REFRIGERATION IN SUGAR LABORATORIES

By G. C. DYMOND, A.I.C.

In the absence of Mr. Dymond, Mr. Moberly kindly offered to read the paper.

Mr. MOBERLY: Gentlemen, I should like to make it clear that in reading this paper I have got nothing to do with it at all. I have not taken any part in the experiments, and I really don't know till it is read very much of what is in the paper. It is only because Mr. Dymond is not here that I am reading it.

The evolution in recent years of reliable refrigeration machines has solved the problem of food preservation in countless millions of homes, and it is somewhat surprising that Sugar Laboratories have not as yet availed themselves of this simple method of preserving the easily fermentable samples of a sugar factory.

It is true, that such a method must first be proved to be above suspicion of any deterioration whatsoever, and therefore a machine must be designed with adequate guarantees and an ample margin of safety.

In 1931-32 W. H. Foster and C. H. Karlson presented a paper to this Association on "The Preservation of Cane Juices by Refrigeration," and showed that given the right conditions, cane juices can be preserved indefinitely.

Recognising the necessity of having the right conditions, the following basic guarantee was set down for a machine: "That six 100 ml. hourly samples of juice having a maximum temperature of 33° C. be reduced to —3° C. in five minutes." J. Cottam, the Engineer in charge of the Norge Refrigerators in Durban, successfully set up a machine which fulfilled these conditions.

The constructional details of an improved machine based on experience during the experiment are to be found in the accompanying figure. The following are the results of the experiments, which were checked by independent chemists.

Various samples of mixed juice taken under ordinary conditions were kept in the refrigerator for periods of time ranging from 12 to 400 hours.

(1)—Period of time 12 hours.

	Corrected Brix.	Sucrose by Jackson & Gillis.	Purity.	Reducing Sugar Ratio.
Ordinary laboratory control	14.37	12.61	87.8	2.54
Double independent check after 12 hrs.	14.41	12.72	88.3	2.52
	14.41	12.54	87.0	2.55

(2)—Period of time 24 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control .	14.33	12.63	88.1	2.69
Double check ..	14.26	12.72	89.2	2.67
	14.26	12.55	88.0	2.54

(3)—Period of time 64 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control	14.16	12.43	87.8	2.65
Double check ..	14.19	12.49	88.0	2.80
	14.14	12.46	88.1	2.81

(4)—Period of time 90 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control	13.95	12.24	87.7	2.61
Double check ..	14.00	12.24	87.4	2.85
	14.00	12.24	87.4	2.85

(5)—Period of time 140 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control	14.08	12.36	87.8	2.59
Double check ..	14.10	12.33	87.5	2.76
	14.10	12.37	87.7	2.74

(6)—Period of time 356 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control	13.79	12.19	88.4	2.63
Double check ..	13.99	12.00	87.0	2.67
	13.79	11.96	86.7	2.67

(7)—Period of time 400 hours.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control	13.51	11.97	88.2	2.85
Double check ..	13.50	11.86	87.9	2.95
	13.50	11.91	88.2	2.93

Average of these tests.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Laboratory control average	14.02	12.34	88.04	2.65
Independent checks average	14.03	12.33	87.86	2.74
	14.04	12.28	87.55	2.72

Slight variations in these results are well within ordinary manipulative or personal standards of accuracy, and the results can be considered very satisfactory.

In order to confirm these figures two runs were conducted over weekly periods. The hourly samples of mixed juice were composited for each day throughout the week, and the collective samples finally composited into a general average sample and analysed when convenient some three days later. The results are interesting and conclusive, as they illustrate the extreme condition possible, should this method be put into ordinary practice.

First week's comparison.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Average week's analsis, mixed juice..	14.71	12.71	86.4	2.71
Analysis of progressive composited sample about 10 days later	14.77	12.87	87.1	2.56
	14.77	12.87	87.1	2.56

Second week's comparison.

	Corrected Brix.	Sucrose.	Purity.	Reducing Sugar Ratio.
Average week's analysis	13.93	12.12	87.0	2.67
Single check on composited sample ..	13.96	12.16	87.5	2.55
Weighted average calculated on daily analysis of samples	13.89	12.08	87.0	2.65

To what extent this method can be put into practice is largely dependent upon the efficiency of the chemical control and the attitude of the Factory Chemist.

Laboratory efficiency is associated with a multiplicity of short period analysis, which have fundamentally originated through fear of fermentation of samples. The result has been that the chemist now utilises these figures, and would indeed be reluctant to reduce their number, in a constant scanning of the whole process.

The subject may be divided into two schools of thought; the one as indicated above, and the second based on the compositing of certain samples under conditions where they will not deteriorate, whereby the saving in time could be devoted to a more searching analysis of those factors, which cannot be attempted under the conditions of routine work to-day.

To those factories with only partial chemical control, this method should come as a boon and a blessing, as it would enable them to carry out their daily analyses on composited samples, which they can feel assured have not deteriorated.

The possibilities are indeed unlimited, and we may even look forward to the day, when planters' samples can be composited in test tubes and tested only at the end of each period.

Analyses by J. C. R. Bijoux and O. H. Feltham.

