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efficiency in our economic machinery. This is not the place, nor have I the time, to deal with this matter more fully, but a little reflection will show that both producers and consumers stand to gain very greatly by improving our system of distribution and by reducing the enormous difference between the farmers' price and the prices which are paid by the individual consumers.

This paper has taken the form of a general survey and, as such, I trust that it has not been without interest. Many of the problems dealt with do not directly concern the sugar producers, but many here are interested also in general farming, and the interests of all here are closely bound up with those of the rest of the agricultural community of South Africa. The prosperity of one part should interest all, and the Statistical Office, with which I am connected, is only anxious to serve in the best way possible the interests of each section of production and of the nation as a whole.

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There being no discussion, the Chairman stated he could only presume that the paper was so excellent that it did not require any discussion. He would like to be able to assure Mr. Kitchener that no Planters would object to the additional census being taken this year, because the value of this additional census was difficult to overestimate. He was looking at it purely from the point of view of one who was personally concerned in the selling of the planters' products, and it would be of immense assistance to all concerned in their sale to have this data. Their difficulty always was to know exactly what their production was likely to be. The census would help them immensely in that respect. They had something fairly definite to go on instead of groping in the dark as they had to do in the past. He would also like to say that in the Census Department of Pretoria they had one of the most enthusiastic staffs in the whole of the Government service. There was nothing that they were asked to do in any shape or form that they did not undertake, and whatever methods might be suggested to them he had found they were always able to improve on those methods themselves. He thanked Mr. Kitchener on behalf of the members for his very excellent paper. (Applause).

Mr. Kitchener said he wished to thank them for the very appreciative manner in which his paper had been received, and also for the very eulogistic remarks passed by the Chairman in respect of his Department. The whole success of his Department was the real live business head they had in Mr. Cousins; he was a regular grafter and grinder; he got every ounce out of his staff but his staff were pleased to serve him loyally. At any time they could be of assistance to the farmers they would be pleased to do so. They knew that in serving the interests of the farming community they were serving the interests of the country as a whole. (Applause).

GENERAL OUTLINE OF CHEMICAL CONTROL OF SUGAR FACTORIES.

(Paper by L. F. De FROBERVILLE, Darnall.)

(1) What is meant by Chemical Control?

There is a certain similarity between the Chemical Control of sugar factories and commercial bookkeeping.

In this latter, a regular system of accounts is kept, tracing the raw material from the time it is purchased right to the end, when the manufactured product is delivered and sold.

The difference between the sale price and the purchase price being the gross profit, all the expenses incurred in the manufacture are deducted, leaving a balance which constitutes the net profit.

In the sugar industry, accounts are being kept so as to trace from beginning to end the different stages of the manufacture.

The difference between the sucrose bought in the cane and the sucrose sold as bagged sugar constitutes what is commonly called the "Loss Acount."

The loss account traces from the beginning, when the sucrose enters the mill as cane, (1) the loss in the crushing plant; (2) the loss in the clarification or defecation, where some of the sucrose is lost in the residues of filtration and some destroyed by inversion; (3) the loss in the evaporating plant, where the difference between the sucrose in the clear juice and in the syrup delivered by the multiple effects represents the loss by entrainment; (4) the loss in the massecuite, where the decrease in the sucrose content indicates the loss by caramelisation or burnt sugar and mechanical losses between the evaporating and boiling plants; (5) the loss in the curing of sugar, where the difference in sucrose is attributed to mechanical losses mainly and to the melting of sugar in the curing process and (6) the loss in the final molasses.

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It is all these losses which the chemical control checks and tries to reduce to their minimum.

"The Chemical control is a system of work, where samplings and analyses are combined with a regular and organised scheme of technical bookkeeping, whereby the chemist can detect, locate and hence control any imperfections in the process of manufacture," says Noel Deerr.

It is the essential part in the manufacture of sugar, because it serves as a guide in view of the improvement of the extraction. Having the necessary information, the maximum efficiency of the machinery in general and a higher recovery can be expected.

(2) Utility of the Chemical Control.

