

# SOME REMARKS ON THE EXHAUSTABILITY OF FINAL MOLASSES, ON THE WINTER RATIO, AND ON THE DETERMINATION OF THE COLOUR OF WHITE SUGAR

By K. DOUWES-DEKKER.

As this is the first opportunity I have had to address you, I think it may be opportune to make a few introductory and explanatory remarks before I proceed to more technical matters.

When the President of this Association asked me to address you at your twenty-third Annual Congress, I very gladly acquiesced because it gave me the opportunity to start right from the beginning, a firm contact between this Association and the young Sugar Milling Research Institute; such contact, in my opinion being one of the main conditions for the healthy growth of this Institute.

I was connected with the Pasoeroean Experiment Station for twenty years and as a matter of course I was already acquainted with the publications of the Natal Sugar Industry, viz. the Proceedings of your Association and the South African Sugar Journal. That is why I feel here as among friends, and I know that the high standard of efficiency achieved in this Industry is due to your unremitting efforts and to the scientific approach to the different problems of your mills. In fact, to be honest, I was a little amazed that this standard was achieved without the assistance of a central research organisation. This does not mean, of course, that I now doubt the value of such an organisation to the Industry, but it means that in my opinion, the mills' technologists have excellently contributed to this result. Not only that the efforts needed for improvements must have taken a good deal of your spare time, but these efforts were directed in a real scientific way. I congratulate you on this remarkable performance.

And now this new Research Institute is to be established. The plans took a few years to find their definite shape. The Proceedings of the Annual Congresses prove that you took a great interest in these plans, and I am very glad about that. For the results of the work of a Research organisation may be excellent and scientifically quite sound, but if they are not applied in the mills, they are more or less useless. And unless there be established a firm contact based on mutual appreciation and interest between the S.M.R.I. and the mills' technologists, our results might not be applied. So the main reason of my rejoicing at your President's suggestion to speak to you, was to get the opportunity to tell you of my conviction of the necessity of collaboration between you and the Institute.

The task of the Institute is to serve. It will be staffed and equipped in the proper way to give you all the assistance and enlightenment you may need. We are anxious to know your problems and we hope to be of use in their solution. But you will appreciate that it will take a certain time before the work will be in full swing. For the present, the Institute is very small, but we are sure that it will gradually extend into a full-sized organisation. In this process of growing, we shall need your assistance and kind consideration. We may ask you for data and other information about the mills, we may require your time and assistance when we visit your mills, so to get completely abreast of the relevant factors. In short, I am afraid, that in the beginning, we may be more of a nuisance than a help. But from the words of the speakers of last year's congress, I understand that you feel the necessity of co-operation and will render your assistance with pleasure.

Under these circumstances, I am convinced of the success of the great experiment we are going to make, that is to build up this unity of centralised research and practice which nowadays is so urgently needed for the further development of the Industry.

Up to the present, researches were executed by the members, and often under the direction of the Association, and the question has arisen whether, by the S.M.R.I. now taking over the research for the Sugar Industry, there will be left for you any work in this line.

My answer to this question is unconditionally "Yes." And this, not because the young research institute cannot tackle all problems at one time, but because there are so many problems in the mills which are better solved by the man on the spot. The literature of all countries with a highly centralised research organisation proves that there are always technologists at the mills who carry on research with excellent results. Personally, I shall encourage as much as I can experiments made by mills' technologists, and I hope that if you feel so, you will discuss your problems with me.

There is another point about which I want to say a few words. I know there is a strong feeling amongst you that the best place to accommodate the Research Institute is somewhere in the sugar belt, because you are afraid that any other place will adversely influence the close contact between the mills and the

Institute. Especially, if I am correctly informed, the opinion prevails that accommodation at Howard College could divert the interest of the staff members of the Institute away from the urgent needs of the industry to what, more or less vaguely, is called long term research. As I have said before, as a consequence of my career in sugar research, I am not less than any one of you convinced of the necessity of a firm contact between Industry and Research Institute, but, in my opinion, this contact depends less on the location of the Institute than on the personal feelings and endeavours of those involved.

And as to the balance of long-term research, and day-to-day problems, well, I am sure that the golden mean can be found without excessive difficulties.

