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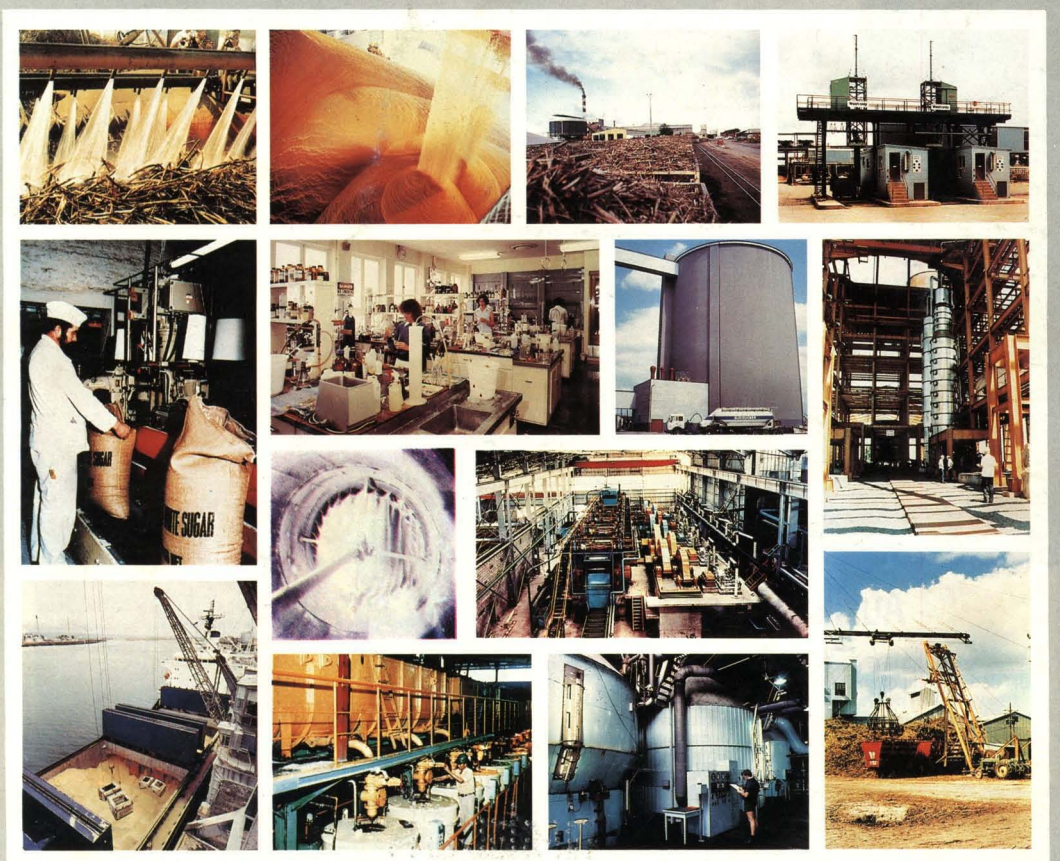

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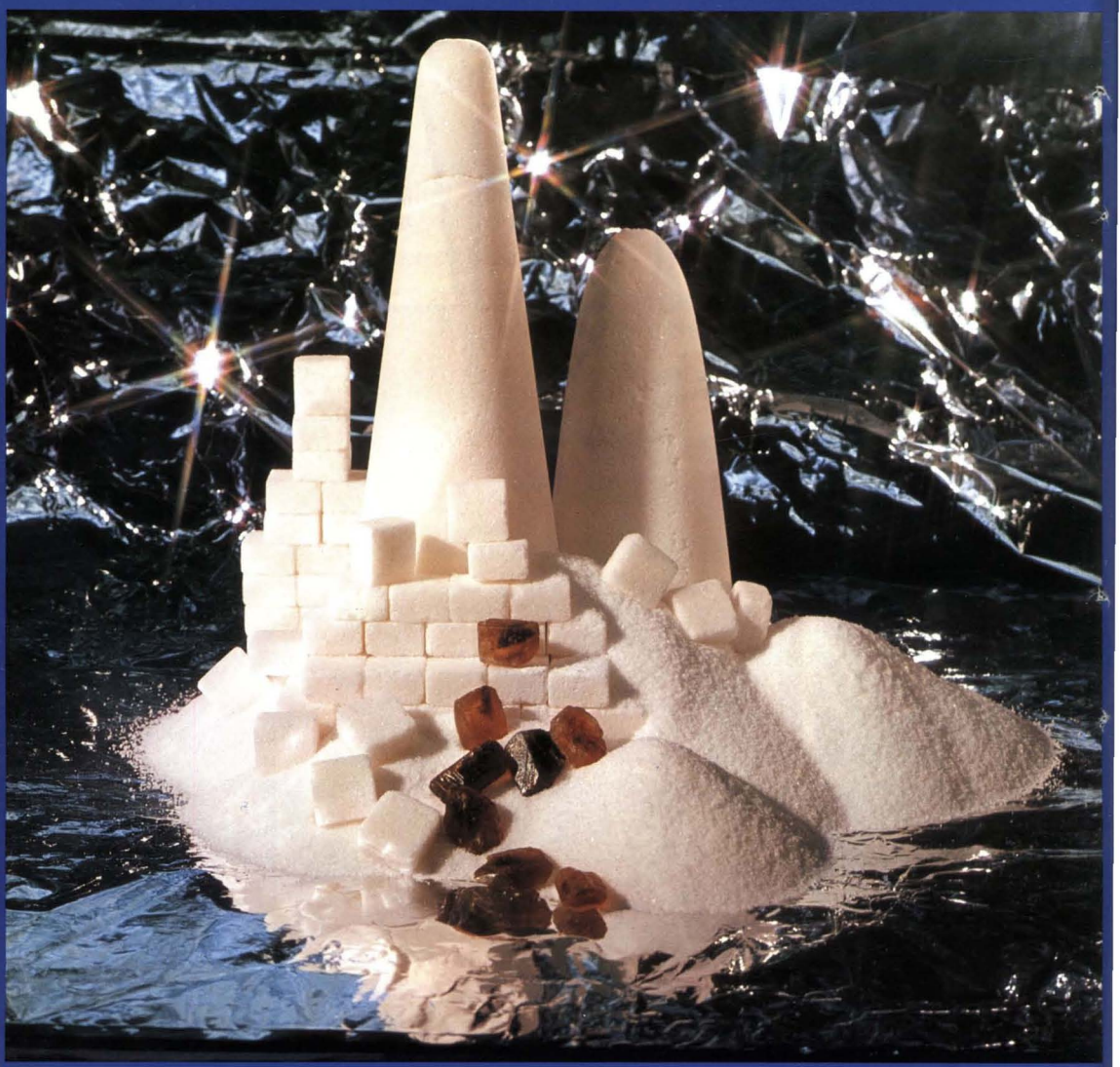

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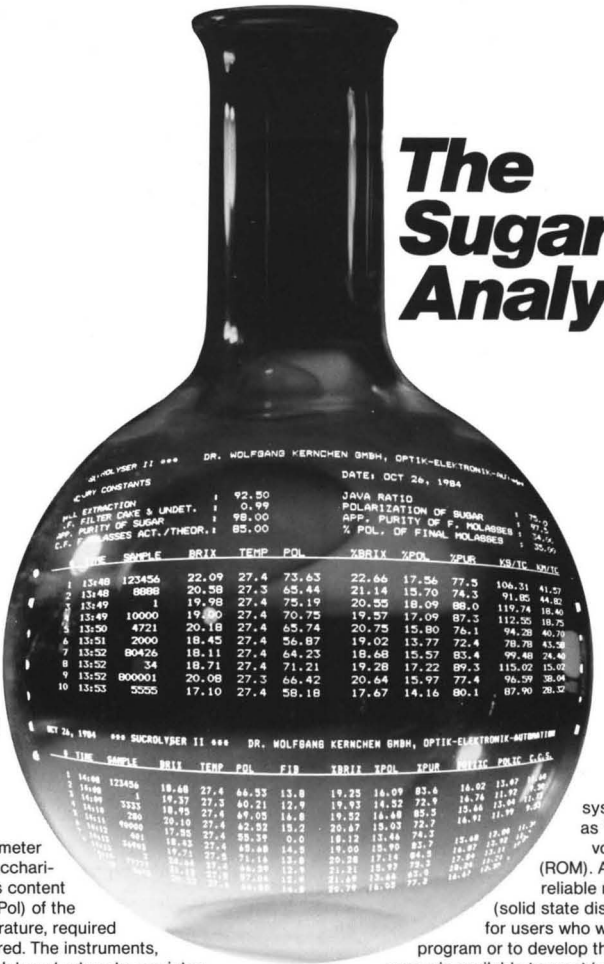

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Notes and comments

World sugar balance, 1985/86

A new estimate of the world sugar balance has been published by F. O. Licht GmbH and is reproduced below, with comparable figures for the previous two years[1]. The production figure is not calculated on exactly the same basis as the recent estimate but it too shows a fall of more than 3 million tonnes from the 1984/85 level and is below consumption level for the first time in six years. Thus world stocks are forecast to fall to 38.2 million tonnes or 38% of consumption, a level which is still too high for comfort for the sugar market. "World stocks need to be substantially reduced next year to raise prices to more remunerative levels.... There is every likelihood that plantings of beet and cane will decline in those countries heavily dependent on the free world market... overall production in 1986/87 may not rise significantly above this year's level of 97 million tonnes. Consumption, on the other hand, can be expected to rise to more than 100 million tonnes, which could lead to a further draw-down of stocks by 3 - 5 million tonnes. Hence stocks could fall to their lowest level for five years and could be even lower than in 1981/82 when prices were significantly higher."

	1985/86	1984/85	1983/84
		tonnes, raw value	
Inital stocks	41,215,000	40,283,000	39,317,000
Production	97,091,000	100,286,000	97,961,000
Imports	27,134,000	28,691,000	29,411,000
	165,440,000	169,260,000	166,689,000
Consumption	99,800,000	98,384,000	96,404,000
Exports	27,453,000	29,661,000	30,002,000
Final stocks	38,187,000	41,215,000	40,283,000
" " % Consumption	38,26	41.89	41.79

Brazil Sugar Institute restructure[2]

By June 1986 the Brazilian government expects to implement a new policy for the sugar and alcohol sector, calling for a modification of its role and a major restructuring of the Sugar and Alcohol Institute (IAA) so as to reduce its functions. The IAA will not be eliminated entirely but it will be reduced to a centre to supervise the crop schedule and implement prices. These functions will be regulated by a new council, the National Sugar and Alcohol Board, and staffing will be reduced to about 200 from the 4500 employed by the IAA and Planalsucar. The latter will be turned into a private foundation and the other faculties of the IAA will either disappear, be taken over by private firms, absorbed by other government agencies or transferred to state governments.

Indonesian sugar situation[3]

Indonesian sugar output is forecast at about 1.9 million tonnes, white value, in 1985/86, up 15% from the 1984/85 production of 1,707,000 tonnes, according to the Indonesian Sugar Council (DGI). However, with domestic consumption currently estimated at some 2 million tonnes, Indonesia will have to continue importing sugar to make up the shortfall. The Indonesian sugar industry suffers from inefficient production methods, poor quality domestic sugar cane and generally low capacity of the country's sugar factories, the Council said. Indonesian domestic sugar prices have risen steeply over the past few years to reach 52 US cents per kilogram at present. The Indonesian government is reported to be determined to raise sugar production, not only to attain self-sufficiency but also to prepare for possible price rises in the export market. Domestic sugar consumption also needs boosting from the present 11.1 kg per caput per annum which is the lowest in the region, against 12.3 kg for Thailand, 25 kg for the Philippines and more than 46 kg for Singapore.

Australian sugar industry problem

The Queensland government has rejected the Australian Federal government's proposal of $A 150 million in grants to assist the sugar industry[4]. This had been contingent upon an additional Queensland contribution of at least $A 75 million and for there to be an agreed, phased program of relaxing regulatory constraints so that the industry might more readily adjust to existing and future market conditions, according to the Federal Minister for Primary Industry.

The combined grants were to provide a No. 1 pool price of $A 230 per tonne in the first year, $A 225 in the second and $A 220 in the third; it was envisaged that after this the industry would have restructured itself so that it could produce sugar at world prices for what exports were to be made. This would involve replacement of the peak/assignment system with one of licensing of growers which enabled planting on the most suitable land and use of cost-saving agronomic practices. Growers' entitlements would be transferable so that individuals could acquire extra production rights while others could sell their entitlements but retain their land for other use or for disposal.

The Queensland and Federal governments are controlled by opposed political parties so that difficulty in reaching accord was to be expected. The state government has instead offered a loan package of $A 20 million to assist cane growers in difficulties; it is for a maximum of seven years and initially at interest rates one-quarter of commercial rates; the terms would be reviewed annually. The Federal Minister has criticized the Queensland proposal as not solving the industry's problems and only postponing the restructuring which it considers inevitable.

Russell Savage, chairman of a Sugar Industry Working Party which recently completed a review of the industry, stated that Australia should not reduce raw sugar production in an effort to boost world prices[5]. It would then merely forgo exports for the benefit of other producers.

1 *Int. Sugar Rpt.*, 1986, **118**, 59 - 64.
2 *GEPLACEA Bull.*, 1986, **3**, (1), Sugar Inf.-1.
3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 38.
4 *Australian Sugar J.*, 1985, **77**, 306.
5 *Reuter Sugar Newsletter*, January 31, 1986.

He claimed that Australia should cut costs and become more efficient by dismantling many aspects of its highly regulated structure. If drastic changes are not made, he said, the industry may well destroy itself, adding that every suggestion for change had been immediately condemned by some sector of the industry.

Canada sugar industry protection call[6]

Canadian beet and corn sweetener interests have launched a lobbying campaign to persuade the Federal government to protect them with special tariff surcharges of the kind used by the United States for many years. As the farmers see it, the tariffs would keep the price of imported raw cane sugar at the artificially high level of 25 Canadian cents a pound against the current Montreal dockside price of about 8 cents. This would provide profitability for the corn sweetener industry but the prime beneficiaries would be the 1400 beet growers.

Consumers would pay the cost, however, estimated at anywhere from $Can 10 million to 330 million. The Canadian Sugar Institute takes a dim view of the proposed tariffs. It represents the sugar importers who supply about 85% of Canada's sugar and its President would like the Federal government, instead of a tariff, to pay farmers a special subsidy of up to $20 million whenever the price of beets falls below the cost of production.

World sugar prices

Indications of severe cyclone damage to the Queensland cane crop raised the London Daily Price for raw sugar from January levels so that it started the month of February at $143.50 per tonne but slid back to $137.50 by February 6, after which reports of the deferral of shipments of Cuban sugar strengthened sentiment and the price rose to $147 on February 10. From then on, prices were reasonably stable to the end of the month between extremes of $143 and $148.50, the month ending with a price of $146.

White sugar prices tended to follow those of raw sugar to a large extent, but the premium between the LDP(W) and LDP tended to widen in the second half of the month, thanks to buying interest from Morocco and Peru. which are not regular importers, as well as from Pakistan and Bangladesh. Thus, the LDP(W) started the month at $181.50, weakened to $174.50 on February 6, rose to $176.50 on February 10 but sank to $172 two days later before starting to climb again. It reached a peak of $178 on February 26 and ended the month at $177.

Discussing the changes and future prospects, E.D. & F. Man conclude[7] that pressures resulting in the drop in production in 1985/86 will still prevail and could result in even lower production for 1986/87, while it is unlikely that sugar imports, which have been held back to a minimum in recent years, will be seriously affected. "Record stocks are already being eroded and those importing countries where stocks remain high, notably the Soviet Union and China, are likely to maintain their policies of recent years and not draw down on their stocks during times of very low prices. Meanwhile, in the short term, the effects of all these contributory factors are being seen. In raw sugar, particularly, surplus stocks in exporting countries, with the exception of Thailand, are already quite low, most significantly in the Philippines, Cuba, Brazil and Argentina. Any large scale raw sugar demand between now and the fourth quarter of 1986 would undoubtedly be difficult to meet. The stage is therefore set for the sugar market to emerge again from its current torpor. The question to be asked is not if, but when the deficit suggested by statisticians the world over translates itself into final buying requirements and consequently higher prices."

British Sugar ownership

S. & W. Berisford, the commodity trading group, bought British Sugar plc for £282 million in 1982 but it has been said that subsequent profits have been disappointing, owing to the tight ceiling on production imposed by the EEC, and a fierce price war in the domestic packet sugar market. Berisford's have been hit by falls in commodity prices and volumes traded, and its metals trading division faces considerable losses on its contracts for tin with the International Tin Council.

It has been reported that Ferruzzi, the giant Italian corporation which owns the Eridania group and almost 50% of Beghin-Say of France, has made an offer for British Sugar which, by way of some complicated proposed arrangements, has been valued at £340 - £400 million. If the deal were to go through, Ferruzzi would emerge as having control of some 2.75 million tonnes of sugar production capacity, more than 22% of the EEC's total A- and B-quotas. This is liable to cause concern to the UK Office of Fair Trading as well as to the EEC Commission. In the meantime, another British foods group, Hillsdown Holdings, has emerged as a 5.95% shareholder in Berisford's, prompting stock market speculation that it is about to launch a full-scale bid. As a consequence of these activities, the price of Berisford's shares, £1.65 on February 25, climbed to £2.02 on February 28 and to £2.11 a week later.

US sugar import quota

Word was impatiently waited as to the intentions of the US administration by sugar suppliers to the US following passage of the Farm Bill and examination of alternatives to a reduction of quotas[8]. With President Reagen scheduled to meet the leaders of the Caribbean Basin countries in Grenada on February 20, it was realised that he would probably use this occasion to make known his plans. In the event, he told the group that he intended to go back to Congress for changes in the stringent provisions on import quotas. He said he would continue to oppose the provision in the bill mandating a cut in the quota.

The US Department of Agriculture announced on February 27 that, instead of cutting the quota, there would be a three months extension of the quota year, to December 31, 1986, which means, in effect, cancellation of any quota for those

6 F.O.Licht, *Int. Sugar Rpt.*, 1986, **118**, 107 - 108.
7 *The Sugar Situation*, 1986, (418).
8 See *I.S.J.*, 1986, **88**, 43.

three months. The announcement was delayed owing to a lack of agreement in the White House Economic Policy Council on what action to pursue to compensate the Caribbean countries whose economies were damaged by the US action[9]. One alternative would be for a program of re-export of Caribbean sugar after refining in the US, while another was the supply of surplus commodities from the US to the Caribbean to the value of the financial loss on sugar exports. Another possibility is the revised "Savannah proposal", but all three have drawbacks and attract opposition from interests in the US, the Caribbean and elsewhere.

It will be necessary to wait to see whether anything can be done to match the actions of the US to the glowing announcement of the Caribbean Basin Initiative, or whether the damage to the suppliers will be a further monument to the astonishing power of the farmers' lobbies in the US which, like that in the EEC, is so much out of proportion to the numbers involved.

Argentina sugar crisis[10]

Argentina sugar exports have recently decreased substantially, from 630,000 tonnes in 1984 to only some 100,000 tonnes last year. World market prices are much lower than the break-even export price which is calculated to be about $330 per tonne. The inevitable bankruptcies have reduced the number of sugar factories to 25, which compares with 37 twenty years ago.

A major problem seems to be an export tariff of 15.5%; industry spokesmen have sought the removal of this tariff but so far the government has failed to respond. Domestic demand has also gradually declined over the past decade by about 10%. Latest estimates put 1985 production at about the 1.1 million tonnes set as a target by the state. This means a surplus of about 150,000 tonnes, as a consequence of which, although the government has set a wholesale price of 0.32 australes per kg, retailers are purchasing at about 0.20 australes and reselling to the public at prices lower than those set by the government. The crisis has resulted in numerous disputes between growers and mill owners over failure to fulfil contracts or pay debts, often owing to a shortage of liquidity. It is expected that output in 1986 will fall even lower, to about 1 million tonnes.

EEC sugar balance, 1985/86

C. Czarnikow Ltd. has recently re-examined the statistical position of the European Economic Community in the light of the more accurate figures available following the 1985/86 campaign[11]. Production has increased by more than 200,000 tonnes since the earlier estimate in December, so that Community output, including DOM cane sugar, will be around 12,719,000 tonnes, white value. With 749,000 tonnes of C-sugar carried over from 1984/85 and free and minimum stocks of 1,384,000 tonnes, and imports from ACP countries and elsewhere of 1,353,000 tonnes, total availabilities amount to 16,205,000 tonnes, white value.

Consumption is assessed at 9,500,000 tonnes, while declarations have been made that 11,000 tonnes of B-quota sugar and 1,012,000 tonnes of C-sugar will be carried over to 1986/87. 248,000 tonnes are expected to be disposed of as net exports in processed products, while the latest Commission figures assume a run-down in free and minimum stocks to 1,300, 000 tonnes. This gives a total exportable supply of 4,134,000 tonnes, of which 1,245,000 tonnes is C-sugar having no support.

