

# THE JUICE CARBONATATION PROCESS AND REPERCUSSIONS OF ECONOMICS ON TECHNOLOGY

By J. RAULT

Having started my sugar career by dealing with the free working juices of tropical Mauritius, the following seven years' struggle with the Natal sulfodefecation process—also an immigrant brought over in the years preceding the 1914 war—painfully taught me, that *filtration through cloth* of the muddy settlings, in spite of a powerful battery of plate and frame machines, was one of the most difficult problems of the South African sugar mills.

All the craft of the "secretive juice temperer", the "cracking point" or various heating temperatures, the ceaseless determinations of  $\text{SO}_2$  in juice, before and after liming, the addition of superphosphate, the fancy end points by litmus paper and acidimetric titrations and later the novelty of pH control improved but little, the filtrability of the muds, which were the seat of heavy losses, frequent factory stoppages and poor results in the subsequent operations of evaporation, crystallisation, curing, with a final poor recovery of a raw sugar causing endless troubles to the refinery and particularly at the filtration stages.

Such losses were aggravated if the finished product was to be placed on the market as a consumption white usually sold on "samples" on account of its colour variations, much to the delight and profit of the speculator buyer.

It was then an accepted statement from the practical miller, that it required 1 ton of cane more to make a ton of sugar when turning from a raw sugar to a white sugar, or in more technical language, a fall in recovery exceeding 5 per cent was to be expected.

Farnell<sup>1</sup> of Uba days, in his investigations on the colloids of cane juices in Natal and Mauritius opened up a line of fruitful research, on the causes of refactoriness which are now being followed up by Alexander and co-workers of the S.M.R.I.<sup>2</sup> and Boyes<sup>3</sup>.

For a short while some South African factories adopted a process of Australian origin, attempting to eliminate the filter station by sending the settlings back to the milling train, using the moving bagasse blanket as a huge filtering medium.

This *prima facie* economical method of cutting costs by short circuiting difficulties, apart from creating milling and fuel troubles, had a major objectionable feature, i.e. the unreliability of chemical control in separating milling and boiling house efficiency as well as the incorrect determination of the sucrose present in the raw material.

Nevertheless a survival of this hyphenated process, is the now successful types of continuous settler, whilst the moving bagasse filter idea has materialised in the large unit rotary vacuum filter which has displaced the plate and frame press, both forming a valuable combination for labour saving and continuous work.

The vacuum filters both in beet and cane carbonatation factories, are operating as real filters. The advent of this type of filter has moreover been a trump card in the successful handling of muddy settlings from cane juices, treated by the very small amount of lime now used in the rehabilitated simple lime defecation process which in Uba days had failed at the filtration stage. As used on cane juices, this filtration is in reality a straining through metallic sieves covered with a layer of bagacillo, delivering a more or less cloudy filtrate, seldom good enough for the evaporator, and for that reason recirculated, increasing the duty on the settling equipment, for a three hours' mill juice capacity.

Refiners' adverse comments on the filtrability of South African raws—a legacy from Uba days—are not without some foundation, notwithstanding the introduction of non-Uba varieties, more modern equipment, and sharper chemical control.

It is not surprising that in 1920, after a few months' operation during the previous season using improvised and inadequate equipment from the sulphitation factory, gifted with a monumental stone lime kiln, a very bold decision was taken to go ahead with the double carbonatation process of juice clarification.<sup>4</sup>

A comparatively old one for beet juice clarification, and the only one still used at the present time, it was somewhat foreign to the cane industry although the Javan technologists had also successfully adapted it for the treatment of tropical cane juices.

The following advantages over the established methods, had influenced this optimism:

- (a) Free running of the filter station and in consequence uninterrupted run of the milling plant.
- (b) A 100 per cent filtered clarified juice, sparkling, lighter coloured to the eye, and moreover, showing by analysis an exceptionally high purity rise.
- (c) An improved speed of the evaporation, crystallisation and curing plant through handling a lower viscosity product, capable of increased turnover from the same size equipment.

- (d) A better quality consumption white, offering possibilities of better prices and ultimate competition with the bone char product of that time.
- (e) Last but not least, in virtue of its lower non-sugar content and lower molasses formation, a boiling house recovery 1 or 2 points ahead of the other processes, when dealing with raw juices of the same initial purity.