I do not think that I need say more on this subject. In the years to come, there will be ample opportunity to review our results and plan for further progress.

The main thing is that we keep in mind our ultimate purpose of furtherance of the application of the most economic methods in the manufacture of sugar from sugar cane in South Africa, and that we shall always remember that this purpose can only be reached by the joint efforts of research and practice.

As a matter of fact, I pondered some time on the subject to speak about this afternoon, and finally decided to select it from some of the questions raised in the talks I had with sugar people in the few weeks I have now been in South Africa. These questions seemed to be of immediate interest, and anyhow it is always profitable to discuss from time to time, a problem which has never been completely solved, but which keeps returning in our mills, often in a new setting.

I will divide my subject in three parts which are all related to the method we use to judge the results of a mill.

The first part deals with the exhaustability of the final molasses. Not so long ago when visiting a mill—not in this country—the figure for the purity of the final molasses was produced, and I was asked for my opinion on it. Of course this question was silly. I mumbled something like “not bad” and matters were left at that. But if one really wants a constructive criticism on the exhaustion of a final molasses, it should be understood that much additional information on a number of the chemical properties of this liquid must be available.

It is nearly sixty years ago that Prinsen Geerligs directed his attention to the nature of the final molasses and after him, quite a number of chemists have given their opinions on the subject. Solubility theories, the eventual formation of complex com-

pounds between sucrose and salts, the phase rule, all played their part in the efforts to find the final solution of the problem. As a result, and after discarding all irrelevant and insufficiently proved conceptions, we nowadays are inclined to consider final molasses simply as a liquid with a distinct solubility for sucrose depending on concentration and temperature. We know this solubility is not equal to the solubility of sucrose in the water present in the final molasses and it has not been sufficiently investigated how it depends on the non-sugars present. But—and this is the main point—we know that this solubility is decreased by increasing the concentration, that is the brix, of the molasses and by lowering the temperature. By these manipulations, the molasses will become supersaturated and theoretically the supersaturated sucrose will be forced to crystallize. Practically, however, we are limited by two factors. By lowering the temperature and by increasing the concentration (brix), the viscosity will become so high that the molasses is no longer manageable and in the second place, the velocity of crystallization will become so small that it is not worth while to wait for the extra amount of sugar to be crystallized. I do not know which of these two limitations is more important and comes in first; neither has it been established that the influences of the increase of the brix and the decrease of the temperature on the increase of the viscosity and on the decrease of the velocity of crystallization respectively, are the same. However, we are perfectly justified in maintaining that there is an upper limit of the viscosity of the final molasses which for practical reasons cannot be increased. Every mill should know this maximum viscosity. McClerey<sup>1</sup> mentions as the average working viscosity for Hawaii, 377 poises and as the tentative purging viscosity standard 600 poises which “could with good economy be raised to 1,200.” When this is known, it is the task of the chemist to find out which is the lowest purity possible at this viscosity.

To solve this problem he has to find experimentally the relationship between the viscosity and the purity of the final molasses of the mill concerned, for which investigation a great number of viscosity determinations are required.

Depending on the concentration and the temperature, an infinite number of viscosities are possible at the same purity. Therefore, it must be previously decided at which concentrations and temperatures the viscosity should be determined, so to be representative for the purity of the sample.

I already mentioned that a final molasses has a distinct solubility for sucrose. Therefore, it is possible to discern between a saturated and a supersaturated molasses. It is obvious that for our purpose it is quite sufficient to restrict the viscosity deter-

minations to the exactly saturated final molasses, as this is the kind of molasses we want to spin off.

The way to proceed is as follows :—

A number of samples of different purities of one final molasses has to be prepared either by forced crystallization under ideal laboratory conditions, or by fixing the required purity by the addition of sucrose (and water). Each sample has to be divided in a set of sub-samples of different concentrations (but the same purity), and of each of the sub-samples, the saturation temperature has to be determined with the aid of the saturascope. Then the viscosity of the sub-samples should be determined at their saturation temperatures. In this way every set of sub-samples will render a relationship between viscosity and concentration, each relationship being characteristic of the purity of the sample the sub-samples were derived from.

