ONE YEAR OF WEEKLY FACTORY REPORT DATA

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The title of this paper is somewhat fallacious, since the Natal mills have prepared weekly factory reports for a good number of years. The new element is the weekly publication by the Sugar Milling Research Institute of reports containing the assembled factory data of all mills. It was felt that this publication would supply a long-felt want of the industry, and, moreover, it seemed desirable to have the data available for reference at the Sugar Milling Research Institute in connection with the proper execution of normal duties.

Stress was laid on the topical nature of the publication—the summaries being posted, at the latest, on Thursdays. This procedure did not allow for waiting for a late report from a mill, and allowed little time for an eventual correction.

After one year of publication, we think it is safe to conclude that the reports were well received by the mills, on the strength of which the publication will be continued. We would like to express our hope that the mills' chemists will keep co-operating by posting their reports, in good time, on Mondays.

With the exception of the Boiling House Performance figure, the data of the reports have previously been used in the Natal sugar industry and do not require special discussion.

The aim of the introduction of the Boiling House Performance as efficiency criterion, was to provide a data which expresses better than the Boiling House Recovery, the *quality* of the work done by the mill. The Boiling House Recovery is essentially a *quantitative* data. The Boiling House Performance tends to neutralise the effect of the mixed juice purity on the percentage of recoverable sucrose and brings sugars of different polarization back to a common standard.

A high Boiling House Recovery figure is more readily obtained at a mill working high purity mixed juice into low polarizing raws, than at a mill working low purity mixed juice into white sugar. The Boiling House Performance figure is intended to give all mills an equal chance.

The Boiling House Performance is based on the Winter assumption that one part of non-sucrose in mixed juice will prevent the crystallization of x parts of sucrose. For x, Winter used a fixed value of 0.4. This is definitely too low for Natal conditions; 0.5 comes much nearer to the truth. It was, however, argued that, since the composition of non-sucrose in high purity mixed juice is not the same as in low purity mixed juice, a fixed Winter factor of 0.5 would not be correct. Or to be more precise, since the percentage of reducing sugars on non-sucrose is usually higher in low purity mixed juice, and since a high percentage of reducing sugars (on non-sucrose) makes for a better exhaustion of final molasses, the Winter factor of high purity juice should be higher.

This reasoning is qualitatively correct, but unfortunately insufficient data are available to bring it to a quantitative basis. Nevertheless, it was felt that the scale of Winter factors (f) assembled in Table I would take into account fairly adequately the varying composition of non-sucrose in juices of different purity.

The difference between the Boiling House Performance and the Boiling House Recovery data of one particular mill is due to two corrections; one for the mixed juice end, and one for the sugar end, of the calculation. The differences at the mixed juice end for different purities, are also given in Table I. They are accurate for 90 Boiling House Recovery, but applicable in all cases of normal recoveries.

It is apparent from this table that, if two mills produce the same type of sugar, mill A working mixed juice of 84.5 purity, and mill B of 87.5 purity, the quality of the work done by both mills will be the same when mill B shows a Boiling House Recovery figure which is 1.6 points higher than the data shown by mill A. The Boiling House Performance figures of course will be identical.

TABLE I.

Mixed Juice Purity	Factor f	B.H.P.-B.H.R.	Mixed Juice Purity	Factor f	B.H.P.-B.H.R.
82–83	0.46	9.9	86–87	0.50	7.7
83–84	0.47	9.3	87–88	0.51	7.2
84–85	0.48	8.8	88–89	0.52	6.6
85–86	0.49	8.3	89–90	0.53	6.1

The final Boiling House Performance figures of the Natal mills' season 1950-51 are assembled in Table II.

TABLE II.

Umfolozi	96.9	Chaka's Kraal ..	97.9
Empangeni . ..	96.3	Maidstone.. ..	96.4
Felixton	97.6	Mt. Edgecombe .	96.9
Entumeni	—	Illovo..	—
Amatikulu.. ..	97.4	Renishaw	96.5
Doornkop	(94.2)	Esperanza.. ..	97.3
Darnall	96.6	Sezela	97.8
Gledhow	96.7	Umzimkulu ..	—
Melville	96.3	*Arithm. av.* ..	**96.8**

The introduction of the Boiling House Performance criterion sets a target for the quality of the work done by the mills—the ultimate figure to be aspired to being 100.