Of the 2,889,000 tonnes of A- and B-quota sugar available for export, licences had been issued for more than half by February 19, while an allowance has also been made of up to 132,000 tonnes for possible raw sugar deliveries to Portugal between the beginning of March, when Portugal's sugar arrangements are formally merged with those of the Community of Ten, and the end of September.

9 *Dyergram*, 1986, (5-86), 1.
10 F.O.Licht, *Int. Sugar Rpt.*, 1986, **118**, 88.
11 *Sugar Review*, 1986, (1746), 25.

Brevities and statistics

South African study on ethanol from cane[1]

A feasibility study into the production and use of ethanol from sugar cane has been launched in South Africa. It is hoped that the first ethanol will be produced in about mid-1986 with full-scale production beginning by the end of the year. Initially, authorization has been granted to farmers for the ethanol to be used on their own farms.

Jamaica sugar production, 1984/85[2]

Sugar output in Jamaica from the 1984/85 harvest totalled 206,775 tonnes, the best performance by the industry for five years. Significantly, the cane : sugar ratio of 10.8 was the best since 1976. The industry has a target of 240,000 tonnes annual production which is expected to be achieved by the more efficient running of the state-owned sugar factories by Tate & Lyle.

Dominican Republic distillery[3]

The Sugar Cane Growers' Federation announced in November that they have started building a plant to produce 120,000 litres/day of alcohol using equipment and machinery provided by a Brazilian export development bank and finance from a US firm which included a loan of $9.7 million. The plant is scheduled for completion by December 1986.

Indonesian sugar projects[4]

Two new sugar estates, one incorporating some surrounding smallholder farms and the other with adjacent mill, are to be established as part of the Indonesian sugar industry. One is to be financed by the Saudi Fund for Development which will lend Indonesia $9.3 million for a period of twenty years for which, after five years grace, an annual interst rate of 3% will be charged. The other, which is in the Agam region, will be financed by the Investment Coordinating Board of Indonesia. Approximately $35 million will be required for the processing plant as well as some $20 million for the plantation operations.

USSR beet harvest, 1985[5]

The Central Statistics Office in Moscow has reported that sugar beet production in 1985 was 82 million tonnes, down 3.9% from 1984 (85,251,000 tonnes). Based on past performance, state procurements can be estimated at some 74 million tonnes (90% of production) which, on the basis of a slightly above-average extraction rate, should yield a total sugar output of 8.6 million tonnes, raw value.

1 *Czarnikow Sugar Review*, 1985, (1744), 173.
2 F.O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 712.
3 *Amerop-Westway Newsletter*, 1986, (146), 9.
4 *Czarnikow Sugar Review*, 1985, (1744), 173.
5 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 69.

Taiwan sugar factory in Indonesia[6]

A factory supplied by the Taiwan Machinery Manufacture Corporation[7], has been erected in the Takalar district, South Sulawesi, and underwent its trial runs in 1985, achieving a reduced boiling house extraction of 92% against a contract performance of 88%. The factory has a capacity of 4000 t.c.d.

St. Kitts sugar reorganization[8]

A newly created state agency, St. Kitts Sugar Manufacturing Corporation, is to run the St. Kitts sugar industry instead of the National Agricultural Corporation previously in charge. The new agency will assume EC$48.1 million (US$17.8 million) in debts accumulated by the NAC. Sugar production in 1984/85 was 26,000 tonnes, 4000 tonnes down on the previous season.

Japan beet sugar production, 1984/85[9]

In the campaign which ended in June 1985, the eight sugar factories belonging to the three groups Nitten, Hokuren and Hokuto sliced a total of 4,040,115 tonnes of beet (3,376,744 tonnes in 1983/84) grown on an area of 75,117 ha (72,522 ha) which yielded 53.78 tonnes/ha (46.56 tonnes/ha). The white sugar yield averaged 14.81% (13.90%) and sugar production amounted to 598,334 tonnes, white value, against 469,405 tonnes in the previous campaign.

Zaire sugar factory expansion[10]

A program due to be completed in 1988 is to raise production at the Kiliba sugar factory to 30,000 tonnes/year from the level of 10,000 tonnes estimated for the 1985 season. To increase capacity from the current 1200 t.c.d., Kiliba has received a loan of $23 million from the African Development Bank.

Nigeria sugar project[11]

The Nigerian subsidiary of Tate & Lyle, the largest sugar company in the country, is to erect a sugar factory complex in the Aadejia Ja'mare region in Kano state. It will involve a cane area of 60,000 ha and financing, sought locally, of about £100 million.

Australian Sugar Journal cessation

After 76 years, the *Australian Sugar Journal*, organ of the Australian Sugar Producers Association, ceased publication with its issue of December 1985.

Pakistan sugar supplies[12]

A strike of cane growers, who have been demanding a 35% increase in cane prices above the level which has applied since 1981/82 (but which is set by the government), has resulted in the closure of a number of sugar factories. It is estimated that with an expected 1,100,000 tonnes output, there will be a deficit of 220,500 tonnes against calculated consumption requirements, and that imports will be required; authorization for importation of 100,000 tonnes was announced in early January[13].

Cane damage by hurricane in Cuba[14]

The Cuban authorities have released reports on the damage caused by Hurricane Kate in November last. In total 1,324,000 hectares were affected and in some provinces practically all the cane fields were greatly damaged. There was also damage to warehouses and sugar factories. Workers may not be able to complete winter cane planting on approximately 1275 hectares. There will be a significant decrease in estimated cane crushing, a drop in sugar production, and difficulties in manual and mechanical harvesting, with increased extraneous matter entering the mills.

Uganda sugar project[15]

A new sugar factory is to be built on the site of the closed Lugazi sugar factory belonging to Uganda Sugar Corporation. It will include equipment and components supplied by Krupp Industrietechnik GmbH of Germany and its subsidiary, Buckau-Wolf India Ltd., to a total value of DM 27 million. The plant will have a capacity of 2300 t.c.d., delivery is to begin in the first quarter of 1986 and operation is planned for the 1986/87 season.

Mauritius sugar exports, 1985[16]

	1985	1984
	tonnes, tel quel	
Belgium	108	359
Canada	0	13,000
Comoro Islands	50	0
France	83,207	66,127
Germany, West	505	501
Holland	1,659	709
Ireland	0	341
Italy	1,352	3,771
Seychelles	50	0
Sweden	73	0
UK	428,574	429,646
USA	23,924	16,270
Total	539,502	530,724
Total, raw value	571,190	561,859*

* I.S.O. figure

Belgium beet sugar production, 1985[17]

The Belgian sugar factories had finished their campaigns by Christmas and production is expected to have exceeded 940,000 tonnes, white value, more than 100,000 tonnes above the outturn in 1984. Beet yields were better at 52 - 53 tonnes/ha against 50.5 tonnes in 1984, and sugar content was also higher at 16.7% against 15.16%.

Drought in Brazil

A severe drought has affected Brazil in 1985 with some areas without rain since May[18]. The affected states are Parana, Rio Grande do Sul, Santa Catarina and São Paulo, and there have been considerable losses of grain and coffee. Estimates of sugar losses have ranged from 150,000 to 850,000 tonnes and production to the end of November was 700,000 tonnes lower than at the same time a year earlier.

Peru sugar production, 1985[19]

Sugar production in Peru in 1985 reached 710,000 tonnes, raw value, somewhat lower than expected earlier. The crop is expected to decline to 700,000 tonnes in 1986.

Nigeria feasibility study for sugar project[20]

The Seven-Up bottling company in Nigeria has commissioned a feasibility study on commercial production of sugar; the company aims at self-sufficiency and intends to develop local raw material resources. The sugar project would have an estimated cost of N 10 million ($108.4 million) and would produce 50,000 tonnes per year.

West Germany campaign results, 1985/86[21]

In 1985/86 West German sugar factories processed 21,007,000 tonnes of beet to give a total of 3,153,000 tonnes of white sugar, including 19,000 tonnes recovered from molasses. The sugar content was considerably higher at 17.29% on beet against 16.24% in 1984/85.

Possible futures market in HFS[22]

High fructose syrup may be next in line for the futures market treatment in the US if the Commodity Futures Trading Commision (CFTC) agrees to a recent proposal by the Minneapolis Grain Exchange. Under the proposal, each contract would represent 48,000 lb of 55% HFS, or one tank car load, corresponding to specifications outlined by the Society of Soft Drink Technicians. The contract months traded would be March, May, July, September and December with delivery on the contracts by shipping certificate. The CFTC will accept public comment on the proposal up to March 17 but it

6 *Amerop-Westway Newsletter*, 1986, (146), 10.
7 See *I.S.J.*, 1985, **87**, 39.
8 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 32.
9 *Zuckerind.*, 1986, **111**, 96 - 97.
10 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 34.
11 *Zuckerind.*, 1986, **111**, 97.
12 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 37 - 38.
13 *GEPLACEA Sugar Letter*, 1986, (11).
14 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 15.
15 *Zuckerind.*, 1986, **111**, 97.
16 *Mauritius Sugar News Bull.*, 1985, (12).
17 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 52.
18 *World Sugar J.*, 1985, **8**, (6), 22.
19 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 55.
20 *World Sugar J.*, 1985, **8**, (6), 28.
21 F.O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 27.
22 *Public Ledger's Commodity Week*, February 1, 1986.

is not known when the contract would begin trading if it is approved.

Mauritius sugar crop, 1985[23]

The 1985 sugar cane harvest began on June 14 and ended on November 29. The 19 sugar factories crushed 5,583,345 tonnes of cane to yield 645,797 tonnes of sugar, tel quel (683,576 tonnes, raw value), against 609,636 tonnes, raw value, in 1984. Average cane yield was 71.3 tonnes per hectare and average sugar extraction 11.57% on cane. The cane crop was larger than in the two previous years but still below the normal for Mauritius owing to a drought which affected parts of the island severely.

Poland sugar production, 1985/86[24]

Despite earlier forecasts of an increase in output this campaign, sugar production in Poland for the 1985/86 crop has recently been estimated at 1.65 million tonnes, white value, which is about 75,000 tonnes below the performance achieved during the previous season. The output might have been even more reduced as deliveries of sugar beet were some 1.7 million tonnes lower than in 1984, but the situation was retrieved as sugar content was considerably higher. According to the official plan, the 1986 crop will be grown on a total area of 500,000 hectares, some 60,000 hectares more than in 1985.

France beet area reduction[25]

At the annual meeting of the French Association of Sugar Beet Growers in December, industry spokesmen announced that the 1986 beet area will probably be reduced by 8 - 10% in order to eliminate production of non-quota sugar, because of the low world market price at which such sugar is sold. Such a reduction would bring the French beet area close to 430,000 hectares, the lowest level since 1973/74. The 1985 area was itself 7% lower than the year before.

Yugoslavia beet campaign, 1985[26]

Processing of sugar beet in Yugoslavia in 1985 involved a total of 6,670,000 tonnes, of which 300,000 tonnes were received from Hungary. As a result of the warm weather prevalent during the season the average weight of roots per hectare was 42.6 tonnes and resulted in an output of 931,000 tonnes of sugar; of this 833,000 tonnes will go into domestic consumption while the remainder will be delivered to Hungary against beet from that country. The Yugoslavian five-year plan for 1986/90 envisages the eventual production of one million tonnes of sugar.

ACP call for sugar talks with EEC Ministers[27]

The 13 sugar producers among the African, Caribbean and Pacific states linked to the EEC want an extraordinary meeting with ministers to demand higher prices despite opposition from member states of the Community, according to diplomats in Brussles. These ACP suppliers may export 1.3 million tonnes of cane sugar annually to the Community at a guaranteed price; they have dismissed a proposed 1.15% price rise and want a 1.3% rise for their raw sugar. They also complain that the prices paid in sterling fluctuate as the currency moves and have rejected a British proposal for compensatory mechanism to even out fluctuations, saying the mechanism will not safeguard income.

South African Sugar Technologists' Association

The 60th Annual Congress of the South African Sugar Technologists' Association will be held at Durban and Mount Edgecombe during June 16 - 20, 1986. Further information relating to subject matters to be covered by the papers to be presented at the Congress are available from: SASTA Secretaries, C/O SASA Experiment Station, Mount Edgecombe 4300, South Africa.

Paper mill control symposium

A symposium and exibition is to be held in Stockholm during May 27 - 30 during which 40 papers will be presented on computer control and simulation of paper making processes and equipment which are being widely adopted to help attain disturbance-free operation leading to more uniform product qualities and a more profitable end-product. A hundred leading suppliers of equipment will be exhibiting their goods. Although none of the papers mentioned in the anouncement of the symposium refers to bagasse paper, it would seem likely these would be presentations relevant to this by-product industry. Further information may be obtained from Mr. Rolf Hurting, Adforum Sverige AB, Villagatan 1, S-11432 Stockholm, Sweden.

Cyclone damage in Australia[28]

A cyclone which buffeted coastal areas along a 200 km strip from Cairns to Innisfail flattened part of the Queensland cane crop and damage could total $A 40 million, although overall export commitments will still be filled. Areas producing about 30% of Australia's sugar were affected but there was little damage to the factories, closed for inter-season maintanance, and none to the Lucinda Point bulk sugar terminal. According to preliminary estimates, the 1986/87 crop will be down 300,000 tonnes from the 3.4 million tonnes of the past season, depending on conditions during the remainder of the crop. A reduction to 3.1 million tonnes would make it the smallest output since 1979/80 and would effectively reduce Australia's surplus stocks.

New "Savannah proposal"

Last year, Savannah Foods & Industries proposed that US sugar refineries be allowed to import up to 1.5 million short tons of raw sugar from the world market, outside of the US import quota, for conversion to high fructose syrup. With its raw material purchased at the world price, this would permit HFS manufacture at a price which would undercut HFS from corn and would permit the refiners to keep their facilities operating at higher than their present low proportion of capacity. Although the amount of corn used for HFS manufacture is only a small fraction of the total crop, corn producers have pressed the US Adminstration to reject the proposal, although no definite decision has been announced. A new proposal has been made by Savannah[29] whereby the imports of outside-quota sugar would be limited to about 425,000 tons from Caribbean countries; this would displace 30 million bushels of corn, not enough to affect the market. However, corn interests may still block the plan.

Japan sugar imports, 1985[30]

Japanese raw sugar imports in calendar year 1985 totalled 1,916,403 tonnes, up 80,385 tonnes from the year before. The major countries of origin were Australia with 544,000 tonnes (up 15,000 tonnes), South Africa with 381,000 tonnes (up 137,000 tonnes), Cuba with 452,000 tonnes (up 226,000 tonnes), Thailand with 305,000 tonnes (down 172,000 tonnes), the Philippines with 115,000 tonnes (down 188,000 tonnes) and Taiwan with 67,000 tonnes (up 41,000 tonnes).

Great Western sugar factories sale[31]

Western Sugar Company, the subsidary of Tate & Lyle which was formed to own and operate six of the beet sugar factories previously owned by Great Western Sugar Co., has reached a preliminary agreement to buy the idle factories at Greeley and Fort Morgan, both in Colorado, plus factory and agricultural equipment from the plants at Sterling and Ovid, Colorado, and Goodland, Kansas.

Distillery project for Hungary[32]

Krupp Industrietechnik GmbH has won an order worth DM 4 million for a distillery plant for potable alcohol at Budafok, near Budapest, in Hungary. Capacity will be 60,000 litres/day and beet molasses will be used as the raw material.

PERSONAL NOTES

After 33 years with the Sugar Research Institute, **Denis Foster,** Deputy Director (Chemistry), has retired. He joined the Institute as Chief Chemist after graduating with a M.Sc. degree from the University of Tasmania and working as CSIRO research officer. He was responsible for elevating the Chemistry Sections of the Institute to their present high standard and has made valuable contributions in the fields of crystallization, filters, cane deterioration and harvesting, bagasse utilization and the development of analytical methods. He has been an author of over 75 technical publications.

23 *Mauritius Sugar News Bull.*, 1985, (11).
24 *Czarnikow Sugar Review*, 1986, (1745), 12.
25 F.O.Licht, *Int. Sugfar Rpt.*, 1986, **118**, 27 - 28.
26 *Czarnikow Sugar Review*, 1986, (1746), 13.
27 *Public Ledger*, February 8, 1986.
28 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 92.
29 *Public Ledger's Commodity Week*, February 15, 1986.
30 F. O. Licht, *Int. Sugar Rpt.*, 1986, **111**, 111.
31 *Dyergram*, 1986, (5-86), 2.
32 *Reuter Sugar Newsletter*, January 14, 1986.

Optimum design of a vacuum pan

By H. N. Gupta* and S. J. Pande†

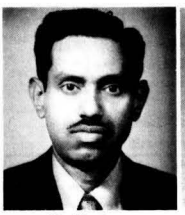
Introduction

Batch-type vacuum pans are still largely used in the sugar industry. Among these, central downtake calandria pans are very popular and are likely to remain in use for a long time. Improved performance of these pans requires better circulation of massecuite, which improves sugar quality as well as crystallization rate.

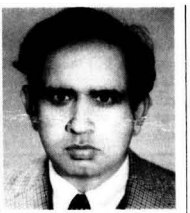
The circulation in vacuum pans at the final stage of boiling is promoted by the bubbles of vapour formed in the tubes; these bubbles of vapour tend to rise, growing as they do so and agitate the mass and lift it towards the surface. Circulation is thus caused and accelerated by the heating medium; on the other hand, it is slowed down by the resistance to flow through the tubes and downtake. In fact Hugot[1] has suggested that minimum head loss through tubes and downtake should be the criterion for the design of the vacuum pans. In his mathematical model, he assumed tube length to be a constant factor. A mathematical model developed by the authors, however, indicates that tube length should not be taken as a constant factor. Boiling at lower hydrostatic heads has also been found to provide a very effective means to improve circulation rates.

Nomenclature

α	—weight fraction for head loss
CR	—circulation ratio
d	—inside diameter of tube, m
D_d	—inside diameter of downtake, m
D_t	—diameter of tube plate, m
g	—acceleration due to gravity, m/sec^2
GV	—graining volume, m^3
HS	—heating surface, m^2
HSL	—Hydrostatic head above the top tube plate, m
K_1	—ratio of heating surface to working volume
K_2	—ratio of interior cross section of tubes to upper tube plate area
L	—length of tube, m
n	—number of tubes
P_d	—head loss in downtake, kg/m^2
P_t	—head loss in tubes, kg/m^2
Q	—flow rate, m^3/s
V	—working volume of pan, m^3
μ	—viscosity of massecuite, poises
λ	—constant



H. N. Gupta



S. J. Pande

It would thus appear that, for efficient operation of a vacuum pan, the head loss through the tubes and downtake and hydrostatic head of massecuite above the tope tube plate should be as low as possible and should be given equal weight at the problem formulation stage.

Apart from achieving a high circulation rate, the other objective of boiling syrup or high purity magma in a vacuum pan is to reduce the purity of the massecuite. It is of advantage therefore to reduce the graining volume as far as possible since the initial high purity syrup or magma taken as "footing" is brought to the working volume by adding first or second molasses of lower purity. Obviously, the lower the graining volume, the higher will be the molasses volume, which will lead to lower purity of massecuite dropped from the pan.

Mathematical model and problem formulation:

The expressions for the objective function and design constraints have been worked out for a given capacity (V) of a pan assigning certain values of K_1 and K_2 and are as follows:

$$HS = K_1 V \quad (1)$$

$$n = HS/d\,(L - 0.03).\pi \quad (2)$$

$$D_t = \sqrt{\frac{nd^2}{K_2} + Dd^2} \quad \text{[Ref 2]} \quad (3)$$

$$GV = 0.7854\,(d^2 n.L + D_d{}^2 L + 0.1\,D_t{}^2) + 0.0476\,(D_t{}^3 \div 0.00168\,V^{1.5}) \quad (4)$$

$$HSL = 0.1299\,D_t + \frac{V - GV - 0.118\,D_t{}^3}{1.0387\,D_t{}^2} \quad (5)$$

$$P_t = \frac{128\,\mu Q}{g\,\pi} \cdot \frac{L}{nd^4} = \lambda \frac{L}{nd^4} \quad \text{[Ref 1]} \quad (6)$$

$$P_d = \frac{128\,\mu Q}{g\,\pi} \cdot \frac{L}{D_d{}^4} = \lambda \frac{L}{D_d{}^4} \quad \text{[Ref 1]} \quad (7)$$

$$CR = \frac{nd^2}{D_d{}^2} \quad \text{[Ref 2]} \quad (8)$$

Expressions 3, 5, 6 and 7 indicate that, to achieve the objective of minimum head loss through the tubes and downtake as well as the minimum hydrostatic head above the top tubeplate, three independent design variables (d, L and D_d) must be optimized keeping other constraints within limits. The optimization problem would be as follows:

Design variables:

$$X = \begin{bmatrix} d \\ L \\ D_d \end{bmatrix}$$

Objective function (OBJ):

$$\text{Minimize } Z = \alpha\left(\frac{L}{nd^4} + \frac{L}{D_d{}^4}\right) + (1 - \alpha)\,HSL$$

Constraints:

$$0.075 < d < 0.125$$
$$0.080 < L < 1.50$$
$$1.00 < D_d < 2.00$$
$$2.00 < CR < 3.00$$
$$GV < 0.35V$$
$$\frac{P_t}{P_d} > 60$$

Results:

A computer program using the interior penalty function method[3] as optimization technique was developed for this problem. Results obtained by using different values of K_1 but for equal weights (0.5, 0.5) to the mixed objective function are given in Table I.