Micheli and de Guylay<sup>2</sup>, who published an extensive investigation into these relationships, found the viscosity to be but slightly dependent on the concentration. In most cases, however, there was a concentration (and temperature) of minimum viscosity, the value of which varied with different materials. By determining this minimum viscosity for all samples of different purities derived from the same molasses, the relationship between minimum viscosity and purity could be found, and from the curve of giving this relationship and the working viscosity of the mill, the standard of purity to be aimed at, might be easily inferred. But as far as I know, this last kind of relationship has not yet been established in an actual case. I was occupied with such investigations when the war interrupted and I regret not to be able to give you more than the general idea of them. The merit of the method is that it may give us, for the first time, the target of purity in terms which can be found empirically, since it must be possible to determine experimentally the maximum viscosity capable of being handled by the equipment.

To those interested in the question why these purity-viscosity relationships have not been investigated long ago, I should point out that the saturascope and the Höppler viscosimeter, both of which are needed for the determinations, are of relatively recent origin.

The described method has one big drawback. The determinations of all these viscosities needed for the complete picture take much time and trouble, and the laboratory of a normal mill is not suited for this kind of special research. Yet by making these determinations for a number of mills, we may find why a purity easily reached by a certain mill, will never be reached by another one. This phenomenon, of course, is related to the difference in the com-

position of the non-sugars of the final molasses, and it has been suggested twenty years ago by Sijlmans that the inorganic non-sugars are mainly responsible. Experimentally found data, however, are not yet available and much work has to be done before the complete interdependence of all properties involved is known.

Besides this experimental method of judging the exhaustion of a final molasses, other ways are available. They mainly consist of a comparison with a statistically found standard such as the purities of previous years or the purity obtained by a neighbouring mill or a sister mill, etc. Sometimes more elaborate methods are applied.

Pagnier<sup>3</sup> determines the difference between the exhaustion of a final molasses and an experimentally found minimum purity, and subsequently judges this difference by comparison with a standard based on experience.

Sijlmans<sup>4</sup>, who had the disposal of the complete analysis of the samples of final molasses of not less than 90 mills, calculated a formula relating the "practical exhaustability" of a final molasses to the composition of the non-sucrose.

This formula was based on a special theory on the specific influences of the reducing sugars and of the ash constituents on the exhaustability of final molasses, which theory was later on proved not to be in complete accordance with the facts. Therefore, it was necessary to calculate a new formula which I undertook to do in 1940.

It is generally agreed that the exhaustability of a molasses is mainly fixed by the composition of the non-sucrose, and it is not far-fetched (at least not for Java molasses) to represent the composition of the non-sucrose by two figures, viz. sulphated ash per cent. non-sucrose and reducing sugar per cent. non-sucrose, non-sucrose being dry matter minus sucrose, as determined by double polarization.

Further, if of a great number of final molasses are known—

(a) the purity,

(b) sulphated ash per cent. non-sucrose,

(c) reducing sugars per cent. non-sucrose,

it is fairly simple to find, mathematically, a formula stating the general relationship between these non-sucrose compositions and the purities. In this way, from 150 different Java molasses, I calculated this formula :—

$$Y = 35.886 - 0.08088 x_1 + 0.26047 x_2.$$

where  $x_1$  = reducing sugars per cent. non-sucrose.

$x_2$  = sulphated ash per cent. non-sucrose.

As anticipated, the influences of reducing sugar and sulphated ash, proved to be opposite.

By applying this formula to any molasses, the non-sucrose composition of which, as represented by  $x_1$  and  $x_2$  is known, the so-called "reasonable" purity (Y) can be calculated. The "reasonable" purity of a final molasses agrees with the average exhaustion of the 150 molasses taken for the calculation of the formula which is representative for the average technological performance and equipment of the Java mills in 1938 and 1939.

This formula will not necessarily apply to other countries, but in spite of all its shortcomings it has given many definite clues to molasses with unacceptable, but not excessively high purities. On the other hand, it showed clearly that some very high purities were merely caused by the properties of the non-sucrose and not by deficiencies of the equipment or the operation. As a whole the formula was useful and sufficiently reliable.