Pioneered by the Natal Estates, and adjusted to the imperatives of local conditions, it has stood the test of 40 years, varying its production from 50 to 100 per cent white sugars, according to the vicissitudes of the market.

Starting at 11 to 13,000 tons in 1920, the factory progressively stepped up its annual production to a level surpassing the 100,000 tons of refined sugar made from canes, in addition to the refining of 12,000 odd tons from the purchase of outside raws, in the course of the same crushing season.

A number of factors have contributed to this industrial progress, but the original claims of the carbonatation process have been the one reliable stabilising element allowing the other forces to operate, whilst smoothing the to be expected conflict between "more sugar and a better quality sugar", with a minimum of capital expenditure.

From its inception one serious drawback, accepted as a very evident debit against the process has offset to a certain extent, the achievement realised by the technologist, not readily expressible in terms of money and for that reason not fully appreciated by the cost accountant drawing a balance sheet.

This drawback is the heavier clarification lime requirements, and the magnitude of the chemical bill artificially swollen by the transport charges from the S.A. Railways.

Here it should be placed on record that since adopting this process, using a local raw material and not an imported one, our national economy has benefited by the transport of no less a figure than one million tons of limestone together with its 10 per cent additional fuel requirements under the form of coke.

It is to be deplored that the spiralling railway transport charges have steadily inflated the cost of limestone off-loaded at the factory, to the absurd level of three times its true value at the Northern Transvaal quarry.

Under such irrational conditions, common sense has reluctantly forced our management in its economy campaign, to go back to a technically less efficient, but definitely cheaper method of cane juice clarification, than the one that has served so long and so well.

Carbonatation will not be entirely dispensed with, but will be given a softer job, namely the comparatively easy duty of polishing further, a material much purer than cane juice, i.e. a remelted raw sugar solution requiring a small percentage of the lime previously used. This explains the subtitle of this communication, but we believe that some notes on our trials and failures, the findings of some problem, the details of which have too long been kept in our files, may prove of interest to our fellow technologists.

### Lime burning

The cost per ton stone, would have been considerably reduced and the necessity for a change of process averted, by the finding of a suitable limestone in our province to replace the Northern Transvaal material, but we failed in our efforts at burning the calcitic Umzimkulu stones, in the standard shaft kiln of carbonatation factories. The suggested experimentation with rotary kilns was too much of an expensive gamble, where no guarantee was given as to the gas production side.

Physical structure and not so much its chemical composition was the obstacle.

We have experimented on a factory scale, with dolomitic limestone, containing as much as 30 per cent of Magnesium Carbonate.

Other very pure, but softer stones, powdering in the kilns, and at other times harder structured but highly siliceous limestones unduly raised the limestone consumption.

A rather unattractive bluish slate-coloured material burning to a light chocolate quick lime, due to manganese and iron, but endowed with excellent burning qualities, after exhaustive laboratory and factory scale testing, is now constituting one of our main sources of supply.

Not quite as good a filtering medium as other white limes, through the finer state of dispersion of its particles, it is nevertheless a more energetic purifier, and a higher lime cream yielder per ton stone burnt, and its brown colour has no adverse effect on the colour of the refined sugar.

The function of a lime kiln is as much that of a continuous CO<sub>2</sub> gas producer, as of a quick lime for clarification purposes. The factory week-end stoppage is a cause of CO<sub>2</sub> waste and temperature disturbance controlled in our case by using fans at the week-end.

It has been found that a kiln gas of lower CO<sub>2</sub> concentration than 30 per cent, slows down the neutralisation speed at the CO<sub>2</sub> tanks.

The running of a limekiln for refining operations, in a sulphitation-defecation factory, is a source of superabundance of gas, where the carbonatation stage should be a very easy problem.

### The Carbonatation Station

Much has already been written on this subject in a previous paper.<sup>5</sup> For the subsequent 14 years, with a growing market for refined sugars, and a colour-quality complex created by the Bureau of Standards, more stress has been laid on this aspect of manufacture, sometimes at the expense of recovery through lack of equipment proportionate to the speed of expansion.

Our constant problem has always been, the efficiency of lime neutralisation at the first carbonatation stage—a crucial operation influencing the settling and filtration rates of large volumes of mud, the immediate concern of the running staff, and also the chemical composition of the filtered juice, vital for the ultimate quality and quantity of sugar recovered.

