cent magnesium, 0·5 per cent to 10 per cent of rare earth metals of which neodymium constitutes at least 50 per cent, with lanthanum and cerium not exceeding 25 per cent separately, the balance being one or more of elements proseodymium, samarium and rare earth metals* — Magnesium Elektron Ltd.

40818. Recovery of zinc from zinciferous material containing iron and apparatus suitable therefor : *Heating the molten dross to evaporate zinc and discharging the iron content from the container* — Revere Copper & Brass Incorp.

Paper & Allied Products

41365. Process for the preparation of hypochlorite bleaching liquor by the chlorination of a lime-containing starting material : *Prepared by chlorinating lime-containing starting material, and the hypochlorous acid so formed is converted to calcium hypochlorite by further adding calculated amount of lime* — India Paper Pulp Co. Ltd. & Tapadar

Textile & Textile Products

41361. Washing and soaping of printed material : *Overflow from the last cistern is fed to the succeeding water cistern and the overflow from the said succeeding is fed to the next and as on, whereby a counter-current is developed within the cistern* — Datar

39886. Process for colouration of textiles and paper with dyestuffs containing quaternary or ternary salt groups : *Printing textile or paper with dyestuff containing quaternary ammonium, ternary sulphonium or isothiouronium salt group* — I.C.I. Ltd.

41298. Viscose rayon : *Extruding in* H_2SO_4 *bath a viscose prepared via alkali cellulose of which the mean degree of polymerization after ripening is greater than 450 and a degree of xanthogenation between 40 and 50* — Comptoir Des Textiles Artificiels

Miscellaneous

40348. Improved crucible power press : *Comprising a fixed mould and a receptacle, swivel joint on a shaft rotating a plunger, a clutch on the shaft, a protective liner in the mould, a ring at the top of the plunger* — Narasimhacharyulu

41421. A process for purifying sugar juice : *Juice treated with lime so that alkalinity of the juice is adjusted so that during carbonation colloidal impurities precipitate* — Svenska Sockerfabriks Aktiebolaget

40021. Catalytic desulphurization of naphthas *Passing naphtha in vapour form over catalyst at a suitable temperature and pressure* — Anglo-Indian Oil Co.

40869. Harvesters of leaf-plucking machines for tea leaf : *A frame-work with another frame-work along with it having adjustable cutting mechanism attached therein* — Gordon

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Letters to the Editor

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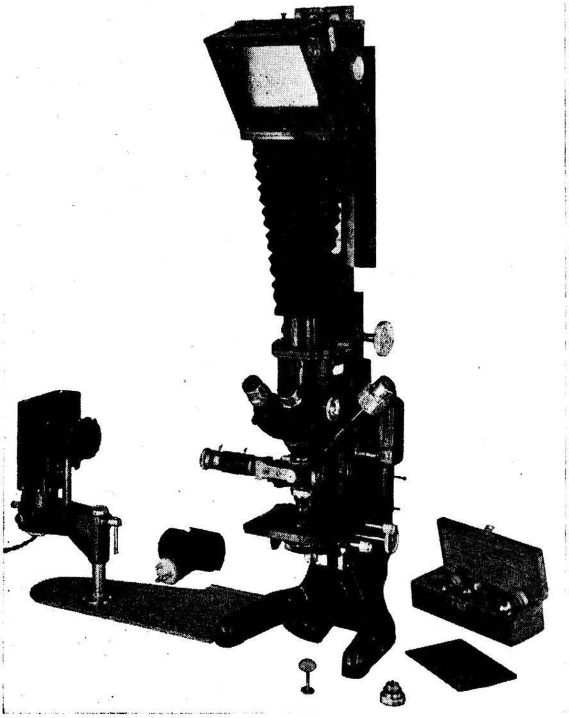


Chemical Examination of the Roots of *Saussurea lappa*, Clarke — Part I: On the Reported Isolation of the Alkaloid "Saussurine"

KAILASH CHANDER SALOOJA, VISHWA NATH SHARMA & SALIMUZZAMAN SIDDIQUI

Chemical Laboratories, C.S.I.R., Delhi

The roots of the medicinal plant *Saussurea lappa*, Clarke, have been investigated for their active principles. The basic fraction obtained by extracting the roots with ammoniacal alcohol has been characterized through its chloroplatinate, $C_{40}H_{55}O_5N_2H_2PtCl_6$; m.p., 200°C. A liquid constituent, b.p. 176°-78°C. at 3 mm.; $[\alpha]^{33}_{D} = +18{\cdot}1$, provisionally named *Kushtin*, $C_{20}H_{26}O_3$, has been isolated from an ether extract of the roots. A comparison of the molecular formula of the chloroplatinate and that of the liquid constituent suggests that the parent base might have resulted through the interaction of ammonia with two molecules of the latter.

SAUSSUREA lappa, Clarke (Hindi — *Kustha, Kuth*), is a well-known medicinal plant used in the indigenous system of medicine for the treatment of cough, asthma, fever, dyspepsia, leprosy, and as a diuretic and anthelmintic. It is also extensively used in China as a powerful stimulant, carminative and antispasmodic. The best quality of the roots is obtained in Kashmir, from where they are exported in large quantities.

Hooper[1] mentions the presence of one solid and two liquid resins in the roots and also traces of an alkaloid. The essential oil from the roots was found by Semmler and Feldstein[2] to consist of aplotaxene, costol, dihydro-costus lactone, costus lactone, costic acid, α-costene and β-costene besides traces of phellandrene, terpene alcohol and camphene. The therapeutic action of the essential oil was studied by Chopra and De[3,4] who noted that it is effective in controlling paroxyms of bronchial asthma. Ghosh, Chatterjee and Dutta[5] have reported the isolation of an alkaloid " Saussurine " in the form of its tartarate from the alcoholic ammonia extract of the roots, but they have not given any physical or chemical data about the alkaloid.

During the course of the present work which was primarily undertaken to study the alkaloidal constituents of the roots, it was observed that the alcoholic extractive from the powdered roots, with or without prior maceration with lime or alkali, gave only a slight precipitate with the usual alkaloidal reagents, and on working up the alcoholic extract from 1 kg. of the drug, it was not possible to isolate any alkaloid from it. On the other hand, a repetition of Ghosh *et al.*'s procedure for the isolation of " Saussurine " through extraction of the roots with ammoniacal alcohol and removal of the solvent at ordinary pressure without previous acidification, yielded a basic fraction which gave alkaloidal tests with Dragendorff's, Wagner's and Mayer's reagents. Attempts to crystallize the basic fraction which is readily soluble in alcohol and methanol, less so in ether and chloroform, and sparingly soluble in water proved unsuccessful. It failed to give any insoluble salt with the usual organic and inorganic acids, and attempts to prepare its tartarate in the manner described by Ghosh and co-workers gave only crystals of tartaric acid. The basic fraction could, however, be characterized through its chloroplatinate, which was obtained in the form of a light-brown micro-crystalline powder melting at 200°C. (decomp.), and analysed for the molecular formula $C_{40}H_{56}O_5N_2.H_2PtCl_6$. In view of these facts and the absence of any physical or chemical data in regard to " Saussurine ", it was concluded that the product isolated by Ghosh and co-workers was a basic condensation product of certain constituent present in the drug with ammonia. This view found further support from the fact that the ethereal extractive of the roots which was free of nitrogen, gives, on treatment with ammonia in the cold, a basic condensation product yielding a chloroplatinate identical in its melting point, solubilities and analysis with the one referred to above. The alcoholic extractive of the drug which gave only slight precipitate with alkaloidal reagents also gave the same chloroplatinate from the nitrogen-containing basic condensation product obtained by the action of ammonia.

In order to further investigate the constituents of the drug, it was extracted with ether, as the higher boiling solvents tended to produce high melting (m.p. above 350°C.), amorphous, resinous products. The concentrate from the ethereal extracts was repeatedly extracted with petroleum ether to separate the essential oils and fatty matter. The petroleum ether insoluble residue, which failed to crystallize from the usual organic solvents, was subjected to fractional distillation under reduced pressure, when a pale-yellow liquid was finally obtained as the major fraction (b.p. 176°-78°C. at 3 mm.), which analysed for the molecular formula $C_{20}H_{26}O_3$ and has been provisionally named as " Kushtin ". It is optically active, $[\alpha]_D^{33} = +18{\cdot}1$ in chloroform solution. It is insoluble in sodium bicarbonate or alkali and does not give any colouration with ferric chloride. It does not reduce Fehling's solution. Titrations with standard bromine solution showed the presence of one double bond in the molecule. From the resultant solution a crystalline bromo derivative, m.p. 172°C. (decomp.), was obtained, which is under investigation.

A comparison of the molecular formulae of the chloroplatinate ($C_{40}H_{56}O_5N_2.H_2PtCl_6$) and that of the liquid constituent obtained above ($C_{20}H_{26}O_3$) would suggest that the parent base might have resulted through the interaction of ammonia with two molecules of the latter. This point as well as further studies in the constitution of these products are in progress.

Experimental

Examination of the Alcoholic Extracts — Alcoholic extracts of the powdered drug with and without previous maceration with 3 per cent alcoholic potash and slaked lime were extracted with 2 per cent hydrochloric acid and the acidic solutions tested after filtration with Dragendorff's, Wagner's and Mayer's reagents. In all the three cases only faint precipitates were obtained.

1 kg. of the powdered drug was percolated with alcohol at the room temperature. The percolates were concentrated under reduced pressure and the residue was extracted with 2 per cent hydrochloric acid. The acidic solution was filtered, basified with dilute alkali and extracted with chloroform. The chloroform solution was washed with water, dried over anhydrous sodium sulphate, filtered and freed of the solvent. The oily residue did not give any precipitate with the alkaloidal reagents and failed to crystallize.

Examination of the Ammoniacal Alcoholic Extract — 500 gm. of powdered roots were extracted in the cold with 5 per cent ammoniacal alcohol. Following the procedure adopted by Ghosh *et al.*, the extract was freed of the solvent on the water bath at ordinary pressure without previous acidification. The residue was repeatedly extracted with 1 per cent sulphuric acid, and the acidic solution was made slightly alkaline with ammonia and extracted with chloroform. The chloroform solution was washed with water, dried over anhydrous sodium sulphate, filtered and freed of the solvent. The basic residue gave thick precipitates with Dragendorff's, Wagner's and Mayer's reagents, and was soluble in alcohol and methanol, less so in ether and chloroform and sparingly soluble in water, and failed to crystallize from any of these solvents. It did not give any insoluble salt with various organic acids, viz. oxalic acid, succinic acid, tartaric acid, etc., or with inorganic acids like hydrochloric acid and sulphuric acid. Attempts to prepare the tartarate in the manner described by Ghosh and co-workers gave only crystals of tartaric acid. A solution of the basic residue in dilute hydrochloric acid, however, gave a thick buff-coloured precipitate of chloroplatinate on the addition of a dilute solution of platinic chloride. The precipitate was filtered, washed with water and dried on a porous plate. The chloroplatinate thus obtained formed a light-brown micro-crystalline powder which darkens from 175°C. onwards and melts with decomposition at 200°C. It is sparingly soluble in cold water, more so in the hot, and insoluble in common organic solvents. Found after drying to constant weight at 100°C. *in vacuo* over phosphorus pentoxide : C, 45·3 ; H, 6·0 ; N, 3·5 ; Pt, 18·1 per cent ; $C_{40}H_{56}O_5N_2$, H_2PtCl_6 requires C, 45·5 ; H, 5·5 ; N, 2·7 ; Pt, 18·5 per cent.