Next I wish to draw your attention to a number of figures relating to the quantitative performance of the boiling house. Zerban in his System of Cane Factory Control of the I.S.S.C.T. says: "This subject is in a bad state of confusion, because, not only the terms used, but also the methods of calculation vary markedly in different countries." Then, not less than eight different "recoveries," one "performance" and one "yield" are defined.

The confusion in my opinion, is partly of historic origin and partly a consequence of the different conditions under which the sugar industry is run in the different countries. Let us take as an example, and just to show that we should not forget that there is also a sister sugar industry, the beet sugar industry of former years. Here, all the factories using the beets, purchased on a weight basis from the farmers, manufactured a raw sugar of a more or less uniform polarization. As a matter of course the performances of these factories were expressed in the amount of sugar produced per unit weight of beets. On the other hand, in Java, where the mills grow their own cane, the overall performance of an estate was best expressed as the amount of sugar made per unit of land from which the cane was harvested. It is quite comprehensible that this last kind of figure was not interesting to the beet sugar industry, because to the owner of a beet factory, the amount of beet harvested per unit of land was only of secondary importance. However, it soon became evident that both figures did not administer full justice to the technological performance of the factory, in the restricted sense of the word. Not only did the sucrose content of the raw material vary from factory to factory, but with the introduction of white sugar manufacture by the mills, the differences in the sucrose contents of the sugars of different factories became inadmissably great. Mutual comparison of the factories was no longer feasible on the basis of

such figures. It became necessary to introduce a new unit applicable to both types of factories in which the differences of the raw material and of the product were accounted for. At the same time, it seemed desirable to separate the boiling house from that part of the factory where the raw material was extracted. The new figure was called the Boiling House Recovery and was defined as sucrose (pol) in sugar produced per cent. sucrose (pol) in mixed juice. This figure is in use in the whole sugar industry and is recognised by the sub-committee on uniformity in reporting factory data of the I.S.S.C.T.

For the purpose of criticising the performance of a mill the B.H.R. is a definite improvement on the figure which gives sugar per cent. cane or beet, but it is far from being perfect. It does not take into account the differences in purity of the mixed juice, and it, in fact, presupposes the pol of a sugar to be its true standard of value. The figure does not make clear that the ultimate purpose of a sugar factory is to manufacture crystallized sugar.

About half-a-century ago, Winter tried to meet the first of these objections, and after carefully studying the performances of a number of raw sugar mills, he expressed the standard performance of such a mill as:—

$S.M. = S - 0.4(B - S)$ , in which formula—

S.M. means Standard Muscovado,

B = brix mixed juice,

S = pol mixed juice.

Winter's formula states that the amount of standard muscovado normally to be expected from a mill can be expressed by subtracting from the pol of the mixed juice 0.4 x the difference of the pol and the brix of the mixed juice, standard muscovado being defined as a raw sugar of 96.5° pol and 0.7 per cent. moisture and the Winter ratio is the proportion between S.M. actually made and S.M. calculated by the Winter formula.

The co-efficient 0.4 takes into account the average purity of the final molasses in the beginning of this century and the normal losses of the mills in filter cake and "unknown." So a normal mill was characterized by a Winter ratio of 100. However, in course of time one learned to push down the losses of the mills and also the purity of the final molasses, and a Winter ratio of far over 100 became normal. Simultaneously, the production of white sugar increased considerably, and the conception of S.M. became obsolete and unsatisfactory for purposes of comparison. Next step, therefore, was to change the definition of the Winter formula, this formula no longer stating the amount of S.M. to be expected from a mill, but the amount of crystallized sucrose

in sugar or "crystal." The Winter formula applied to mixed or any other juice states the amount of available crystal in this liquid.

To calculate the Winter ratio, the crystal content of the produced sugars should be known. They are calculated on the supposition that a sugar consists of 100 per cent. pure crystallized sucrose, plus a certain amount of molasses, the purity of which is taken to be equal to the purity of the final molasses of the mill concerned.