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†H. B. Technological Institute, Kanpur, India.

1 "Handbook of Cane Sugar Engineering" (Elsevier, Amsterdam) 1972, 632-638.
2 Jenkins: *Proc. Queensland Soc. Sugar Cane Tech.*, 1958, 202-204.
3 Rao: "Optimization theory and application" (Wiley Eastern Ltd.) pp. 392-424.

Table I. Optimization of design variables

$V = 28\ m^3$, $K_2 = 0.5$

Particulars	K_1		
	6.56	5.90	5.25
Initial design vector			
d (m)	0.10	0.10	0.10
L (m)	1.20	1.00	0.86
D_d(m)	1.35	1.41	1.40
Initial value of OBJ	12.642	9.775	8.171
Final value of OBJ	11.419	7.968	6.035
Optimum design vector			
d (m)	0.1026	0.1028	0.1060
L (m)	1.183	0.939	0.809
D_d(m)	1.357	1.437	1.494
Initial head loss	23.752	18.116	14.924
Final head loss	21.377	14.652	10.876
Initial HSL (m)	1.531	1.431	1.417
Final HSL (m)	1.458	1.282	1.191
Percentage reduction			
(a) in head loss	9.99	19.12	27.12
(b) in HSL	4.77	10.41	15.95
Optimum number of tubes	508	582	587
Optimum tube plate diameter (m)	3.541	3.752	3.944
D_d/D_t	0.383	0.383	0.379

Discussions

The results shown in Table I indicate that, as a result of these studies, head losses may be reduced by 9.99% - 27.12% and HSL reduced by 4.7% - 15.95%. These reductions, although not very great, are nevertheless significant since these reductions have been achieved on the designs of the vacuum pans reported to have good performances.

These studies suggest that tube diameter should vary as the value of K_1 varies. In actual practice manufacturers are using a standard tube of 98 mm inside diameter for a 28 m^3 capacity vacuum pan irrespective of the value of K_1 selected. It may however not be feasible to change the tube diameter for different values of K_1 owing to the large inventory to be maintained by the manufacturers and users. Nevertheless, the smallest inside diameter suggested in these studies is 102.6 mm as against 98 mm and machinery manufacturers should therefore give serious thought to this aspect.

The existing practice of using a standard tube length is also not favoured by these studies. In fact, tube length should be selected according to the value of K_1 to achieve the best performance of the vacuum pan.

These studies have not been extended to higher capacity vacuum pans but the authors feel that similar studies should be conducted to determine the tube diameter and tube length required to achieve the best performance of such pans.

Table I further indicates that the optimum downtake diameter also varies with the value of K_1. The ratio of D_d/D_t works out at about 0.38 and is near to the present practice of 0.40. However, the authors feel that the downtake diameter should be altered in accordance with the optimization studies so that head loss is minimized.

Conclusion

The tube diameter and tube length of a vacuum pan should be selected on the basis of assigned design value of V, K_1 and K_2. The downtake diameter bears a constant relation with tube plate diameter but this should be established by carrying out optimization studies.

Summary

In the present work an attempt has been made to determine the optimum values of design parameters for a vacuum pan to achieve best performance. The results have been obtained with the help of a computer program using the interior penalty function method as optimization technique. The studies suggest that the existing practice of using standard tubes of 98 mm inside diameter for a 28 m^3 capacity pan should be changed to use of at least 102.6 mm inside diameter while the tube length should be selected on the basis of the ratio of the heating surface to working volume of the pan. The downtake diameter bears a certain relation to the tube plate diameter but should be selected on the basis of the optimization studies.

Conception optimale d'un appareil à cuire

Dans ce travail on a essayé de déterminer les valeurs optimales pour les paramètres caractéristiques d'un appareil à cuire, de manière à obtenir la meilleure performance. Les résultats ont été obtenus en utilisant un programme d'ordinateur qui utilisait la méthode de la fonction à pénalité interne comme technique d'optimisation. L'étude suggère que la pratique courante de faire appel à des tuyaux standards d'un diamètre interne de 98 mm pour un appareil d'une capacité de 28 m^3 devrait être modifiée de manière à utiliser au moins 102.6 mm comme diamètre interne. La longueur des tuyaux devrait être sélectionnée sur la base du rapport de la surface de chauffe sur le volume utile de l'appareil. Il existe une certaine relation entre le diamètre de la descente et le diamètre de la plaque à tuyaux, mais le choix des valeurs devrait être établi sur la base d'études d'optimisation.

Optimale Konstruktion eines Kochapparates

In der vorliegenden Arbeit wurde ein

Versuch unternommen, optimale Auslegungswerte für Kochapparate zu bestimmen, um Bestleistungen zu erzielen. Die Ergebnisse wurden mit Hilfe eines Computerprogramms, das die innere Straffunktion als Optimierungstechnik verwendet, erhalten. Die Untersuchungen ergeben, daß die übliche Praxis der Verwendung von Standard-Rohren mit einem Innendurchmesser von 98 mm für einen 28-m^3-Apparat auf wenigstens 102.6 mm verändert werden sollte, während die Rohrlänge auf der Basis des Verhältnisses Heizfläche zu Arbeitsvolumen des Apparates gewählt werden sollte. Der Durchmesser des Zentralrohres steht in einer gewissen Beziehung zum Rohrboden-Durchmesser, sollte aber auf der Basis der Optimierungsuntersuchungen ausgewählt werden.

Diseño optimal de un tacho

En este trabajo se ha ensayado determinar los valores optimales de los parámetros de diseño para un tacho con el fín de lograr su funcionamiento mejor. Los resultados se han obtenido con el ayudo de un programa para un computador que emplea el método de función a pena interna como técnica de optimización. Los estudios sugieron que la práctica actual del uso de tubos normales de diámetro interno de 98 mm en un tacho de una capacidad de 28 m^3 tendría que cambiarse de modo que se usarán tubos de diámetro interno de 102.6 mm por lo menos. La longitud del tubo tendría que seleccionarse sobre el base de la razón entre la superficie de calefacción y el volumen útil del tacho. Hay una cierta relación entre el diámetro del tubo central y el diámetro de la plancha de tubos, pero ése tendría que seleccionarse sobre el base de los estudios de optimización.

Replacement of lead by aluminium hydroxide for clarification of beet end samples

By Robert B. Lew

(Amstar Corp., Spreckels Sugar Division, Woodland, CA 95695, USA)

Introduction

Since 1982, Spreckels Sugar Control Laboratories have successfully replaced the use of lead compounds with a combination of anion resin and activated carbon for decolorizing sugar end and Steffen samples[1]. However, at the start of the 1983 spring campaign, beet end samples were still being clarified with lead sub-acetate (dry lead) and basic lead acetate solution (wet lead).

When diffusion juice was treated with Duolite A-102D anion resin and Darco G-60 activated carbon, the resulting filtrate was slightly cloudy and had a purplish colour. In order to measure the pol value, an additional filtration through a membrane filter was required. Such filtration is time-consuming and membrane filters are relatively expensive. Consequently, the possible use of other reagents for clarifying diffusion juice was investigated.

Robert B. Lew

Aluminium sulphate[2,3] and aluminium chloride[4] have been used as clarifying agents in the determination of sugar in beets. These aluminium compounds, when used as the sole clarifying agent, were found incapable of clarifying diffusion juice. Clarke[5] has reported using a mixture containing 3 parts of aluminium sulphate, 4 parts of calcium carbonate, and 2 parts of charcoal by weight for clarifying cane juices, raw cane sugar, and refined sugar. Attempts at using this mixture to clarify diffusion juice were unsuccessful.

Hydrated aluminium hydroxide, also known as alumina cream, has been employed alone or in conjunction with basic lead acetate as a clarifying agent in sugar analysis[6]. Aluminium hydroxide is a slightly soluble compound and exhibits amphoteric behaviour in aqueous medium. Addition of a base to a solution containing aluminium ions results in the formation of a white, gelatinous precipitate of aluminium hydroxide. Precipitation of aluminium hydroxide begins at an apparent pH about 5. At an apparent pH slightly above 9, aluminium hydroxide starts to redissolve forming aluminate ion.

Aluminium chloride, aluminium sulphate, and aluminium hydroxide are not considered to be toxic materials.

1 Lew: *I.S.J.*, 1983, **85**, 323-327.
2 Hobbis: *Paper presented to the 22nd General Meeting Amer. Soc. Sugar Beet Tech.*, 1983.
3 Kolberg: *ibid.*
4 Martin *et al.*: *J. Amer. Soc. Sugar Beet Tech.*, 1980, **20**, 597-609.
5 *Report presented to the 1982 Meeting, U.S. National Committee on Sugar Analysis.*
6 *NBS Circular*, 1942, (C440).

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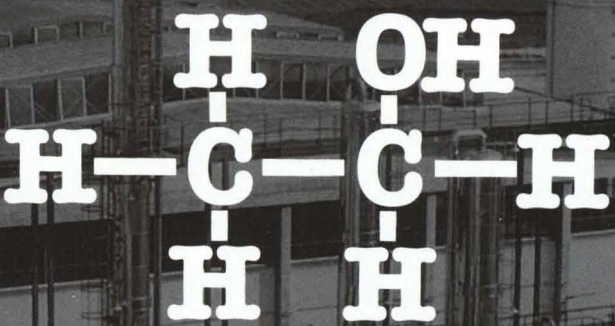

Sugared or amylaceous raw material
(fruits, beet, cane, molasses, grains, etc...)

Batch or continuous fermentation

Recuperation of CO_2, yeast

Distillation, rectification, deshydratation
High yields - low energy consumption

By-products valorization
Waste concentration
Waste incineration

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Special disposal procedures of wastes containing these compounds are not required. Consequently, the use of aluminium hydroxide for clarifying beet end samples was examined.

For process control applications, it is believed that aluminium hydroxide should be prepared *in situ.* Aluminium chloride was selected instead of aluminium sulphate for furnishing the aluminium ion because $AlCl_3,6H_2O$ dissolves at least 10 times faster than $Al_2(SO_4)_3,18H_2O$. In addition, the chloride salt is less expensive than the sulphate salt.

Several bases such as magnesium oxide, calcium oxide, calcium hydroxide, sodium hydroxide, and ammonium hydroxide could be used to supply hydroxide ions for the formation of aluminium hydroxide. However, calcium hydroxide and ammonium hydroxide were chosen as the reacting base because of their low cost and suitability.

Development of method

If aluminium compounds are to replace lead compounds for clarification of beet end samples, three factors that are important to process control analysis must be satisfactory. These factors are: (a) filtration rate of the sample, (b) colour of the filtrate, and (c) agreement of results.

Clarification of diffusion juice for determination of sugar

Samples of twenty-six grams each were transferred into 200 cm^3 volumetric flasks. About 150 cm^3 of distilled water and different amounts of $AlCl_3,6H_2O$ and NH_4OH were added to each flask. The samples were diluted to volume, mixed thoroughly, and filtered. For comparison purposes, a sample was clarified with basic lead acetate solution and used as control. Filtration rates of samples clarified with aluminium hydroxide were compared visually with that of the control sample. Results are tabulated in Table I.

Table I. Clarification of diffusion juice for determination of sugar

$AlCl_3,6H_2O$ (m mole)	NH_4OH (m mole)	Filtration rate	Filtrate	Sugar % sample
1.9	3.7	Slower than control	Slightly cloudy	—
2.8	5.6	Slower than control	Clear	12.40
3.7	6.8	Slightly slower than control	Clear	12.46
4.1	7.3	Similar to control	Clear	12.42
4.6	9.3	Similar to control	Clear	12.42
Basic lead acetate		Control	Clear	12.40

The data indicate that when 4.1 millimoles of $AlCl_3,6H_2O$ and 7.3 millimoles of NH_4OH were used, the filtration rate of the sample and the clarity of the resulting filtrate were similar to those of the control sample. In addition, the sugar content obtained from aluminium hydroxide clarification agreed closely with the value obtained from the sample clarified with basic lead acetate solution.

Clarification of cossettes for determination of sugar

Clarification of beet brei with aluminium sulphate has been tested extensively in our tare laboratories. Data accumulated over the past three years strongly indicate that the cold aluminium sulphate digestion method is applicable for clarifying cossette brei in the determination of sugar content. The aluminium sulphate clarification procedure as reported by Kolberg[3] was used in this study.

Determination of apparent purity coefficient (APC): Extracts of cossettes were prepared by blending 1 part of cossettes by weight with 2 parts of hot distilled water by volume for 5 minutes and filtering through a Buchner funnel with filter paper. After cooling, different amounts of $AlCl_3,6H_2O$ and $Ca(OH)_2$ were added to a 200 cm^3 portion of extract, mixed for 2 minutes, and the mixture filtered through RA226 filter paper. A 200 cm^3 portion of extract was clarified with dry lead and used as a control sample. The absorbance was measured at 420 nm using 1-cm cells. Results are presented in Table II.

The absorbance and pol value of filtrates resulting from aluminium hydroxide clarification differ slightly from those of the control sample. Visually, filtrates obtained from aluminium hydroxide treatment were clear and exhibited little or no colour. Approximately 1.5 g of the aluminium salt and 0.75 g of hydrated lime would be needed to yield a filtration rate similar to that of the lead-treated sample. To ensure the presence of an adequate amount of aluminium hydroxide, a slight excess of reagents, 2.0 g $AlCl_3,6H_2O$ and 1.0 g $(Ca(OH)_2$, was chosen for clarification of cossette extract in the determination of cossette purity.

Clarification of beet end samples

Investigative procedures similar to those described above were used in ascertaining the quantity of aluminium chloride and calcium hydroxide needed for clarification of samples in the determination of APC of diffusion juice and in the determination of sugar

Table II. Clarification of cossettes with aluminium hydroxide for determination of APC

$AlCl_3,6H_2O$ (g)	$Ca(OH)_2$ (g)	Filtration rate	Filtrate	
			Absorbance	Pol (°S)
1.0	0.50	Sl. slower than control	0.070	22.36
1.5	0.75	Similar to control	0.039	22.33
2.0	1.00	Similar to control	0.032	22.31
2.5	1.25	Similar to control	0.025	22.25
Dry lead		Control	0.014	22.40

in pressed pulp and pressed pulp water. The amounts of reagents recommended for clarifying various beet end samples are found in the procedure section.

The filtration rate of samples clarified with aluminium hydroxide appeared to be pH-dependent. Beet end samples clarified with aluminium hydroxide filtered faster at pH 8-9 than at pH 6-7. Diffusion juice treated with aluminium chloride and calcium hydroxide for APC determination filtered slightly more slowly by comparison with a lead-clarified sample. The filtration rates of cossette extract, pressed pulp, and pressed pulp water clarified with aluminium hydroxide were similar to those of corresponding samples clarified with lead compounds.

Table III. Comparison of APC and sugar content obtained using aluminium hydroxide, aluminium sulphate, and lead clarification

Apparent purity coefficient

Cossettes			*Diffusion juice*		
$Al(OH)_3$	*Dry lead*	*Δ(Al-Pb)*	*$Al(OH)_3$*	*Dry lead*	*Δ(Al-Pb)*
86.6	87.0	-0.4	88.3	89.0	-0.7
87.3	87.6	-0.3	89.4	90.0	-0.6
88.6	88.8	-0.2	90.4	90.3	0.1
87.0	87.3	-0.3	90.2	90.2	0.0
87.2	87.5	-0.3	90.6	90.8	-0.2
86.3	86.6	-0.3	91.1	91.2	-0.1
		Ave. -0.3			Ave. -0.3

% Sugar (by polarimetry)

Cossettes			*Diffusion juice*		
$Al_2(SO_4)_3$	*Hot lead*	*Δ(Al-Pb)*	*$Al(OH)_3$*	*Wet lead*	*Δ(Al-Pb)*
13.80	13.76	0.04	11.86	11.84	0.02
14.70	14.70	0.00	12.28	12.22	0.06
13.80	13.70	0.10	12.84	12.84	0.00
13.88	13.92	-0.04	12.68	12.68	0.00
14.98	15.00	-0.02	12.42	12.38	0.04
15.48	15.46	0.02	12.72	12.72	0.00
		Ave. 0.02			Ave. 0.02

Pressed pulp			*Pressed pulp water*		
$Al(OH)_3$	*Dry lead*	*Δ(Al-Pb)*	*$Al(OH)_3$*	*Dry lead*	*Δ(Al-Pb)*
1.36	1.38	-0.02	1.00	1.00	0.00
1.36	1.36	0.00	0.87	0.89	-0.02
1.60	1.66	-0.06	0.78	0.78	0.00
1.34	1.32	0.02	0.80	0.82	-0.02
1.10	1.10	0.00	0.85	0.85	0.00
0.89	0.89	0.00	0.96	0.96	0.00
		Ave. -0.01			Ave. -0.01

Recommended procedure

Apparatus

Rudolph Autopol IIS automatic saccharimeter with 200-mm flow-through cell or equivalent

Carl Zeiss manual refractometer or equivalent

Oster multi-speed blender, Model 855-04K, or equivalent. The blender is set to operate at 4700-6150 rpm.

Reagents

Aluminium sulphate solution (0.30% $Al_2SO_4)_3,18H_2O$, w/v)

Aluminium chloride solution (20.0% $AlCl_3,6H_2O$, w/v)

Dilute ammonium hydroxide [9.5% NH_4OH (Sp.Gr., 0.90), v/v]

Aluminium chloride hexahydrate, crystal

Calcium hydroxide, powder

Celite diatomaceous earth filter aid.

Procedure: Sugar determination

Cossette brei is prepared by passing approximately 2.5 gallons of cossettes through a Spreckels cossette saw. The resulting brei is mixed by squeezing through the fingers several times. RA226 filter paper with added filter aid is used for filtration of samples. Samples are cooled to 20°C prior to polarimetry and measurement of refractometric Brix.

Cossettes: Transfer 26.00 ± 0.02 g of cossette brei to a 1-pint blending jar and add 179.1 cm^3 of aluminium sulphate solution. Blend the mixture for 2 minutes, filter, and measure the pol value of the filtrate.

Diffusion juice: Transfer 26.00 ± 0.02 g of cooled diffusion juice to a 200 cm^3 volumetric flask. Add 120-150 cm^3 of distilled water, 5 cm^3 of aluminium chloride, and 10 cm^3 of dilute ammonium hydroxide, dilute to volume and mix thoroughly. Filter the sample and determine the pol value of the filtrate.

Pressed pulp: Transfer 50.0 ± 0.2 g of pressed pulp to a blending jar. Add 400 g of distilled water, 2.2 g of calcium hydroxide, and 4.0 g of aluminium chloride, blend the mixture for 5 minutes, filter and measure the pol value of the filtrate. Calculate the sugar content by using the following formula:

$$\% \text{ Sugar} = \frac{(0.26 \times \text{Pol})\ (\text{Wt. water added} + \text{Wt. water in pressed pulp})}{\text{Wt. pressed pulp taken}}$$

Pressed pulp water: Add 0.5 g of calcium hydroxide and 1.0 g of aluminium chloride to 200 cm^3 of pressed pulp water. Mix for about

ISJ Abstracts

Cane sugar manufacture

Fouling rates for tubular juice heaters

L. J. Watson and P. G. Wright. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 201 - 208.

From measurements of the heat transfer coefficient (HTC) in tubular juice heaters over the initial period of operation, it has been possible to determine the cleanliness of the heater in terms of the equivalent hours of operation required to produce the scale present at start-up. It is shown how the HTC can be predicted as a function of time and juice velocity provided the rate of fouling is known; comparison of the initial HTC after cleaning with the value predicted by the equation will give an indication of the effectiveness of the cleaning procedure. A fouling rate factor F introduced in an equation for calculation of the overall HTC has typically a value of 0.0035 for secondary juice heaters operating under mild scaling conditions, although values up to five times this can occur where the juice is of low Brix. Juice heaters should be operated at as high a juice velocity as possible; this can be achieved by reducing the flow area per pass and increasing the number of passes through the heater. The maximum velocity is governed by the maximum tolerable pressure drop across the heater. Juice velocities encountered in practice are between 1.5 and 2.2 m/sec. (See also Wright: *I.S.J.*, 1982, **84**, 212.)