The same equipment has had to deal with the juice from a milling train increasing its crushing rate from a level of 140 to 180 tons per hour, limiting the carbonatation cycle to barely seven minutes per tank, the continuous settling to  $1\frac{1}{4}$  hours forcing the vacuum filters to a duty of 80 to 85 lbs. of wet cake per sq. ft. per hour.

This liming and gassing stage was further overloaded by the treatment of outside raws, and our own last 3rd sugars, remelted, and worked in the raw juice circuit.

The very justified criticism of our results, is the excessive elimination of reducing sugars to the extent of 35 to 50 per cent of the original present in mixed juice, i.e. a start from a glucose ratio 3.0 finishing at 1.5 to 2.0 in clarified juice.

We have found that out of the factors causing this destruction, namely high temperatures, high pH, and time of contact, it is the second one which is the most potent.

More damage is done by liming and gassing at a pH 11.3 instead of 10.5, than by raising the juice from the accepted 55°C to the high level of 70°C, when working at the lower pH range.

Maintaining the higher pH range is, however, the one positive means of increasing the speed of CO<sub>2</sub> absorption, which the workman will always resort to, when pressed for time in gassing the amount of lime necessary for safe filtration.

Numerous investigations spread over a number of years have invariably confirmed the fact that a better preservation of reducing sugars, and a remarkable lowering of residual lime salts, have resulted by keeping the pH low during the simultaneous addition of lime and gas.

The enforcement of this very desirable procedure, was always defeated by the impossibility of keeping pace with the mill.

We must admit our failure in solving satisfactorily, the physico-chemical phenomenon of high CO<sub>2</sub> gas absorption, and out of many designs, the best of a bad job, is the system of perforated baffles that we have used since 1934, notwithstanding its known obstacles to circulation and homogeneous reaction.

Whilst fighting a losing battle at the carbonatation tanks, a mass of data have been accumulated on the ever changing conditions.

This work does not claim to have been conducted with the rigorous exactitude and unselfish academic outlook of pure research, but was necessitated through the day by day problems confronting the technologist, responsible for controlling process operations, and solving in a realistic way, the conflict between high production capacity and quality work, with an eye on economics.

These investigations cover a wide field, viz. gas absorption, glucose destruction, pH range during carbonatation, lime salt formation, colour, filtration and settling rates, filter cake washings, etc. the details of which would unduly lengthen this communication.

A few notes and figures are nevertheless presented.

The progressive action of carbonatation during the treatment of a first carbonatation tank lasting approximately 8 minutes follows a pattern expressed in the following table:

3,500 galls. Raw Juice at 70°C.	Galls. Lime Cream added 20° Be	Brix density	Purity	Glucose Ratio	pH	Lime Salts (milligrams per litre)
—	—	14.7	85.5	3.2	5.6	900
After 2 minutes...	200	13.5	88.8	2.6	10.8	800
„ 5 „	300	13.2	89.5	2.3	10.6	700
„ 8 „	420	12.7	90.6	2.1	9.7	600

### Final Limesalts after 2nd Carbonatation

In spite of a very accurate end-point control at the 2nd carbonatation, by factory pH meters, variations of 8.3 to 8.7 have very little influence on the final limesalt content of clarified juice.

This is governed by the nature of the raw juice, and especially the pH reaction during the lime addition at the first CO<sub>2</sub> stage.

The use of soda ash as a delimer at the second carbonatation has helped to reduce by 25 to 30 per cent the level of soluble lime salts, and in its turn definitely lowered the ash content of our refined sugar.

### Action of Carbonatation on the Mineral Impurities of Juice

In the course of the past 20 years the average ash content has been 3.48 per cent sucrose in raw juice and 2.39 per cent sucrose in clarified juice showing an inorganic impurity elimination of 31.1 per cent.

It is interesting to study the nature and percentage of the elements composing the mineral constituents of mixed juice and the changes that occur by clarification, on a representative sample collected for the whole crushing season.