Of course, the Winter formula is not infallible, its main drawback being that it does not take into account the differences in the composition of the non-sugars of the mixed juice. Nevertheless, the Winter ratio is a distinct improvement on the B.H.R. and serves admirably for many purposes. It has taught us for example, the influence of the method of juice clarification on the yield of the mill.

For the defecation, the sulphitation and the carbonation method, the following average figures were found in Java :—

	Defeca- tion.	Sulphita- tion.	Carbona- tion.
Removal of non-sugars %			
non-sugars in mixed juice	12.7	11.7	27.9
Winter ratio ... ..	98.0	97.0	99.0

It is interesting to know that the average amount of lime used in the sulphitation method was nearly twice as high as the amount of lime used in the defecation method. Nevertheless, more non-sugars were precipitated by defecation than by sulphitation, the amounts being calculated by the rises in purity of the juices. But, I suspect the low Winter ratio of the sulphitation mills to be not only a consequence of this slight rise in purity, but to a certain degree, also of sucrose losses caused by inversion, because sulphitation factories manufacturing white sugar are likely to sulphitate their syrup rather heavily. The important fact remains, that we know that, as an average, the carbonation factories made 2 per cent. more crystal than the sulphitation factories, and the defecation factories 1 per cent. more.

Any abnormality in the Winter ratio of a mill has to be explained. I happen to know of a carbonation factory with a Winter ratio of 95.8. The non-sugar elimination was reasonable, being 27.2 per cent., so sucrose was lost somewhere. Indeed, the unknown losses were 4.3 per cent. and the purity of the molasses 3.70 higher than the "reasonable" purity.

The Winter ratio has not been introduced in all sugar producing countries. I suppose the custom of paying the farmers on a sucrose base is more or less unconsciously responsible for this fact. Indeed, it seems rather difficult to explain that only part of the

sucrose in the delivered raw material is available for crystallization due to its being accompanied by an unknown amount of non-sugars, the other part for this reason being of small value. But this is what the Winter formula clearly indicates, and by acknowledging this fact, it is a better criterion for the technological performance of a mill than the B.H.R.

In the last part of my lecture, I shall not discuss a facet of the quantitative performance of a mill, but some features related to the quality of the product.

I once met the General Manager of one of the big Japanese sugar firms, and he told me he did not agree with the efforts of the sugar chemists to manufacture an even purer and whiter sugar. In fact—he said—"they do not want to manufacture a foodstuff, but a chemical." The remedy he suggested was to add vitamins and hormones to sugar and to evade in this manner the criticisms expressed in certain countries. I do not propose to entertain you on the subject of vitamins in sugar or molasses, although there is at the moment a certain interest in this matter. I will deal only with the more old-fashioned kind of sugars.

Chemical, physical and bacteriological analysis of a sugar sample now allow us to express the relevant properties of this sample by a number of figures which together represent a much better judgment on its quality than ever could be arrived at by the old subjective method of visual inspection.

The approach to some of these figures, however, has caused many difficulties. One of the most tricky analytical problems, for example, has always been to express the colour of a solid in unambiguous figures.

Nowadays, this problem has been completely solved by the building of highly ingenious instruments with the aid of which, the percentage of light reflected by a sample of the solid can be measured from wavelength to wavelength throughout the whole visible part of the spectrum. In this way the so-called reflection curve can be constructed, which curve is the physical equivalent of what we usually call colour. Some of the instruments to be used in such determinations are completely automatic, and by pressing a button, the reflection curve of a sample will be recorded in a few minutes. Simultaneously, with the development of better instruments, our knowledge of the fundamentals of colour vision has deepened and the third important item was the international standardisation of the units in which the results are expressed. It would take me more than one morning to describe all details of this work. It may suffice to give you some results of special interest in specifying the colour of white sugar.