It may be objected that this target is too far away from the present level. We shall not give a definite opinion on this argument, but would rather point out that while the amount of sucrose lost in the boiling house averaged 16.06 per cent. on sucrose in cane in 1925, this loss was 9.59 per cent. on sucrose in cane in 1949. This is an enormous improvement, mainly due to better factory equipment and the successful attempts of the Natal technologists in making the best use of this equipment. Has there come an end to the improvement of our equipment, and shall we conclude that the present generation of technologists is incapable of following in the footsteps of their predecessors ? The answer is "No," and for this reason I think we may be confident that in due course the target can be reached.

It is self-evident that a rise in Boiling House Performance can be achieved only by reducing the losses of sucrose in filter cake, in final molasses, and as "undetermined;" and it is also evident that, generally, the losses in final molasses offer the best opportunity for controlled attack.

In this connection it is somewhat disappointing to conclude from the report sheets that nearly half of the mills do not know how much sugar they have lost in final molasses and are satisfied with reporting the combined undetermined and molasses losses. These mills probably do not have a molasses weighing apparatus, and I cannot stress too strongly the desirability of acquiring such an instrument as an indispensable expedient for the mill's superintendent in his attempts to improve the performance of the mill.

The absence of scales, on the other hand, cannot be an excuse for neglecting the losses in molasses. A discussion of their nature may therefore be expedient. Many theories have been developed to explain the phenomenon of the formation of final molasses. These have been fully discussed by the author in "Chemisch Weekblad" **46** (1950) 134, but since we are more concerned here with the practical side of the problem, it should merely be pointed out that two factors determine the theoretical loss of sucrose, viz. the amount and the quality of the non-sucrose present in clarified juice. The amount of non-sucrose in clarified juice, which in normal cases is nearly equal to the amount of non-sucrose in final molasses, largely determines the weight of final molasses, and the specific capacity to prevent sucrose from crystallizing determines the exhaustability. With regard to the crystallization-preventing quality of non-sucrose, it can be said that the influence of inorganic components is generally more preponderant than the influence of organic components. For these reasons juice clarification should aim not only at the maximum removal of non-sucrose, but particularly at precipitating ash components. The result of a better clarification effect is, for example, clearly demonstrated by the Java carbonatation mills, which show a Boiling House Performance two points higher than the sulphitation mills.

Weight and nature of non-sucrose in clarified juice determine the amount of sucrose which has to be lost in any case. In actual practice we find that not inconsiderable amounts are additionally lost due to the imperfection of the equipment of the vacuum pan, crystallizer and centrifugal departments, and the way in which these apparatus are handled.

Kelly[1] summarizes the ways in which crystallizable sucrose can be lost in final molasses as follows:

1. incomplete crystallization;
2. false grain formation to an extent and of a type resulting in fine grain passing through the gauze of a fugal;
3. overcharging of fugal;
4. leaking gauze of fugal;
5. overheating, either at a massecuite reheater, or use of too much water in the form of steam at the fugals themselves;
6. excessive or incorrect washing of sugar in the fugal with water;
7. where dilution may be practised instead of, or as an adjunct to, reheating;

and concludes that, in his experience, more sugar is often lost by causes 2-7 than by incomplete crystallization.

I do not think that many technologists would want to oppose Kelly's statement. The considerable differences in the purities of the final molasses often observed in consecutive strikes are there to prove the correctness of his views.

By the causes mentioned, sub 2-7, sucrose which has already been crystallized is lost; but by incomplete crystallization is meant that more sucrose should have been crystallized before the massecuite leaves the crystallizer. This should have been achieved either by boiling to a higher density or by improving the conditions which control the speed of crystallization in the crystallizers, for example by cooling to a lower temperature.