A microcomputer-based juice sample tracker at Condong mill

G. A. Bentley, B. H. Cheetham and C. M. Wilson. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 215 - 221.

Details are given of a microcomputer-based sampling system built to replace an older SRI tracking system and able to carry out all the functions of the previous scheme, namely enter, count and track samples automatically, send actuating signals to the juice collection mechanism, print and display sampling status information and signal when fibre samples were to be taken from pre-determined cane deliveries; the new system can also track cane from two different growers that is delivered in one bin, is sufficiently flexible to allow changes in the cane receival system in the future, and displays all the information required by the operators in a clear and simple manner. Descriptions are given of the hardware, software, operation and initial costs, and reasons are given for preferring the microcomputer scheme to a programmable logic controller system.

Installation of an operator station at Fairymead

R. J. Swindells, A. H. Westmoreland, P. Finn, R. Hendy and D. Hislop. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 223 - 228.

In 1984, the next stage of development of the hierarchical automatic control scheme for cane milling and diffusion at Fairymead[1] was carried out, whereby the communications, logging and supervisory functions were transferred from the minicomputer to an Intel microcomputer and two data loggers added. Details are given of the principal factors governing the choice of hardware, of the hardware itself and of the control network, software and back-up provisions.

Computers as research aids within the Sugar Research Institute

C. G. Murphy and W. McWhinney. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 229 - 233.

Information is given on the hardware and software used at SRI in four main areas: data acquisition and experimental control; scientific computation, including modelling, simulation and graphics; retrieval of information from scientific publications and exchange of information with other scientific and government institutions; and preparation of documents. All Australian sugar factories have access to the main computer for information but not for use as a development computer for e.g. developing a factory program.

A supervisory system for juice process control

M. W. Webster, G. J. McGrath, D. L. McAllister and C.J. McLean. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 235 - 239.

An automatic control system at Pioneer sugar factory is described which provides supervisory control of the juice flow from mills to discharge from the evaporator, evaporation control, and automatic start-up of the clarifier mud filters. The sequence program monitors tank levels, starts pumps, opens control valves, adds saccharate or flocculant, opens steam valves and alerts the operator by alphanumeric message of any problem in starting-up. Each action is subject to pre-determined control parameters which are readily adjustable by the operator. Because of leaking feed control valves between the effects, automatic start-up and shut-down of the evaporator was not achieved, and the main role of the system was to maintain levels, syrup Brix and steam flow, although this did solve the problem of fluctuation in throughput by 50 - 100 tonnes/hr. The entire mud filtration system, incorporating four filters, is started automatically, but mud conditioning is required on a Monday start-up so as to lighten the mud after the week-end shut-down.

The use of corrosion-resistant steel in sugar milling

I. Clark, K. White and A. J. Bursle. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 253 - 259.

The properties of austenitic stainless steels (alloys of iron, chromium and nickel), of ferritic stainless steels (alloys of iron and chromium) and of Duplex stainless steels (alloys of iron, chromium and nickel that are mixtures of austenite and ferrite and have a higher yield stress than either of the other two groups mentioned above) are described, and their applications generally and in the sugar factory, where corrosion resistance is desirable, are indicated. The question of corrosion and abrasion is discussed.

1 See Maclean & Swindells: *I.S.J.*, 1985, **87**, 25A.

Beet sugar manufacture

The use of reagents for treatment of flume-wash water

A. P. Parkhomets and A. I. Sorokin. *Sakhar. Prom.*, 1985, (5), 50 - 52 *(Russian).*

The effects of six additives (including calcium hydroxide) on the pH, alkalinity, COD and volume of mud after settling as well as on the bacterial counts in flume-wash water were determined. All six caused noticeable improvement in the purification by comparison with the untreated control, but only Magnafloc LT-25 and polyacrylamide at doses of 2 and 3 mg/litre, respectively, caused no change in pH while providing a marked fall in the amount of suspended matter. Liming before addition of ferric chloride, ferric sulphate and aluminium sulphate, respectively, improved the performances of the three additives and permitted reduction in the dosage rates, but care is needed to prevent deposition of calcium sulphate, chloride and carbonate on pipeline walls (calcium chloride can also corrode metal).

Equipment design for efficient energy utilization in the beet sugar industry

K. Urbaniec. *Sugar Tech. Rev.*, 1985, **12**, 101 - 116.

In a review including 71 references to the literature, the author stresses the importance of design of the sugar factory equipment in regard to energy consumption. Diffusers should be so designed that they can operate at a low juice draft while producing cold raw juice. Heat losses in carbonatation tanks can be reduced by preheating the raw juice with spent carbonatation gas, while scrubbing the incoming CO_2 with hot ammoniacal water would raise the temperature and the moisture content of the gas, thus reducing the amount of heat transferred from the juice to the CO_2. Carbonatation under pressure would also be of benefit, as would recovering the heat generated by the reaction of CaO with water and with CO_2. In the case of evaporators, top priority is given to maintenance of optimum vapour temperatures, with a tendency for temperature differences between vapours in successive effects that are lower than recommended in the past, even at the expense of larger heat transfer surfaces. While no revolutionary new designs have been produced for juice heaters, there is the possibility of saving energy through judicious choices of equipment; although plate heat exchangers are the type that adapt most easilly to different operating conditions, there are applications where other designs can be used to advantage, particularly tube-in-shell and spiral types. Advances in boiling technique and the use of massecuite stirrers and of automatic control have contributed to energy economics; although continuous pans have an energy-saving potential, particularly because of their inherent ability to eliminate fluctuations in heating vapour demand, it is felt that the advance that has been made with batch vacuum pans makes it difficult for the continuous types to compete. Despite the considerable advantage of continuous centrifugals over batch machines in terms of electrical energy consumption, there are still problems to overcome, including fluctuations in the amount of run-off, crystal breakage and less precise control of the washing operation. Considerable work has been done in recent years on reduction of energy consumption in pulp drying; although the energy consumption in pressing is only a fraction of that in drying, limitations are imposed in the form of product quality and investment costs, so that there have been no substantial advances in press design. The benefits of vapour compressors for evaporator stations are demonstrated by data from three sugar factories.

Determination of the optimum diameter of a steam line

P. Hoffman. *Listy Cukr.*, 1985, **101**, 111 - 114 *(Czech).*

A nomogram is presented for establishing the diameter of a steam line as a function of the volume and pressure of saturated steam and of its flow rate in the line. The nomogram covers a range of 10 - 200,000 kg/hr for the rate of throughput, an absolute pressure of 0.02 - 6.0 MPa, a flow rate of 5 - 80 m/sec and pipe diameters in the range 10 - 1000 mm. Selected pressure losses are 1, 2.5 and 5% per 100 m of straight pipeline with a wall roughness of approx. 0.5 mm.

Electrochemical properties of calcium carbonate mud during saturation

L. M. Khomichak, R. S. Reshetova and M. I. Daishev. *Izv. Vuzov, Pishch. Tekh.*, 1985, (1), 31 - 33 *(Russian).*

In experiments in which model 15% sugar solutions were carbonatated, the e.m.f. of the mud obtained by filtration was determined by electro-osmosis at 20°C. In other experiments, acetic acid, acetic acid + NaOH and NaOH alone were added to the initial solution before carbonatation. In all the tests except those in which NaOH was added alone, the conditions represented a lack of natural alkalinity and, regardless of pH in the range studied (approx. 6 - 11), the e.m.f. remained positive as a result of CO_3^{--} precipitation as calcium carbonate; the minimum e.m.f. occured at pH 8.5 - 9.5 and rose on both sides of the range. Where NaOH was added to give a natural alkalinity of 0.042% CaO, the e.m.f. became negative at approx. pH 8.3 - 8.5, reached a minimum at pH 9.5 - 10, and thereafter rose steeply to change from negative to positive with increase in pH to about 11. The negative e.m.f. was a result of formation of sodium carbonate. Carbonatation at high temperature may induce a change from negative to positive e.m.f. where its maximum negativity is only slight, explaining why there is a marked adsorption of 2nd carbonatation juice impurities when the carbonatation is preceded by a second liming.

Impurity distribution between phases in the calcium carbonate mud-solution system

N. A. Arkhipovich *et al. Izv. Vuzov, Pishch. Tekh.*, 1985, (1), 113 - 114 *(Russian*).

The theory of mud precipitation is briefly discussed, and laboratory carbonatation of

juices containing varying quantities of solid phase reported; both theoretical and experimental results in terms of impurity distribution between the mud and 1st carbonatation juice showed that mud precipitation was a reversible process, but with the rate constant of forward reaction K_1 far exceeding that of the reverse reaction K_2 up to 1.5 hours of contact between the mud particles and the juice; thereafter, the value of K_2 rose as peptization took place with increased time of contact, and there was increased accumulation of suspended particles in the juice. Hence, there is need to establish optimum ageing to give best settling rate and filtrability.

Type OKK 1400-M continuous mixing centrifugal for sugar factories

J. Krecmer. *Czechoslovak Heavy Ind.*, 1985, (7), 2 - 4.

Details are given of the Czechoslovakian-built OKK 1400-M continuous centrifugal and of its performance[1].

Sabac and Pozarevac sugar factories

F. Komon. *Czechoslovak Heavy Ind.*, 1985, (7), 26 - 30.

The equipment and processes used in the two title sugar factories in Yugoslavia are described.

Effects of "Technical instructions - air" and of the order relating to industrial furnaces on the sugar industry

H. U. Reichel *Zuckerind.*, 1985, **110**, 479 - 485 (*German*).

Legal requirements pertaining to air pollution control in West Germany and how they affect the sugar industry, particularly with regard to boiler and pulp dryer emission, are discussed.

Results of trials on Perner 12 and Perner 12 R beet slicers at Novy Bydzov sugar factory

I. Stuchl. *Listy Cukr.*, 1985, **101**, 134 - 140 (*Czech*).

Factory trials on a modified form of the Perner 12 beet slicer are reported, and advantages of the 12 R machine indicated as a better drive unit (based on a thyristor-controlled D.C. motor instead of commutator type) and an efficient cleaner in the form of a rotary brush which is forced against the knives at regular, pre-set intervals (photographs illustrate the clean state of a knife in the 12 R after slicing 290 tonnes of beet compared with a knife clogged with residual material after slicing only 98 tonnes of beet in a Perner 12 machine). The new slicer has nominal daily throughput of 1250 tonnes.

Sugar technology

E. Reinefeld and K. Thielecke. *Chem. unserer Zeit*, 1984, **18**, (6), 181 - 196; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (11), Abs. 11 R427.

A short survey is presented of beet sugar technology, covering development of the industry, principles of technology, juice purification and technological progress. The number of West German sugar factories fell from 71 to 48 after 1950, and the average daily slice is >5000 tonnes, with some factories processing 10-13,000 tonnes of beet/day. Approximately 30% of the fuel consumed by a factory is used to dry pulp. Heat economy measures have permitted a one-third reduction in energy usage. The questions of environmental protection and of sugar uses in West Germany are discussed.

Optimum conditions of cavitation-aeration treatment of juice in main liming

V. A. Tsys', Yu. D. Golovnyak, A. F. Nemchin, R. G. Zhizhina and Yu. V. Anikeev. *Sakhar. Prom.*, 1985, (6), 28 - 30 (*Russian*)

Experiments showed that the optimum quantity of air to inject into the juice during liming was 0.8 - 1.2 m^3 per m^3 (at s.t.p.), allowing for recycling of 1st carbonatation juice or mud to preliming. Under these conditions, the liming process was accelerated but the settling and filtration properties of 1st carbonatation juice were the same as with conventional liming, while the colour, reducing matter and lime salts contents in 2nd carbonatation juice were lower than in the control. Best results were obtained with fractional cold and hot liming and separation of predefecation mud before aeration and the hot stage, the cold stage being cut from 20 to 10 minutes and the hot stage being maintained at 10 minutes. Decrease in the amount of lime adversely affected settling and filtration.

Intensification of sugar crystallization in crystallizers

V. I. Tuzhilkin *et al. Sakhar. Prom.*, 1985, (6), 30 - 32 (*Russian*).

Factory-scale experiments involved adding up to 3.5% *C*-sugar (by weight) to low-grade massecuite in the first of a battery of crystallizers, followed by mixing and cooling from e.g. 75° to 60°C, removal of 7 - 12% of the massecuite for intermediate centrifugalling and feeding of the run-off to the second crystallizer in the battery (the sugar from the centrifugal possibly being fed to the first crystallizer). Results showed that the new system accelerated crystal growth and hence shortened the overall cooling period while increasing molasses exhaustion.

Factory tests on experimental models of belt-type vacuum filters

R. I. Smirnov *et al. Sakhar. Prom.*, 1985, (6), 32 - 35 (*Russian*).

Details are given of two belt filters of Soviet construction, differing only in their dimensions, and of trials with them. Comparison of the performance of the smaller model with that of a rotary vacuum filter of comparable filtration surface area showed a thicker layer of cake of lower sugar content at a much greater throughput in the case of the belt filter. The larger model treated juice at a rate equivalent to 151 tonnes of beet per hour, delivering 710 litres of filtrate per m^3 of treated juice and separating at least 12 tonnes of mud/hr at a sugar loss of 0.042% on beet.

1 See Kadlec *et al.* : *I.S.J.*, 1985, **87**, 103A.

Use of flocculant from pulp dust to improve 1st carbonatation juice settling

A. R. Sapronov *et al. Sakhar. Prom.*, 1985, (6), 35 - 38 (*Russian*).

Addition of beet pulp acid hydrolysate to 1st carbonatation juice at 0.03% w/w increased the settling rate and reduced mud volume by comparison with no flocculant in laboratory experiments, better results being obtained at pH 5 and 7 than at pH 1 and 10. The positive effects of the flocculant were also demonstrated in factory-scale tests in which results in February (without flocculant) were compared with those in March (with flocculant when the beet pol was lower). Details are given of the procedure and plant used to hydrolyse dried beet pulp and dust with HCl.

Calculation of (the parameters of) a vacuum system in a sugar factory allowing for steam compressibility

V. N. Gorokh, B. F. Us. and K. O. Shtangeev. *Sakhar. Prom.*, 1985, (6), 40 - 44 (*Russian*).

A worked example is given of calculation of the parameters involved in a sugar factory vacuum system so as to demonstrate how to achieve optimum dimensioning and layout of the equipment and piping as a function of pressure loss and desired throughput.

Determination of pulp yield in the diffusion process

V. G. Yarmilko, L.M. Osadchii and N. V. Kulinich. *Sakhar. Prom.*, 1985, (6), 47 - 49 (*Russian*).

A formula is presented for calculating the amount of beet pulp discharged from the diffuser as a function of beet marc, cossettes dry solids and sugar content, and press water and cell juice purities. Comparison of experimental with calculated values showed maximum error of 0.05% on beet in the calculated values. A table is presented showing the amounts of pulp of 0.3 - 1.5% sugar content and of 6.5 - 25% dry solids at a beet marc content of 3.5 - 5.5%.

Method of unloading exhausted cossettes from a tower diffuser

B. A. Melent'ev and V. D. Naumenko. *Sakhar. Prom.*, 1985, (6), 51 (*Russian*).

Because of unreliability in operation and difficulties in repair maintenance of chain conveyors used to discharge exhausted cossettes, a new arrangement has been introduced at a number of Soviet sugar factories. It consists of four small hoppers around the perimeter and towards the top of the diffuser into which the pulp passes and falls down chutes (two square-sectioned inclined and two round vertical lengths) leading to a common chute feeding a screw conveyor.

Gypsum - cost-effective pulp pressing aid

P. Caulkins, G. Holman and L. Norman. *Sugar J.*, 1985, **47,** (12), 21 - 23.

Additions of a gypsum slurry to the wet beet pulp before pressing reduced the moisture content of the pressed pulp by up to 3.2 units compared with no treatment in full-scale tests in 1983/84, while even better results were achieved during the first 90 days of the 1984/85 campaign (up to 7.4 unit reduction to 74.2% moisture when 2.93 lb gypsum was added per short ton of beet) although under anomalous conditions associated with the processing of frozen beets. Evaluation of the cost effectiveness of the treatment showed a 35% reduction in pulp drying costs compared with the two earlier campaigns when no gypsum was used.

Centrifugal vibrations

E. Brommundt. *Zuckerind.*, 1985, **110,** 563 - 567 (*German*).

In a discussion of vibrations, it is pointed out that the normal problems associated with baskets rotating at high speeds become that much greater in the case of batch centrifugals because of the occurrence of relatively large imbalances and the reductions in rotary speed during a working cycle; occasionally the layer of sugar temporarily blocks the flow of mother-liquor and causes a ring of syrup to remain in fixed position on the basket screen, resulting in spontaneous vibration until the sugar layer breaks and syrup flows again, whereupon the sudden release will cause marked imbalance. The discussion is limited to suspended centrifugals as exemplified by the single- and triple-pendulum designs. It is stressed that simplified model calculations do not provide clear-cut explanations of the oscillating behaviour of batch centrifugals. Mathematically, it is shown that there are four or five critical basket speeds in the normal working range (ignoring the elasticity of the base of the centrifugal housing). Resonance transmission is controlled in both designs, and not all the calculated critical speeds will be noticeable. Occasional marked eccentricity of the basket may be caused by spontaneous vibrations resulting from the interplay between excitations caused by internal damping and fluidity on the one hand and external damping in the hinged supports on the other.

Centrifugal vibrations

H. Hartmann. *Zuckerind.*, 1985, **110,** 567 - 568 (*German*).

The difficulty of including in a mathematical model all the parameters contributing to vibrations in a batch centrifugal is emphasized, and mention is made of a more-or-less complete model developed in several stages by Brommundt in collaboration with BMA and which has permitted detailed investigation of vibratory behaviour. Results have been incorporated in the design of specific machines, particularly those in the G series. The features of these centrifugals are described, especially in relation to measures aimed at countering vibrations or neutralizing their effect.

Vibrations in sugar centrifugals

H. Houben. *Zuckerind.*, 1985, **110,** 568 - 570 (*German*).

Three aspects of the vibratory behaviour of automatic batch centrifugals are examined : the damping effect of the

spherical cup from which the gyratory system is suspended, the possibility of reducing shaft and basket deflection and increasing the critical speed of rotation by ensuring that the moment of inertia of the basket relative to the axis of rotation is greater than that relative to a transverse axis through the centre of gravity of the basket, and vibrations in the supports of the motor bearing caused by imbalance during basket rotation.

The newly developed Selwig & Lange 1500 Z strato-gyro centrifugal

S. Matusch. *Zuckerind.*, 1985, **110,** 570 - 571 (*German*).

Advantages in regard to vibration control of the K 1500 Z machine, which has a basket 1 m high and 1.6 m in diameter, are indicated. Designed on the three-pendulum principle, the centrifugal is provided with automatic damping means; a piezo-electric receiver fixed to the monitor casing measures the vibration velocity of the casing which oscillates with the basket as one unit. At 50 mm/sec a warning signal is emitted, and at 80 mm/sec the centrifugal speed is reduced to 200 rpm by regenerative braking. Since the monitor casing and basket vibrate together as a single unit, in the case of extreme imbalance only the non-rotating casing would strike the base plate. There are fewer critical speeds than with a single-pendulum centrifugal, and the interval between critical and nominal speed of 1000 rpm is more favourable. Springs in the three supports permit greatest possible isolation of the vibrating basket + casing from the staging.

Anopur - a new system for anaerobic treatment of highly polluted effluent

J. Redwanz. *Zuckerind.*, 1985, **110,** 573 - 577 (*German*).

The Anopur system, as used for flume water treatment at Wevelinghoven sugar factory, consists of anaerobic methanization followed by an aerobic stage, mud from which is recycled to anaerobic treatment in a circular reaction vessel containing a central feed pipe. Fresh preheated effluent is fed at the top and mixed by agitator with some waste water taken from the surface of the effluent already undergoing treatment; the mixture passes down to the base of the vessel, while any floating mud particles are drawn off via the feed pipe from the surface of the contents. The effluent mixture is distributed throughout the vessel by agitators located on opposite sides of the reactor. The treated water is force-fed to the second stage with simultaneous gas separation. Results for 1984/85 (and for post-campaign manufacture of potato crisps) are reported, showing a 90 - 96% reduction in COD (from an initial 4000 - 6000 mg/litre) in Stage 1, and a 70 - 85% reduction of the residual COD in Stage 2, plus a noticeable reduction in the Ca^{++} content in both stages. A maximum 4176 m^3 of water was treated daily, yielding a maximum 10,120 m^3 of biogas.

