THE CONSTRUCTION OF TWO LABORATORY VACUUM PANS

By J. BRUIJN

In the course of clarification tests and other work in connection with the filterability problems of raw sugar the need arose for a laboratory vacuum pan. For investigating the influence of certain non sugars and the influence of different varieties of cane on the filterability of raw sugar a vacuum pan was required for the production of raw sugar.

As small vacuum pans were not commercially available, they had to be constructed. The size of pan chosen was just large enough to produce in one strike sufficient sugar for a complete analysis and a filterability test. In this way a strike content of 4*ltr.* was decided and later a second vacuum pan was made with three times this strike content, to be able to make an A and a B strike from the same starting material.

The various data are given in Table I.

TABLE I

	Pan 1	*Pan* 2
Diameter	6 in.	9 in.
Heating surface in ft.^{2}	0.392	0.885
Strike volume in ft.^{3}	0.148	0.495
Ratio $\frac{\text{heating surface ft.}^2}{\text{content ft.}^3}$	2.8	1.8
$\frac{\text{Graining volume}}{\text{Strike volume}}$	⅓	⅓
Heating in watts	800	2,500
Evaporation capacity $\frac{\text{lb. of water}}{\text{ft.}^2 \text{ of heating surface}}$	6	8

It was considered impossible to scale down a calandria of an industrial pan. In both pans the height of the heating surface is one-third of the height of the strike level. The heating surface is formed by the walls of the pan. Steam for heating was considered but it was decided that electrical heating would be more convenient in a laboratory.

The massecuite is circulated by a specially designed stirrer. In figure 1 a detailed picture of pan 2 is given.

The heating surface is formed by a brass vessel (A) having a diameter of 9 inches and a height of 42 inches. Around the sides 4 electric heating elements are wound (B), covered by asbestos insulation (C). The wall of the pan is formed by a Quickfit quartz pipe segment (D) of 9 inches by 18 inches, which allows an unrestricted view of the boiling massecuite. This quartz cylinder is clamped by a brass ring (F) held by 4 brass rods (E). Rubber washers provide an air-tight seal. In the bottom of the pan there are three needle valves for syrup, water and seed slurry. Two stainless steel electrodes are connected to a conductivity indicator and a pocket with a temperature sensitive resistor is connected to a supersaturation indicator based on boiling point elevation. In the centre of the bottom is a gate valve to drop the strike when finished. The smaller pan has no valve and the strike has to be poured out of the top.

Through the lid of the pan passes a stainless steel shaft carrying three propellors in a draft tube. The shaft runs in a ball and thrust bearing. A gland of graphite and asbestos fibre gives a vacuum seal.

A reduction gearbox is fitted on the top to reduce the motor speed to 140 r.p.m. A gearbox small enough to fit on top of the pan was not obtainable and was made by using lathe change wheels. The stirrer speed decided on was 140 r.p.m., the stirrer being fitted in a draft tube, giving one of the most suitable types of agitator for crystallizers according to literature. Above a speed of 400 r.p.m. secondary grain is introduced by damage to the crystals and by the mechanical stimulus given to the massecuite [1]. To cope with the varying liquid level, the draft tube had to be provided with holes, decreasing its efficiency to a certain extent. A draft tube rising with the liquid level would have been better.

In the top of the pan there is a dome where the vapour is taken off and a thermometer and a temperature sensitive resistor are fitted. A vacuum gauge is also fitted in the lid. The supersaturation indicating instrument was made following a design by Genie's [2]. Two thermistors are connected in a bridge circuit. One is in the boiling massecuite, one in the vapour. The difference in resistance is proportional to the temperature difference. This difference is corrected for the purity of the massecuite in a special circuit, and translated into supersaturation by a millameter with a supersaturation scale.

Finally, figures for a boiling made with pan 1 are given in Table II.

TABLE II

Syrup obtained from Natal Estates	
Purity of syrup	87.9
Purity of A molasses	72.9
Boiling time	4.25 hour
S.G.S. of sugar	0.43
Percentage conglomerates (number %)	3
Filterability	78

References

(1) H. H. Newman and R. C. Bennett, Circulating Magma Crystallizers, Chem. Eng. Progress, **55**, 65 (1959).