A higher strike density aims at reducing the solubility of sucrose; a more appropriate use of the crystallizers aims at reducing the oversaturation. The concentration of the massecuite is usually limited in practice by the maximum viscosity of massecuite which can be handled by the equipment. Installation of modern high-powered centrifuges which allow more viscous massecuite to be spun should therefore result in considerably lower final molasses purity.

McCleery, in Hawaii, estimates that a decrease of 2.6 purity points should result when the viscosity of the final molasses is raised from 300 to 600 poises and that a further reduction of 2 points is possible when the equipment is capable of handling final molasses of 1,200 poises viscosity.

No information is available about the viscosity, and only scarce information about the percentage of water, of Natal final molasses. The water content is probably not inconsiderably higher than 15 per cent., which is a normal figure for countries like Australia and Java.

The conclusion to be drawn from this diversion from our main point is that there is probably ample scope for an eventual increase of the Boiling House Performance by carefully controlled attempts to reduce the purity of our final molasses.

Returning to the weekly report sheets, I want to draw your attention to another phenomenon. When the Boiling House Performance, or for that matter also the Boiling House Recovery, data of the first five to seven weeks of the season are plotted in a diagram, a steady rise is generally observed before a more or less constant level is reached. What is the reason that it takes a mill often more than a month to reach its normal level of efficiency ?

In Fig. 1 a typical, actual case is illustrated. Similar effects can, however, be observed in other mills. In trying to analyse the data of the mill of Fig. 1, we realised that our conclusions could be of limited value only, since we had only a restricted knowledge of the relevant facts, but still we think it is worth while to discuss the case. The relevant data are assembled in Table III.

TABLE III.

Period ending.	Boiling House Recovery.	Boiling House Performance.	Mixed Juice Purity.	Final Molasses Purity.	Tons of Cane crushed.
20/5	86.0	93.7	84.7	35.0	*16,049
27/5	87.7	95.2	85.8	35.8	10,078
3/6	89.0	96.6	86.3	36.9	10,429
10/6	89.9	97.4	86.5	38.8	10,584
17/6	90.2	98.0	86.3	38.5	11,019
24/6	90.6	98.0	86.8	37.6	11,033
1/7	90.7	98.0	87.2	37.2	11,345
8/7	90.8	98.1	86.9	39.4	11,078
15/7	91.0	98.4	87.1	37.3	11,212
22/7	91.2	98.4	87.4	38.1	11,072

*11 days.

Till the end of the week ending 17th June, 6,198.4 tons of recoverable sucrose had entered the mill in mixed juice. Had, during that period, the Boiling House Performance been 98, i.e. the level of the next twelve weeks, 6,074.4 tons of crystal in sugar would have been produced. Actually 5961.5 tons were produced. What happened to the 112.9 tons of crystal unaccounted for ? Since the mill did not report separately the losses in filter cake, in final molasses and undetermined, this question unfortunately cannot be answered. However, we draw attention to the fact that the final molasses purity during the first week was lower than the purity in the 98 Boiling House Performance level period. This makes it highly improbable that the 112.9 tons were lost in final molasses. The sugar must have been lost in filter mud or undetermined, which prompts the question: Are there any technical reasons for increased losses in filter mud or undetermined, inherent to the beginning of the season ? Generally speaking, we do not think so, or in other words, there must be a remedy for this type of loss, and finding the remedy would increase the average Boiling House Performance not inconsiderably.

In Fig. 2, part of the graph of another mill is given. This graph shows that the Boiling House Performance figure in four weeks reached a value of about 96.5, which level was, with a few exceptions, maintained throughout the season. A striking difference between the Boiling House Performance curves of Figs. 1 and 2 is, however, that the first is smooth, while the fluctuations from week to week in Fig. 2 are much more pronounced. This observation leads to the question: What is the accuracy of Boiling House Recovery and Boiling House Performance data "For the Week ?" For their computation, the results of two taxations are used and the combination of the errors in these taxations reflect in the Boiling House Performance and Boiling House Recovery data. The stock of a mill working 15,000 tons of cane per week is round about 600 tons of sucrose, the taxation accuracy of which amount is probably not better than 15 tons. The amount of crystal handled in one week being about 1,700 tons, one should not be surprised when "This Week" Boiling House Performance and Boiling House Recovery data fluctuate one point from week to week.