Viscosity of low-grade massecuites: effect of crystal content and size as well as potential applications of viscometry

T. Szekrényesy, L. Parádi, K. Hangyál and K. Liktor. *Zuckerind.*, 1985, **110,** 586 - 590 (*German*).

Since increase in the crystal content of a massecuite can only come about through reduction in the mother-liquor, viscometry will give a measurement for any massecuite sample (observed viscosity) that is always greater than that of the fluid component and is in 1st approximation proportional to the relative space occupied by the crystals in suspension.

Investigations of the relative viscosity η_r as a function of crystal content gave values similar to those of Rouillard & Koenig[1]; for massecuites in equilibrium, i.e. when the mother-liquor is saturated and the crystal size remains constant, $\ln \eta_r = a' m_{cr} / m_m$, where a' is a constant dependent on crystal size distribution, m_{cr} is the total crystal mass, and m_m is the mother-liquor mass. Temperature was found to have noticeable effect on η_r. The frequent absence of crystal size and shear rate in data provided by other authors makes difficult comparison between the various viscosity values. However, all authors agree that the effects of crystal size, crystal size distribution and crystal shape increase with increase in the gross crystal content. Differences in opinions on the manner in which crystal size affects viscosity are attributed to possible disregard of side-effects that, when taken together, were much greater than those under investigation. So as to obtain results comparable to those of other authors in regard to the effect of crystal size, not only the crystal content but also the shear rate and the nature and range of the crystal size distribution must be given, and the viscosity determined must be defined (apparent or differential). Studies of changes in the rheology and composition of low-grade massecuites during cooling demonstrated the increase in viscosity of the massecuite and mother-liquor as well as in the relative viscosity with fall in temperature and increase in crystal content. Values obtained for the crystal content as a function of time were 0.5 - 1.0% (m/m) lower when relative viscosity was used as basis than when the conventional method based on mother-liquor separation was used, although the suitability of the relative viscosity method was confirmed by the pattern of curves which was similar for both methods with different crystallization programs. The relative viscosity approach has been applied to the design of a rheological detector based on a Searle-type rotary viscometer having an inner interchangeable rotating cylinder by means of which the braking torque is measured and the value transmitted to a recorder, thus providing information on the progress of crystallization, e.g. indicating when the mother-liquor still contains crystals or bubbles.

Application of numerical analyses for pan automation

P. Bonnenfant. *Zuckerind.*, 1985, **110,** 591 - 596.

See *I.S.J.*, 1985, **87,** 27A.

1 *I.S.J.*, 1982, **84,** 26.

Effects of some parameters and potential application of viscometry with low-grade massecuite

T. Szekrényesy, L. Parádi, K. Hangyál and T. Liktor. *Cukoripar*, 1985, **38,** 41 - 46 (*Hungarian*).

See *I.S.J.*, 1986, **88,** 38A.

The effect of a two-magma sugar boiling scheme on sugar quality

L. Parádi and L. Hegyessy. *Cukoripar*, 1985, **38,** 47 - 52 (*Hungarian*).

Since 1978, Sarkad sugar factory has used a two-magma boiling scheme in which *A*-massecuite is boiled on a magma of affined *B*-sugar and "mixed juice" (thick juice plus dissolved sugar dust from the granulator), *B*-massecuite is boiled on a magma of *C*-sugar mingled with *A*-molasses, and the low-grade massecuite is boiled from diluted *B*-molasses that may or may not have been treated by the Quentin process. Investigations conducted in the 1983/84 campaign showed no great difference between this system and schemes at two other factories (one using magma only for *B*-massecuite boiling, the other using no magma at all) in terms of sugar solution colour, turbidity, ash content and crystal size, while the colour increase associated with increase in crystal size was smaller at Sarkad than the other factories. However, when the colour content in each of four layers around the crystal nucleus was measured by dissolving each in turn, the fourth layer in crystals larger than 0.80 mm contained more colour in the Sarkad scheme than in the other two systems. A thick juice purity of at least 88 is needed at Sarkad in order to provide sugar of desired quality. The typical number of thermophiles per 10 g of sugar was found to be well below the average for the Hungarian industry, while no yeast cells were found.

Aspects of selecting sugar factory heat exchangers

K. Hangyál and A. Zsigmond. *Cukoripar*, 1985, **38,** 59 - 64 (*Hungarian*).

Technico-economic considerations in selecting juice heaters and evaporators of required capacity are discussed, and an evaporator arrangement is described that is suitable for use in a factory slicing 6000 tonnes of beet per day.

Application of surface-active additives for sugar factory

T. Takahashi and T. Yomoto. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1985, **34,** 1 - 11 (*Japanese*).

Addition of 100 and 200 ppm acetylated monoglyceride to low-grade massecuite during the first half of the boiling cycle in experiments generally shortened the boiling and centrifugalling times, even with low massecuite fluidity, but also reduced solids and pol recovery. Use of the surfactant in a boiling scheme involving double curing, with magma sugar and syrup purities kept constant, led to reduction in the amount of recycled syrup and low-grade massecuite by comparison with conventional processing, and the overall effect outweighed the disadvantage of greater requirements of movement water and hence increased evaporation. Addition of sucrose fatty ester of high hydrophilic-lyophilic balance to low-grade massecuite just prior to dropping from the pan caused considerable reduction in boiling and centrifugalling times and slightly increased sugar purity. The economics of using each surfactant have been calculated.

Demineralization of pre-concentrated beet thin juice by ion exchange resin

Y. Tokuda and K. Kato. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1985, **34,** 82 - 90 (*Japanese*).

Pre-evaporation of thin juice reduced the ammonia and organic acids contents and thus eased the load on the subsequent cation-anion-anion-cation exchange resin system used for demineralization. There was a substantial reduction in both regenerant costs and in fuel costs through judicious re-use of sweet-water from the columns, which also led to stable evaporation of the treated juice as a consequence of the reduced fluctuation in juice Brix. The increased Brix resulting from the pre-evaporation caused a fall in the specific flow rate in the resin columns, with a consequent increase in purity.

A new approach to full seeding

P. W. van der Poel, M. A. M. de Schutter, C. C. Bleyenberg and P. M. T. van Heeschvelde. *Sucr. Belge*, 1985, **103,** 15 - 24.

See *I.S.J.*, 1985, **87,** 26A.

Juice evaporation by (pulp) dryer flue gas in association with the latter's treatment

P. Vermeulen. *Zuckerind.*, 1985, **110,** 681 - 685 (*German*).

At the Rethen factory of Hannoversche Zucker AG, boiler flue gas is used for beet pulp drying in three units, the waste gas from which passes through two parallel washers and is used to pre-evaporate thin juice to 21.5°Bx in two falling-film units. Washing removes most of the dust and SO_2, while condensing of the vapour from the falling-film evaporators removes further fine dust and sulphur. Before entering the evaporators, the thin juice is cooled to 60°C in plate heat exchangers which are also used to heat the evaporated juice from 44° to 90°C. The quadruple-effect evaporator (with two parallel 3rd effects) was expanded by installing a falling-film evaporator as 5th effect in which pan vapours raise the juice Brix from 62° to 72°, thus easing the load on the pan station and allowing sufficient 3rd effect bleed for heating. The overall effects of the system are discussed, including a 92.7% reduction in dust emission, a 75% decrease in SO_2 emission, one of 12.5% in the quantity of flue gas emitted, a fall in fuel consumption and availability of electricity for sale to the public utility. A constant rate of 30 tonnes/hr was maintained in the falling-film pre-evaporators at a relatively low power consumption of 420 kW. Some problems are briefly mentioned concerning the blowers for the flue gas from the pulp dryer, the pumping of the pre-evaporated juice, and the flue gas condensate. The economics of the system are calculated.

Sugar refining

Continuous sugar boiling

B. Bastier. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 11 pp.

Brief descriptions and diagrams are given of the Fives-Cail Babcock, BMA, Langreney and South African continuous vacuum pans, and the pros and cons of continuous boiling discussed on the basis of experience at Nantes refinery and Chevrières beet sugar factory, at both of which continuous boiling is used only for 1st strikes. In addition to the normal advantages of any continuous process, continuous boiling permits a better heat balance, reduces colour formation and sucrose inversion (as a result of the low massecuite level above the calandria and low steam pressure) and allows for vapour recompression through the absence of ingress of air (since the strike is not dropped) and of entrainment. The major disadvantage of continuous boiling is scale formation, which necessitates pan cleaning every seven days at the two plants and consequent breaks in the continuity; reduction in the final massecuite concentration by 1 - 2% so as to decrease scaling leads to lower sugar recovery. Another problem that may arise is the risk of greater crystal size distribution as a consequence of massecuite bypass and longer boiling time (although this will be of major concern only where there is need for a narrow crystal size range).

Energy savings in the refining process using and/or recompressing the vapour from a continuous boiling pan connected with continuous deep vacuum crystallizers

C. Longue Epée and V. N. Truoc. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 16 pp.

Details are given of the boiling house operations at Nantes refinery, where the Brix of the standard liquor is raised from 65 - 66° to approx. 72.5° in a system comprising a plate heat exchanger (using vapours at 5 psi from the continuous vacuum pan as heating medium) and a flash tank, from which the liquor flows to another heat exchanger where its temperature is raised from approx. 63° to 80°C using steam at 19 psi before entering the vacuum pan. The pan acts as the 1st effect of a double-effect system in which a syrup concentrator serves as 2nd effect. A plate-type heat exchanger and flash tank operating in parallel with the vacuum pan are used for continuous concentration of the sweet-water from the char filters, etc. The heat exchanger uses steam at 19 psi and the flash tank pan vapour at 5 psi; the steam valve is automatically controlled on the basis of Brix measurement. The concentrator vapour and that part of the pan vapour not used for sweet-water concentration are recompressed to 19 psi by passing them through a multi-jet stato-compressor, which is an ejector operating on the venturi principle with a variable-geometry neck at the inlet to the diffuser; this reduces energy losses in the form of shock waves when the mixture of driving and reheat steam flows at supersonic speeds. The compressor and concentrator cost a total of $150,000 but provide an annual saving of $70,000.

Fifty years of constructing lined silos for granulated sugar storage

A. P. Neilson and S. E. George. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 12 pp.

A general description is given of the design of linings for 29 bulk sugar silos constructed over a 50-year period by B C Sugar at the company's four beet sugar factories and one cane sugar refinery in Canada. Experience in the operation of the silos (two of which are for conditioning as well as storage) and problems that have arisen are discussed.

Sugar silo lining maintainance at B C Sugar

A. D. Chapman. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 10 pp.

Repairs and upgrading work carried out on the wooden lining in one of two granulated sugar silos at the Vancouver refinery of B C Sugar are described. The silo, of 8000 short tons nominal capacity, is used exclusively for sugar conditioning, so that the wooden lining is subject to more wear than the other silo which is used only for storage of the sugar it receives from the conditioning silo.

Electric boilers: an alternative source of steam

J. A. Bezerra. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 23 pp.

A government program for industrial utilization of excess electric power produced by the numerous hydroelectric schemes in the country has been initiated in Brazil, and details are given of the system installed by Amorim Primo S/A in its refinery which comprises a 69 kV transmission line, a 50 MW substation and two electric boilers each generating 30 tonnes of steam per hour. After 10,000 hours of operation, no scale was found in the boilers and only 5 days was required for general maintenance, the costs of which were insignificant by comparision with those for the previous oil-fired boilers. The boilers are of higher thermal efficiencies than the previous units, are easier to operate and require less shutdown time. Return on investment was rapid.

Noodsberg silos ready for new season

Anon. *S. African Sugar J.*, 1985, **69**, 146.

A brief illustrated account is given of the pair of bulk sugar conditioning silos at Noodsberg. The sugar is reclaimed from the bottom of the silos and taken to a rail loading station or is returned to the refinery for packaging. Two batch weighers weigh the sugar leaving the refinery and that amount of conditioned sugar to be transported by rail. The silos and equipment are designed to handle more than 140 tonnes of sugar per hour. Three air-conditioning units (one as standby) continuously pass heated and dried air up through the sugar, which falls down through the silos under plug-flow conditions.

Laboratory studies

Development of a method for sucrose determination in condensate water

E. Angulo A. and F. Pérez S. *CubaAzúcar*, 1983, (Oct./Dec.), 3 - 6 *(Spanish).*

A spectrophotometric method has been developed whereby the sucrose present in condensates (0 - 100 mg/litre) develops a colour with sodium malonate dissolved in concentrated sulphuric acid, which is measured at 524.1 nm. Experiments were made to determine optimum conditions; these were 2.5% reagent concentration, sample:reagent ratio 1 : 5, time and temperature of heating 15 minutes at 100°C. Sensitivity was about 10 mg/litre and the reaction products were very stable. The reagent could be kept for at least 15 days and the results of the analysis were not affected by the NaCl concentration, at least up to 500 mg/litre. Precision and accuracy were acceptable for this type of analysis.

Determination of phosphates in the colloidal state and micro-dispersed in different products of the cane sugar manufacturing process

G. Fernández M., M. Darias P. and J. O. Guerra. *CubaAzúcar*, 1983, (Oct./Dec.), 37 - 40 *(Spanish).*

Variations of a method involving the reduction of the phosphomolybdic complex in acid medium with hydrazine sulphate were tested using primary juice, clear juice, sugar and molasses. None of the variants gave significantly different results except for the fourth in which acidification was with perchloric acid.

The Sucrolyser automatic system for quality analysis of sugar cane juice

W. Kernchen. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 164 - 174.

The Sucrolyser automatic cane juice analysis system manufactured by Dr. Wolfgang Kernchen GmbH is described.

Effect of induced beet tissue polarization on surface retention of colouring matter

L. A. Fedorenchenko, L. D Bobrovnik, I. S. Gulyi and T. A. Martynenko. *Sakhar. Prom.*, 1985, (5), 48 - 49 *(Russian).*

The effect of passing an electric charge through 2 × 2 × (1.5 - 2) cm samples, cut at random from a beet, on colour adsorption was investigated. The samples were held for 10 - 30 minutes in hot water at 80 - 85 °C to simulate diffusion and then electrically charged for 5 - 15 minutes. Initial studies concerned the potential difference pattern with time after the current had been switched off. The polarization coefficient was unaffected by the heating duration, but rose as did the potential difference at any given time during discharge with increase in the density of the vascular bundles in the sample, the overall effect being a change in the pattern of the induced polarization curve, and the coefficient was positive throughout discharge. In the subsequent studies, two samples subjected to simulated diffusion, but only one electrically charged, were immersed in a solution made up with phenol and ferric chloride (since iron and polyphenol complexes are responsible for a major portion of the colour in diffusion juice) and the colour adsorption by both samples determined. Results showed that the electrical treatment increased adsorption by 5 - 7%.

Nuclear analytical methods in the sugar industry

J. Fráná *et al. Listy Cukr.*, 1985, **101,** 114 - 117 *(Czech).*

Descriptions are given of three nuclear analytical methods of application in the sugar industry: neutron activation analysis, induced neutron analysis using prompt gamma radiation, and particle-induced X-ray emission (PIXE). The first method has been used for analysis of soil, soil extracts, beet and sugar, and detection limits are given for 39 trace elements in a 2-g sample of sugar. The second method has been applied to analysis of soil, beet and trash (detection limits are given for 19 trace elements), while the third method was used to analyse a sample of mineralized cube sugar doped with lead to give a concentration of 2 ppm.

High-performance liquid chromatography in sugar analysis

K. F. Ivie. *S. African Sugar J.*, 1985, **69,** 154 - 157.

See *I..S.J.*, 1983, **85,** 57.

Changes in the growth rate by modified crystal morphology

C. A. Accorsi. *Zuckerind.*, 1985, **110,** 489 - 493 (*German*).

In crystallization studies, single crystals of sucrose of modified habit and form factors in the range 75 - 120 cm^6/g^2 were grown in unstirred aqueous solutions of 1.10 supersaturation at 30°C. The crystal growth rate in pure and impure solution was determined, and the contribution of the individual faces to the rate determined. Crystals having marked extension to faces *a* and *c* grew more slowly than those having a considerable development of face *p*. The highest growth rate occurred where the *a*:*b* and *a*:*c* ratios were greatest (as in sucrose crystals grown in the presence of dextran) and noticeable development of face *p'* occurred. This can benefit growth which is governed by surface reaction.

Oligosaccharides produced by the transglucosidation action of *Protaminobacter rubrum* α-glucosidase

S. Fujii, K. Yoshinaga, S. Kishihara, M. Komoto and K. Suzuki. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1985, **34,** 37 - 44 (*Japanese*).

Details are given of the enzymatic formation of various oligosaccharides from sucrose under controlled conditions. The *P. rubrum* α–glucosidase was used either in immobilized form or in partially purified form. HPLC showed that palatinose was the main product, with trehalulose, isomaltose and (in small quantities) isomelezitose as lesser products.

By-products

Bagasse particle boards with fire-proofing materials

O. Carvajal, M. E. Rodríguez and G. Almarales. *Revista ICIDCA Supplt.*, 1984, (3), 1 - 8 (*Spanish*).

A fire-retarding agent, manufactured in Cuba and based on ammonium phosphate and urea, was added in proportions up to 10% to a bagasse particle board mix, and the effects determined on a number of physical properties of the resultant boards (density, modulus of rupture, traction,and dilatation and absorption after 2 and 24 hours. In addition, the resistance of the boards to combustion was determined. The results were analysed and it was concluded that a 4% addition was preferred.

Substitution of asbestos by bagasse fibres in asbestos-cement products

M. Serantes L. and I. Gómez P. *Revista ICIDCA Supplt.*, 1984, (3), 16 - 24 (*Spanish*).

An account is given of trials in which bagasse fibres were used for reinforcement of concrete in place of asbestos fibres. The test panels used 2 - 5% of bagasse and 0 - 4% of asbestos. The properties of the bagasse-cement products were not as good as those of the asbestos-cement products and the effects of mineralization with aluminium sulphate and sodium silicate were small. However, the substitution provided considerable savings in costs and need for importation of asbestos.

Evaluation of the behaviour of the depithing installation at Central Camilo Cienfuegos, 1980/81 season

O. Castellanos. *Revista ICIDCA Supplt.*, 1984, (3), 42 - 53 (*Spanish*).

Equipment installed for bagasse depithing consists of three Centurion 12-1200 machines supplied by the Pallmann company of West Germany. Experience has shown that there are a number of variables which affect depithing and which are out of the operator's control but affect the economics of the process. Under the test conditions the plant did not meet the project specifications and further study is necessary to optimize the production process and minimize costs.

High yield pulp from bagasse: possiblities and prospects

P. López G. *CubaAzúcar*, 1983,

A new technology for production of high yield pulp from bagasse, with characteristics similar to those of hardwood pulps, has been developed by the Cuba 9 Experimental Centre. The depithed bagasse is treated with 2 - 4% of chemical products at 80 - 100° C and is then sent to a two-stage disc refiner, after which follow classification, purification and bleaching with hydrogen peroxide to 50 - 55% Elrepho brilliance. The process gives a higher yield and requires less investment than the conventional chemical pulping while the effluent contains less contaminants. On the other hand it requires more electrical power for the refining and the pulp resistance and brilliance are inferior to those of chemical pulp.

Ultrafiltration of invert syrups for bottled drinks

P. Friedman, A. Fariñas and I. Alegret. *CubaAzúcar*, 1983, (Oct./Dec.), 15 - 19 (*Spanish*).

Ultrafiltration has been applied to 70°Bx invert syrups to remove polysaccharides and thereby avoid floc formation in the bottled drinks in which the syrups were used. The treatment was successful in eliminating the polysaccharides, initially present at a concentration of 562 ppm, and no floc formation occurred on adding alcohol to the treated syrup. Throughput fell during six hours of treatment from 8.6 to 6.8 litres/m²/hr but was restored on cleaning with a 0.2% NaOCl solution at 70°C for one hour, the membranes having almost the same throughput as initially after two weeks of such cycles.

Studies of sanitary parameters in vinasses produced by alcoholic fermentation of intermediate and by-products from cane sugar manufacture

G. J. Cárdenas and R. M. Ruiz. *Rev. Ind. Agríc. Tucumán*, 1984, **61,** (1), 91 - 117 (*Spanish*).

Analyses were made of COD, total solids, organic matter and ash in vinasses derived from alcohol fermentation of clear juice, acidified juice, syrup and molasses. The results were similar in most cases and reasons for the differences are discussed.

Inhibitory effects of substrate and product in the rapid fermentation of sugar cane molasses

A. Navarro, G. S. Boero, M. I. Vega and D. A. S. Callieri. *Rev. Ind. Agríc. Tucumán*, 1984, **61,** (1), 119 - 128 *(Spanish).*

Both high initial reducing sugars content and high ethanol content in the mash had inhibitory effects on the rate of fermentation and were synergistic, and studies have been made on both effects and their interaction. The effects are also more complex than in the fermentation of a simple sugar, probably because of the complex nature of molasses.