Treatment of the Ethereal Extract with Ammonia — 500 gm. of the powdered roots were extracted with ether, and dry ammonia was passed through the well-cooled extract. The ethereal solution was well washed with water, and freed of the solvent. The residue which gave thick precipitates with Dragendorff's, Wagner's and Mayer's reagents was extracted repeatedly with dilute hydrochloric acid. The acidic solution was basified and extracted with chloroform. The chloroform solution was washed with water and evaporated on the water bath, and the residue was dissolved in dilute hydrochloric acid. The acidic solution gave a chloroplatinate on the addition of a 4 per cent solution of platinic chloride (yield, 0·37 gm.). The chloroplatinate showed the same melting point as the one obtained above by following the procedure of Ghosh *et al.*, and gave no depression in the melting point on admixture with it. Its solubilities were also similar. After drying to constant weight at 100°C. *in vacuo* over phosphorus pentoxide, it gave C, 45·3 ; H, 5·8 ; N, 3·0 ; Pt, 18·2 per cent ; $C_{40}H_{56}O_5N_2$, H_2PtCl_6 requires C, 45·5 ; H, 5·5 ; N, 2·7 ; Pt, 18·5 per cent.

Treatment of the Alcoholic Extract with Ammonia — The alcoholic extract from 500 gm. of powdered roots was saturated with dry ammonia and the reaction mixture was left overnight in the ice box. The solution was evaporated on the water bath and finally *in vacuo*. The residue gave copious precipitates with Dragendorff's, Wagner's and Mayer's reagents. It was extracted with dilute hydrochloric acid, and the acid solution, after basifying with dilute alkali, was extracted with chloroform. The chloroform solution was washed with water, dried over anhydrous sodium sulphate and freed of the solvent, when a dark-brown treacly residue was obtained which could not be crystallized. Its solution in dilute hydrochloric acid yielded a light-brown micro-crystalline chloroplatinate which gave no depression in the melting point on admixture with samples of the chloroplatinates obtained in the foregoing experiments. After drying to constant weight at 100°C. *in vacuo* over phosphorus pentoxide it gave C, 44·9 ; H, 5·6 ; N, 2·9 ; Pt, 18·1 per cent ; $C_{40}H_{56}O_5N_2$, H_2PtCl_6 requires C, 45·5 ; H, 5·5 ; N, 2·7 ; Pt, 18·5 per cent.

Isolation of " Kushtin " from the Ether Extract — 500 gm. of powdered roots were extracted with ether and the extract was freed of the solvent on the water bath and finally *in vacuo*. The residue (33·4 gm.), which was free of nitrogen, was extracted repeatedly with petroleum ether. The petroleum ether insoluble fraction (2·9 gm.), which could not be crystallized from the usual organic solvents, was subjected to fractional distillation at 3 mm. pressure, when " Kushtin " was finally obtained as a pale-yellow, thick liquid distilling at 176°-78°C. It is soluble in ether, ethyl acetate, chloroform and benzene and sparingly so in alcohol, methanol and petroleum ether. It is insoluble in sodium bicarbonate or potassium hydroxide, does not give any colouration with ferric chloride, and does not reduce Fehling's solution. In 1 per cent solution in chloroform it gave $[\alpha]_D^{33} = +18·1$. Found : C, 77·2 ; H, 8·6 per cent and M.W. (after Rast), 312 ; $C_{20}H_{26}O_3$ requires C, 77·0 ; H, 8·3 per cent and M.W., 314.

0·0265 gm. of the substance in dry chloroform was titrated, under ice cooling, against 0·0906 per cent bromine solution in the same solvent. After the addition of 15·2 c.c. of the bromine solution, it was found to be in excess. (Bromine solution required for one double bond, 14·9 c.c.) The resultant solution was freed of the solvent at the room temperature. The oily residue, on crystallization from methanol, yielded colourless needles of a bromo derivative melting at 172°C. (decomp.).

Acknowledgement

The authors take this opportunity to thank the Chief Conservator of Forests, Government of Jammu and Kashmir, for supplying a fresh, authentic sample of the drug.

REFERENCES

1. HOOPER, cf. DYMOCK, WARDEN & HOOPER : *Phar. Indica*, 1890, II, 298.
2. SEMMLER & FELDSTEIN : *Ber.*, 1914, **47**, 2433.
3. CHOPRA, R. N. & DE, PREMANKUR : *Indian Med. Gaz.*, 1924, **59**, 540.
4. Idem. : *Indian J. Med. Res.*, 1929, **17**, 351.
5. GHOSH, CHATTERJEE & DUTTA : *J. Ind. Chem. Soc.*, 1929, **6**, 517.

The Riboflavin Excreting Mutant & the Problem of Variability in Yeasts

B. RANGANATHAN & M. K. SUBRAMANIAM
Indian Institute of Science, Bangalore

Artificially produced top yeasts excrete into the wash considerable amounts of riboflavin. The possibility that these may be highly useful for industrial exploitation necessitated a consideration of the problem of stability in yeasts.

Systematic observations of the changes in the sculpturing of the giant colonies of top yeasts extending over the years indicate only a waxing and waning of the size of the sculptured rim during the different seasons when cultured at the room temperature.

The waxing and waning of the sculptured rim parallels the predominance of the rough and smooth types of colonies in the two-chromosome control. Since the top yeasts appear to be the result of a chromosomal translocation, the genic sequences should have been altered and as a result mutations at the loci governing the nature of sculpturing should produce phenotypic expressions entirely different from that observed in the control. Tetraploids are highly stable and hence types suitable for industry should be polyploids.

Introduction

THE recent discovery[1] that a top yeast, isolated by us[2] three years ago, gives not only a better yield, but excretes into the wash a considerable amount of riboflavin, led to the suggestion that the strain may be useful for compressed yeast manufacture. As pointed out in a previous contribution[3] one of the important considerations to be kept in view is the stability of the strains. The problem of stability has received scant attention and rather confusing statements are found in the literature on yeasts. From his investigations on *Nadsonia*, Skovsted[4] concluded that reverse mutations do not occur and that " each type under fixed conditions produces a limited number of mutations only but where the mutants produce a number of new mutations " (p. 451). This view is apparently that of Winge[5] also who considers that it is impracticable to keep a type unchanged except for short periods. The appearance of minor mutations may change the original type considerably and when, after lapse of some time, one comes across a sector having an identical type of sculpturing as the original type at the start of the experiment, he believes that one cannot at all be sure that it is the original type.

The Problem

The above conclusions, if accepted literally, raise other fundamental questions: (1) If there is such variability, is it a general phenomenon affecting also the genes responsible for the specific biochemical behaviour of the various strains ? If the answer is in the affirmative, then the classification of yeasts into species is not valid at all. Winge and Laustsen[6] remark : " If a particular *Saccharomyces* species, or variety is wanted, the proper way is to obtain the original culture, if this is possible " (p. 344). But then, if the species was isolated and described several years before, the culture obtained cannot be identical as that investigated by the discoverer. It naturally follows that the very use of the name " species " itself would become questionable in the case of yeasts.

When this is the case regarding the so-called species in yeasts, one can imagine the validity of the claim of Skovsted[4] that his type 20 which arose by mutation could be described as a new species. Anyway, even if the above claim is accepted as valid, it does not entitle one to imagine that new species originate in higher animals and plants in such a simple fashion.

(2) If there is such high mutability and progressive transformation going on in cultures, how is it that yeasts used in industry are highly stable ? Winge[5] offers the following explanation. While under industrial conditions Natural Selection weeds out those mutants having inferior growth rate, these persist in pure cultures where the limited amount of medium leads to early stoppage of growth with the resulting persistence of the mutants as resting cells. To those who are familiar with the problems concerning the so-called " bacterial dissociation "[7], the above explanation of Winge[5] is too simple to be valid. Competition should be keener when the environment is the limiting factor.

Investigators on yeasts have only dimly realized that very intricate populational problems determine the establishment of particular types of mutants. It has to be definitely understood that in liquid media while the total number of cells may go on increasing, only a certain percentage are viable and these reach a maximum which is steady during further growth. From the time the viable cells reach their maximum, the " populational pressure " selects those mutants having a higher growth rate or viability. It is not, therefore, a mere question of growth rate alone. Viability comes into the picture. Under certain conditions, even mutants having a slower growth rate but a higher viability can establish themselves[8]. The nature of the environment determines both growth rate and viability.

Winge's[5] explanation takes into consideration only hypomorphic mutants. What about the hypermorphic ones having superior growth rate as well as viability ? Winge and Roberts[9] consider that hypermorphs can occur (p. 269). If that is so, then, even under industrial conditions selection should proceed to a stage where further mutations in the positive direction under such specific conditions is not possible.

(3) If the cultures are progressively changing their characteristics, is there any method by which they could be stabilized ? To those interested in producing new strains for industry this is a vital question and for this vital question there is no answer in the published literature.

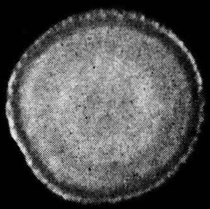
To us this problem has been one of major importance. It is virtually impossible to carry out simultaneously the cytogenetical and biochemical investigations on the new strains. New strains have first to be produced and their stability tested before any biochemical investigations are possible. Very early during our investigations we discovered[10-14] that induction of tetraploidy was possible.

Stabilization by artificial induction of polyploidy thus became a possibility, and continuous observations on the giant colonies of the induced tetraploids[12,13] confirmed their stability. This led to the next logical conclusion that when mutations at the loci determining the nature of sculpturing of the giant colony could be prevented from finding expression, similar mechanisms should operate in the case of those loci controlling biochemical characteristics also.

Thus the gloomy picture that emerges after a critical evaluation of the previous literature ceases to have any reality and as would be shown in the discussion, our co-ordinated intensive work indicate that it may be possible to produce specific stable types.

Isolation & Previous Investigations on the Strain

The new strain was obtained when the two-chromosome control was treated with acenaphthene for 90 days[2,15]. It was isolated at the same time as the autotetraploid, BY 3, and the culture was kept growing in wort and wort agar. A cytological examination immediately after isolation revealed two unequal chromosomes. The cause for this inequality was assumed to be the result of a loss of a bit of one of the chromosomes and its poor growth was attributed to this deficiency. The culture was kept in a very active condition and it began to show normal



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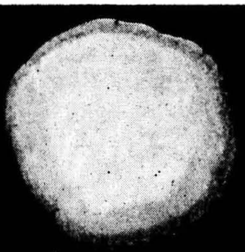

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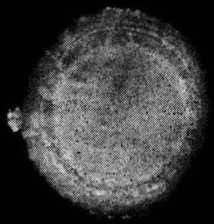

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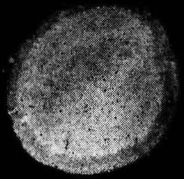

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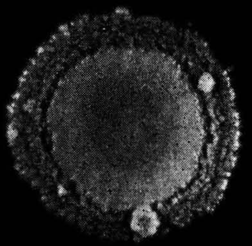

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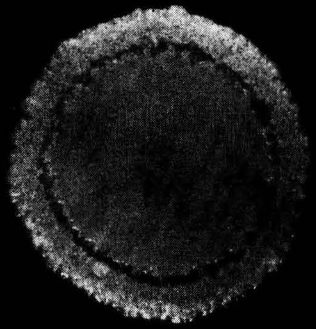

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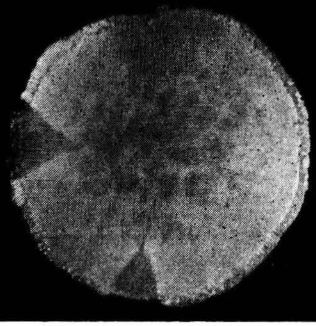


growth after the lapse of a few months. The acenaphthene treatment was carried out in wort, the strain was purified by plating in wort agar, and it was grown in wort and wort agar. The adaptation to normal growth should, therefore, be the result of a simple gene mutation. A locus determining growth rate occurs in the control[3] and the mutation should have been to a relatively hypermorphic allele.