TABLE II

	1945 SEASON			1944 SEASON		
	NATAL ESTATES (% composition of ash)			(% composition of Ash in Molasses)		
	Raw Juice	Clar. Juice	Exh. Mol.	Renishaw	Esperanza	Natal Estates
SiO <sub>2</sub> insoluble ... ..	11.37	1.61	.26	4.05	3.06	.74
Iron and Alumina ... ..	1.97	.34	1.02	2.26	2.22	1.18
P <sub>2</sub> O <sub>5</sub> ... ..	9.22	.89				
CaO ... ..	7.49	17.77	17.58	9.00	17.47	17.58
MgO ... ..	9.41	1.13	.45	9.02	4.88	traces
K <sub>2</sub> O ... ..	29.50	37.11	38.02	35.68	34.46	39.72
Na <sub>2</sub> O ... ..	2.99	2.81	3.20	2.68	1.92	3.22
CO <sub>2</sub> ... ..	.78	15.79	14.91	.30	.28	14.16
SO <sub>3</sub> ... ..	17.30	8.41	6.16	21.04	20.16	6.13
Cl. ... ..	12.50	18.53	23.52	20.35	19.60	22.49
	102.53	104.34	105.12	104.38	104.05	105.22
Deduct oxygen for chlorine ... ..	2.81	4.17	5.29	4.58	4.41	5.06
TOTAL ... ..	99.82	100.17	99.83	99.80	99.64	100.16

For comparison purposes the same determinations had also been carried out on the molasses ash of the CO<sub>2</sub> factory and two other sulphitation factories in the course of the previous season, 1944.

The relationship between ash in raw and clarified juice does not form part of the control of most factories, but one Zululand factory working by sulphitation had this information available and showed practically no drop and more often an increase after clarification.

The above table shows that carbonatation elimin-

ates completely magnesia, nearly all the silica, most of the iron alumina and phosphate.

It removes also a high percentage of the sulphate radicle, whilst increasing the percentage lime content mostly under the form of organic lime salts, appearing as carbonates, through incineration for analytical purposes.

The influence of cane maturity and the period of the crushing season on exhaustion of final molasses and the variations of some of its constituents is noted hereafter:

TABLE III

	CARBONATATION (Natal Estates)				SULPHITATION				
	Up to end of August	Sept.	Oct.	Nov.	D.K.	Gl.	Z.S.M.	RN.	Esp.
Apparent purity ... ..	41.75	43.51	44.55	45.15	36.95	41.39	44.92	42.74	39.39
Sucrose purity ... ..	42.79	43.10	43.96	44.82	38.25	40.02	44.64	43.30	40.11
Ash per cent Brix (carb.) ... ..	14.02	14.32	13.72	13.91	11.66	10.35	12.02	12.11	12.09
Glucose Ratio ... ..	27.8	23.2	21.0	17.2	47.3	37.45	30.10	29.30	36.40
Glucose/Ash Ratio ... ..	.85	.70	.67	.67	1.55	1.21	1.12	1.05	1.21
Alcogel percentage ... ..	2.09	2.89	2.80	2.39	5.65	5.43	5.35	6.30	5.71

### Wax Content of Filter Cake

A reference to old records on Uba days shows the remarkable change for the better that has taken place during recent years,<sup>6</sup> in the percentage of this refractory substance present in one factory refuse.

TABLE IV  
Wax (chloroform extract)  
per cent  
Dry Filter Cake

Ottawa... ..	17.54				
Gledhow ... ..	12.94				
Tinley Manor ... ..	12.14				
Tongaat ... ..	10.25				
Sezela ... ..	12.73	June	July	Aug.	Sept.
Mount Edgecombe ...	—	3.46	3.11	2.75	2.46

An industry for recovering cane wax from filter cake was a payable proposition at that time.

It is strange to find that worked on the tonnage of Filter cake, the total elimination of wax was not much higher in the carbonatation factory, being in the region of 3,140 lbs. of Wax per 1,000 tons of canes, against 3,214 lbs. for the sulphitation factories, which were experiencing great difficulty in filtering this refuse.

Further experiments at the carbonatation stage, showed that during this operation most of the wax had been saponified by the first small dose of lime, which formed a precipitate unfilterable at that stage—whilst the subsequent additions of lime cream and its carbonating were snow-balling this viscous mud, until it became filterable at the end of the operation.

Here are two examples of this investigation, carried out on factory products, collected during the normal progressive action of carbonatation, with lime cream added in 4 successive charges up to a total of 12 per cent on juice.