The Boiling House Performance curve of Fig. 2 should, for this reason, be considered as a normal curve.

Summarizing, we would like to conclude that a period of one week is in some respects somewhat short for the purpose of factory control and caution in drawing conclusions from "For the Week" figures is recommended.

The last data to be discussed relate to additional fuel used by the mills. The final report data are assembled in Table IV.

TABLE IV.

Mill.	Tons coal.	Tons wood.	Mill.	Tons coal.	Tons wood.
Umfolozi ...	30	8,060	Chaka's Kraal .	15	46
Empangeni ...	—	1,167	Maidstone	—	130
Felixton	326	858	Mt. Edgecombe.	—	—
Entumeni ...	—	—	Illovo	—	—
Amatikulu ...	—	86	Renishaw	—	—
Doornkop ...	189	429	Esperanza	—	20
Darnall... ...	947	873	Sezela	—	1,350
Gledhow ...	—	—	Umzimkulu ...	—	52
Melville	229	2,695			

In order to obtain data referring to the use of additional fuel actually burned under the boiler, the mills were requested to report the amounts of coal and wood, not including the amounts used for loco's and workshop. Taking as the average heat value of bagasse, coal and wood, 4,500, 11,000 and 4,500 B.T.U. per lb. respectively, the amounts of coal and wood were transformed in the corresponding amounts of bagasse, which were then added. The amounts of bagasse produced by the mills were estimated with the aid of the formula

$$\frac{\text{Tons of cane crushed} \times \text{fibre per cent. cane}}{94 - \text{moisture per cent. bagasse}} = \text{weight of bagasse.}$$

Next, the weight of bagasse corresponding to the added amounts of additional fuel was expressed as a percentage of the total weight of bagasse produced, and entered in Table V. The percentages less than 0.1 per cent. were omitted.

Sugar Milling Research Institute,
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TABLE V.

Umfolozi	5.60	Doornkop	2.76
Empangeni . ..	0.60	Melville	7.13
Felixton	0.80	Chaka's Kraal ..	0.70
Darnall	1.17	Sezela	1.45

No great accuracy is claimed for the data of Table V. They show, however, that with a few exceptions, the produced bagasse is adequate for the fuel demands of the mills and justify the hope that, by proper measures, the relatively small quantities of additional fuel, the costs of which are, however, not negligible, can be reduced.

REFERENCE.

[1]Proceedings Q.S.S.C.T. 1946 p. 135.