Indirect evidence in support of the above possibility was obtained from the observations of Prema Bai[16] on the nutritional requirements of this strain. In comparison with the control and the autotetraploid, this top yeast, BY 2, was relatively autotrophic. This surprising result indicated that the real change is not one of deletion but a translocation. In the control there is a locus governing the growth rate. The chromosomal translocation may have resulted in an alteration of some of the gene sequences and the poor growth may be the consequence. The appearance of a more efficient allele at the growth-rate locus is probably the observed adaptation for normal growth in wort and wort agar.

Whether this type of mutation is induced only by acenaphthene or whether the different agencies inducing polyploidy produce also top yeasts was next investigated. A tetraploid and a top yeast, BY 5, were isolated from a culture kept in an active condition in the ice room for 90 days[17]. The similarity between the giant colonies of the tetraploids and top yeasts produced by such entirely different agencies was remarkable[12]. Prema Bai (unpublished) discovered that their nutritional requirements were also identical.

← FIG. 1 — BY 2: 12-DAY GROWTH, 2·2 CM., 27TH SEPTEMBER 1946 (*After Subramaniam and Rangnathan*).

FIG. 2 — BY 5: 12-DAY GROWTH, 1·7 CM., 6TH NOVEMBER 1946 (*After Subramaniam and Ranganathan*).

FIG. 3 — BY 2: 18-DAY GROWTH, 2·7 CM., 28TH FEBRUARY 1947.

FIG. 4 — BY 5: 18-DAY GROWTH, 2·4 CM., 28TH FEBRUARY 1947.

FIG. 5 — BY 2 (LONG MYCELIAL): 23-DAY GROWTH, 1·7 CM., 10TH APRIL 1947.

FIG. 6 — BY 2 (SMALL MYCELIAL): 23-DAY GROWTH, 2·2 CM., 10TH APRIL 1947.

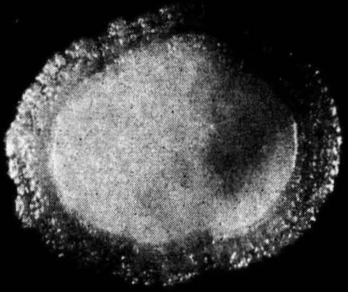
FIG. 7 — BY 5 (LONG MYCELIAL): 34-DAY GROWTH, 3·2 CM., 21ST APRIL 1947.

Stability tests were started before the commencement of the biochemical investigations and judgement was based on the changes occurring in the giant colonies. The method for the preparation of giant colony media has already been given elsewhere[12]. The colonies were grown at the room temperature.

Observations

The top yeasts obtained after treatment with acenaphthene (BY 2) and culturing in the ice room (BY 5) produced giant colonies (FIGS. 1 and 2) identical in appearance. These were smooth, thin and glistening and had a circular furrow near the margin. The area outside the furrow was rough. These photographs were taken late in September and early in November 1946. In February 1947, the area outside the marginal furrow was wider (FIG. 3) and its sculpturing more pronounced. The strain, BY 5, on the other hand, developed into a colony indistinguishable (FIG. 4) from that observed in November 1946 (FIG. 2). All along, the cells in the cultures were polymorphic and an attempt was made to study whether there was any difference in the appearance of the colonies grown from the long and the short mycelial cells. These types were repeatedly plated during March 1947 and giant colony inoculations were carried out. Both types produced giant colonies remarkably similar in appearance (FIGS. 5 and 6). The colony in Fig. 5 shows two mutants as rosette-like knobs. The long mycelial cells of BY 5 gave a colony (FIG. 7) resembling that illustrated in Fig. 4. It showed two sectors. As expected, the short and long mycelial types in wort-agar cultures gave only cells widely ranging in size (*see* Text Figs. 3 and 5, Subramaniam and Ranganathan[12]), leading to the conclusion that polymorphism is not due to specific genetic factors. In May-June 1947, BY 2 and BY 5 colonies resembled in their sculpturing those illustrated in Figs. 5 and 6 and hence experiments were carried out to test whether the two strains obtained by entirely differing agencies were comparable.

The two strains were, therefore, cultured separately in wort and 24 hour cultures were mixed together, well shaken and used for giant colony inoculation. The colony which developed (FIG. 8) showed no sectors indicating that they were identical in genetic



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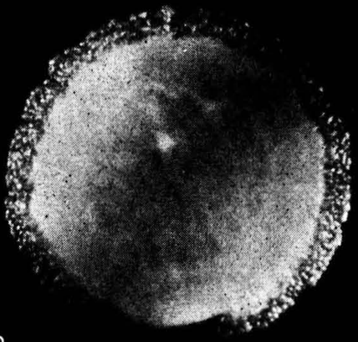

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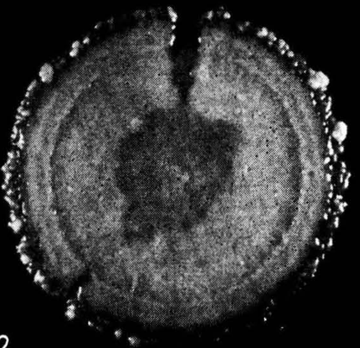

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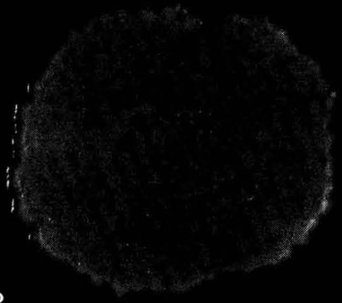

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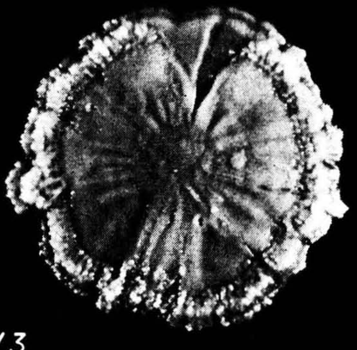

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constitution. The colony of BY 2, which was grown at the end of September 1948, is illustrated in Fig. 9. The sculptured rim was less broad and reminiscent of the condition in September 1946. It shows also a smooth sector. The stability of the two strains was tested again after a lapse of 14 months in January 1949. During the interval, little attention, beyond regular sub-culturing once in 5 weeks, was bestowed on them. The colony of BY 2 (FIG. 10) is comparable with that obtained more than 2 years back. The colony of BY 5, on the other hand, is highly sectored (FIG. 11) but had the characteristic furrow as well as the sculptured rim.

Actively growing cells of the top yeast, BY 2, were treated for about 5 months with acenaphthene during the latter part of 1948 and the resulting culture was composed entirely of cells having a comparable polymorphism as the original type. The giant colonies of the purified treated culture were different in appearance. It was dirty brown in colour, was uniformly smooth and had no marginal furrow or a sculptured rim (FIG. 12). During the summer of 1949 it suddenly sporulated after only 4 weeks' growth on the agar slant and the culture could not be revived. Further experiments to confirm that tetraploidy could be induced in top yeasts is under investigation.

In the control two-chromosome strain, a particular genic combination (*rim/smooth*) mimics the sculpturing of the giant colonies of the top yeasts. Such a colony was illustrated as Fig. 1*f* by Subramaniam and Ranganathan[3]. Periodically this unstable combination turns up in the control cultures and another example is illustrated in Fig. 13.

Discussion

From a continuous series of observations on reverse mutations in our control, it was suggested that multiple alleles occur at the locus determining the nature of sculpturing of the giant colonies[18,19]. Prema Bai's[16] investigations indicated that the top yeasts are the result of a chromosomal translocation. If we assume that as a consequence of this chromosomal translocation the genic sequences in the two unequal chromosomes of the top yeasts have been altered, the mutations at the loci governing the nature of sculpturing of the giant colonies should produce phenotypic expressions entirely different from that observed in the control. That mutations to the different alleles are occurring at the locus would be evident from the waxing (FIGS. 5 and 6) and waning (FIGS. 1 and 2) of the size of the sculptured rim of the top yeasts during the different months of the year, when cultured at the room temperature. As would be seen from Figs. 1 and 4 in the initial publication by Subramaniam and Ranganathan[12], the control colony was *smooth* when the sculptured rim of the top yeasts was narrow. In April-May, when the colony of the control was *rough* (Fig. 3, Pl. 1 ; Subramaniam, Ranganathan and Krishna Murthy[19]), the top yeasts developed into colonies having well-sculptured broad rims (FIGS. 5 and 6). This correlation suggests that mutations to the different alleles occur in the top yeasts also, but that the ascending grade of complexity in the giant colony sculpturing is absent in the top yeasts. Fig. 11 of the top yeast, BY 5, indicates that different allelic combinations occurring in the top yeast may also give rare types of sculpturing not usually observed in active cultures. Just as in the different strains of the control, the changes in the giant colony characteristics in BY 2 and BY 5 are parallel but not synchronous.

It is interesting to refer here to the resemblance of a particular genic combination in the control mimicking the type of sculpturing observed in the top yeasts. This implies that the characteristic sculpturing observed in top yeasts is not something novel. Goldschmidt's[20] investigations indicate that phenocopies may resemble those normally produced by genetic factors. Not only the environment but the genotype also determines the mode of expression. The altered genotype resulting from a chromosomal translocation conditions probably the expression of the different alleles in the top yeast.

The changes observed in the top yeasts are reversible as in the control[18] and progressive non-reversible changes have not been

← FIG. 8 — BY 2 + BY 5 : 14-DAY GROWTH, 2·5 CM., 15TH JULY 1947.

FIG. 9 — BY 2 : 16-DAY GROWTH, 2·6 CM., 30TH SEPTEMBER 1947.

FIG. 10 — BY 2 : 29-DAY GROWTH, 2·8 CM., 12TH JANUARY 1949.

FIG. 11 — BY 5 : 27-DAY GROWTH, 2·8 CM., 3RD JANUARY 1949.

FIG. 12 — BY 2 TREATED WITH ACENAPHTHENE : 27-DAY GROWTH, 3·5 CM., 11TH MARCH 1949.

FIG. 13 — BY 1, CONTROL : 19-DAY GROWTH, 3·0 CM., 14TH SEPTEMBER 1948.

observed in top yeasts during the past three years. Since the genes at the locus determining the nature of sculpturing of the colonies show reversible mutations and when the environment determines which of the mutants should predominate during any particular season, we have to conclude that the genes governing biochemical characteristics should behave in an identical fashion.

Winge[5] considers that mutations affecting physiological characteristics should also occur. He, however, qualifies the above statement and suggests that these mutations may not affect the ability to produce species-specific enzymes but modify the quantity of the enzymes produced. The probable cause for the above state of affairs was indicated by Subramaniam[21] in an earlier contribution. It appears as if a number of genes control the different fundamental steps of fermentation of any sugar and hence mutation of any one of them may affect adversely the fermentative ability of the strain. The logical conclusion was that the genes responsible for the various basic steps of fermentation should possess very low mutation frequencies. Are they heterochromatic? That it may be so was indicated by the fact that these genic combinations begin functioning only when duplicated above a particular basic stage of endopolyploidy. It was also indicated[14] that this method of genic action is not something unique. A further extension is possible. The genes said to initiate the production of melibiozymase or galactozymase may, in all probability, govern only the master reactions.

Much of the confusion seen in the literature is primarily due to the inability of the investigators to classify the mutations into distinct categories. It appears likely that polyploidy, chromosomal translocations and gene mutations have all been treated as though they belong to the same category. The first two are non-reversible while the last one ought to be reversible.

Our observations indicate that non-reversible mutations resulting from chromosomal changes could be induced. The problem of stability is, therefore, capable of an analysis. Among chromosomal changes, translocations belong to a separate category. Only once during the past five years have we observed the spontaneous occurrence of a top yeast in our control. All the strains of top yeasts in our collection were isolated after long exposure of the control to chemical and physical agencies. While in 1945 top yeasts could be obtained from the control by such agencies, similar production was not possible in 1947 when the experiments were repeated[13]. Treatment with acenaphthene for about 45 days produced only a tetraploid. Since the control does not normally give rise to top yeasts, it could be classified as stable. On the other hand, if a strain produces top yeasts with a high frequency, one has to naturally assume that it is unstable. The wide differences between the morphological and biochemical characteristics of the top yeasts, as compared with that of the control, indicates that it could even be described as a new species. An origin of new species is thus possible and in a strictly comparable manner as presumed in the case of higher organisms. Is it this type of mutation that Skovsted[4] observed in *Nadsonia*?