Nutritional contribution of protein and metabolisable amino-acids in bulls fed high levels of molasses/urea. I. Protein-free diets

A. Ramírez. *Cuban J. Agric. Sci.*, 1984, **18,** 301 - 310.

Experiments with young bulls showed that, although a high molasses diet plus 2% urea contained 70% non-protein nitrogen, 60% of the requirements in protein and metabolisable amino-acids was provided by bacterial synthesis of N in the rumen which the diet stimulated.

Biostil - a unique process for ethanol fermentation

C. Thorsson. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 175 - 181.

See *I.S.J.*, 1984, **86,** 192.

Effect of yeast population on alcohol production

J. C. Fandialan and A. T. Angeles. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 182 - 187.

The effect of yeast cell density (number of viable colonies per ml) on alcoholic fermentation of cane molasses using *Saccharomyces cerevisiae* was determined in experiments involving eleven population levels (0 - 10) corresponding to densities in the range from 221×10^8 to 5×10^2, respectively. Results showed that alcohol yields and fermentation efficiencies were higher with the lower populations which, however, required longer fermentation times than the higher populations, which gave poorer results. Best results were given by populations of 3×10^8/ml (an alcohol yield of 10.7% and a fermentation efficiency of 83.79% over a period of 49.33 hr) and 83×10^2/ml (corresponding values of 11.88%, 85.64% and 62.66 hr).

Evaluation of several yeast isolates and *Zymomonas* strains for alcohol production

E. D. Colle, J. C. L. Garcia and E. J. del Rosario. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 188 - 202.

Out of 133 yeasts isolated from cane molasses and beer samples taken from Philippines alcohol distilleries, 12 were found to have more desirable fermentation properties than yeasts widely used in the Philippines and US. Strains of *Zymomonas mobilis* showed great promise. Data are tabulated.

Management and utilization of distillery slops

P. V. Madrid, E. L. Rosario, M. A. Tetangco and T. C. Mendoza. *Proc. 29th Ann. Conv. Phillippines Sugar Tech. Assoc.*, 1982, 203 - 228.

Vinasse applied to the soil at rates of 150, 200 and 250m³/ha increased cane and sugar yield but reduced pol content, apparent purity, Brix and sugar yield per tonne of cane by comparison with the untreated control. There was some initial leaf damage, but recovery was fairly rapid; there was no varietal sensitivity nor adverse effect on germination. Best results were obtained by applying the vinasse immediately after planting or after stubble shaving in the case of ratoons. Treatment had a tendency to raise soil pH, the effect increasing with amount of vinasse applied. The stands of leguminous intercrops with cane were reduced by vinasse applied at a very early stage of plant growth, so that application should be made before the planting of such intercrops.

Distillery operation and treatment of slops

E. C. Primer. *Proc. 29th. Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 229 - 237.

The essential stages in cane molasses fermentation and distillation, and factors of importance are described, and recovery of liquid CO_2 and of dried yeast is discussed. Details are given of a two-stage anaerobic process for treatment of vinasse, which has reduced the BOD by >98% and the total suspended solids by >97%.

Effect of volume and time of application of distillery slops on the growth and yield of sugar cane

M. Y. Gonzales and A. P. Tianco. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 467 - 490.

In small-plot field trials, application of vinasse at 83, 166 and 249 m³/ha in addition to the normal fertilizers increased plant cane yield by 12.3, 10.4 and 10.4% and sugar yield by 15.4, 13.4 and 16.8%, respectively, compared with the control, while 249 m³/ha vinasse increased sugar recovery per tonne of cane by 5.5 and 4.2% compared with the control and 83 m³/ha vinasse, respectively. However, vinasse at 166 and 249 m³/ha reduced the sugar recovery per tonne of cane by 3.7 and 5.3%, respectively, when applied to ratoon cane, although cane and sugar yields were unaffected. Vinasse increased soil pH, available K_2O, Ca and Mg as well as juice ash content. The responses of different cane varieties to different application rates of vinasse as well as time of application require further investigation. There is also need to determine the maximum amount of vinasse that may be applied without adversely affecting final sugar yield and/or factory performance.

An efficient ethanol fermentation of acid hydrolysate from hemicellulose-extracted bagasse

M. C. Hsie, W. F. Yee, L. H. Wang and S. L. Sang. *Taiwan Sugar*, 1985, **32,** (2), 16 - 21.

Enrichment with yeast extract or vinasse improved the poor fermentation efficiency of bagasse acid hydrolysate by comparison with molasses, although the ethanol concentration in the final beer was still only approx. 4% v/v, and energy consumption in ethanol recovery by distillation was high. However, combining the hydrolysate with molasses to give a total sugar concentration of 20 - 25% w/v before fermentation increased the efficiency to a level just below that of molasses alone to give an ethanol concentration of up to 11.5% v/v compared with up to 10.5% using only molasses.

A new approach to feeding horses

J. Harland. *British Sugar Beet Rev.*, 1985, **53,** (2), 20 - 22.

Reference is made to the value of molassed beet pulp as a horse feed; chief advantages are: the lysine content in the feed (although a lysine/methionine supplement is needed when the horses are given rations of high cereal content), a favourable calcium:phosphorus ratio (too high a P level is deleterious to horses), the fact that the energy content is in the form of non-heating energy (as opposed to oats), and the digestible fibre content.

Patents

UNITED KINGDOM

Alcoholic fermentation

Degrémont S.A., of Rueil-Malmaison, France. **2,121,821.** June 2, 1983; January 4, 1984; September 11, 1985.

For fermentation of molasses or sugar juice, 200 ppm (3 - 154 ppm) (50 ppm) (20 - 1000 ppm) (5 - 200 ppm) (500 ppm) of a 24% (35%) by weight hydrazine hydrate solution is injected as antiseptic in three 50-ppm doses (continuously) during the 16 - 20 hours during which the fermenter is being filled. The antiseptic may be introduced in the usual additives such as anti-foam agents during fermentation, and may be prepared from hydrazine hydrate and a higher alcohol in the C_3-C_8 group at an alcohol:hydrazine hydrate ratio of 0.5 - 2 : 1. The hydrazine hydrate permits the leaven to be preserved for at least 6 weeks. The residual liquors from the fermentation are totally free of hydrazine, which is destroyed during distillation, so that they may be used as animal fodder.

Glucose isomerase immobilization

UOP Inc., of Des Plaines, IL, USA. **2,122,621.** June 25, 1982; January 18, 1984; September 25, 1985.

Glucose isomerase is immobilized onto a support matrix which has been impregnated with a salt (magnesium halide, sulphate, nitrate, hypophosphite, fluorosilicate, acetate or lactate) containing not less than 0.1mM (0.1 - 2) (0.13) divalent Mg^{++} ions per g matrix. Contact between the Mg salt and the support matrix takes place at 0 - 70°C, and the matrix may be an organic oxide impregnated with a polyamine cross-linked with an excess of a bifunctional reagent (glutaric aldehyde, succinic dialdehyde, terephthalic aldehyde or toluene diisocyanate). After immobilization (which takes approx. 30 hours), adhering but unbound enzyme is recoverd by washing with e.g. brine. The half-life of the system is increased by >34% by the treatment, and conversion of glucose to 42% fructose at 60°C and pH 8.0 - 8.3 has been demonstrated.

Animal feed supplement

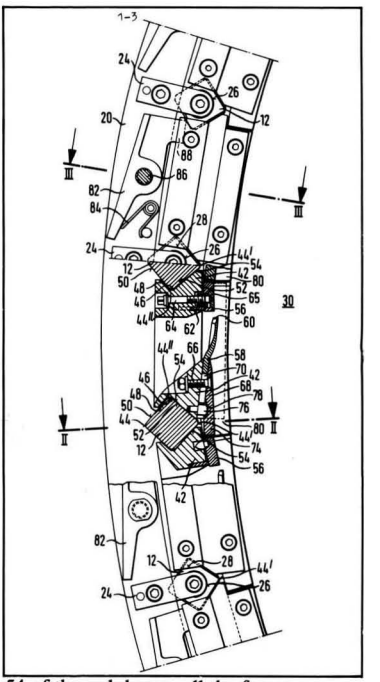
Pacific Kenyon Corporation, of Long Beach, CA, USA. **2,123,671.** June 22, 1982; February 2, 1984.

A solid animal feed supplement of 5 - 30% water content by weight is prepared from e.g. cane or beet molasses of 60 - 85°Bx by adding 0 - 5% by weight (1 - 3%) (1 - 4%) calcium hydroxide or oxide, 0.5 - 6.0% by weight of a suitable feed-grade water-soluble phosphate or phosphoric acid, and magnesium oxide to give 1 - 15% MgO by weight in the mixture, the pH of which is 3.0 - 6.5 (3.5 - 6.0) (8 - 10.5), the ratio of phosphate to calcium reactant is 1 : 4 and the sugar concentration is 45 - 95% (55 - 80%) by weight. Other additives may be incorporated in the supplement, including protein, fats, minerals, vitamins, etc., as well as reinforcing cellulose fibres such as bagasse.

Beet slicer

H. Putsch GmbH & Comp., of Hagen, Germany. **2,133,278.** December 15, 1983; July 25, 1984.

One end of the rotary drum in a centrifugal beet slicer is formed by a drive disc, the outer periphery of which carries equally spaced detachable rods 12, preferably of square cross-section and with their longitudinal axes parallel with the drum axis, so that an inner edge 44' of each rod faces the drum axis, and a straight line connecting this edge 44" and the opposite edge would pass through the drum axis. Between each pair of adjacent rods is a blade box 42 with blade 58 having a cutting edge 60; sections of the blade box embrace edges 44" of the rods by means of a prismatic recess 46, so that one face 48 of the recess partially embraces the outwards slanting plane surface 50 of rod 12 in each case. The other face 52 of the recess substantially abuts against the entire inwards slanting surface 54 of the rod. Face 48 does not rest against face 50 during slicing but, under the effect of the cutting and centrifugal forces of the blade boxes, presses with face 52 against surface



54 of the rod; hence, all the forces are transmitted via surface contact to the rods, the alignment of which causes the resultant force to act substantially perpendicularly to the contact face between the blade box and a rod. A blade arrangement 56 formed as a wearing part is secured to the blade box 42 and is adjustable by means of a wedge key 62, while another (interchangeable) wearing part is clamping plate 68 located over the rear edge 72 of blade 58; this plate has a section 74 that extends to the rear and covers the free part of rod 12 as well as part of the adjacent blade box 42 that is not covered by blade arrangement 56. Lateral wearing strips mounted on blade box 42 overlap the associated rod 12 as well as the adjacent blade box to the same extent as section 74 of the respective clamping plate 58. The slicer also incorporates a special system for locking the blade boxes in the radial direction; signal transmitters may be included to indicate the respective position of the special locking lever and hence the actual locking of the blade boxes.

Rotatool

THE WATER DRIVE. In addition to the normal metal cased flexible drives for tube cleaning, some Mills have found these ALKATHENE covered drives (through which cold water passes) very effective indeed for their cleaning operations. The water emerges through the front ports of the bearing (onto which the cleaning tool or brush connects) and it cascades over them during use; at the same time washing the tubes through and carrying away the loosened deposit. It also makes the work much easier for the operators and is not as fatiguing because the weight factor is reduced. The Alkathene casing makes for much easier handling too and is impervious to water and scale.

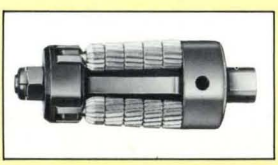
S.T. MODEL. Trolley mounted machine with eyebolts for suspension purposes. The power unit selection is 1.5 Kw (2 hp) for flexible drives up to 32 ft. (10 metres) in length, 2.2 Kw (3 hp) 45 ft. (14 metres) in length, 3 Kw (4 hp) 60 ft. (18.30 metres) in length, and 4 Kw (5.5 hp) up to 75 ft. (22.86 metres) in length. Special machines are always welcome. Available in all the usual A.C. voltages. Fully protected, electrically and mechanically.

T.B. BRUSH. This design of brush is used mainly for light brushing and polishing of tube surfaces in all types of tubular plant and is particularly useful for CURVED tubes. Two types are available, i.e. LIGHT pattern filled with 32/33g or 30g FINE wire and HEAVY pattern (in larger hubs containing more wire) filled with 27g. crimped wire. Made in all sizes between 16 mm and 76 mm diameter in the LIGHT pattern and 38 mm to 102 mm diameter in the HEAVY pattern.

D.S. BRUSH. A robustly made brush, double filled, for prolonged cleaning work in STRAIGHT tubes. Various grades of filling can be made available, including small diameter coil spring inserts for extra heavy cleaning work; in lieu of the normal 28/29g. wire. Effective working diameters are between 28 mm and 76 mm.

S.H.K. BRUSH. This brush has a very strong scouring action indeed and is much in demand by some Sugar Mills. Rapidly cleans and polishes all types of STRAIGHT tubes leaving an excellently burnished surface. It is filled with 27g. crimped wire as standard. Available in tube sizes 19 mm to 102 mm internal diameter.

P.H. CLEANING TOOL. Available in single, double and triple form (according to choice) for brass and copper tubes up to 2" (51 mm) internal diameter. Equally suitable for all steel tubes from 38 mm to 102 mm internal diameter. The orthodox tool for the removal of hard scale from STRAIGHT and CURVED boiler tubes, etc.



E.T. CLEANING TOOL. By far the most popular tool with SUGAR MILLS for the rapid and safe removal of hard linings of scale up to say 1.60 mm thick in EVAPORATOR and JUICE HEATER tubes in one pass. Fast and effective, and equally safe in Brass or Copper tubes. Supplied in a range of tube bore sizes from 29 mm to 57 mm inclusive.

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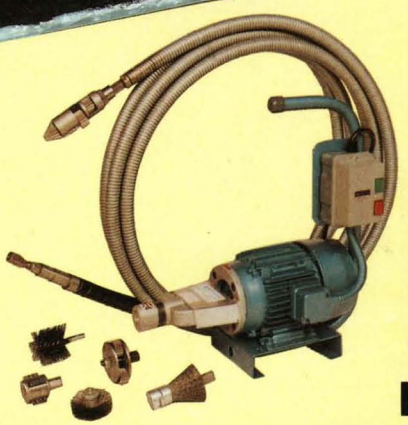

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1 minute, filter, and measure the pol value of the filtrate.

$$\% \text{ Sugar} = 0.26 \times \text{Pol}$$

Procedure: Apparent purity determination

Cossettes: Transfer 200 g of cossette brei to a blending jar, add 400 cm^3 of nearly boiling distilled water and blend for 5 minutes. Filter the mixture through a Buchner funnel with filter paper (VWR #617). Cool and determine the Brix of the extract.

Add 1.0 g of calcium hydroxide and 2.0 g of aluminium chloride to 200 cm^3 of extract and mix for 2 minutes. Filter the mixture and measure the pol value of the filtrate. Calculate the apparent purity coefficient by using the following formula:

$$\text{APC} = \frac{(0.26 \times \text{Pol})100}{\text{Brix} \times \text{Apparent Density at } 20°\text{C}}$$

Diffusion juice: Cool 200 cm^3 of sample and determine the Brix value. Add 2.0 g of calcium hydroxide and 4.0 g of aluminium chloride, mix the sample for 2 minutes, filter and measure the pol value of the filtrate. Calculate the apparent purity coefficient by using the formula above.

Results

Table III lists the comparative test results as determined by using the proposed aluminium hydroxide and aluminium sulphate methods and the standard dry and wet lead clarification methods. The data indicate that, in most cases, the apparent purity coefficient of cossettes and diffusion juice obtained with aluminium hydroxide clarification is slightly lower than the value obtained from samples clarified with dry lead. The small differences in sugar content for cossettes, diffusion juice, pressed pulp, and pressed pulp water are not considered significant.

Statistical evaluation of comparative data obtained by our factory Control Laboratories are summarized in Tables IV and V. The average differences in sugar content resulting from aluminium and lead clarification, as noted in Table IV, are relatively small and are not significant at the 95% probability level. Data reported by two of our factory laboratories as shown in Table V indicate that the average difference of –0.2 purity unit for diffusion juice is highly significant. However, for process control purposes, such small differences are acceptable. In the case of cossette purity, the average differences on data reported by both Manteca and Woodland factories are not considered significant.

Table IV. Comparative data for aluminium hydroxide, aluminium sulphate and lead clarification (Woodland Factory)

	Cossettes	*Diffusion juice*	*Pressed pulp*	*Pressed pulp water*
No. of sample (N)	63	89	64	91
Ave. % S (aluminium)	13.948†	12.234*	1.174*	1.4634*
Ave. % S (lead)	13.970	12.197	1.166	1.4632
Ave. diff. (Al-Pb)	–0.022	0.037	0.008	0.0002
Std. dev. (Ave. diff.)	0.099	0.186	0.051	0.0361
t-value	1.76	1.88	1.25	0.05
Significance, %	91	93	78	<10

*Aluminium hydroxide clarification
†Aluminium sulphate clarification

Table V. Comparison of APC obtained using aluminium hydroxide and dry lead clarification

	Manteca factory	*Mendota factory*	*Woodland factory*
Diffusion juice (N)	37	67	45
Ave. diff. (Al-Pb)	0.11	–0.22	–0.19
Std. dev. (Ave. diff.)	0.64	0.54	0.49
t-value	1.04	3.33	2.60
Significance, %	70	>99	99
Cossettes (N)	43		45
Ave. diff. (Al-Pb)	0.19		–0.10
Std. dev. (Ave.diff.)	0.93		0.42
t-value	1.34		1.60
Significance, %	81		88

Acknowledgement

The author wishes to thank James A. Porter, Robert L. Alcorn, and Leroy J. Schafer for their cooperation in obtaining the comparative data in our Control Laboratories.

Summary

A lead-free method for clarification of beet end samples has been developed. This alternative method is based on the use of aluminium hydroxide prepared *in situ* using aluminium chloride and calcium hydroxide or ammonium hydroxide. Pol measurements of filtrates obtained from aluminium hydroxide clarification agreed closely with those resulting from lead clarification. In most cases, the filtration rate of samples clarified with aluminium hydroxide is similar to that of samples treated with lead compounds. The method is applicable for clarification of cossettes, diffusion juice, pressed pulp and press water.

Remplacement du plomb par l'hydroxide d'alumine pour la clarification des échantillons dans la réception des betteraves

On a développé une méthode exempte de plomb pour la clarification des échantillons de betteraves. Cette méthode alternative est basée sur l'utilisation d'hydroxide d'alumine préparée *in situ* au départ de chlorure d'alumine et d'hydroxide de calcium ou d'ammonium. Les polarisations obtenues pour des filtrats préparées par une clarification à l'hydroxide d'alumine étaient très proches des valeurs obtenues avec une clarification

au plomb. Dans le plupart des cas la vitesse de filtration des échantillons clarifiés à l'hydroxide d'alumine était semblable à celle des échantillons traités au plomb. On peut utiliser la méthode pour des cossettes, du jus de diffusion, des pulpes pressées et pour l'eau de presse.

Ersatz von Blei durch Aluminiumhydroxid für die Klärung von Proben aus dem Vorderbetrieb

Eine bleifreie Methode zur Klärung von Vorderbetriebsproben wurde entwickelt. Diese alternative Methode basiert auf der Verwendung von Aluminiumhydroxid, das *in situ* aus Aluminiumchlorid und Calcium- oder Ammoniumhydroxid verwendet wurde. Polarisationsmessungen von Filtraten der Aluminiumhydroxid-Fällung stimmten gut mit denen der Bleifällung überein. In den meisten Fällen war die Filtrationsgeschwindigkeit der mit Aluminiumhydroxid gefällten Proben der mit Blei-Verbindungen behandelten Proben ähnlich. Diese Methode is anwendbar für die Klärung bei der Polarisation von Schnitzeln, Rohsaft, extrahierten Schnitzeln und Preßwasser.

Sustitución de plomo por el hidróxido de aluminio para la clarificación de muestras provenidos de la recepción de las remolachas

Se ha desarrollado un método que no utiliza plomo para la clarificación de muestras provenidos de la recepción de remolachas. Este método alternativo se base en el uso de hidróxido de aluminio formado *in situ* empleando cloruro de aluminio y el hidróxido de calcio o de amonio. Había buena concordancia entre valores de pol obtenido de filtrados de clarificación con hidróxido de aluminio y ellos que resultan de clarificación con plomo. En la mayoría de casos, la velocidad de filtración de muestras clarificado con hidróxido de aluminio es semejante a ella de muestras tratado con compuestos de plomo. El método puede aplicarse para la clarificación de cosetas, jugo de difusión, pulpa prensada y agua de las prensas.