(2) G. V. Genie, An instrument for concentration or supersaturation recording of boiling sugar solutions, I.S.J., **60**, 35 (1958).

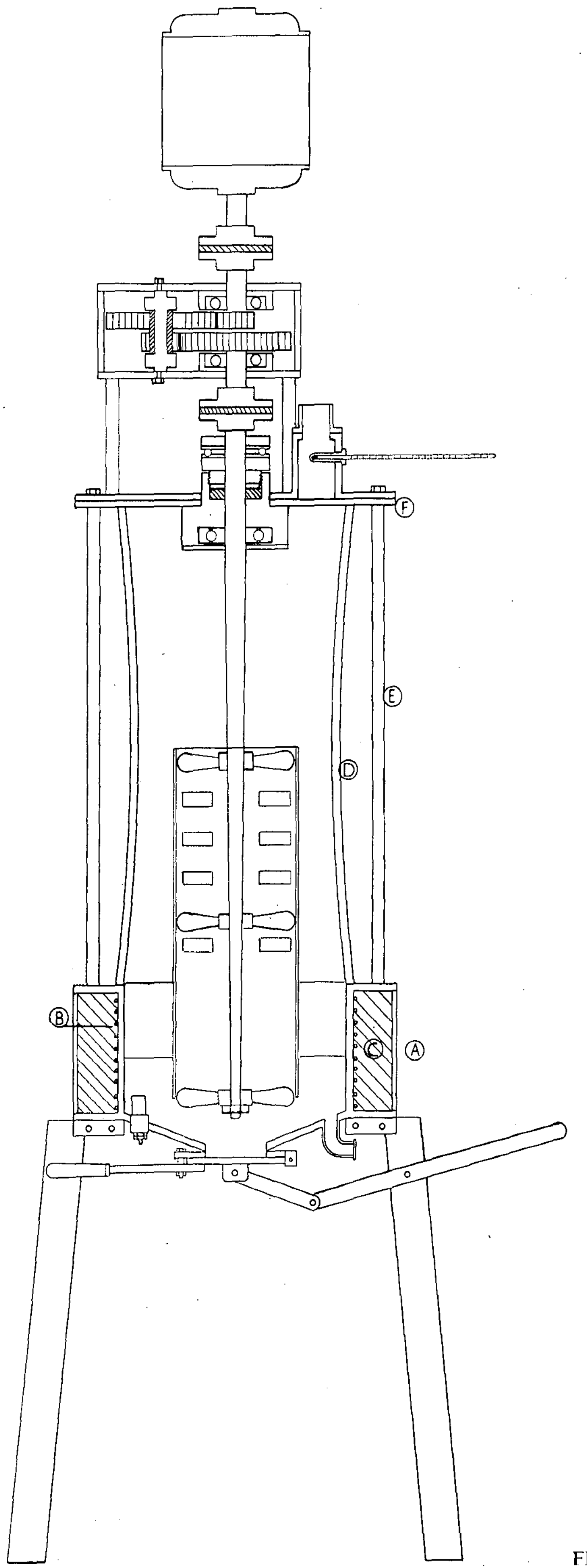
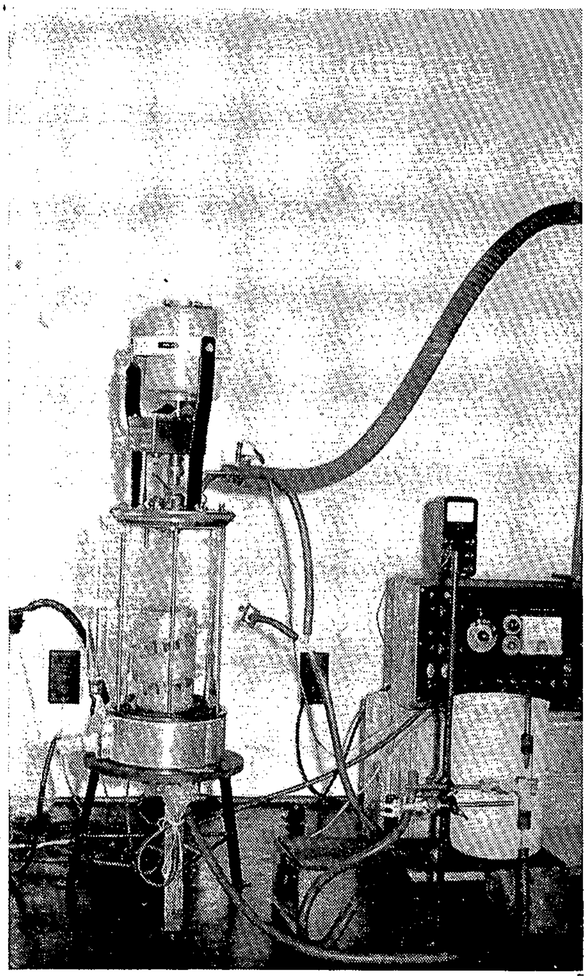
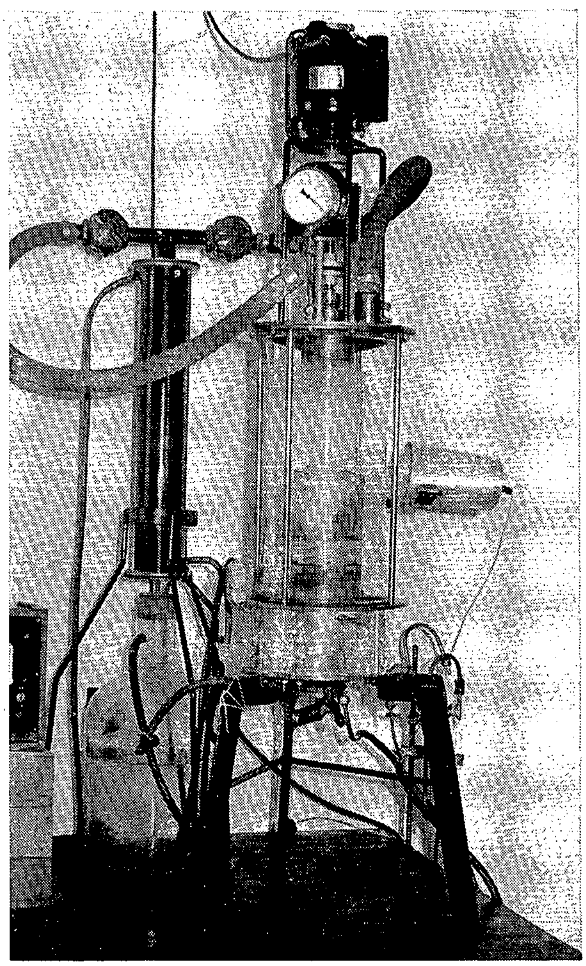