Tetraploid sectors occur periodically in our control two-chromosome strain. It was indicated previously that it may be possible to obtain tetraploid top yeasts. The autotetraploid, BY 3[11], exhibits identical nutritional requirements as the control[16] but it has a quicker growth[22] and fermentation rate[23]. The polyploids are highly stable but there is a limit to the duplication of the chromosomal complement. The high stability of the types used in industry is not due to chances for unlimited proliferation or a favourable environment but should be the result of polyploidy. The conscious and unconscious selection that has gone on should have resulted in the selection of ideal polyploids.

Induction of polyploidy is a possibility and hence the question of stability ceases automatically to be a nightmare to the practical breeder.

Summary

1. Artificially produced top yeasts appear to be autotrophic and aerobic and excrete into the wash considerable amounts of riboflavin. The possibility that these may be highly useful for compressed yeast manufacture necessitated a consideration of the problem of stability in yeasts.

2. Investigators subscribe to the belief that yeasts are unstable. The problem of stability has received only scant attention and no previous attempt has been made to

discover methods to induce stability. Literal acceptance of the above view would not only invalidate the classification of yeasts into species and genera but would also leave unexplained why the strains used in industry are highly stable.

3. Systematic observations of the changes in the sculpturing of the giant colonies of top yeasts extending over two years indicate only a waxing and waning of the size of the rough rim during the different seasons when cultured at the room temperature.

4. The waxing and waning of the sculptured rim parallels the predominance of the rough and smooth types of colonies in the control which have already been interpreted as the result of mutations to different alleles at the locus determining the nature of sculpturing. Since the top yeasts appear to be the result of a chromosomal translocation, the genic sequences should have been altered and, as a result, the mutations at the loci governing the nature of sculpturing should produce phenotypic expressions entirely different from that observed in the control. Tetraploids are highly stable and industrial types should be polyploids.

5. Induction of polyploidy is a possibility.

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REFERENCES

1. MITRA, K. K. : *J. sci. industr. Res.*, 1949, **8B**, 236.
2. SUBRAMANIAM, M. K. & RANGANATHAN, B. : *Nature*, 1946, **157**, 49.
3. Idem. : *J. sci. industr. Res.*, 1949, **8B**, 5.
4. SKOVSTED, A. : *C.R. Lab. Carlsberg. Ser. Physiol.*, 1943, **23**, 409-453.
5. WINGE, O. : ibid., 1944, **24**, 79.
6. WINGE, O. & LAUSTSEN, O. : ibid., 1939, **22**, 337-355.
7. BRAUN, W. : *Bact. Revs.*, 1947b, **2**, 76-114.
8. Idem. : *J. Bact.*, 1947a, **53**, 250-251.
9. WINGE, O. & ROBERTS, C. : *C.R. Lab. Carlsberg. Ser. Physiol.*, 1948, **24**, 263-315.
10. SUBRAMANIAM, M. K. : *Curr. Sci.*, 1945, **14**, 234.
11. Idem. : *Proc. Nat. Inst. Sci.*, India, 1947, **13**, 129.
12. SUBRAMANIAM, M. K. & RANGANATHAN, B. : ibid., 1948, **14**, 279-283.
13. SUBRAMANIAM, M. K. & KRISHNA MURTHY, S. N. : *Proc. Ind. Acad. Sci.*, 1949, B, **30**, 185.
14. MITRA, K. K. & SUBRAMANIAM, M. K. : *La Cellule*, 1949, **53**, 7-12.
15. SUBRAMANIAM, M. K. : *Sci. & Cult.*, 1946, **12**, 217-219.
16. PREMA BAI, M. : *Curr. Sci.*, 1947, **16**, 316-317.
17. SUBRAMANIAM, M. K. & RANGANATHAN, B. : *Sci. & Cult.*, 1947, **13**, 102.
18. SUBRAMANIAM, M. K. & KRISHNA MURTHY, S. N. : *Curr. Sci.*, 1948, **17**, 92.
19. SUBRAMANIAM, M. K., RANGANATHAN, B. & KRISHNA MURTHY, S. N. : *La Cellule*, 1948, **52**, 39-60.
20. GOLDSCHMIDT, R. B. : *Physiological Genetics*, McGraw-Hill, 1938.
21. SUBRAMANIAM, M. K. : *Proc. VII. Internat. Cong. Agr. Ind.*, Paris, 1948.
22. PREMA BAI, M. & SUBRAMANIAM, M. K. : *Curr. Sci.*, 1947, **16**, 380-381.
23. MITRA, K. K. : ibid., 1948, **17**, 55.

Some Factors Affecting the Bactericidal Property of Lemon-Grass Oil Emulsions

S. M. BOSE, C. N. BHIMA RAO & V. SUBRAHMANYAN

Department of Biochemistry, Indian Institute of Science, Bangalore

Factors effecting the germicidal efficiency of commercial lemon-grass oil samples have been examined with a view to standardizing conditions for the preparation of disinfectants. It has been demonstrated that the bactericidal efficiency of lemon-grass oil is directly proportional to the citral content in it. Homogeneous dispersion of the oil and stability of the emulsion are two important factors on which its bactericidal action depends. Of the emulsifying agents tried triethanolamine or potassium oleate and rosin soap have been found to be the best. Particle size and germicidal potency of several emulsions have been studied. No direct relationship exists between the viscosity of lemon-grass oil emulsions and its bactericidal action. The maintenance of the *p*H of the emulsified disinfectants within a specific range is important from the point of view of the stability of emulsions. Use of emulsifying agents and the solvents in excess in the preparation of disinfectants is shown to lower the bactericidal action and the stability of the emulsions on dilution.

VERY little work has been done on the factors influencing the disinfecting potency of emulsified disinfectants. Romaine[1] indicated in a general way the important factors upon which the phenol coefficient of a pine-oil disinfectant depends, viz. (i) the amount of bacteria-killing constituents in pine oil; (ii) the emulsifiable properties of pine oil; and (iii) the emulsifying properties of the emulsifiers used. Daniels and Lyons[2] studied the influence of physical properties (viz. adsorption, solubility, particle size, hydrogen-ion concentration, viscosity and surface tension) of certain phenyl-substituted acid solutions on their bactericidal power. Martin Frobisher[3] studied the influence of surface-tension depressants on the germicidal activity of certain phenols. De and Subrahmanyan[4] studied the effect of the concentration of soap used on the bactericidal action of essential oil emulsions.

In a previous communication[5], it has been reported that of a number of Indian essential oils examined, lemon-grass oil possesses the highest bactericidal action, although its efficiency is much reduced in the presence of organic matter and the activity against Gram-positive organisms is low and practically nil against acid-fast organisms. In the present study, the factors affecting the germicidal efficiency of lemon-grass oil have been critically examined with a view to standardizing the conditions necessary for the preparation of a suitable disinfectant out of it. The influence of the following factors: (a) concentration of the chief constituent in the oil; (b) emulsifiable property of the oil; (c) efficiency of different emulsifying agents; (d) concentration of the emulsifying agent; (e) stability of emulsion; (f) use of alcohol in the preparation of emulsion via solution; (g) *p*H of emulsion; (h) particle size; and (i) viscosity on the germicidal efficiency of lemon-grass oil have been investigated.

As the present investigation requires the preparation of only oil-in-water type emulsions, our attention has been confined to the selection of only hydrophilic emulsifiers. For the preparation of oil-in-water emulsions, the emulsifying properties of different soaps[6-8], sulphonated oils[9], water-soluble gums[10], gelatin[11], etc., are well known. A few of the more efficient and easily available emulsifying agents have been used in the present study.

With regard to each class of emulsifying agents, there is a specific range of *p*H at which only the emulsion is stable. It is a well-established fact that emulsions prepared with soaps are stable at alkaline *p*H only. According to Krantz and Gordon[10], gum-acacia emulsions are stable over the *p*H range 2-10, gum-tragacanth emulsions over the *p*H range 1·9-2·3. Emulsions prepared with sulphonated vegetable oils are most stable at a slightly acidic *p*H[12]. Investigations by Friedman and Evans[11] showed that gelatin emulsions are stable at the *p*H range 3-6. In the present study, the *p*H of lemon-grass oil emulsions prepared with different emulsifying agents have been so adjusted as to make them stable.

Experimental

Commercial samples of lemon-grass oil obtained from different sources were analysed for citral content by the hydroxylamine hydrochloride method[13]. As mentioned in the previous communication[5], the different samples of oils were emulsified under identical conditions using 1 per cent of the oil to be tested, 1 per cent potassium oleate as the emulsifying agent and 0·5 per cent potassium carbonate as the emulsion-stabilizer, and examined for the Rideal-Walker coefficient using *B. typhosus* as the test organism. The results are given in Table I.

TABLE I — CITRAL CONTENTS & BACTERICIDAL POTENCIES OF COMMERCIAL SAMPLES OF LEMON-GRASS OIL

Sample No.	Original oil		Citral content equalized to 80±0·5%	
	Citral %	R-W coeff.	R-W coeff.	Particle size, μ
1	41·44	6·5	13·5	...
2	71·85	9	14	...
3	78·28	12·5	15	6·41
4	62·40	6	12	...
5	48·21	3	11	7·84
6	52·47	8·5	15	6·33
7	72·27	9	14	...
8	55·15	5·5	10	7·99
9	68·79	9	15	...
10	82·04	14	...	...
11	64·09	8	15	...
12	45·84	4	11·5	...
13	74·20	8	10·5	7·68
14	80·13	9	...	8·09

As the emulsions were prepared under identical conditions, the different R-W coefficients obtained for different samples of oils may be due to varying amounts of citral contents as also to the varying emulsifiable properties of the oils.

In order to eliminate the influence of the varying amounts of citral present in the oils, the citral contents of all the samples were brought to the same level (80 ± 0·5 per cent) by adding the required amounts of citral isolated[14] from a sample of freshly re-steam-distilled lemon-grass oil by mechanically shaking the oil with a solution of a mixture of sodium sulphite and sodium bicarbonate and liberating citral from the solution of the additive compound formed by alkali and ether in the usual way and finally vacuum distilling the compound at 10 mm. pressure. These oils of the same level of citral content were emulsified under identical conditions and examined for R-W coefficient as mentioned before. Those samples which showed marked variation in R-W coefficients, even after equalization of citral contents, were selected and the emulsions examined in the ultra-microscope for particle size by the method as described by Freundlich[15]. The results obtained demonstrate that the emulsifiable property of the oils is partly responsible for differences in R-W coefficients. The results are shown in Table I.

To demonstrate the influence of citral content of the oil on its bactericidal action, the following experiment was conducted.

From freshly re-steam-distilled lemon-grass oil containing 87·43 per cent citral, the pure compound was isolated[14] by the sodium sulphite process. The citral isolated had b.p. 107°-109°C. at 10 mm. pressure and ref. index 1·4873 at 20°C. To the aldehyde-free oil, different proportions of pure citral were added so as to obtain several samples of oil of identical emulsifiable properties but of different citral contents. The emulsions were prepared under identical conditions and examined for their bactericidal action by the Rideal-Walker method. The results are given in Table II.

The results showed that the citral content of lemon-grass oil is one of the main factors on which its germicidal power depends.