TABLE V  
Wax % Dry Cake      Nitrogen % Dry Cake

1st charge ... ..	9.28	5.59	.927	.908
2nd ,, ... ..	4.98	4.43	.828	.855
3rd ,, ... ..	2.36	3.76	.640	.738
4th ,, ... ..	2.87	2.51	.520	.608

These same tests showed that in what concerns nitrogen removal, there was a positive increase by the progressive lime treatment.

Although the nitrogen content of sulphitation cake is 1.25 per cent dry substance against 0.47 per cent in the more bulky carbonatation one, the total pounds of nitrogen removed per 1,000 tons of canes is 250 lbs. against nearly double that amount i.e. 498 lbs. in the case of the carbonatation factory.

### Gum Content

An objectionable viscous constituent of sugar liquors is "gum"—a complex substance more correctly labelled "alcojel" after the analytical procedure for its determination. It is probably related to that other villain "starch", the scapegoat lately loaded with so many sins.

A fairly close inverse relationship exists between filtrability and alcojel content.

The comparatively smaller percentage of this impurity in carbonatation products, whether thick syrups, molasses or sugars is the reason for their superior working quality.

The progress of its removal during the "refining" of a raw juice at the carbonatation stage is demonstrated in the following 4 examples:

TABLE VI  
Alcojel per cent Brix on  
Filtered Juice

Raw Juice (unfilterable) ...	Alcojel per cent Brix on Filtered Juice				Pentosan	
	4.42	2.47	3.07	—	% gum	% Brix
After 3% lime cream add. ...	2.02	1.72	1.54	.83	15.68	.131
" 5% " " " " " " " " " "	1.27	.93	1.08	.64	19.76	.126
" 8% " " " " " " " " " "	.53	.69	.85	.49	22.15	.109
" 10% " " " " " " " " " "	.52	.53	.24	.30	25.45	.087

### Purity Rise and Boiling House Recovery

This incursion in the behaviour of some non-sugars, very seldom studied in the usual factory control, is a confirmation of the statement that the unusual purity rise between raw juice and carbonatation clarified cane juice, must be accepted as a positive removal of non-sugars, and not as sometimes suggested a camouflaged destruction of reducing sugars, obscuring the nature and relationship of non-sugars, which are replaced by worse products of decomposition, from high temperature carbonatation.

This substantial purity rise—one of the highest in the world sugar industry—has seldom been under five degrees and is more often over.

The average of South African factories not using carbonatation is seldom over 1.5 and more often barely 1°.

The annual S.M.R.I. Summary of factory figures, brings definite evidence on this subject by the computation of non-sugars, where it is shown that 80 per cent of the original amount present in initial raw juice, still finds its way into molasses, against only 55 per cent for the carbonatation factory, through its more energetic removal at the filtration stage.

Unless this very reduced amount of non-sugars, has the power of carrying away a very much larger proportion of sucrose, and like beet juices cannot be brought down to a low purity molasses, it stands to reason that the carbonatation factory is in a more favourable position to recover a high percentage of crystals, than the others burdened with larger volume of molasses.

Notwithstanding the unfavourable glucose to ash ratio of our liquors, improved crystallisation technique has lowered the purity of final molasses—nearer that of other factories and it is definitely the shortage of pan and specially low grade centrifugals, that has been the obstacle to further progress.

The boiling house recoveries of most South African factories refer to the raw sugar production and do not divulge the ultimate results obtained on 100 per cent refined, as shown in our case.

The following table based on the elementary mathematics of the S.J.M. formula clearly shows the position for a 100 per cent white sugar manufacture, and the influence of juice and molasses purity on the boiling house recovery.

In practice the real boiling house recovery, will be found on a somewhat lower range, by the constant deduction of 1.5 per cent for losses in filter cake and undetermined.

TABLE VII  
BOILING HOUSE RECOVERY

Purity Mixed Juice	Defecation Sulphitation clarified juice	Purity Carbonatation clarified juice	Sulphitation Molasses Purity					Carbonatation Molasses Purity				
			40	39	38	37	36	45	44	43	42	41
84	85.5	89.0	88.69	89.16	89.60	90.03	90.45	89.89	90.29	90.68	91.05	91.41
85	86.5	90.0	89.59	90.02	90.43	90.83	91.22	90.91	91.27	91.62	91.95	92.28
86	87.5	91.0	90.48	90.87	91.24	91.61	91.96	91.91	92.23	92.54	92.83	93.13
87	88.5	92.0	91.34	91.69	92.04	92.37	92.69	92.88	93.17	93.44	93.20	93.96

In working out this table we have liberally conceded a 1.5 purity rise for the other process and limited the carbonatation to the bare 5°.