FIGURE I

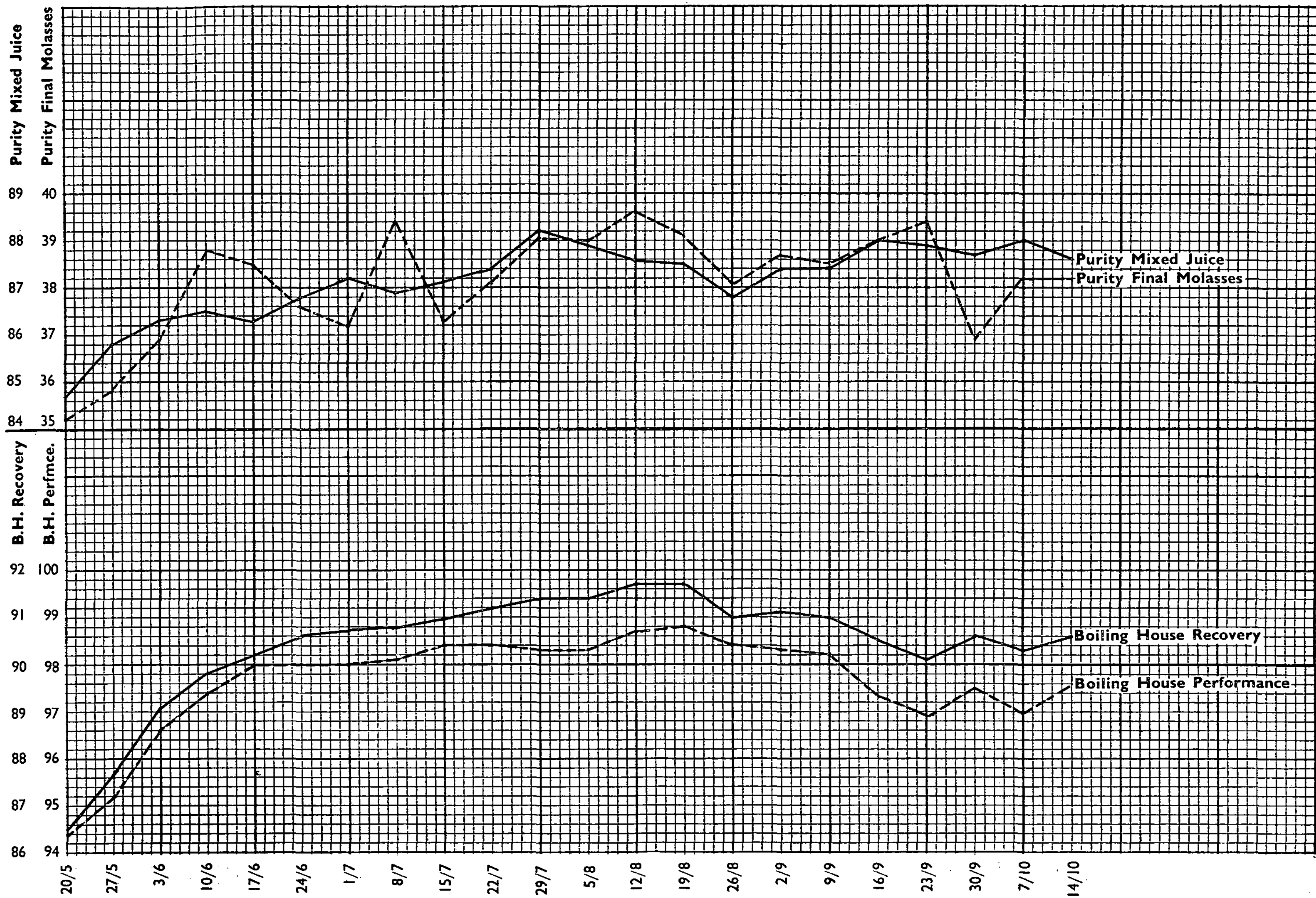
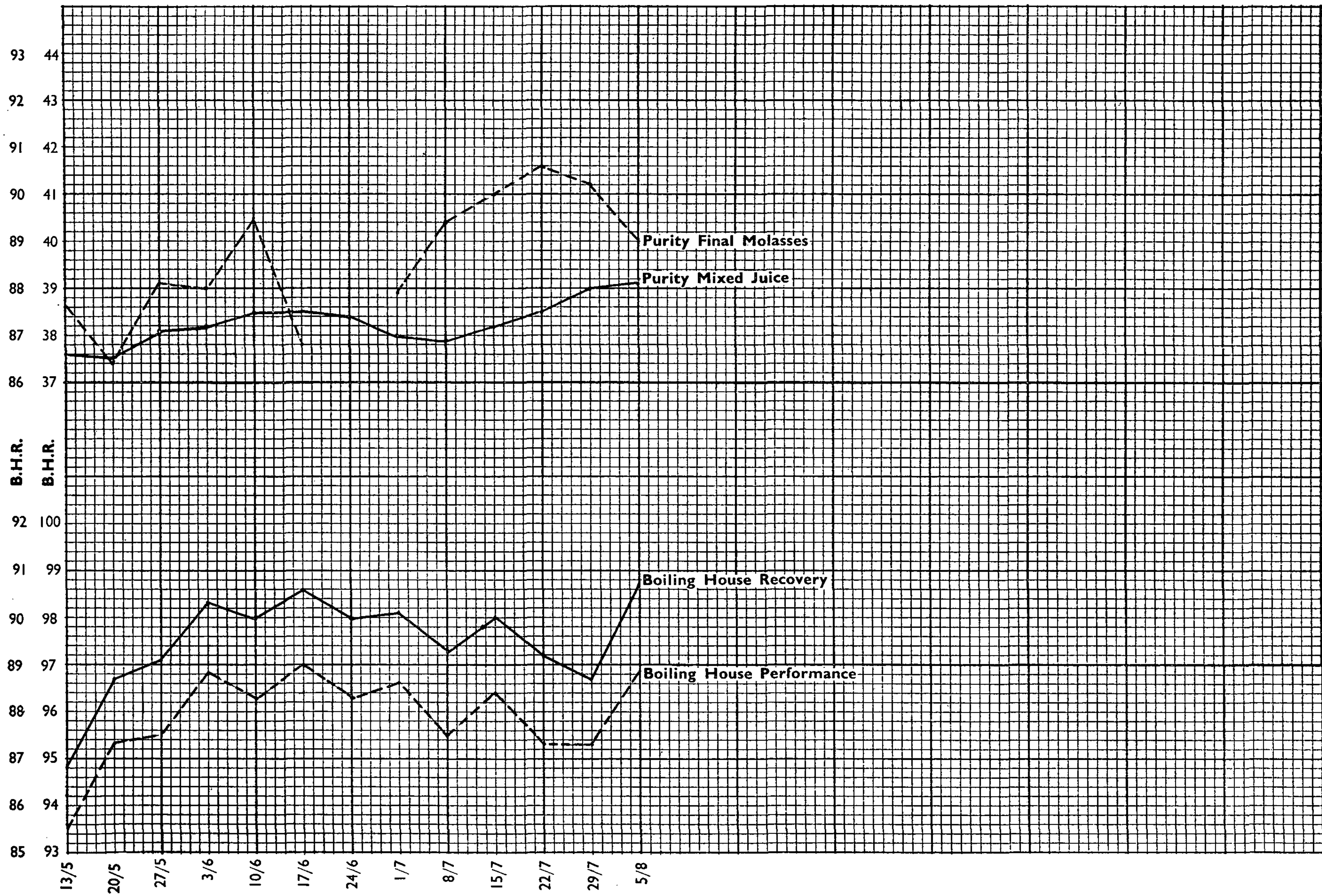