Next, to demonstrate the influence of different emulsifying agents on the germicidal action of lemon-grass oil, a sample of freshly re-steam-distilled oil of high citral content (84·20 per cent) was emulsified using 1 per cent oil and 1 per cent of different emulsifying agents. Each of the soaps or gums used was first soaked in a small amount of water,

TABLE II — INFLUENCE OF CITRAL ON THE BACTERICIDAL ACTION OF LEMON-GRASS OIL

SAMPLE OF OIL	CITRAL, %	R-W COEFF.
Fresh re-steam-distilled oil	87·43	17·5
Aldehyde-free oil	...	<1
Sample A	20	3
Sample B	40	7
Sample C	60	10
Sample D	80	13·5
Pure citral	...	20

the oil added and the mixture triturated thoroughly in a mortar till the oil was properly incorporated and a creamy paste resulted. On dilution to the required volume, the paste formed a milky emulsion which was finally homogenized thrice in a small mechanical homogenizer. In the case of Turkey red oil, it was mixed with lemon-grass oil by trituration in a mortar, diluted to the required volume and mechanically homogenized. In the case of gelatin, it was first dissolved in hot water, cooled, the oil incorporated and the mixture mechanically homogenized, but the emulsion was not stable even for the duration of the test period.

The fatty oil soaps used were prepared from the corresponding oil and caustic potash solution by the " boiling process ". Triethanolamine oleate or stearate was prepared by dissolving the equivalent amount of triethanolamine and oleic or stearic acid in absolute alcohol, refluxing the mixture for about 3 hr. and then distilling off the alcohol. Potassium oleate or stearate was prepared by the neutralization of an alcoholic solution of oleic or stearic acid by alcoholic potash in a similar way. Rosin soap was prepared by refluxing for about 12 hr. a mixture of powdered rosin and caustic potash dissolved in alcohol. In the preparation of these soaps, alkali was used in a slight excess of the theoretical amount. The soaps prepared were finally dried in a desiccator.

The *p*H of the individual emulsions was so adjusted as to make them quite stable. Saturated solutions of tartaric acid and sodium carbonate were used for adjusting the *p*H on the acid and alkaline side respectively. All determinations or adjustments of *p*H were made in the Leeds and Northrup glass-electrode potentiometer against standard M/20 buffer solution of potassium hydrogen phthalate.

Each emulsion was examined with the least possible delay for R-W coefficient, particle size, viscosity and stability. Viscosity was determined by the standard method[16] in Ostwald's viscometer using a glass thermostat at 25°C.±0·1. The time of flow was recorded ten times for each sample and averaged and the results were expressed in centipoises. In order to compare the stability of the emulsions prepared, they were kept in tall glass cylinders of the same size, exposed to atmospheric conditions and the period after which there was any separation of oil was noted. The results are given in Table III.

TABLE III — INFLUENCE OF DIFFERENT EMULSIFYING AGENTS ON THE BACTERICIDAL ACTION OF LEMON-GRASS OIL (CITRAL CONTENT, 84·20%)

EMULSIFYING AGENT USED	*p*H	R-W COEFF.	PARTICLE SIZE, μ	VISCOSITY, centipoises	APPROXIMATE DURATION OF STABILITY OF EMULSION, days
Potassium stearate	8·08	9·5	9·05	1·420	2
Potassium oleate	8·13	16·5	6·37	1·153	60
Groundnut oil soap	8·16	11·0	8·33	1·199	10
Coconut oil soap	8·19	10·0	9·19	1·318	5
Castor oil soap	8·05	10·5	8·63	1·190	10
Rosin soap	8·02	16·5	6·95	3·205	60
Triethanolamine stearate	7·40	9·0	9·12	3·609	3
Triethanolamine oleate	7·43	16·5	6·19	3·181	60
Turkey red oil (sulphonated castor oil)	6·51	9·0	9·91	2·201	10
Gum acacia	5·28	13·0	8·13	2·324	45
Gum tragacanth	2·18	6·0	12·36	29·32	30
Gelatin	4·95	...	...	...	very unstable

The results clearly show the comparative efficiency of different emulsifying agents used.

De and Subrahmanyan[4] found 1 per cent soap to be the optimum concentration for the emulsification of 1 per cent essential oil. To determine whether the concentration of water-soluble gum-acacia had any influence on the germicidal action of lemon-grass oil, a number of emulsions containing 1 per cent oil but different amounts of gum were prepared under identical conditions and their bactericidal power was determined. The results are shown in Table IV.

TABLE IV — INFLUENCE OF THE CONCENTRATION OF GUM-ACACIA ON THE BACTERICIDAL ACTION OF LEMON-GRASS OIL (CITRAL CONTENT, 84·20%)

EMULSIFYING AGENT USED & CONCENTRATION, per cent	R-W COEFF.	APPROXIMATE DURATION OF STABILITY OF EMULSION, days
Gum acacia (1)	13	45
,, (1·5)	13	45
(2)	11	60
,, (2·5)	9·5	60
,, (3)	8	90
,, (4)	3·5	90

With a concentration lower than 1 per cent gum, the stability of emulsion was not satisfactory. It is also obvious that increasing amounts of gum lower the germicidal activity appreciably.

To study whether the variation of *p*H within the specific range at which the emulsion would remain stable for a long period could exert any influence on the germicidal action of lemon-grass oil, an emulsion which would remain stable over a long range of *p*H was selected. It was observed that the emulsion prepared with gum-acacia could remain stable for a long period at different *p*H values (range, 3-9). The *p*H of a portion of the emulsion prepared with 1 per cent oil and 1 per cent gum was brought to the alkaline side, that of a second portion to the neutral and that of the rest on the acid side. The emulsions of different *p*H values were tested both fresh and after 15 days' storage in glass-stoppered bottles for the R-W coefficient and change of odour. The results are given in Table V.

TABLE V — INFLUENCE OF *p*H ON THE GERMICIDAL ACTION OF LEMON-GRASS OIL (CITRAL CONTENT, 84·20%) EMULSION

EMULSIONS	*p*H	R-W COEFFICIENT Fresh	R-W COEFFICIENT 15 days old	CHANGE IN EMULSION AFTER 15 DAYS' STORAGE
Sample I	3·47	13	<1	No separation, original odour changed
Sample II	7·02	13	9	No separation, original odour retained
Sample III	9·01	13	4	No separation, original odour changed, entirely different from that developed in Sample I

The results showed that *p*H had apparently no influence on the bactericidal action of freshly prepared emulsion, provided the emulsion remained stable at the altered *p*H.

Instead of preparing the emulsion directly, preparation of a solution of lemon-grass oil and emulsifier which on dilution with water would form a milky emulsion, is more advantageous for practical purposes. Hence, it was thought desirable to study the effect of the solvent used on the bactericidal action of the disinfectant preparation. Absolute alcohol, being a common solvent for the oil as well as for the comparatively more efficient emulsifying agents like triethanolamine or potassium oleate and rosin soap, was used for these experiments. The solutions were prepared with 1 gm. lemon-grass oil, 1 gm. potassium oleate and varying proportions of absolute alcohol and subsequently diluted to 100 c.c. with the required volume of water to form emulsions. The emulsions formed were tested for R-W coefficient and stability as before. The results are shown in Table VI.

TABLE VI — EFFECT OF ALCOHOL ON THE BACTERICIDAL EFFICIENCY OF LEMON-GRASS OIL (CITRAL CONTENT, 84·20%) SOLUTIONS WHICH ON DILUTION FORM EMULSIONS

PREPARATION OF EMULSION	R-W COEFF.	APPROXIMATE DURATION OF STABILITY OF EMULSION, days
(1) Oil, oleate and alcohol made up to 50 c.c.	3	1
(2) ,, 40 ,,	4	2
(3) ,, 30 ,,	6	7
(4) ,, 20 ,,	9	15
(5) ,, 10 ,, and emulsion formed	12	25

The results showed that it is important to reduce the proportion of the solvent to a minimum to ensure maximum bactericidal potency of the preparation.

Discussion

Commercial samples of lemon-grass oil were found to have R-W coefficients ranging from 3 to 14 and citral contents varying from 41 to 82 per cent. Table II shows that lemon-grass oil owes its disinfecting power principally to its citral content. Hence, the estimation of citral in the original oil is an index of its efficiency for use as a disinfectant.

The other factors on which bactericidal action of lemon-grass oil emulsion depends are its maximum and uniform dispersion in water and stability of emulsion. The results recorded in Tables I and III show that the efficiency of emulsification and the stability of emulsion formed are dependent on the emulsifiability of the oil and the efficiency of the emulsifier used. Table I shows that a few samples of oil (sample Nos. 4, 5, 8, 12, 13, 14) could not be emulsified to the same extent as the other samples, although the emulsions were prepared under identical conditions and the same emulsifying agent was used. The emulsions prepared with the former gave comparatively lower R-W coefficient. As the citral content of all the samples was equalized and as the emulsions were prepared under identical conditions, the lower R-W coefficient, as obtained with these samples, is due to their low emulsifiable property as is indicated from the comparatively larger particle size of the emulsions prepared out of them. These samples of oils of lower emulsifiable property had a dark colour in comparison with the light colour of the other samples and contained resinous impurities, showing that the distillation in such cases was carried too far during manufacture.

As shown in Table III, with the use of different emulsifying agents in the preparation of emulsions, different R-W coefficients were obtained, although the same oil was used in all the cases. It is obvious, therefore, that the bactericidal action of an emulsified disinfectant is dependent to a great extent upon the efficiency of the emulsifying agent used. Of the several emulsifying agents examined, triethanolamine oleate, potassium oleate and rosin soap were found to be more efficient than others. The emulsifying capacity of stearate soap was inferior to that of the oleate soap. Gum-acacia was better than tragacanth as an emulsifying agent for lemon-grass oil.

The difference in the degree of emulsification with different emulsifying agents is also obvious from the varying particle size, viscosity and stability of the emulsions, although the difference is not very marked in some cases. As is to be expected, with finer particle size of the emulsions, the bactericidal potency is found to be higher. The bactericidal action of an essential oil emulsion may be caused by its covering power on the bacteria which are killed by adsorption of the essential oil. Hence, the more finely dispersed is the oil, the more is its covering power on the bacteria and hence the higher its bactericidal efficiency.

The viscosity of lemon-grass oil emulsions prepared with different emulsifiers, however, appears to have no direct influence on their bactericidal property. Although the viscosity of rosin soap or triethanolamine oleate emulsion is comparatively higher than that of the emulsion prepared with potassium oleate, their R-W coefficients are of the same order. Again, the viscosity of tragacanth emulsion is appreciably higher than that of the acacia emulsion, but the R-W coefficient of the former is much lower than that of the latter. Daniels and Lyons[2] also could not find any relationship between the viscosity or *p*H of certain phenyl-substituted acid solutions and their bactericidal action.

The results given in Table V indicate that there is no variation of germicidal potency in the freshly prepared emulsions of neutral, acidic or alkaline *p*H if the emulsion remained stable at different *p*H values ; the variation in *p*H, however, exerts an adverse effect on the conservation of the original potency in stored emulsions as also on the retention of the perfume. The emulsion having neutral *p*H maintained the original potency and perfume on storage, whereas in emulsions of highly acidic or alkaline *p*H the original disinfecting potency and perfume rapidly deteriorated. Again, the characteristic smell developed in the stored emulsion of acidic *p*H was entirely different from that developed in the emulsion of alkaline *p*H.

The results given in Table IV reveal that 1·0 to 1·5 per cent gum is the optimum concentration for the emulsification of 1 per cent lemon-grass oil as also for conserving its highest bactericidal action. Higher concentration of gum lowers the R-W coefficient markedly, although the emulsions prepared with higher concentrations of gum were stable over longer periods. This reduction in bactericidal potency may be due to adsorption of excess gum on the surfaces of bacteria with the formation of a protective film. Martin Frobisher[3], and De and Subrahmanyan[4] also observed that an excess of soap inhibited the bactericidal action of certain phenols and emulsified disinfectants and stated that excess of soap coated the bacterial surface with a film which would protect the cells from contact with the disinfectant.