Within the usual range of South African mixed juice purities say 85, we see that it is possible to exhaust the final molasses with a purity as high as 44 in carbonatation, and still be slightly better off than a defecation sulphitation factory exhausting down to 36—a low level reached by two mills, whilst the rest are nearer 40 this season.

On the other hand, the same carbonatation factory, if provided with well balanced boiling house equipment, starting from an 86 purity mixed juice and exhausting its molasses to 41 purity would still be 1.7 per cent better off in recovery than the others, after a major effort to lower their final molasses to 36 purity from an 86 juice purity start.

This is much in accordance with previous Javan experience, where the carbonatation factories were usually 1 to 2 per cent ahead of the others in their boiling house recovery.

The money value of this improved recovery on a 100,000 tons sugar crop at the average selling price of sugar, represents a substantial source of revenue, that goes far to compensate the heavy chemical bill incumbent to the process.

In going back to the cheaper juice clarification methods, after spending the capital necessary for the altered type of equipment, there is a risk of sacrificing the potential extra boiling house recovery unless the purity of molasses is lowered a further seven degrees on the present range (42 to 45).

Other imponderables, together with the very evident saving in the limestone bill have been the decisive factor, in this triumph of economics over technique.

#### REFERENCES

- <sup>1</sup> Farnell, R. G. W. 1925. I.S.J. 254.
- <sup>2</sup> Proceedings, 33rd Congress, S.A.S.T.A. pp. 65 and 68.
- <sup>3</sup> Proceedings, 32nd Congress, S.A.S.T.A., p. 37.
- <sup>4</sup> Journal of Industries, S.A., Oct. 1920.
- <sup>5</sup> J. Rault, Working with the Carbonatation Process. Proceedings, 20th Congress, S.A.S.T.A. p. 40.
- <sup>6</sup> Fertilizer value of Filter Cake. Proceedings, 16th Congress, S.A.S.T.A.

**Mr. Boyes** asked Mr. Dedekind if the carbonatated lime was used again after being passed through the Dynocone centrifuge.

**Mr. Dedekind** replied that carbonatated lime was not used again but sent into the fields. The Dynocone centrifuge was an ingenious piece of machinery which seemed to be most satisfactory in its operation.

**Mr. Eddings** asked Mr. Chiazzari—

- (1) What methods were used to measure and control pH at the saturators?
- (2) Why was it felt desirable to apply accurate automatic pH control?
- (3) What are the effects subsequently observed on the process when the pH of liquors in the saturators is allowed to fluctuate?

**Mr. Chiazzari** replied that for Nos. 1 and 2 saturators, straight titration with N/28 HCl was used, and in No. 3, sometimes phenol red solution and sometimes titration with N/100 NaOH, depending upon filtration qualities and the desired pH. Owing to the high pH prevailing in No. 1 saturator, requir-

ing a large volume of CO<sub>2</sub> and also the necessity to quickly reduce the high alkalinity, this meant a rather onerous task would be imposed on any pH controller. Nos. 2 and 3 saturators and sulphitation are very different propositions, the control being within comparatively narrow limits and so more readily adapted to instrumentation.

**Mr. Perk** asked Mr. Chiazzari did he intend adjusting the pH by controlling the gassing or by adjusting the lime, and might not any attempt to adjust it by gassing interfere with the proper working of the lime kiln?

**Mr. Chiazzari** replied that the gas from the lime kiln was practically constant and the control would be by gassing. He said they always had an excess of gas which was blown off into the atmosphere. The gas in the saturator went in at constant pressure and because lime was also burnt for the raw house there was always a surplus of gas.

**Mr. Rault** said Mr. Chiazzari was wise in using the gas from a lime kiln for conducting his carbonatation of melt. Those refineries who had to rely on the low concentration of CO<sub>2</sub> in flue gas were always limited in the possibility of additional lime treatment for better filtration. The gas absorption efficiency was so low with a 10 per cent CO<sub>2</sub> gas content that this had to be balanced by a huge pumping plant and size of carbonatation tanks and prolonged time of gassing. The worst feature was the high alkalinity level at the first liming tank in order to promote speed of absorption. He felt that the long gassing time, sometimes presented as a help for filtration, was really a necessity called a virtue.