It is only a few decades past since science has found its way into sugar mills. Formerly cane was sent to the mill by cart-loads, (so many of these per acre), to be crushed by most primitive mills and the sugar obtained, loaded in sacks or bags, was weighed. This was the only check on the work of the factory and the result was expressed as so many tons of sugar per acre.

But by degrees mills have been improved, powerful crushing plants have been put up, new machinery has been erected, increasing the efficiency of these mills and as the working of all this improved machinery implied greater skill and attention, it was found necessary that science should come in to control the imperfections in the process of manufacture and to correct them.

A great step forward has been made, improvements in all the stages have been carried out, new and scientific methods have been devised and adopted and every day, something new is proposed; but it is not perfection yet and there is still a great deal more to be done.

The Chemical control is averred an absolute necessity nowadays in modern factories, because so many factors are against the sugar industry: (1) increase in the cost of machinery; (2) more expensive labour; (3) fluctuation in the market price of sugar and other causes; that it is only by skill, knowledge and science that difficulties can be overcome and that improvements can be made to convert the factories into really paying businesses.

Chemical control is imperative. It must be exerted from the very beginning, that is from the time that the cane is received in the mill-yard right to the end, when the manufactured sugar goes out of the factory.

(3) Control of the Weight of Cane.

When a tabular form is drawn to represent the result of a sugar season, the main information required to establish the basis of the calculations is: (1) The weight of the cane; (2) the indicated sucrose in the juice; (3) the weight of the sugar bagged.

This tabular form, known under the name of "Factory return and Loss Account," shows the recovery of sucrose as well as the losses in the different stages of the manufacture, working them out as percentages on the weight of the cane and on the indicated sucrose in the juice.

The cane whether it belongs to the mill-owner or the planter, is received in trucks and is weighed before crushing. We shall disregard the time lost between the cutting and the crushing of the cane, although deterioration, which sets in very rapidly after the cane has been cut, may be considerable when several days elapse before the cane is crushed, especially when adverse climatic conditions prevail.

But let us hope that in the near future, steps will be taken that freshly cut cane is sent to the mills to avoid losses due to fermentation, deterioration, drying, etc.

In cane growing countries, where the soft cane is cultivated, the weight recorded by the weighbridge is the correct one, because the soft cane drops its trash easily and is quite clean when loaded in trucks; but this is not the case with the Uba cane and the accurate weight of the cane sent to the mill is most difficult to obtain. In fact, the cane must be clean, sound, matured and free from foreign matter, so that the material bought answers to the requirements known as good sound marketable cane. Unfortunately, these qualities are not often seen in as much as the weight of the cane, although most correctly taken or registered automatically on the weighbridge is not real on account of the impurities, such as trash and tops and sometimes roots and dirt, which are valueless and which increase the weight of the material, causing a greater value to be given for a less weight of clean cane, since the basis of payment rests on the weight shown by the weighbridge.

Arbitrary percentages or averages derived from tests previously made are sometimes deducted for impurities, but these deductions do not give the real weight of the cane.

From my own many years' experience, the percentage of foreign matter, including cane tops, varies in wide proportions, between 2 per cent and 15 per cent of the weight of the cane. I must say that these high percentages are not often seen by those responsible, but are due to the carelessness of boys cutting the cane, when strict supervision is not exercised upon them.

Is it possible to strike an average and what should it be to suit both parties, millers and planters?

I have known a sugar mill in Mauritius where the weight of the clean soft cane was easily checked. This factory had in front of it's sets of mills a cane cutter, which, by its rapid revolution, produced a fair quantity of finely cut cane chips, which fell between the slats of the cane carrier, forming a heap in front of the first mill bed. This heap represented an absolute average of the totality of the cane crushed, and on sampling the exact richness of the cane and its fibre content were known, and as the samplings of the bagasse and of the mill juices were correctly taken, all the necessary information was obtained con-

cerning the extraction of the juice by the mills; the quantity of sucrose received in the juice, that lost in the bagasse and the exact weight of the cane was checked.