The results given in Table VI indicate that excess of solvent used in the preparation of lemon-grass oil solutions markedly reduces the bactericidal efficiency and stability of the final emulsion. Even with the use of the least possible solvent, the R-W coefficient (12·0) and duration (25 days) of stability of the emulsion formed are much lower than the R-W coefficient (16·5) and the duration (2 months) of stability of the emulsion prepared directly without the use of solvent, although the same sample of oil and the same emulsifying agent were used in either case (cf. TABLES III and VI). Chick and Martin[17] compared the power of a germicide emulsified or dissolved and noted the superiority of the emulsified form and stated that emulsified disinfectants possess superior efficiency, because owing to the higher adsorption, the bacteria become surrounded rapidly by emulsified disinfectants in much greater concentration.

The results of the present investigation may find practical application in the preparation of an emulsified disinfectant out of lemon-grass oil.

Summary

(1) The citral contents and R-W coefficients of a number of commercial samples of lemon-grass oil have been determined.

(2) The influence of several important factors on the germicidal efficiency of lemon-grass oil emulsions has been studied. It has been demonstrated that all other factors being identical, the bactericidal efficiency of lemon-grass oil is directly proportional to the citral content.

(3) The highest and most homogeneous dispersion of the oil in water and the stability of the emulsion are two important factors on which its bactericidal action depends. These factors again are naturally dependent on the emulsifiable property of the oil and the efficiency of the emulsifying agent used in the preparation of the emulsion.

(4) The comparative efficiency of different emulsifying agents has been studied with reference to bactericidal action, particle size, viscosity and stability of lemon-grass oil emulsions. Triethanolamine or potassium oleate and rosin soap have been found to be more efficient than the other emulsifiers examined.

(5) Particle size and germicidal potency of the emulsions prepared with different emulsifiers have been correlated. No direct relationship, however, has been found between the viscosity of the emulsion and the bactericidal action.

(6) The *p*H of emulsified disinfectants is important from the point of view of the stability of emulsion. The variation of *p*H within the specific range at which the emulsion would remain stable appears to have no influence on the bactericidal action of freshly prepared emulsions but adversely affects the bactericidal property of the emulsions on storage.

(7) Use of an emulsifying agent in concentrations higher than the optimum has been found to lower the bactericidal action of lemon-grass oil emulsions.

(8) The least possible amount of solvent should be used in the preparation of disinfectant solutions which, on dilution, form emulsions. Excess of solvent used in the preparation of disinfectant solution of lemon-grass oil has been observed to lower their bactericidal action as also the stability of the emulsions formed on dilution.

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REFERENCES

1. ROMAINE : *Soap* (S.P.S.), 1932, **8**, 105.
2. DANIELS & LYONS : *J. Phys. Chem.*, 1931, **35**, 2049.
3. MARTIN FROBISHER, JR. : *J. Bact.*, 1927, **13**, 163.
4. DE & SUBRAHMANYAN : *Ind. J. Med. Res.*, 1930, **17**, 1154.
5. BOSE, BHIMA RAO & SUBRAHMANYAN : *J. sci. industr. Res.*, 1949, **8**, 157.
6. PICKERING : *J. Chem. Soc.*, 1907, **91**, 2001.
7. WHITE & MARDEN : *J. Phys. Chem.*, 1920, **24**, 617 ; YAJNIK & ILHAI : *Kolloid.-z.*, 1925, **37**, 139.
8. HOCKENYOS : *Ind. Eng. Chem.*, 1929, **21**, 647 ; WILSON : ibid., 1930, **22**, 143 ; FREEMAN & SCHWAB : *J. Amer. Pharm. Assoc.*, 1933, **22**, 232 ; RISI & BERNARD : *Can. J. Res.*, 1934, **11**, 247.
9. HART : *Ind. Eng. Chem.*, 1929, **21**, 85 ; ibid., (*Anal. Ed.*), 1932, **4**, 119.
10. MARSHALL: *Pharm. J.*, 1909, **28**, 257; CROCKETT & OESPER : *Ind. Eng. Chem.*, 1917, **9**, 967 ; CLARK & MANN : *J. Biol. Chem.*, 1922, **52**, 160 ; KRANTZ & GORDON : *J. Amer. Pharm. Assoc.*, 1926, **15**, 93 ; 1930, **19**, 1181 ; SMITH & HAZLEY : *Quart. J. Pharm. & Pharmacol.*, 1930, **3**, 362.
11. BRIGGS & SCHMIDT : *J. Phys. Chem.*, 1915, **19**, 478 ; HOLMES & CHILD : *J. Amer. Chem, Soc.*, 1920, **42**, 2049 ; NUGENT : *Trans. Farad. Soc.*, 1922, **17**, 703 ; FRIEDMAN & EVANS : *J. Amer. Chem. Soc.*, 1931, **53**, 2898.
12. BENNETT : *Practical Emulsions*, 1946, p. 7.
13. Essential Oil Committee of the Society of Public Analysts : *Per. Ess. Oil Rec.*, 1930, **21**, 39.
14. TIEMANN : *Ber. Chem. Ges.*, 1899, **32**, 812 ; FINNEMORE : *The Essential Oils*, 1926, p. 126.
15. FREUNDLICH : *Colloid & Capillary Chemistry*, 1926, p. 397.
16. FINDLAY : *Practical Physical Chemistry*, 1938, p. 176.
17. CHICK & MARTIN : *J. Hyg.*, 1908, **8**, 698.

Radioactivity of Travancore Monazite Sands, Rocks & Mineral Waters

A. O. MATHAI

University of Travancore, Trivandrum

The radioactivity of several typical samples of rocks and mineral waters of south Travancore has been estimated using an emanation electroscope. As compared with similar sources in other places, the activity of spring and well waters including those collected from the monazite beds is rather low. The average radium content of the igneous rocks is $2{\cdot}16 \times 10^{-12}$ gm./gm. which is in close agreement with that obtained for the basalts of the Deccan. It is nearly three times the value obtained for the granites of the Kolar Gold-fields. The radium content of Travancore monazite sand is $12{\cdot}32 \times 10^{-10}$ gm./gm. This agrees with the result obtained for the same mineral collected from Norway, Brazil, etc. It also shows that the average uranium content of Travancore monazite is 0·36 per cent.

STUDIES on the distribution of radioactive elements within the accessible regions of the earth's crust as also in the atmosphere are assuming importance. They provide information on the origin of the earth's internal heat and on ionization phenomena in the atmosphere. They are also of help in prospecting for radioactive minerals.

Investigations on radioactive minerals in India have been but few. The monazite sands of Travancore have received considerable attention. More recently, the radium contents of rocks of the Kolar Gold-field Mines[1], and the Archean rocks of Mysore[2] have been examined, and the emanations of the Tuwa hot springs in Bombay have been studied by Sierp and Steichen[3].

A study of the radon contents of spring and well waters and of the radium contents of granites and monazite sands from south Travancore has been recently undertaken under the auspices of the Travancore University. The results obtained are presented in this paper.

Experimental

Electroscope — An emanation electroscope has been designed and constructed (FIG. 1) for this investigation. The thick lead-walled instrument is divided into the ionization chamber A and the electroscope chamber B. The former has 2 nozzles for evacuation and suction of the active gases while the latter is provided with the charging key K and thick glass windows W for observation. The gold-leaf system consists of the central electrode P ending in a circular disc D within the ionization chamber, whose other extremity is in the electroscope chamber carrying the pillar Q to which is attached the gold leaf G. The insulator S for the gold-leaf system is a sulphur plug held within a vulcanite ring with a guard ring in between. The charging key connected to H.T. supply when pressed touches Q and thus charges the gold-leaf system.

The required voltage (*c.* 300 volts), as measured by an electro-static voltmeter, was obtained from a megger, thus avoiding the need for keeping a H.T. dry cell battery. The lack of a steady H.T. supply, however, prevented the proper use of the guard ring. Still the natural leakage of the instrument was so low that it could keep a charge for nearly 48 hr. The rate of collapse of the gold leaf, ending in a fine quartz fibre and illuminated from behind, was observed by a microscope with divided eye piece. The ionization chamber was evacuated using a *Cenco Hyvac* pump, into which space the active gases collected from the de-emanation equipment was admitted every time.

FIG. 1

De-emanation: (a) Mineral Waters — The water specimens collected from different sources were taken to the laboratory in corked bottles as quickly as possible to avoid too much decay of radon, the required correction for the interval being applied in every case. A known volume of the liquid was boiled vigorously for half an hour and the escaping gases were collected through a Leibig's condenser. The gases thus collected were allowed to stand for the decay of any thoron present and then sucked into the evacuated ionization chamber through drying tubes finishing with a current of fresh air from outside through the system until the pressure is normal.

(b) Rocks — 25 gm. of each of the samples were finely powdered in an agate mortar and fused with excess of sodium carbonate in a platinum crucible. The fused mass was dissolved in a convenient volume of distilled water. The cloudy solution was filtered and the alkaline filtrate kept aside as solution No. 1. The residue was digested with strong hydrochloric acid and diluted to form solution No. 2. The alkaline and acidic solutions thus obtained were allowed to stand for a few days for the radon to collect, after which they were subjected to the same treatment as was described for mineral waters. Knowing the total quantity of radon collected during a known interval, the radium content of each of the samples was calculated.

(c) Monazite Sand — This mineral could not be decomposed by alkaline fusion. Borax fusion adopted by Strutt[4] was, therefore, applied. 2·5 gm. of the finely powdered mineral were fused with 15 gm. of borax in a platinum crucible for an hour. The fused mass on cooling gave a clear, light-yellow, glass-like substance which was powdered and digested with dilute hydrochloric acid to give a nearly clear solution. The solution was treated as before.

Calibration of the Electroscope — A small quantity of a laboratory sample of radium bromide was taken and compared with a 1 mg. radium needle obtained from the Government Hospital, Trivandrum, using the emanation electroscope for γ-ray comparison. It was then dissolved in water acidulated with hydrochloric acid and containing a few grams of barium chloride in solution to minimize chances of precipitation of the active substance. A standard solution of known strength was thus obtained with which the electroscope was calibrated. A leakage of 1 div./min. corresponds to $1{\cdot}19 \times 10^{-10}$ gm. of radium in solution containing the equilibrium quantity of radon.

Almost all the samples included in this study were tested for dissolved radium and the results every time were in the negative (TABLES I, II and III).

TABLE I — MINERAL WATERS

SAMPLE	EMANATION CONTENT (Curies per litre)
A. Well waters	
Sample No. 1	$2{\cdot}71 \times 10^{-10}$
,, No. 2	3·89 ...
,, No. 3	2·92 ...
,, No. 4	1·43 ...
,, No. 5	1·49 ...
,, No. 6	0·18 ...
,, No. 7	0·10 ...
,, No. 8	2·67 ...
B. Spring waters	
Trivandrum No. 1	$7{\cdot}47 \times 10^{-10}$
,, No. 2	2·68 ...
Warkala No. 1	0·07 ...
,, No. 2	0·79 ...
,, No. 3	0·98 ...
,, No. 4	3·85 ...
,, No. 5	0·26 ...
,, No. 6	1·47 ...
,, No. 7	9·36 ...

C. Waters collected from the sea, the monazite beds of Manavalakurichy and from within the railway tunnel at Aryancavu in the Western Ghats showed no detectable trace of radon.

TABLE II — ROCKS

SAMPLE	RADIUM CONTENT (gm./gm.)
Sample No. 1	$2{\cdot}60 \times 10^{-12}$
,, No. 2	2·28 ...
,, No. 3	1·60 ...

TABLE III — MONAZITE SAND

SAMPLE	RADIUM CONTENT (gm./gm.)
Chavara monazite	$12{\cdot}78 \times 10^{-10}$
Manavalakurichy monazite	11·85 ...