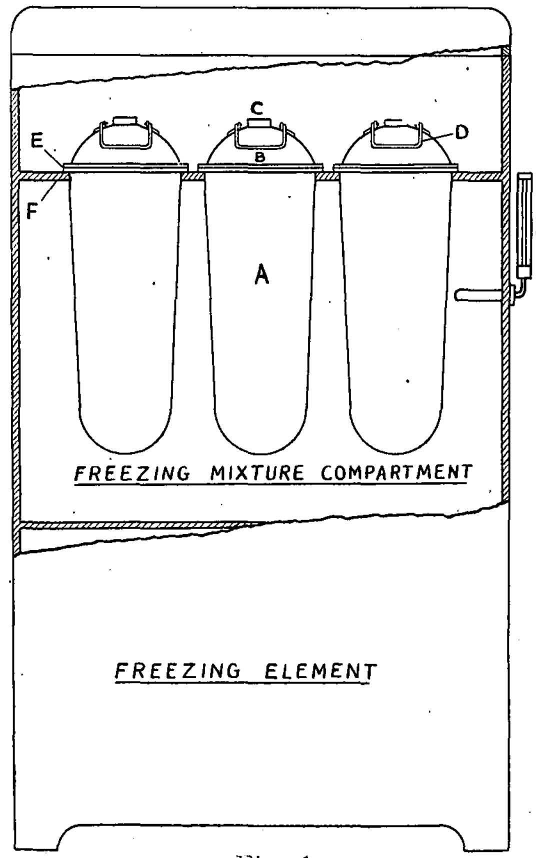

Fig. 1.

A.—Six or more containers 14in. deep from flange, 5in. diam. tapering to 4in. diam. at bottom, made of copper.
B.—Brass top cover with simple slot device into flange for lifting of containers.
C.—Inch aperture for adding samples, rubber stopper.
D.—Loose handles for lifting whole container.
E.—Projecting flange with rubber ring supported by F.
F.—Perforated supporting shelf of non-corrosive metal.
G.—Low temperature thermometer (centigrade).

The PRESIDENT: It is unfortunate that the author is not here to reply to the discussion. I think the subject he has brought forward is very interesting, and we are indebted to him for bringing it before us in the form of this paper. Is there anyone here prepared to reply to the discussion on behalf of Mr. Dymond?

Mr. J. C. R. BIJOUX: Mr. Chairman, seeing we took a great part in testing these figures, we might be able to give information in the absence of Mr. Dymond.

Mr. DODDS: A method such as this has such obvious possibilities that surely it has had some study and consideration in other countries. I should like to know whether Mr. Bijoux can give us any information as to the tentative use of this method in other sugar growing countries.

Mr. BIJOUX: I do not think that we can. We came across no other data connected with the sugar industry, but surely it must exist with regard to other industries.

Mr. DODDS: Were you able to freeze molasses?

Mr. BIJOUX: Yes—it went satisfactorily hard.

Mr. BECHARD: There is only one point I want to mention. I do not want to detract from the usefulness of the method, which is obvious, if it can be introduced under laboratory routine conditions. There is only one point about the attitude of the chemist. There is another school of thought apart from the two mentioned here, that is it is generally reckoned that two or three or more analyses or replications are better than a single analysis. A sample may be contaminated. To rely on one single sample for a period that could be so long might be harmful. A minimum number of samples would have to be done.

Mr. BIJOUX: I must tell you that we quite agree with Mr. Bechard. We pointed that out to Mr. Dymond—it is not because we like a lot of work—but samples should be done as regularly as possible. The more information you have for the factory, the better it is for the factory manager as well as the staff. But we also agreed that though we may possibly reduce the amount of tests to be done to say every two hours, or every four hours, we would not be prepared to go further than that.

Mr. MOBERLY: There is just one thing I would like to have seen in these tests. You have the purity of 88. I would like to see some experiment with some juices of 78 or less. There is no doubt that the result would be just as satisfactory, but to make the experiment conclusive I think that similar tests should be done on low purity juices that are definitely known to be contaminated—juices in which fermentation has started, and various other unsatisfactory conditions—to see how their keeping qualities are affected. I should imagine that the result would be as satisfactory as shown here, but the experiment. as it stands, does not for the moment go quite far enough.

Mr. ELYSEE: Can Mr. Bijoux state definitely that the fermentation would be prevented. or the fermentation germ destroyed, because I know of the instance of fermentation bacteria brought out from the Pasteur Institute, where they are kept on ice in transport on board ship. When they start the culture the fermentation germs are just as vigorous as they were at the Institute. Would Mr. Bijoux say the addition of a preservative, such as corrosive sublimate would help?

Dr. McMARTIN: I should like to pass some comments on this question of the frozen bacteria. I think the effect of constant chilling is simply to inhibit the activity of the bacteria because we can have bacterial deterioration of ice cream. The effect of the mercuric chloride is to destroy the bacteria. The mercury forms a simple compound with the protoplasm, which it precipitates. Possibly the freezing does kill a large number, but there would be a certain number of bacteria with a higher resistance which would not be killed.

There is one other point I should like to make. It seems to me, looking through these tables, that there is a slight reduction in sucrose now. I think that has contributed to the fermentation due to micro-organisms in the juice. The growth of micro-organisms in any medium follows a very definite sequence of events. Plotted as a curve, it shows, in the first place, a phase of very slow growth ,in which they accommodate themselves to the new state of conditions. After that their increase is very much more rapid, and the curve of growth becomes logarithmic, so that in any new set of conditions into which bacteria or micro-organisms are introduced, you have very slow activity at first. It is followed by a very rapid increase in activity. I was wondering whether we were not at the bottom of the curve of the bacterial activity. If these cultures had been kept appreciably longer, would we have got a much more rapid rate of deterioration. I don't know about 400 hours but I suppose that is the longest time any sample would want to be kept. But still I would just point out a word of warning, had they been kept longer, there might have been much more rapid deterioration than at first shows here.

Mr. BIJOUX: It is quite unlikely that we should need to keep juices longer than 400 hours and in routine work nothing like such a long period, so we need not fear any great increase in bacterial activity.

The CHAIRMAN: It is a pity Mr. Dymond was not here for the discussion but in his absence we thank him for this interesting work.