But this last is an exceptional case and is certainly not seen in Natal. In other soft cane countries, where the weight of the cane for some reason is not thoroughly reliable, they resort to inferential calculations or deductions to obtain the quantity of cane crushed. But these methods are based on factors which have been determined experimentally and which vary for different locations; but here, in Natal, up to now, no practical method has been proposed to check the weight of the cane crushed on account of the variation in the quality of the Uba, in its composition and in the quantity of foreign matter weighed as cane.

If the cane could be thoroughly hand trashed or cleaned, the difficulty would be overcome and this operation representing only a slight increase in the cost, would be welcomed by all.

However it is accepted now by both parties, millers and planters, that the weight of the cane given by the weighbridge, in working order, is correct, irrespective of the impurities and this weight forms the fundamental basis of the control. But it stands to reason that the cane delivered to the mill must be as clean as possible.

The sucrose content of the cane depends upon the weight given by the weighbridge. A cane containing 3 per cent trash and impurities, giving 13.50 per cent sucrose, will certainly not be similar to a clean cane having the same richness. In the first case, it is only 97 of cane which marked 13.50 per cent sucrose and 100 of cane will give 13.92 per cent, hence a less sucrose content registered.

The same applies to the analysis of the bagasse and the result will be different if deduction is made for trash and impurities. As most of these impurities remain in the residue after the crushing, then the loss in the bagasse is less than what it should be.

When the juice is accurately measured and the sucrose in the juice detected by analysis, the total quantity of sucrose in the juice is obtained. If this quantity of sucrose is divided by the aggregate weight of cane and impurities which produced it, the quotient will be a smaller figure than it would be if the cane only was taken as divisor, this quotient being the percentage of extraction on cane; therefore the control starts on a basis which credits the mill with a poorer cane and as in the course of the manufacture, everything is calculated on the weight of cane, the percentages are less than reality.

(4) Control of the Efficiency of mills.

The Uba cane sent to the mill is so variable in quality, due to variations in the fibre content, in its more or less juicy condition in variable quantities of solids contained in the juice, it cannot be assumed that the percentage of extraction of juice by the mills will be kept almost constant. It is only by testing regularly the work of each mill once or twice a week, that useful information can be gathered. In consequence, the settings of the mills are altered to fit the condition of the cane to be crushed.

(5) Control of the Imbibition water.

Water spread over the bagasse to produce its exhaustion in sucrose must be measured either in a watermeter, through which cold filtered or cold clean water is passed and which gives reliable figures or in tanks with overflow pipes for constant volume.

Numerous trials made with hot and with cold water have not proved better in one sense than the other. If the use of hot water has the advantage of heating the bagasse, it has also the disadvantages of (1) heating the rollers, (2) rendering the measurement rather difficult on account of the temperature and the steam produced, (3) corroding pumps and pipes when the condensed water from the steam drums of the evaporating plants is used. But care should be taken that the water used for cooling purposes on the bearing of the mills does not get mixed with the juice expressed, because then the relation:—Weight of cane, weight of water, weight of juice, weight of bagasse will no more be correct.

Knowing the weight of water, also that of the mixed juice, and taking the weight of cane given by the weighbridge, then the weight of bagasse is obtained.

(6) Control of the Juice.

The real control starts when the juice expressed by the mills is measured or weighed. Here again, the measuring tanks must be accurately gauged to have the exact volume, and the temperature must be taken to bring the volume of the juice to the normal temperature. This part is the first step towards exact control and all the other analyses in the course of the manufacture, when worked out as percentages on the sucrose in the juice, show the losses in each stage; any difference between two successive stages being the unavoidable loss which the chemist must try to reduce to its minimum.

But precision in the analyses of bagasse, juices and the other products of the factory is not sufficient for a thorough control. The several samples collected for analysis must represent an absolute average of the total bagasse and of all the juices in the course of the manufacture, because the variations which are so great in the composition of the Uba cane are reflected in the same manner in the quality of both bagasse and juice extracted. Therefore the samplings must be intelligently and regularly taken and should not be left to the care of little Indian boys, unless strict supervision is exercised over them. Automatic sampling machines for juices and syrups are most useful and should be put up to avoid the risks of false information from unfair and irregular samples.