Discussion

Mineral Waters — The average value obtained for the emanation content of the mineral and well waters of south Travancore places them very low in the order of activity of similar sources throughout the world. For example, the average value obtained by Seirp and Steichen for the well waters of Tuwa village seems to be about 5 times the highest value for well water obtained here while that of the hot springs of Tuwa is nearly a 100 times that of the strongest among the springs. It is, however, interesting to note that the traditional preference among the residents of Trivandrum and Warkala is in favour of springs having a larger emanation content. Curie and Laborde[5] have come to the same conclusion regarding the physiological effects and radioactive contents of the thermal springs of Austria.

The low activity of waters collected from the dripping waters within the Aryancavu railway tunnel through the Western Ghats shows that the radium content of the hard rocky formations above is low.

The poor radon content of water collected from sluices over the monazite beds is surprising, especially when compared with the high activity reported for water found in the pitch blende-occurring regions of St. Joachimsthal of Bohemia. The only possible explanation seems to be the poor emanating power of the radium present in the mineral. The following experiment confirmed this view. About 200 gm. of monazite sand was allowed to remain in contact with about $\frac{1}{2}$ litre of distilled water for 2 weeks. The water, on examination, showed the presence of no detectable trace of radon. As calculated from the radium content of monazite, the emanating power of monazite sand remaining in contact with water under normal conditions is less than 0·05 per cent of the total emanation content. In the case of uranium mineral, Boltwood[6] has shown that even brief contact with the mineral can impart to the water remarkable radioactive properties due to dissolved radon. Markal[7] made quantitative studies of the emanating power of residues of uranium ore from St. Joachimsthal and found that under moist conditions as much as 3·4 per cent of the theoretical value of the total emanation content was liberated by the material. The present value is less than a hundredth of that obtained by Markal and probably accounts for the low emanation content of the water.

Rocks — The average radium content of the three types of igneous rocks is $2{\cdot}16 \times 10^{-12}$ gm./gm., which is in close agreement with the average value of $2{\cdot}2 \times 10^{-12}$ gm./gm. obtained by Joly[8] in 1911 for the basalts of Deccan. But the mean value obtained later in 1924 by Poole and Joly[9] for the plateau basalts of Deccan and by Watson (loc. cit.) for the granite of the Kolar Goldfields was only $0{\cdot}8 \times 10^{-12}$ gm./gm. which is decidedly less than the average radium content of rocks of south Travancore included in this study.

The data collected in the course of this work are evidently inadequate to form any general conclusion regarding the radium content of Travancore rocks. A representative collection of typical samples is expected to become available shortly from the Geological Department of this University enabling more extensive investigations to be made.

Monazite Sand — The average radium content of Travancore monazite is $12{\cdot}32 \times 10^{-10}$ gm./gm. Travancore monazite thus appears to be about 8 times richer in radium content than Brazilian monazite, which was shown by Baltuch and Wissenberger[10] to contain $1{\cdot}54 \times 10^{-10}$ gm./gm. radium. The result is in agreement with the value of Strutt for Swedish, Brazilian and Norwegian monazites. According to the present results, the uranium content of Travancore monazite is about 0·36 per cent, which is of the same order as that obtained for monazite sand of north Carolina, Norway, Brazil and Connecticut[11]. This value is, however, only about a tenth of that reported to be present in exceptional specimens of vein monazite found in Travancore[12]. The proportion by weight of radium to meso-thorium prepared from Travancore monazite is about 98 per cent while about 16 per cent of its γ-ray activity is due to the radium content. Compared with the commercial preparations of meso-thorium from Brazilian monazite[13], these values are appreciably lower.

Acknowledgement

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REFERENCES

1. WATSON, H. E. & PAL, G. : *Phil. Mag.*, 1914, **28**, 44.
2. WATSON, H. E. & SMEETH, W. F. : ibid., 1918, **35**, 206.
3. SIERP, H. & STEICHEN, A. : *Ind. Med. Gaz.*, Dec. 1911.
4. STRUTT : *Proc. Roy. Soc.*, 1905, **76**, 88, 312.
5. CURIE, P. & LABORDE, A. : *Comptes Rendus.*, 1904, **138**, 1150.
6. BOLTWOOD, B. B. : *Am. J. Sci.*, 1904, **18**, 378.
7. MARKAL, J. : *Phys. Zeits.*, 1927, **28**, 10.
8. JOLY, J. : *Phil. Mag.*, 1911, **22**, 134.
9. POOLE, J. H. J. & JOLY, J. : ibid., 1924, **48**, 828.
10. BALTUCH & WEISSENBERGER : *Zeits. Anorg. Chem.*, 1914, **88**, 88.
11. *Radioactive Substances & Their Radiations*, Rutherford, p. 461.
12. *Imp. Min. Research Bureau, Pub. on Monazite*, p. 6 (1920).
13. *Radioactive Substances & Their Radiations*, Rutherford, p. 550.

A Rapid Method for the Analysis of Natural Graphite

K. K. MAJUMDAR
Indian School of Mines & Applied Geology, Dhanbad

A rapid and convenient method for the analysis of graphite based on the procedure adopted for the proximate analysis of coal is described. No special equipment is needed in carrying out the analysis and the values obtained are about 1 per cent lower than those obtained by combustion in oxygen.

ALTHOUGH natural graphite is extensively employed in industry, no rapid and convenient method of analysis appears to have been developed. The dearth of literature on this subject has been recently pointed out by Karunakaran and Narasingha Rao[1]. Some of the known methods of analysis of graphite are : (1) reduction of lead oxide ; (2) wet combustion ; (3) combustion in oxygen ; and (4) fusion with caustic potash.

Reduction of Lead Oxide — In this method[2], a weighed quantity (about 0·5 gm.) of graphite is intimately mixed with about 30 gm. of litharge and heated in a fire-clay crucible till the contents melt. On cooling, the bead of lead formed by reduction of litharge by carbon is collected, cleaned and weighed. The method is fairly accurate and rapid, but is not entirely satisfactory. Because of high viscosity of molten litharge, lead globules are sometimes found disseminated in the solidified matrix and low results are obtained. The crucible required should be dense and should be capable of resisting corrosion. Fire-clay crucibles made in India are generally porous and unsuitable for these determinations. Further, a crucible can be used but once as it gets badly corroded.

Wet Combustion — This method[3] consists in oxidizing graphite by a mixture of sulphuric and chromic acids and absorbing the carbon dioxide evolved. The values for carbon observed by this method are usually high as the sulphur dioxide evolved during the experiment is also absorbed in the absorption system.

Combustion in Oxygen — Combustion of a weighed quantity of graphite in a current of oxygen and determination of the weight of carbon dioxide produced is the usual method followed at present[4,5]. Combustion tubes of silica are required.

Fusion with Caustic Potash — This method[6] consists in fusing graphite with solid caustic potash in a silver crucible when the impurities dissolve. The fused mass is extracted with water, and the residue consisting of graphite and oxide of iron dissolved in an acid. The graphite left over is weighed. The values obtained are always low.

An attempt has been made in our laboratories to determine the relative merits of the methods and to devise a simple and rapid procedure for the estimation of carbon in graphite.

Experimental

Reduction of Lead Oxide — A weighed quantity (about 0·5 gm.) of finely powdered and dried graphite was mixed with 30 gm. of litharge and 10 gm. of sodium carbonate and fused in a Battersia fire-clay crucible No. C in a muffle furnace at about 1000°C. When effervescence ceased, the crucible was taken out and the contents poured into a cast-iron mould. The lead bead was cleaned and weighed.

Wet Combustion — The apparatus consisted of an all-glass distillation flask (250 c.c.) fitted with a dropping funnel, the stem of which nearly reached the botton of the flask. The dropping funnel was connected to a drying tube. The flask was connected in series to an absorption bottle containing a strong solution of potassium permanganate saturated with carbon dioxide, a U-tube containing fused calcium chloride, a short silica tube containing coarse copper oxide and heated to 500°C., a weighed potash bulb, and finally, an aspirator through a guard tube.

0·2 gm. of graphite was oxidized with a mixture of sulphuric and chromic acids (125 c.c.) in the distillation flask in a current of air and the weight of carbon dioxide determined and the carbon content was calculated in the usual way.

Combustion in Oxygen — This was carried out according to Himus[7], with slight modification. Copper oxide packing was only 4″ long, because graphite contains very little volatile matter. The carbon dioxide was absorbed in *carbosorb.*

Proposed Method — This is based on the procedure adopted for the proximate analysis of coal. 1·0 gm. of graphite was heated in a procelain or silica crucible with its lid on for 7 min. over a No. 4 Mecker burner at about 800°C. for the determination of volatile matter. The graphite was then burnt off in a muffle furnace and the ash content determined. The carbon content was calculated by deducting the sum of volatile matter and ash. The experimental results are shown in Table I.

TABLE I

SOURCE OF GRAPHITE	ASH % (a)	VOLATILE MATTER % (b)	GRAPHITE CARBON % 100 – (a + b)
Ceylon	3·62	1·40	94·98
Mysore	32·93	2·52	64·55
Mexico	12·508	1·84	85·66
Korea	18·38	1·85	79·77
Madagascar	12·49	2·24	85·27

The results obtained by the different methods outlined above are shown in Table II.

TABLE II

SOURCE OF GRAPHITE	LEAD OXIDE METHOD %	WET COMBUSTION %	COMBUSTION IN OXYGEN %	PROPOSED METHOD %
Ceylon	95·21	93·05*	96·10	94·98
Mysore	63·69	66·11	66·23	64·55
Mexico	87·04	86·42	86·93	85·66
Korea	80·41	80·70	80·89	79·77
Madagascar	86·95	...	87·60	85·27

* Incomplete.

It will be seen from the above that the values obtained by the proposed method are about 1 per cent lower than those obtained by combustion in oxygen. It is rapid and requires no special equipment.

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REFERENCES

1. KARUNAKARAN & NARASINGHA RAO : *Curr. Sci.*, 1947, **16**, 218.
2. VILLAVECCHIA, V. : *Treatise on Applied Analytical Chemistry*, 1918, II, p. 399.
3. STRASCHILL, M. : *Chem. Ztg.*, 1937, **61**, 328.
4. SCOTT, W. W. : *Standard Methods of Chemical Analysis* (Van Nostrand), 5th ed., I, p. 235.
5. SCHWARZ, E., BERGKAMF, V. & HARANT, L. : *Z. Angew. Chem.*, 1930, **43**, 333.
6. SPENCE, H. S. : *Graphite* (1920), *Report No.* 511, *Canadian Mines Branch.*
7. HIMUS, G. W. : *Fuel Testing* (Leonard Hill), 2nd ed., p. 48.

Letters to the Editor

RIBONUCLEASE ACTIVITY OF SOME INDIAN PULSES & OILSEEDS

IN THE COURSE OF OUR CYTOCHEMICAL studies of yeast cells[1] and fungal mycelia, it was found essential to employ specific enzymes for the location and characterization of cellular bodies. One of the enzymes which is attaining great importance in such studies is ribonuclease which has been prepared by Kunitz in a crystalline form from beef pancreas[2]. This enzyme has been used recently for distinguishing the ribonucleo protein components of the cell.

A preparation of ribonuclease has been made by Schlamowitz and Garner[3] from germinated soya beans. We have made a survey of the ribonuclease contents of indigenous pulses and oil seeds readily available in the market, such as : soya beans (*Glycine hispida*) ; Bengal gram (*Cicer arietinum*) ; green gram (*Phaseolus mungo*) ; horse gram (*Dolichos biflorus*) ; castor (*Ricinus communis*) and groundnut (*Arachis hypogaea*).