What is white sugar? Apparently a sugar with a white colour. But what is white colour? Here opinions begin to diverge. If we take two samples of white sugar it is, as long as the difference in colour is not too small, easy to tell which is whiter. But if the difference becomes smaller, Mr. A. will tell us that this sample is whiter, because the other one has a greyish tinge. Mr. B., however, will favour the opinion that the greyish sample is whiter because he objects to the somewhat yellow tinge of the other one. Apparently here is a need for arbitration, for a method to settle unambiguously which sample is the whiter. We wish to express the whiteness of a sugar by one figure with which comparison of samples is simple and reliable. Now it is feasible to determine under standardised conditions, the reflection curve of a sugar sample and the modern theory of colour vision allows us to express such curves in three sets of figures. To elucidate this point, I should remind you of the law of Grassman which states that every possible colour can be matched by a mixture of a standardised white and a primary colour. The primaries are the monochromatic colours of the spectrum, and the system of specifying a colour in such terms is called the monochromatic system in contrast with the trichromatic system, the use of which is less suited to express the colour of nearly white materials. To define a colour of a solid in this monochromatic system, we merely have to calculate from the reflection curve:—

- (a) the brightness of the colour relative to a pure white previously defined.
- (b) the proportion of primary and white necessary to match exactly the colour of the sample. This proportion is generally called saturation.
- (c) the wavelength of the primary.

A low saturation means a nearly white colour, and when the saturation is zero, the colour according to its brightness, will find its place in the series of white via grey, till black. The colours of a photographic negative, for example, have zero saturation. 100 per cent. brightness, which can only be reached by a white body, is equal to the standard.

A first grade refined sugar may show the following figures:—

Brightness	75 per cent.
Saturation	5 per cent.
Dominant wavelength	580 m.mu.

A good plantation white may be characterised by:—

Brightness	68 per cent.
Saturation	10 per cent.
Dominant wavelength	580 m.mu.

It has been proved that the dominant wavelengths of all white and near-white sugars are practically the same. So the important figures are brightness and saturation, but as I pointed out to you, we want

only one figure on which to base our opinion of the colour.

Therefore, the next question deals with the relative value of these terms. We may put it in this way: is a sugar characterised by a brightness of 70 per cent. and a saturation of 15 per cent. whiter, or less white, than a sugar characterised by a brightness of 63 per cent. and a saturation of 5 per cent.? The first one will have a light yellow tinge, the second one will be greyish. It is clear that no physical method can be used to solve this question, which is of a psycho-physiological nature.

To get an answer, however, a simple method was devised. We selected 20 samples of white sugar, the whitest being the best carbonatation white we could find, the others gradually coming down to a three years' old sulphitation sugar of decidedly brownish tinge. The reflection curves of these samples were determined and their brightness and saturation values calculated.

The next step was to submit the samples to the judgment of different groups of experts on sugar quality. The first group was formed by managers and chemists of the mills, the second group was selected from brokers and sugars export firms, the third group was supposed to be neutral and was formed by staff members of the Experiment Station, and the fourth one represented the consumers, and was formed by a number of housewives. Each expert was asked two questions. In the first place, he or she, was required to arrange the sample in sequence of whiteness, and in the second place, he or she, was to state which samples could be classified as "white" and which samples were not entitled to this description.

As a whole there was a fair agreement in the relative position of the samples as arranged by the observers, though there happened to be quite unpredictable deviations from the average sequence. Attempts were then made to relate this average sequence to a combination of the figures for brightness and saturation as calculated from the reflection curve. A satisfactory agreement was found by subtracting half the saturation from the brightness. This new figure was called the remission value;  $R.V. = B - \frac{1}{2}S$  and expresses in one figure the generally acknowledged whiteness of a white sugar.

The answer to the second question, was that samples with a R.V. above 61 were, according to *communis opinio*, entitled to be classified as white.

An interesting feature of this inquest was that, as a whole, the housewives proved to be the best judges of colour. Their mutual agreement in placing the samples was greatest and their individual sequences closest with the sequence of the R.V.

I am sorry to report that the mill experts exhibited the largest deviations from the R.V. sequence. It is further worth-while to note that, in a similar inquest held in Holland by the Textile Research Institute, it was also found that the ladies possessed the greatest ability to judge a colour.