Sugar industry process control using multivariate analysis

By Jean-Luc Dupouey & Christophe Rigo
(CERF, La Bretagne, 97490 Ste. Clotilde, Réunion)

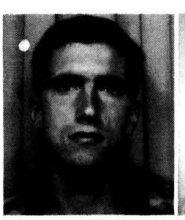
Introduction

It is typical for factories to take samples regularly at various points along the production line for analytical control. The data are mostly used in such limited contexts as adjusting a piece of equipment, comparing operating conditions or results of the current situation with earlier ones. In fact, the amount of data collected for an entire factory or during a whole year is much too great for a global analysis.

With the use of multivariate statistical analysis, the bulk of data collected can be globally processed. This method has been applied to data collected weekly in sugar factories in Réunion Island.

Material and method

Factory data



Jean-Luc Dupouey

Christophe Rigo

Since 1952, when Mr. E. Hugot set up a cane sugar factory analytical control system in Réunion, 70 values concerning the entire process are collected each week in each of five factories. In other words approximately 6400 values are collected during a harvest season.

The apparent purities of different intermediate products of sugar production have been used for this analysis. In fact, the purity is the simplest criterion used for the measurement of the degree of sugar exhaustion. The flow diagram shown in Fig. 1 illustrates samples taken into account during sugar extraction.

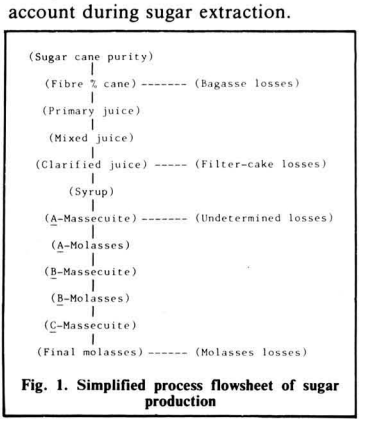


Fig. 1. Simplified process flowsheet of sugar production

Different losses such as bagasse, molasses, filter-cake and undetermined losses have also been included in the analysis.

Similarly, potentially explanatory data such as campaign week number, factory number, tonnage, sucrose content, fibre and clarified juice pH have been used.

The technical terms used were explained by Hugot[1].

A new methological approach: principal components analysis

The whole of the data collected during the campaign in all factories forms a cloud of some 90 points (individuals) in a 19-dimensional space formed by the 19 chosen variables. The shape of this cloud of points is found to be elongated towards some preferential directions with respect to the correlations between the original variables. Principal components analysis consists of calculating these privileged axes with respect to the original variables. These axes, called principal components, are classified in order of decreasing variability and can be considered as new artificial variables. The original variables or the cloud of points can then be represented on this view system of axes.

From the mathematical point of view, the search for the principal components is carried out by finding the eigenvalues and eigenvectors of the correlation matrix between the original variables. Anderson[2] provides an introduction to multivariables statistical techniques.

Three points of interest arise from the principal components analysis:

(a) first, this analysis allows the initial variables, which are generally correlated, to be replaced by non-correlated factors which are easier to manipulate;
(b) second, it frequently allows the reduction, to a certain extent, of the number of variables to be taken into consideration; and
(c) last, it provides an interpretation of initial observations.

Results and discussion

Histogram of the eigenvalues

The histogram of the percentage of total variance explained by each axis (Fig. 2) shows the presence of three predominant axes totalizing 70% of the total variance of the cloud of points. It can therefore be assumed that the whole of the variation in the analytical control results can be reduced to three principal factors.

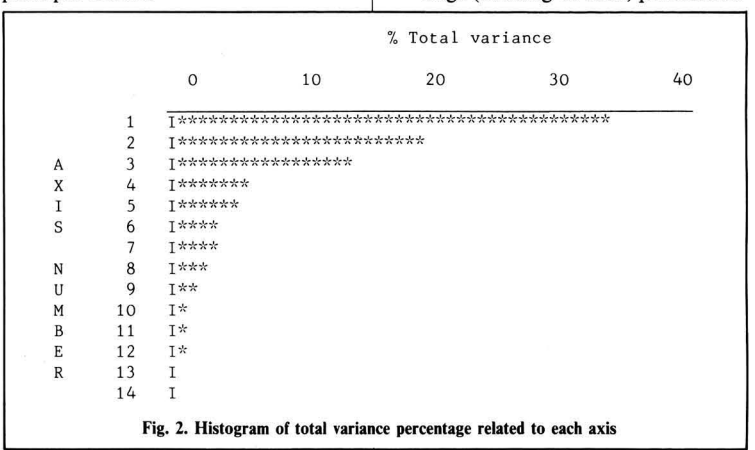


Fig. 2. Histogram of total variance percentage related to each axis

Study of variables projection

From the examination of the original variables projections in the planes of axis 1 and 2 (Fig. 3) and axis 1 and 3 (Fig. 4), the groups of variables constituting each axis can be distinguished as follows:

(a) axis 1: purities of primary juice, mixed juice, syrup and *A*-massecuite. A strong relationship is observed between undetermined losses and this axis, and it can therefore be assumed that these losses occur during this stage (cleaning of mills, purification of juice, evaporation of juice);
(b) axis 2: purities of *B*-massecuite, *B*-molasses and *C*-massecuite. It is ascertained that the purity of *A*-molasses is related to both axes 1 and 2 (importance to the process of

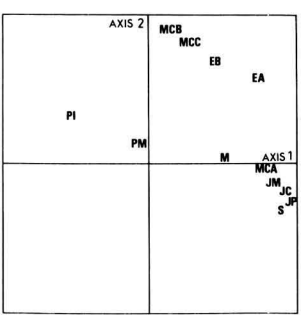


Fig. 3. Projection of variables in the planes of axis 1 and 2 of the principal components analysis. *Key:* JP, purity of primary juice; JM, purity of mixed juice; JC, purity of clarified juice; S, purity of syrup; MCA, purity of *A*-massecuite; MCB, purity of *B*-massecuite; MCC, purity of *C*-massecuite; EA, purity of *A*-molasses; EB, purity of *B*-molasses; M, purity of final molasses; PM, molasses losses; PI, undetermined losses

1 "Handbook of cane sugar engineering" (Elsevier, Amsterdam) 1979, 1079 pp.
2 "An introduction to multivariate statistical analysis" (Wiley, New York) 1958.

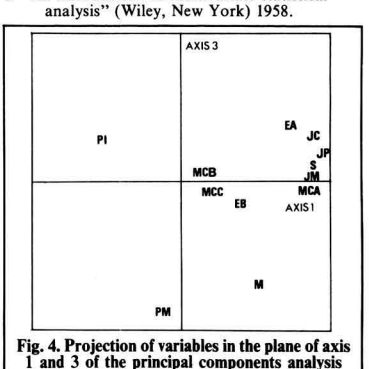


Fig. 4. Projection of variables in the plane of axis 1 and 3 of the principal components analysis

the *A*-purity drop).

(c) axis 3: the variables are found to be linked with final molasses purity.

It can therefore be concluded that the sugar manufacturing process is divided into 3 independent stages: from factory entrance to *A*-molasses, from *A*-molasses to *C*-massecuite and the production of final molasses.

The graphs include only those variables having a correlation greater than or equal to 0.5 with at least one of the three axes. The other variables provide little information and therefore do not appear. On the other hand, bagasse and filter-cake losses, which seem to form higher order axes (4 and 5 respectively), were not included either.

Study of the projection of individual points

Axis 1: The study of the positions of the individual measurements along axis 1 shows a very strong relationship with the campaign week (Fig. 5). The maxima of the purities in the first stage of the process are obtained during mid-campaign and the time during which the optimum period occurs depends on the geographical location of the factories. For example, for factories in the windward region, the optimum period occurs between the 14th week and the 21st week while for those in the leeward region, it occurs between the 10th week and the 12th week of the campaign. The minima show the beginning and the end of the campaign. It is evident that the purity of sugar cane delivered to the factories is a prime factor in the first stage of the process. This purity is linked to the agronomical value of the cane delivered and may also be linked to the time between the harvesting and the milling of the cane. It has also been found that one day of strike in factory B is enough to decrease the purity in this stage of the process to an extreme.

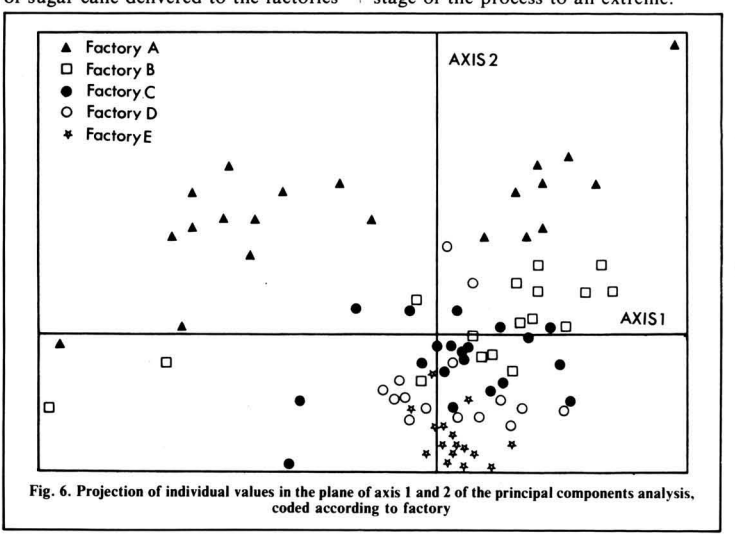


Fig. 6. Projection of individual values in the plane of axis 1 and 2 of the principal components analysis, coded according to factory

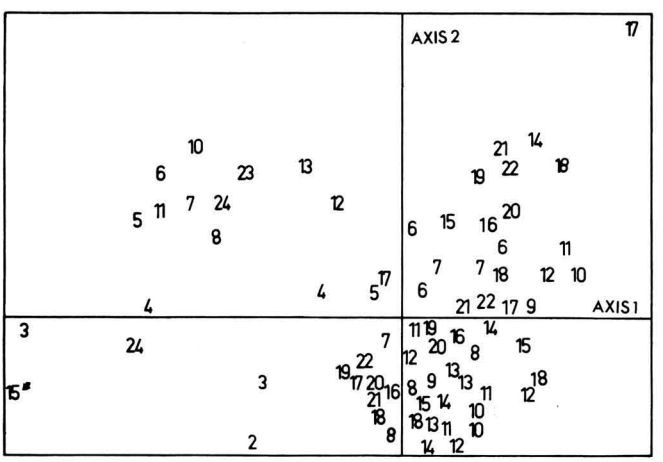


Fig. 5. Projection of individual values in the plane of axis 1 and 2 of the principal components analysis, coded according to campaign week. The arrow shows the week during which the strike took place.

The technical performance of each factory can also be noted using the graph. Consequently, one can observe the direct effects of the poor working performance of factory A at this stage of the process: extremely heterogeneous results were obtained (the factory's values are scattered all along axis 1) and the purities remained very low during the start-up period (at least eight weeks longer than the other factories).

Axis 2: The points along axis 2 are grouped with respect to the factory where the samples were taken (Fig. 6). Each factory appears in a distinct area on the graph in contrast to axis 1 where no such factory effect is observed.

The variations observed in the second stage of the process are mainly due to differences in the factory's

manufacturing process and in their ability to extract the maximum amount of sugar. The purities decrease from factory A to factory E.

Axis 3: The purity of the molasses which is the final measure of the technical performance of the factory has its own determining factor as it forms an axis on its own. However the study of the individual points does not reveal this peculiarity. Only a strong relationship with the fibre % cane measured by the factory could be ascertained. This relationship can be explained since the calculation of the fibre % cane takes into account not only all components of the sugar cane but also the non-cane (melassigenic products from non-cane).

Conclusion

Using the results obtained, it has been found possible to:

(i) divide the different stages of the process into homogeneous parts,
(ii) identify the factors responsible for the variability during each of these stages, and
(iii) compare the efficiency of the factories.

Further analysis can be carried out, for example, by taking a given factory in a given week, projecting it as a supplementary element on the principal components and then tracking the efficiency of each factory throughout the campaign. This analysis can also be carried out with values obtained during a good campaign (eg. 1982) and the results then used as a reference for evaluation of working efficiency.

Hence, principal components analysis is a useful tool for process control in the sugar industry and one which most certainly can be made applicable for other industries as well.

Summary

The bulk of data collected each year from the cane sugar factories of Réunion Island is a good base for process control which, however, involves the use of multivariate statistical analysis. We have therefore made use of a principal components analysis to study a set of 19 variables consisting of the weekly measurements of the purity of each intermediate product in the manufacture of sugar at five factories for the 1983 harvest (about 90 points). Results show that the total variability can be divided into three principal axes, each corresponding to a specific part of the process. The study of individual points allows us to identify the factors responsible for each axis. With the use of diagrams, one can judge the efficiency of any given factory during any given week, in relation to the factory results as a whole during the entire year.

Application des méthodes d'analyse multivariable au contrôle de fabrication en sucrerie de canne

L'important volume de données collecté chaque année dans les sucreries de l'Ile de la Réunion constitue une base intéressante de contrôle de la fabrication, qui necéssite toutefois l'emploi d'analyses statistiques multivariables. Nous avons donc étudié par analyse en composantes principales un tableau de 19 variables (les puretés de tous les produits intermédiaires de la fabrication du sucre) mésurées chaque semaine de la campagne de récolte 1983 dans 5 usines (environ 90 points). Les résultats montrent que la variabilité totale se résume à trois axes principaux correspondant chacun à une partie du procédé. L'étude des individus permet d'identifier les facteurs de variation expliquant ces axes. On peut, à l'aide des graphiques obtenus, visualiser à tout moment la position d'une usine à une semaine donnée par rapport à l'ensemble de l'ile et de l'année.

Prozeßkontrolle in der Zuckerindustrie unter Verwendung von mehrdimensionaler Analyse

Die vielen jedes Jahr von den Rohrzuckerfabriken auf Réunion gesammelten Daten sind eine gute basis für die Prozeßkontrolle, die jedoch die Verwendung einer mehrdimensionalen statistischen Analyse erfordert. Wir haben daher eine Haupt-Komponent-Analyse verwendet, um einen Satz von 19 Variablen aus den wöchentlichen Reinheits-Messungen der einzelnen Zwischenprodukte bei der Zuckerherstellung in fünf Fabriken für die Ernte 1983 (ungefähr 90 Punkte) zu untersuchen. Die Ergebnisse zeigen, daß die gesamte Variation in drei Hauptachsen geteilt werden kann, die jeweils einem spezifischen Teil des Prozesses entsprechen. Die Untersuchung der einzelnen Punkte erlaubte, die verantwortlichen Faktoren für jede Achse zu identifizieren. Bei Verwendung des Diagramms kann jedermann die Effektivität einer beliebigen Fabrik während einer beliebigen Woche im Verhältnis zu den Fabrikergebnissen des ganzen Jahres insgesamt beurteilen.

Aplicación de métodos de análisis multivariable al control de fabricación en la industria azucarera

La mayoría de dados colegido cada año en las azucareras de la isla de Reunión provee una basa adecuada al control del proceso. No obstante, este necesita el uso de análisis estadístico multivariable. Hemos aplicado análisis de los componentes principales al estudio de un juego de 19 variables que constituyen las medidas semanales de las purezas de cada producto intermedio de la fabricación de azúcar en cinco azucareras durante la zafra de 1983 (algunos 90 puntos). Las resultas demuestran que la variabilidad total puede dividirse en tres ejes principales, cada uno correspondiente a una parte específica del proceso. El estudio de puntos individuales nos permite identificar los factores responsables para cada eje. Con el uso de diagramas, es posible juzgar la eficiencia de cualquiera azucarera durante cualquiera semana con relación a las resultas enteras del año.

A colorimetric method for the determination of chemical oxygen demand

By Santosh Kumar, Hridayabhiranjan Shukla and Lakshmikanthrao Viswanathan

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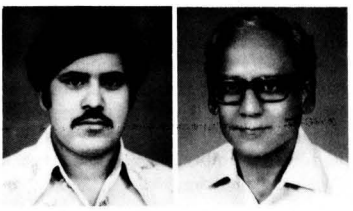
Introduction

The standard method for the determination of Chemical Oxygen Demand consists of refluxing the diluted effluent samples with potassium dichromate and concentrated sulphuric acid for 2 hours followed by titration against standard thiosulphate or ferrous ammonium sulphate solutions[1]. The accuracy of COD values obtained by this method depends upon many factors such as temperature uniformity during refluxing, constant water supply for the condenser, concentration of sulphuric acid in the reaction mixture, etc. The method is tedious, as not many samples can be handled at a time. So there is a need for some faster method by which several samples can be analysed at a time with considerable accuracy.

The new colorimetric procedure employs the principle that when any effluent sample is treated with potassium dichromate and concentrated sulphuric acid, there is a change in the colour from dark orange through green to blue. The intensity of the colour increases with increase in the concentration of organic substances in the effluent sample. This principle has been exploited to develop a colorimetric method for the determination of chemical oxygen demand values. Various factors affecting this method and optimum conditions for accuracy have been studied in detail for application to distillery effluent.

Materials and methods

For comparison, chemical oxygen demand was determined by the standard method[1], 20 ml of the diluted effluent being refluxed for 2 hours with 10 ml of standard 0.25 N potassium dichromate and 30 ml of concentrated sulphuric acid. After cooling, the mixture was diluted to about 100 ml with distilled water and titrated against standard 0.25 N ferrous ammonium sulphate. A blank was run in the same manner with distilled water in place of the sample and COD per ml of



S. Kumar V. Viswanathan

sample calculated from the formula

$$COD = (a-b) \times c \times 8000/d$$

where a = Titre value using blank (ml)
b = Titre value with sample (ml)
c = Normality of ferrous ammonium sulphate
d = Volume of the sample taken (ml)

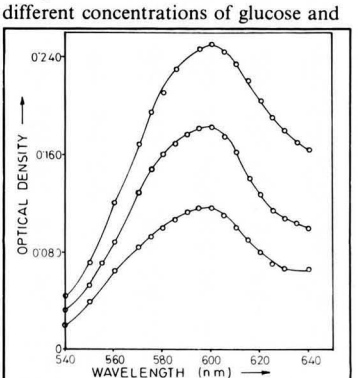
All the reagents were of analytical or equivalent grade. The samples submitted for analysis were various concentrations of glucose chosen as standards for comparative estimation and distillery effluent or spent wash. Since the fresh spent wash cannot be kept too long, it was concentrated to about 50° Bx for storage and diluted for analysis.

The same reagents in the same ratio and concentration as in the standard method were used for colorimetric determination of the COD values. Since a lot of heat is produced during the addition of concentrated sulphuric acid, the experimental conditions such as the size of the tubes and rate of addition of acid, etc., were maintained uniform throughout these investigations. After adding the reagents the tubes were kept in a boiling water bath for 1 hour and the colour produced was read using a Bausch & Lomb Spectronic 20 spectrophotometer. For convenience the % transmittance was read initially and then converted into optical density.

Different concentrations of glucose were chosen as standard to determine the linearity of the curve in the present procedure. The distillery effluent samples had been treated with special bacterial cultures without aeration[2-6]. Various types of treated and untreated samples of distillery effluent were chosen to check the efficiency and accuracy of the present method. The colour produced was read at 600 nm since the absorption maxima was found at this wavelength. COD values given on the horizontal axis in the graphs have been determined by the standard method of refluxing followed by titration with ferrous ammonium sulphate. Samples of known COD values were diluted to different extents for use in the different experiments.

Results and discussion

Since the colour produced during the reaction of effluent with concentrated sulphuric acid and potassium dichromate is of different hues, the absorption spectrum of the colour developed was first investigated. After heating in the water bath for 1 hour the spectra of the colour obtained with different concentrations of glucose and



Fi. 1. Absorption spectra of colour developed in 1 hour by the reaction with glucose sample; the COD of the samples A, B and C was 12,500, 15,000 and 24,000 ppm, respectively

1 "Standard Methods for the Examination of Water and Waste-Water" (American Public Health Association, American Water Works Association and Water Pollution Control Federation Inc., New York) 1960, pp. 19, 297.
2 Dahiya & Prabhu: *Proc. 4th Joint Conv. STA. DSTA and SISSTA* (India), 1971, G31-G36.
3 Idem: *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G36-G38.
4 Dahiya *et al.*: *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1975, G69-G71.
5 Agnihotri & Prabhu: *Proc. 42nd Ann. Conv. Sugar Tech. Assoc. India*, 1978, G65-G79.
6 Kumar & Viswanathan: *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India*, 1982, G71-G83.