(7) Control of the Sulphitation.

Whether it is intended to produce refining crystals

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or white sugar for the market, sulphurous acid is used to decolourise the cane juice expressed by the mills. Besides it coagulates and precipitates some of the impurities in the juice, resulting in greater fluidity, easier defecation and filtration, better crystallisation in the vacuum pan and after. But sulphur di-oxide is not the only substance produced by the combustion of sulphur, there is also some sulphuric acid in variable quantities which must be eliminated on account of its power of inversion and furthermore, as more lime is required for neutralisation, it means an increase in the quantity of lime salts so troublesome in the manufacture.

The sulphurous gas issued by the furnaces should be bubbled through water for the separation of sulphuric acid and although some sulphur di-oxide is dissolved and lost, yet the total quantity of the sulphuric acid is removed and the manufacture becomes easier when less lime salts are produced. Therefore the control of the sulphitation of juices is necessary so as to eliminate altogether the sulphuric acid from the fabrication.

(8) Control of the Minor losses.

Undoubtedly the biggest losses occur in the crushing plant and in the final stage, that is in the molasses. The lesser ones are:—

(1) The loss in the filter-press cakes, where owing to the slimy and viscid composition of the impurities precipitated during defecation and collected in the scum tanks for further treatment and filtration, the pores of the filter cloths get clogged and the filter-press is rendered absolutely useless after a short time. In the sulpho-defecation process, the loss in sucrose relatively to the weight of cane is pretty high and amounts to a figure which the carbonatation process fails to reach, although 8 to 10 times more lime is used and more press-cakes are obtained; (2) the loss by inversion caused for the most part by the necessities of the market, when white sugar or a similar grade is required and implying a more or less acid working of the juices; (3) loss by entrainment in the evaporating plants as well as destruction of sucrose or sugar burning by high temperatures.

Mechanical losses, such as dripping of juice from pipes and taps, occasional overflowing of tanks, losses in the curing of the sugar are those minor losses which should be remedied at once because it means lack of attention on the part of the workmen in charge.

All these losses added together must form the balance between the sucrose received in the juice and the bagged sugar.

(9) Control of the Crystallisation in motion.

Crystallisation in motion is meant to produce as complete crystallisation of sucrose as possible, by displacing them in the medium where particles of dissolved sucrose are available for the increase in size of the existing crystals, during the time that the massecuite cools down in motion. Therefore the feeding of the massecuite with treacles of variable purities deserves particular attention when beneficial results are expected.

(10) Control of the Loss in the Molasses.

The loss in the final or exhausted molasses is a big item and should be ascertained exactly. When the molasses are correctly measured, a certain accuracy is obtained by the analysis of the average samples; but it must be borne in mind that the composition of the final molasses is quite different from that of the original juice. In this latter, the percentage of non-sugar is small, whereas in the molasses, the greater part of the sucrose having been crystallised out, there remains a high proportion of non-sugar which prevents the further crystallisation of the sucrose they still contain. Furthermore, the analysis of the molasses by simple polarisation fails to show the real quantity of sucrose remaining, on account of active substances which affect the true polariscope reading and generally diminish it. It is for the chemist to operate in such a way that the real quantity of sucrose in the molasses is detected.

If the cane juice was composed merely of sucrose dissolved in water, the direct polarisation would indicate it in totality; but as the cane juice is a most complex mixture of different sugars, salts, gums, etc., the direct polarisation does not give the real reading and it is only by the inversion process of analysis that the substances are rendered inactive and that the real sucrose is detected. This influence is felt with greater intensity when the quotient of purity is low; but when the percentage of sucrose on the total solids increases, there is decrease of the influence which becomes nearly nil, when the purity of the juice exceeds 85 or 86. It is therefore necessary to detect the quantity of sucrose by the double polarisation method, if not in all the juices, at least in the mixed mill juices and in the final molasses. The difference between these two quantities represents the sucrose recovered minus those losses in the different stages of the manufacture.

(11) Control of the Flue gases.