After soaking the seeds overnight in a stream of running water and germinating them in the dark for a period varying from 3 to 6 days until the seedlings measured 5 to 6 cm., the material was ground up in a porcelain end runner with glycerol sufficient to reach a 40 per cent concentration in the macerated mixture. The extract was filtered through cloth after 48 hr. autolysis in the cold and the ribonuclease activity of the crude filtrate was determined by the method of Kunitz. A 1·0 per cent solution of purified yeast nucleic acid (B.D.H.) in citrate buffer of *p*H 6·2 was employed as substrate. 1 c.c. of the substrate was treated with 1 c.c. of crude glycerol preparation of the enzyme and the reaction was allowed to proceed at 37°C. for 18 hr. The reaction mixture was treated with 2 c.c. of uranyl acetate[4], allowed to stand for 30 min. and filtered. 2 c.c. of the clear filtrate were digested with 1 c.c. of 70 per cent perchloric acid according to the method of King[5]. The digest was taken up with water, and transferred to a 50 c.c. volumetric flask. 1 c.c. of 5 per cent aqueous ammonium molybdate solution and 0·5 c.c. of amidol solution were added and the mixture made up to 50 c.c. After 5 min. the blue colour which developed was measured in a photoelectric colorimeter (Lumetron 402 E) using 630 M filter. The phosphate contents were read off from a previously calibrated graph. Reagent blanks and enzyme substrate controls were run and corrections applied in calculating the activity of the preparation.

SOURCE OF ENZYME	MICROGRAMS OF P/c.c.
G. hispidia	100
C. arietinum	75
P. mungo	394
D. biflorus	112
R. communis	430
A. hypogaca	380

The results (TABLE I) show that *P. mungo*, *R. communis* and *A. hypogaea* constitute rich sources of the enzyme. Preparations from *R. communis* and *C. arietinum* have been found to be free from proteoclastic activity, a circumstance of great importance in securing ribonuclease preparations free from proteolytic enzymes.

Our grateful thanks are due to the *Council of Scientific & Industrial Research* for financing the scheme of which this work forms a part.

B. BHIMESHWAR
N. SREENIVASAYA

Section of Fermentation Technology
Indian Institute of Science
Bangalore

REFERENCES

1. BHIMESWAR, B. & SOMA KUMAR : *J. sci. industr. Res.*, 1948, **7B,** 131.
2. KUNITZ, M. : *J. Gen. Physiol.*, 1940, **24,** 15.
3. SCHLAMOWITZ MAX & GARNER, R. L. : *J. Biol. Chem.*, 1946, **163,** 487.
4. MACFADYEN, D. H. : ibid., 1934, **107,** 299.
5. KING, E. J. : *Biochem. J.*, 1932, **26,** 292.

BOUND TRYPTOPHANE IN PREPARATIONS OF PAPAIN

FOR A QUANTITATIVE ESTIMATION OF VITAmins and amino acids of tissues and tissue fluids, suitable pre-treatment of the research material is essential for (1) releasing the bound vitamins and (2) for the hydrolytic liberation of amino acids from proteins. Acids, alkalies and specific enzymes are generally employed for this purpose. Acid hydrolysis results in a total or partial destruction of some of the amino acids. Alkali, likewise, destroys amides, arginine, cystine and partially lysine and brings about a complete racemization of the amino acids. Enzymes hydrolyse the materials into their constituent amino acids and liberate the bound vitamins, if present. But one drawback with regard to the employment of enzymes for the hydrolysis of the protein is that the enzymes themselves may be associated with constituents to be assayed. The preparation of enzymes should be (1) free from those constituents which are intended to be estimated and (2) free from interfering enzymes which may take the action to a further undesirable stage, involving the destruction of the amino acid or the vitamin under consideration. Control experiments are usually carried out to account for (1) but an ideal enzyme preparation should be practically free from such constituents. During our studies on the amino acid make up of virus-infected sandal leaf, the material was digested with a preparation of cyanide-activated papain, made according to the method of Ganapathi and Sastri[1]. The preparation was found to be free from tryptophane as revealed by microbiological assays.

It was, however, of interest to determine if tryptophane was present in the preparation in a bound and unavailable form. The sample (1 gm.) was hydrolysed with 12 per cent baryta for 24 hr. on a sand bath and the baryta was thereafter removed as sulphate.

The filtrate was concentrated under vacuum, the reaction adjusted to *p*H 6·8, made up to 25 c.c. and preserved under toluene at 0°C. The total solids of the extract on total ash-free basis was 15·2 mg./c.c.

The tryptophane-free medium was composed of:

Glucose 2·0 gm.; sod. acetate 2·0 gm.; salts A and B 0·5 c.c. each; xanthine, uracil, adenin, guanin 1 mg. each; B_1 50 γ; B_2 50 γ; B_6 100 γ; cal. pantothenate 50 γ; niacin 100 γ; pab. 10 γ; biotin 0·1 γ; folic acid 1 γ; cystine 20 mg.; acid hydrolysate of casein 250 mg.; *p*H 6·8; volume made up to 50 c.c.

1·5 c.c. of the above medium was transferred to pyrex tubes, previously sterilized. For the development of the standard tryptophane curve the following levels of *dl*-tryptophane solution were added: 1γ, 2γ, 3γ, 4γ, 5γ and the total volume in each tube was made up to 3 c.c. with distilled water.

To the tryptophane-free medium the following levels of 1 : 3 diluted alkali hydrolysate of papain were added: 0·1, 0·2, 0·4, 0·6, 0·8 and 1·0 c.c. and the final volume was made up to 3 c.c. with distilled water. The tubes were steamed for half an hour.

A 24-hr. culture of *L. arabinosus* (N.C.T.C. 2161) previously washed thrice with physiological saline and suspended in 50 ml. of sterile saline was employed for inoculations, each tube receiving a drop of this suspension. The tubes were incubated at 37°C. for 72 hr. and the entire reaction mixture (3 c.c.) was titrated against N/20 NaOH using Brom-thymol-blue. The results are graphically represented.

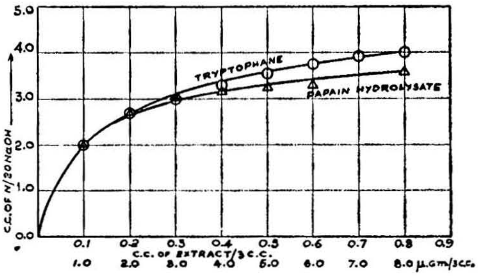

FIG. 1 — GROWTH OF RESPONSE OF *L. arabinosus* TO ALKALI HYDROLYSATE OF PAPAIN.

Discussion

1. *L. arabinosus* which responds to free tryptophane is unable to utilize the bound tryptophane present in samples of papain, prepared according to the method of Ganapathi and Sastri[1].
2. The bound tryptophane in papain is, however, released on alkali hydrolysis and amounts to 0·2 per cent on the moisture and ash-free preparation.
3. Preparations of papain can be used as an ideal hydrolytic agent for releasing tryptophane bound in proteins and for its subsequent estimation by *L. arabinosus*.

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R. RAM MOHAN
M. SREENIVASAYA

Section of Fermentation Technology
Indian Institute of Science
Bangalore
September 11, 1949

REFERENCE

1. GANAPATHI & SASTRI: *Biochem. J.*, 1939, **33**, 1175.

A NOTE ON THE CONSTITUTION OF BIOCHANIN A

IN AN EARLIER COMMUNICATION[1] ON THE constitution of biochanin A, it was mentioned that a ketone, m.p., 160°C., provisionally named as biochanetin A, was obtained by a mild hydrolysis of biochanin A. This ketone, which analysed for $C_{15}H_{14}O_5$ (air-dried sample) and which was characterized through a crystalline oxime, m.p., 222°-23°C., was presumed to be a trioxyphenyl 4-methoxybenzyl ketone. On the basis of the constitution of biochanin A as 5, 7-dioxy-4'-methoxy*iso*flavone, a ketone obtained by its mild hydrolysis should be identical with 2, 4, 6-trioxyphenyl 4-methoxybenzyl ketone, m.p., 192°-93°C., synthesized by Baker and Robinson[2] and also by Shriner and Hull[3]. This ketone was also synthesized by the present authors for comparison, and an air-dried sample of it analysed for $C_{15}H_{14}O_5$, H_2O. The water of crystallization could be completely removed only by prolonged heating at 100°C. *in vacuo* over phosphorus pentoxide. Thus biochanetin A proved to be different from the synthetic ketone.

In a recent experiment in which a larger quantity of biochanin A (1 gm.) was hydrolysed under slightly different conditions, details of which will be published later, two crystalline ketones were obtained by fractional crystallization of the phenolic part of the hydrolysis products through dilute alcohol. The more soluble fraction yielded a ketone, m.p., 160°C., identical with biochanetin A. The less soluble fraction, on repeated crystallizations from dilute alcohol, finally yielded a product, m.p., 192°-93°C., which analysed to $C_{15}H_{14}O_5$, H_2O. On drying at 100°C. *in vacuo* over phosphorus pentoxide for 5 hr., it lost 1 molecule of water and analysed for $C_{15}H_{14}O_5$. It did not depress the melting point of a synthetic sample of 2, 4, 6-trioxyphenyl 4-methoxybenzyl ketone and thus proved to be identical with the latter. With the isolation of this ketone through the hydrolysis of biochanin A, a so far inexplicable point in regard to the constitution of biochanin A has been accounted for.

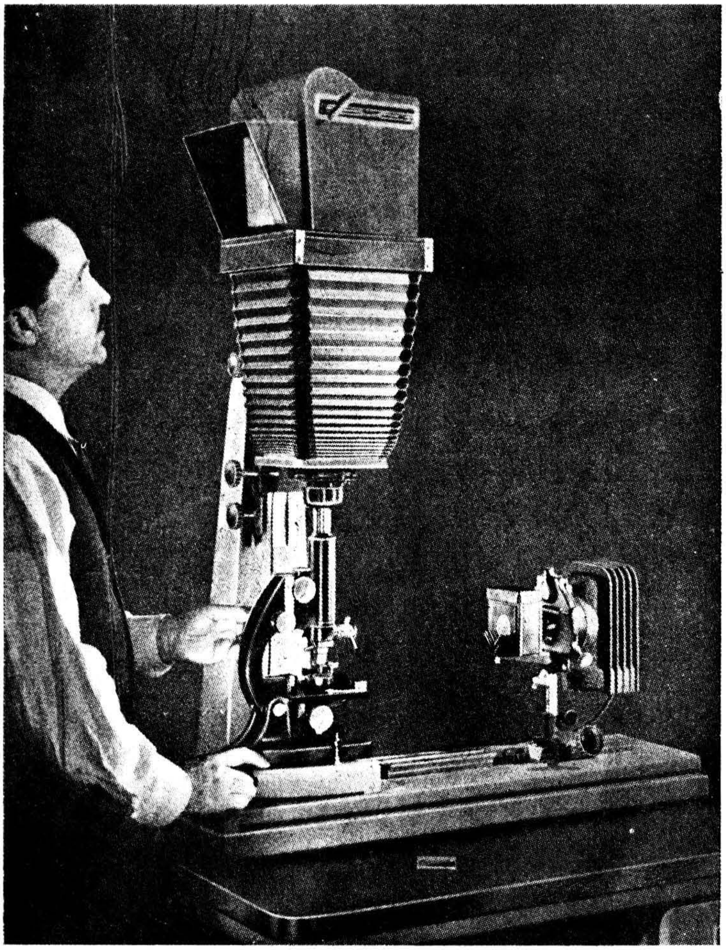
Work on further elucidation of the constitution of the ketone biochanetin A is in progress.

JOGENDRA LAL BOSE
SALIMUZZAMAN SIDDIQUI

Chemical Laboratories
C.S.I.R.
Delhi

REFERENCES

1. BOSE & SIDDIQUI : *J. sci. industr. Res.*, 1945, **4**, 231.
2. BAKER & ROBINSON : *J. chem. Soc.*, 1926, 2713.
3. SHRINER & HULL : *J. org. Chem.*, 1945 **10**, 288.



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