Purity Mixed Juice
Purity Final Molasses
89 88 87 86 85 84
40 39 38 37 36 35
B.H. Recovery
B.H. Perfmce.
92 91 90 89 88 87 86
100 99 98 97 96 95 94
20/5 27/5 3/6 10/6 17/6 24/6 1/7 8/7 15/7 22/7 29/7 5/8 12/8 19/8 26/8 2/9 9/9 16/9 23/9 30/9 7/10 14/10
Purity Mixed Juice
Purity Final Molasses
Boiling House Recovery
Boiling House Performance

FIGURE 2



Purity Final Molasses
Purity Mixed Juice
Boiling House Recovery
Boiling House Performance
B.H.R.
B.H.R.
93 44
92 43
91 42
90 41
89 40
88 39
87 38
86 37
92 100
91 99
90 98
89 97
88 96
87 95
86 94
85 93
13/5
20/5
27/5
3/6
10/6
17/6
24/6
1/7
8/7
15/7
22/7
29/7
5/8

Mr. Barnes said, regarding the use of coal, that he assumed reference was made to the fuel needed for the additional duty required of boilers. He did not know what was used for starting up boilers at the beginning of the crop and it seemed to him that there should be adequate fuel for the manufacture of raw sugar from the cane itself. In Jamaica all sugar mills had rum distilleries attached to them and in very rare cases was it necessary to use extra fuels under normal operating conditions.

Dr. Douwes Dekker agreed that the information on the fuel position should be more complete. At the Natal mills it was on the average satisfactory; but this opinion would have to be revised as soon as manufacture of by-products from bagasse was considered or when a low fibre variety of cane was introduced.

Mr. Lewis said that some of the mills might be under capacity in boiler power. More bagasse would be used to get them going, which added weight to the suggestion that boiler house plant be included for consideration. Fortunately the industry had more bagasse than it knew what to do with.