The Uba cane gives enough bagasse for the heating of the boilers and it is only occasionally that some additional fuel, wood or coal, is required, especially during the week-ends when crystallisers are kept in motion. When fuel is burnt in furnaces, the heat generated serves to produce steam at a certain pressure, for the use of the engines and of the boiling plants of the mill; but all the heat produced is not utilised, a fair proportion is wasted in the flues and in the atmosphere.

Some mills utilise these waste gases to heat the feed water of the boilers circulating through economisers of different patterns and make, often bringing the temperature of the water to boiling point and over; others produce superheated steam by the utilisation of the high temperature existing in the flues; but all the mills are not provided with these improvements and the waste gases and the high temperature are lost.

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The analysis of the flue gases by the orsat or any other suitable apparatus gives the composition of the gases and the temperature is recorded by means of the pyrometer; any defect in the admission of air in the draught and in the setting of the dampers is brought to notice at once and the necessary alterations can be made, because the flue gases should contain a maximum of carbon di-oxide, indicating the complete combustion of the fuel. The result will be steady steam pressure, regular and full day's work of the factory.

(12) Necessary Outfit for the Control.

Besides the usual laboratory instruments including bottles, graduated flasks, crucibles, basins, etc., the laboratory must have very delicate and sensitive balances, a perfect polariscope; tested brix and specific gravity hydrometers; a refractometer, which is necessary for the control of the fabrication, because its use has the advantages over the brix or the specific gravity spindles of speed, easy manipulation, less quantity of sample for determination and more correct information. A flue gas apparatus, as the orsat, and a pyrometer for the temperature of the gases, a small hand-driven centrifugal to test the massecuites and treacles and so necessary for the detection of the degree of exhaustion of treacles added to the massecuites in crystallisers, when these machines are worked as such and not as mere coolers. A powerful hand or belt driven small mill or a disintegrator and a strong press for the analysis of samples of cane.

From a well equipped laboratory under honest, intelligent and clever European chemists and assistants, who understand their work, who can interpret and apply analyses, will come reliable and correct information which should improve the fabrication for the benefit of the mill-owners and of the sugar industry in general.

DISCUSSION ON THE PAPER.

Mr. Lomeau stated they had all listened with interest to Mr. de Froberville's paper. As he noticed a number of very capable chemists in the audience he would like to take the opportunity of suggesting to them the desirablity of getting a uniform control if possible. This had been done in some countries with a measurable amount of success and he believed it was a step in the right direction if they could get together and devise some form of uniform control. The actual working out of the purity differed according to the various methods employed and if they could have some uniform control to apply to all the factories it would be very valuable indeed.

The Chairman in thanking Mr. de Froberville for his excellent paper, stated that he thought it would be a very difficult matter for chemists or any scientists to express technical subjects in such a way as to be easily understood by those who had very little knowledge of the subject. He had to admit however that Mr. de Froberville had succeeded in doing so, and where a more technical paper would perhaps have been of little interest to him because he would not have understood it, he had been able to follow Mr. de Froberville with very great interest. (Applause).

THE SULPHO-DEFECATION PROCESS IN NATAL.

(Paper by L. E. Rouillard, La Mercy.)

Every newcomer to South Africa connected with the sugar industry cannot help thinking as soon as he learns of the average recovery of sucrose from the usual sulphitation process, that he is going to improve matters and make a name for himself. I cannot say that this was my impression when I first joined the industry, as then it had no chemical history, and I was probably the first chemist called upon to deal with Uba juice, but I shall never forget the disappointment I experienced after calculating my first weekly return.

The purity and sucrose content during that particular year were extremely good, everything seemed to have worked normally during the manufacture, but the recovery was such that it was impossible not to doubt the correctness of my figures. I thought the polariscope was out of order, that the samples had been badly taken, that the juice was leaking out somewhere or that it had been purposely thrown out of the factory. After a time I was compelled to believe that nothing was wrong except the refractory nature of the Uba juice, and it seemed quite plain to me that for certain reasons the sulphitation process was not suited to, or was not properly applied, to this particular cane juice.

As the position to-day has not so materially altered as to make us feel satisfied that the results leave nothing to be desired, I wish to express my views