Now you must have noticed that there is one point I have not yet mentioned, that is, the influence of the size of the crystals on the whiteness of a sugar. If from a certain basic material, say syrup, a coarse and a fine grain are boiled, cooled, centrifuged and dried under exactly the same conditions, the finest grain will show the whitest colour, although the content of coloured matter in both sugars will be the same. The fine sugar is even likely to possess a slightly higher content of coloured impurities. The R.V. of the finer sugar consequently will be higher, and to compare the intrinsic properties of the coarse and fine sugar we must in some way, allow for the size of the grain. This was found to be possible. By a simple formula, the R.V. could be reduced to a grain size of 1 mm., and this new value was called the reduced remission value. The R.R.V. tells what the R.V. of a sugar would be if the grain had an average size of 1 mm., all other properties being the same.

In a number of years, the R.V. has proved to be of excellent value in judging a sugar. Sugars of different years could be compared and also the keeping qualities of a sugar were established without difficulty. The R.V. proved to be superior to the results of any determination of colour properties of the solution of the sugar. A drawback was, the great amount of time taken by the determination of the reflection curve for which purpose the König-Martens spectrophotometer was used. But this difficulty can nowadays be overcome by the use of an automatic electric photometer, the price of which, however, seems to be more or less prohibitive.

I should perhaps point out that the R.V. is to be applied only to normal near-white sugars of low saturation. For darker raws, the colour should be expressed by the monochromatic system. In this case, however, I prefer to investigate the properties of the solution of the raws because in refining the raw sugar, it is the solution which is to be processed.

#### REFERENCES.

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- <sup>2</sup> Micheli and de Guylay (1940), *Int. Sugar Jnl.*, **42**, 144.
- <sup>3</sup> Pagnier (1940), *Archief Suikerindustrie Nederl. Indie*, **1**, 529.
- <sup>4</sup> Sijlmans (1934), *Archief Java Suikerindustrie*, **42**, 167.

Sugar Milling Research Institute,  
Howard College,  
Durban.  
April, 1949.

The PRESIDENT thought that if the lecture were an example of what the Milling Research Institute would provide, this Institute would be most valuable. He was glad the speaker placed so much emphasis on the viscosity of molasses and the viscosity and purity relationship. The speaker had also expressed the view that the dominant factors in determining the exhaustibility of molasses were sulphated ash and reducing sugar ratio. Our results were often compared with those of other countries, but it should be remembered that reducing sugar content was much lower, and sulphated ash rather higher in our molasses, than in those of other countries. Organic non-sugars were not apparently taken into consideration at all, and he asked whether there were organic compounds such as gums which might have an effect on viscosity.

Dr. Douwes-Dekker has referred to boiling-house recovery and efficiency standards. We had used certain efficiency standards in the past to which he had not referred. These were reduced boiling-house recovery and boiling-house recovery, E.S.G. There was a serious objection to the reduced boiling-house recovery, in that this figure was a function of the actual purity of the molasses, without the purity of the mixed juice being considered as one of the factors affecting the actual purity of the molasses. As the lecturer had mentioned, with a low purity of mixed juice one could expect a low purity of molasses, and countries working with a high juice purity, such as South Africa, were treated unfairly when comparisons were made.

Mr. DUCHENNE considered it would be very good to have a scientific basis for calculating the virtual purity of molasses, rather than, as at present, assuming 0.40 as the value of M in the S.J.M. formula. He thought that work should be done on the classifying of white sugar in a manner similar to that proposed by Dr. Honig at the ninth congress of the International Society of Cane Sugar Technologists. As far as colour measurement was concerned, he enquired if the "Lovibond" colorimeter might not be suitable for routine measurements.

Mr. RAULT asked what the highest Java standard was for white sugar. One could go on improving until one had a pure chemical, but he asked who was to decide what would be the standard for the best white sugar?

Dr. DOUWES-DEKKER, replying to Mr. Duchenne, said that it would not be as easy as in Java to find a simple, statistically accurate formula, because of the small number of factories. The best thing would be to find by experiment the purity to which the final molasses could be exhausted. One of the available methods was based on the determination of the viscosity of the molasses at different concen-

trations and temperatures. It is anticipated that by this method, a definite clue to the problem could be found. In Java, where the requirements were high, other makes of colorimeters were preferred to the "Lovibond."

In reply to Mr. Rault, he thought it too much to describe in a few words how standardisation was worked in Java. At a later time there would be ample opportunity to discuss this subject, as the Government now intended to introduce standardisation of sugar.