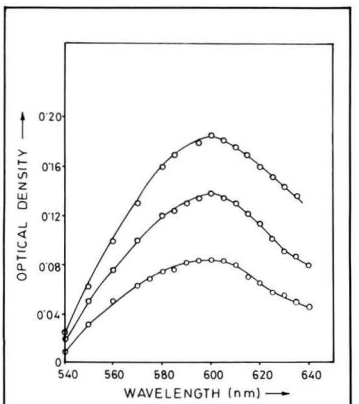


Fig. 2. Absorption spectra of colour developed in 1 hour by the reaction with distillery effluent (spent wash) sample; the COD of the samples A, B and C was 7500, 12,500 and 18,000 ppm, respectively

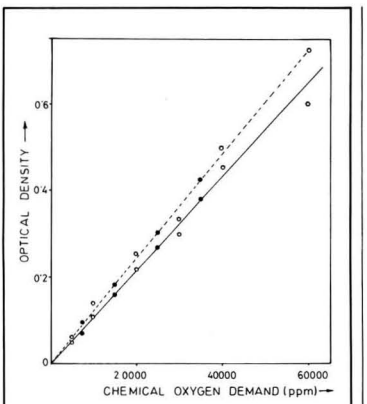


Fig. 3. Intensity of colour without refluxing (solid line) and after refluxing for 2 hours (broken line) using distillery effluent samples; darkened symbols represent values calculated by the least squares method

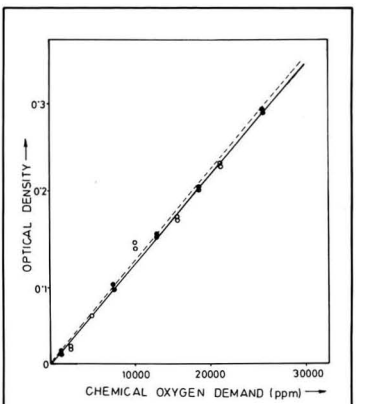


Fig. 5. Intensity of colour in distillery effluent samples with refluxing for 2 hours (solid line) and with heating for 1 hour in boiling water bath (broken line); darkened symbols represent values calculated by the least squares method

of distillery effluent were determined over the range 540 nm to 640 nm. The results are presented in Figures 1 and 2. It was found in all cases that the absorption maximum was at 600 nm and this wavelength was therefore used in all further experiments.

In order to determine the effect of duration of heating in the water bath the effluent samples, diluted to different levels, were heated with the reagents for 0, 1 and 2 hours. The colours produced were compared with that obtained with the same sample after refluxing for 2 hours as in the standard procedure. In the first case, samples with COD values ranging from 5000 to 60,000 ppm were taken and, after the addition of concentrated sulphuric acid, the tubes were immediately cooled in tap water for 15 minutes. The optical densities of the colour produced were proportional to COD (Figure 3). However the optical densities obtained in case of refluxed samples were greater than those obtained when the reaction was not subjected either to heating in the water bath or to refluxing. The above results are to be expected because oxidation by dichromate will be more complete at higher temperature and longer time. It is remarkable that the major part of the reaction is completed in the very short time from adding the reagents to subsequent cooling of the tubes.

The values obtained by keeping the reaction mixture for one hour in a boiling water bath were compared with those obtained after refluxing by the standard procedure using glucose and effluent samples. The values obtained by the two methods agreed very closely (Figures 4 and 5).

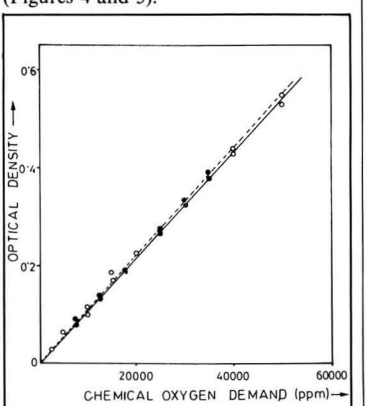


Fig. 4. Intensity of colour in glucose samples with refluxing for 2 hours (solid line) and with heating for 1 hour in boiling water bath (broken line); darkened symbols represent values calculated by the least squares method

The experiments were repeated but keeping the reaction mixture in the boiling water bath for 2 hours and optical densities compared with those after 2 hours refluxing (Figure 6). In both cases a linear relationship between colour and COD was obtained but, surprisingly, the optical densities were greater in the effluent sample heated for 2 hours in the boiling water bath than that of corresponding refluxed samples. This suggests that distillery effluent probably contains volatile organic compounds that escape before complete oxidation can occur during

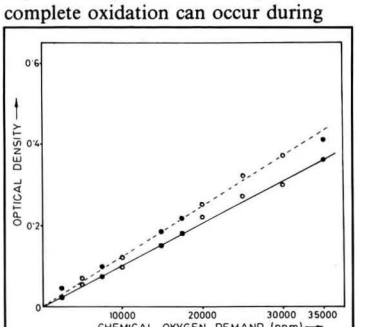


Fig. 6. Comparison of 2 hours heating in a boiling water bath (broken line) with 2 hours refluxing (solid line) using distillery effluent samples; darkened symbols represent values calculated by the least squares method

refluxing. When the above experiment was repeated taking various dilutions of glucose as samples, the same optical density was given under both conditions (Figure 7). The possibility of escape of volatile material during the determination of COD of distillery effluent samples has not usually been appreciated.

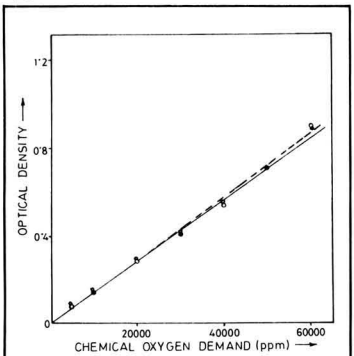


Fig. 7. Comparison of 2 hours heating in a boiling water bath (solid line) with 2 hours refluxing (broken line) using glucose samples; darkened symbols represent values calculated by the least squares method

In order to determine the optimum time of heating for maximum colour production, samples were heated for different periods in a water bath. The time intervals chosen were 0 min, 15 min, 30 min, 45 min, 60 min, 90 min and 120 min. COD values in the samples varied from 5000 to 40,000 ppm. With glucose the reaction was nearly complete within 30 to 45 minutes, depending on the COD level. In the case of distillery effluent the reaction was generally over after 60 minutes (Figures 8 and 9). However, in some cases, there was an increase in colour up to 90 minutes. At COD values higher than 30,000 ppm, the colour increased even up to 2 hours but in these cases the rise in optical density was no longer linear with the increase in COD. Thus for routine purposes, 60 minutes is taken as optimum heating time.

Following the experiments, the following procedure was adopted:

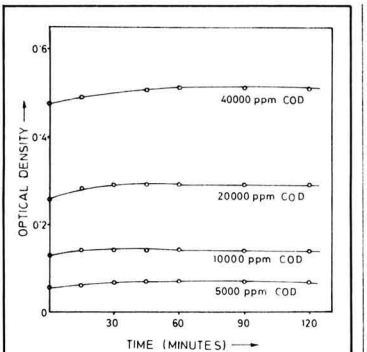


Fig. 8. Time curve of colour development in a glucose sample on heating the reaction mixture for 1 hour in a boiling water bath

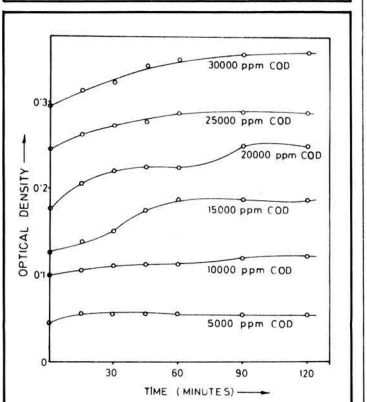


Fig. 9. Time curve of colour development in a distillery effluent sample on heating the reaction mixture for 1 hour in a boiling water bath

2 ml of 0.25 N potassium dichromate solution and 6 ml of concentrated sulphuric acid are added in that order to 3 ml of suitably diluted effluent sample in boiling tubes which are immersed in a boiling water bath for one hour. The tubes are cooled in running water and the colour read in a Spectronic 20 spectrophotometer at 600 nm. A standard curve is prepared using different dilutions of sample of a similar type of effluent the COD of which has already been determined by the standard procedure of refluxing for 2 hours.

Optical density values were calibrated in terms of COD by using samples subjected to the standard procedure. The calibration was checked with different dilutions of glucose and effluent samples of known COD as determined by the standard procedure. The graphs were linear up to a COD load of 60,000 ppm in the case of glucose and up to 30,000 ppm in the case of distillery effluent (Figures 10 and 11). The calibration curves for glucose and the distillery effluent showed a similar tendency. However, until further experience is gained with different type type of effluent samples, it is advisable to calibrate the procedure by determining the COD of one sample by the standard procedure of refluxing for 2 hours.

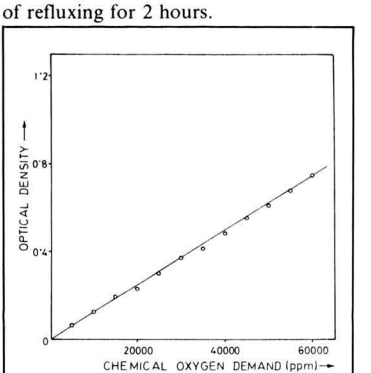


Fig. 10. Standard curve for the relationship between optical and COD using glucose samples

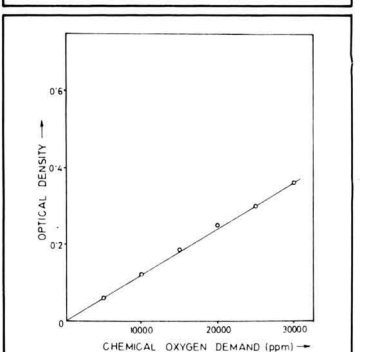


Fig. 11. Standard curve for the relationship between optical density and COD using distillery effluent samples

The colorimetric method is simple, accurate and fast and several samples can be handled at a time. It is very sensitive and can measure conveniently COD values down to 100 ppm. However, most of the effluent samples used in this study had very high COD values and were usually diluted about 50 times.

A number of samples of glucose, untreated distillery effluent and distillery effluent treated to different extents by a special bacterial culture without aeration were submitted to analysis by the colorimetric procedure as well as by the standard procedure. Generally, deviation was less than ±10% (Table I). It is believed that the colorimetric method will be of great use when a large number of samples of a similar nature have to be analysed on a routine basis.

The method has been standardized specifically for treatment of distillery effluent. It is quite likely that the method will similarly be of great use for routine handling of a large number of samples of other types of effluents.

Acknowledgements

The authors wish to thank Mr. N. R. Khariawala, Director, National Sugar Institute, Kanpur, for providing necessary facilities and encouragement during the investigation.

Summary

A new colorimetric method for the determination of chemical oxygen demand (COD) has been developed and optimum conditions have been studied in detail. In this procedure the diluted sample is treated with potassium dichromate and concentrated sulphuric acid, heated in a boiling water bath, and the colour produced is read in a spectrophotometer. It was found that the intensity of the colour is directly proportional to COD value. COD values for distillery effluent determined by this colorimetric method were found to be comparable with those obtained by the conventional method.

Table I. Comparison of the colorimetric procedure and the standard procedure for COD determination

Type of sample	*COD by the standard method*	*COD by the colorimetric method*	*% deviation from the COD values obtained by the standard method*
Standard glucose samples	5,500	5,000	−9.0
	9,000	10,000	+11.0
	15,000	15,000	—
	21,000	20,000	−4.6
	29,000	30,000	+3.6
	39,000	40,000	+2.9
	50,000	50,000	—
Untreated distillery effluent samples (diluted from concentrated spent wash)	5,000	5,000	—
	8,000	7,500	−6.25
	14,000	13,000	−7.2
	20,000	20,000	—
	27,500	26,500	−3.3
	32,000	34,000	+4.6
	38,000	39,000	+2.9
Distillery effluent samples (treated with anerobic bacterial cultures)	2,500	2,500	—
	6,000	5,000	−16.6
	9,000	9,000	—
	12,000	11,500	−4.2
	14,000	14,500	+3.5
	17,000	17,000	—
	20,000	19,500	+2.5
	22,000	22,000	—
	22,500	22,500	—

Une méthode colorimétrique pour la mesure de la demande chimique en oxygène

On a développé une nouvelle méthode colorimétrique pour la détermination de la demande chimique en oxygène (DCO) et on a étudié en détail les conditions optimales. Dans cette analyse l'échantillon dilué est traité avec du dichromate de potasse et de l'acide sulfurique concentré. On le chauffe ensuite dans un bain d'eau bouillante et on détermine à l'aide d'un spectrophotomètre la coloration produite. On a observé que la coloration développée est directement proportionelle à la valeur de la DCO. Pour des effluents de distillerie les valeurs de DCO déterminées par la méthode colorimétrique étaient comparables à celles obtenues par la méthods conventionnelle.

Eine kolorimetrische Methode für die Bestimmung des chemischen Sauerstoffbedarfs

Eine neue kolorimetrische Methode für die Bestimmung des chemischen Sauerstoffbedarfs wurde entwickelt und deren optimale Bedingungen genau untersucht. Bei diesem Verfahren wird die Probe mit Kalium-bichromat und konzentrierter Schwefelsäure behandelt, in einem kochenden Wasserbad angewärmt und die entstandene Farbe mit einem Spektrophotometer gemessen. Es wurde gefunden, daß die Intensität der Farbe direkt proportional dem CSB ist. CSB-Werte von Brennerei-Abwässern, die nach der kolorimetrischen Methode bestimmt wurden, sind vergleichbar mit denen, die mit der konventionellen Methode erhalten wurden.

Un método colorimétrico para la determinación de la demanda química en oxígeno

Se ha desarrollado un neuvo método por colorimetría para la determinación de la demanda química en oxígeno (DQO) y se han estudiado en detalle las condiciones optimales. En este procedimiento, la muestra diluida se trata con dicromato de potasio y ácido sulfúrico concentrado, se calienta en un baño de agua herviendo, y el color producido se mide con un

New books

The South African sugar year book, 1984-1985

Glen Dewey (Ed.) 198 pp; 20.8 × 29.5 cm. (The South African Sugar Journal, P.O. Box 1209, Durban, South Africa.) 1985. Price: R 22.00.

The new year book is No. 55 in the series and includes a brief synopsis by the editor of the 1984/85 season in South Africa and a number of special articles and features on various aspects of the country's sugar industry, including an up-date on studies aimed at controlling the eldana borer pest. Reports are presented of the South African Sugar Association, the S.A.Cane Growers' Association, the S.A. Sugar Millers' Association, the S.A. Sugar Technologists' Association and their annual general meetings, and also on activities of the Sugar Milling Research Institute in 1984/85. An annual review of the milling season in southern Africa includes details of sugar companies, cane production, cane quality and extraneous matter, mill performance, sugar recoveries, etc., for South Africa and partly for Malawi, Swaziland and Zimbabwe, with data by individual factories tabulated for aspects of cane crushed; sugar produced; analyses of bagasse, juice, filter-cake, syrup and molasses; massecuite quantities and analyses; average monthly control data; cane varieties and rainfall; comparative data from 1925 onwards; and equipment used and power consumption in South African and Swaziland factories. A reference section contains information on the structure of the South African sugar industry and its enterprises, milling companies and industry statistics, with a section on neighbouring countries. The year book is the definitive up-to-date compendium of information on the sugar industry of South Africa, with that on the other countries as a bonus.

continued from previous page

espectrofotónetro. Se ha observado que la intensidad del color es en proporción directa con el valor de la DQO. Para efluentes de destilería, los valores de la DQO determinado por el método colorimétrico estuvieron comparables con ellos obtenidos por el método convencional.

Economic aspects of biotechnology

Andrew J. Hacking. 306 pp; 14.7 × 22.6 cm. (Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, England.) 1986. Price: £35.00

Biotechnology has been defined as the application of scientific and engineering principles to the processing of materials by biological agents to produce goods and services. Much research has been done to develop feasible and practical processes yet, for many involved in such work (including the author before he entered industry), knowledge of the costing and economic practicality of application of the processes is limited or absent. The present book is intended to repair this lack. It first examines the influence of the diverse markets, demand and pricing policies on biotechnological products, then the influence of general economic and accounting principles which illustrate the reasoning behind the development or abandonment of projects of equal scientific appeal. Production and pricing of raw materials is emphasized as probably the most significant single input, while fermentation costs are examined using data from existing industries, as are problems of downstream recovery and product purification. Enzyme catalysis is described with special emphasis on the cost saving benefit of immobilization. The impact of new genetic technology and its extraordinary success in attracting investment in venture companies is discussed. The sections likely to be of most interest to our readers are concerned with three biotechnical processes which have become of importance in the fairly recent past : alcohol manufacture as a fuel and chemical raw material, sweeteners (particularly HFS) manufacture from corn, and the treatment of wastes for both decontamination and recovery of valuable products such as methane and single-cell protein. The influence of political and economic factors on the first and the differences in a number of countries, particularly Brazil and the US, are discussed, together with an appraisal of the biotechnical contributions to world energy needs. The book places these topics in a wider context which should be considered by the advocates of particular technologies, adoption of which may or may not prove to be economical.

Laboratory manual for South African sugar factories including the Official Methods

436 pp; 14.3 × 24 cm. (South African Sugar Technologists' Association, c/o SASA Experiment Station, Mount Edgecombe, South Africa 4300.) 1985. Price: US $30.00.

The third edition of the South African laboratory manual has brought up to date the 1977 version as a result of the labour of the Factory Control Advisory Committee of the S.A.S.T.A. under the Chairmanship of Mr. J. B. Alexander. The new edition is in fact the seventh version of published chemical control methods, the first three having appeared as part of the Association's Congress *Proceedings* of 1927, 1930 and 1931 and the fourth as a book of "Recommended Methods". The 1985 manual incorporates various modifications to official methods, includes details of the gas chromatographic method which is now official for sucrose determination as well as being used for fructose and glucose in mixed juice and molasses. The various chapters cover definitions, mass determination of factory materials, calculations, sampling equipment, analytical equipment, reagents, sampling and analytical procedures for factory products and miscellaneous materials. A chapter is included on safety and first aid, and an index; the table of contents is so detailed, however, that it is likely to be of more use than the index. The book is well printed and appears in an open binding which is convenient to the user. It will, of course, be required reading for those concerned with factory control in South Africa but will also be useful in other countries in providing details of techniques and equipment which may well be applicable in their sugar industries.

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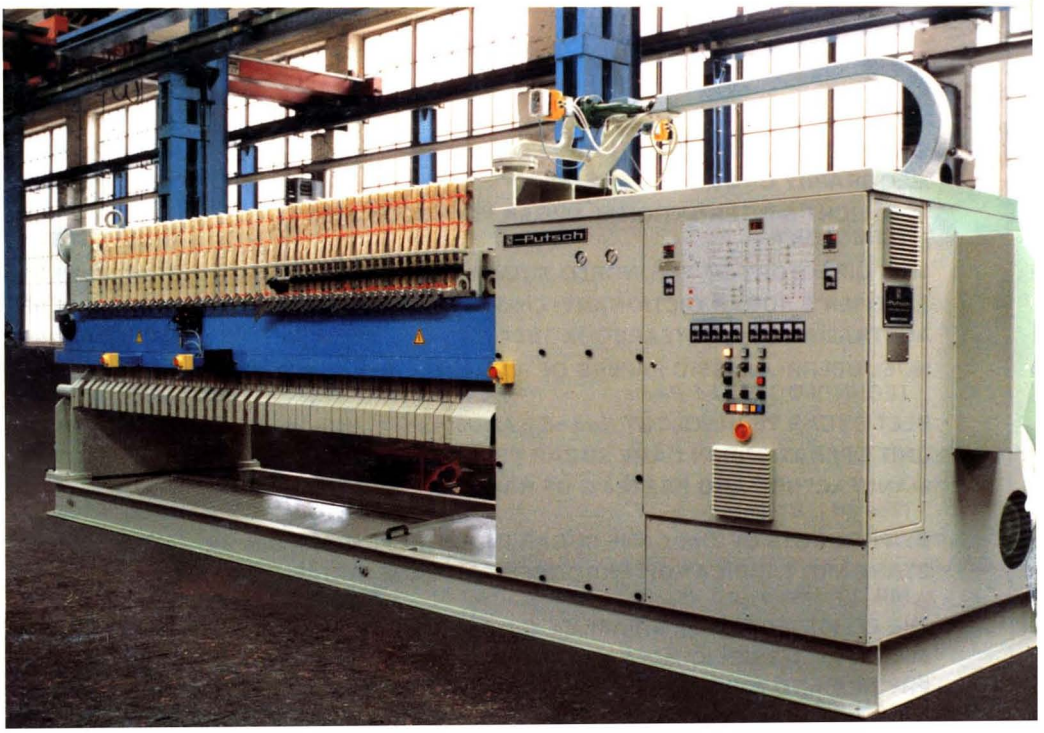

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