**Mr. Noel** was surprised at the number of techniques used to produce the same quality of refined sugar. He considered there must be one method which was more economical than the others.

**The Chairman (Mr. Bentley)** said that at the moment all methods had their own supporters.

**Dr. Douwes-Dekker** had hoped that some sort of an answer to that question would have been put forward today. He was sure that in the course of time, with the five different processes in use in this country, it would be possible to determine which was the most economical.

**Mr. Alexander** asked Mr. Thumann if a special type of vegetable carbon was to be used at Umfolozi to facilitate ash removal.

**Mr. Thumann** in reply said he did not expect any ash removal at all from treatment of the liquor with activated carbon.

**Mr. Young** asked Mr. Thumann how fouling of the electrodes in the pH meter had been overcome.

**Mr. Thumann** replied that this was due to the type of glass now used. A certain amount of fouling,

however, still took place, but it was not of much importance, because electrodes could normally be used for several hours.

**Mr. Antonowitz** enquired whether Mr. Thumann meant that it was the quality of the glass electrode which kept it clean, and that no special procedure was necessary to prevent fouling.

**Mr. Thumann** said in reply there were several different types of instruments, some fouled up quicker than others. Nowadays with the better quality of glass used, excessive fouling need not be experienced.

**Mr. Beesley**, in answer to a remark about the poor ash removal of vegetable carbon, pointed out that Norit carbon was used at Illovo and that the refined sugar had a very low ash content.

**Mr. Alexander** said he was referring to the removal of ash by vegetable carbon and not the amount of ash left in the sugar as such.

**Mr. Dedekind** asked about the cleaning procedure at Umfolozi and at Hulsar as far as the cleaning of tubes was concerned.

**Mr. Thumann** said the quality of the liquor was such that there was very little deposit on the pan tubes.

**Mr. Alexander** explained that they had some scaling of their calandrias. He thought this was mostly due to calcium sulphate left on the strips from the previous process. He thought the answer to that problem was by boiling out with caustic soda.

**Mr. Dedekind** asked if it was a mild steel ribbon that was in use at Hulsar.

**Mr. Young** said that the pans used did not require a lot of cleaning as there was very little scale built up.

**Mr. du Casse** said he noticed that a 22-23" of vacuum was used at Umfolozi and he asked at what temperature the pans were boiling and was there no risk of entrainment at what was probably a very high temperature?

**Mr. Thumann** replied at 150-155°F. He considered there was no risk of entrainment by boiling under a vacuum of 22-33". Boiling can be done under any vacuum and entrainment will not take place if the vacuum is not altered suddenly.

**Mr. du Casse** said that in his experience boiling at 22/23" of vacuum, the temperature would be over 150°F and one would have trouble with water getting into the vacuum pump. If the pan was boiling at a high temperature it had to be eventually cooled down and he said that by dropping the temperature one was bound to have entrainment.

**Mr. Thumann** said that at Umfolozi they had no trouble with water getting into the pump as they had an air extractor. The level of the massecuite in the pan was only about  $4/4\frac{1}{2}$ " above the tube plate. He did not consider the temperatures used at Umfolozi unduly high, in the first place because of the low level of massecuite and secondly because of the high grade of the massecuite. In raw sugar C massecuites when the Brix was 99/100° one could anticipate a temperature of about 170°F. The higher the level of the pan the more the risk of entrainment.

**Dr. Douwes-Dekker** agreed with Mr. Rault that it was a pity that this more or less ideal method of juice clarification is now being abandoned. He said this was also happening in Java for the simple reason that the carbonation process was too expensive to use in sugar manufacture. We could be pleased that the carbonation process was still

being retained, not in application to mixed juice, but to refinery melts. This was because the carbonation process was more efficient in a high density medium than in the low density and that is why its use was continued in refinery processes.

**Mr. Carter** said on behalf of his colleagues who had joined the Industry in 1922 he would like to pay a tribute to Mr. Rault for his tuition at the Technical College which laid the foundation on which they had built over the years.

**The Chairman (Mr. Bentley)** also paid tribute to Mr. Rault on his retirement, saying that not only had he been an active member of the Council but also an active member of the Association. He said that he was sure Mr. Rault would continue to attend our meetings, so this, as far as we are concerned, was not really his swan song.

We hope to see him for many years to come.