FIGURE 1.



Pan No. 1 with boiling control instrument.



Pan No. 2 with condensor.

Mr. Chiazzari: In using this laboratory pan, have you gained any knowledge which would be useful in designing an ordinary industrial pan?

Mr. Bruijn: The purpose of the pan was to enable us to make, at the S.M.R.I., raw sugars from various sources and to get an idea of what influences filterability. In almost all cases a sugar boiled in a laboratory pan has had a higher filterability figure than the sugar boiled in a factory pan.

Mr. Douwes Dekker (in the chair): The specific grain size of the sugar is rather small. The worst part of the crystal is the outside, so do you think that this might be a reason for the higher filterability figure?

Mr. Bruijn: I carried out tests on industrial A sugars, where the outside of the crystal was dissolved completely, and still did not get a figure as high as 78, it was nearer 50, so the size of the grain does not appear to be the complete answer to the difference in filterability.

Mr. Renton: There is a mechanical stirrer in this laboratory pan. Have you compared boilings, with the stirrer operating and then not operating, and tested the resulting filterabilities?

Mr. Bruijn: With the stirrer not operating, the boiling time was longer and the filterability slightly lower, but still very much better than industrial pans.

At present insufficient data are available to make true comparisons between factory boilings and boilings in the S.M.R.I. laboratory.

Dr. Douwes Dekker: We thought there might be a connection between high filterability and the good circulation in our pan, due to the stirrer, and that we might be boiling at a lower average degree of supersaturation, with less fluctuation than a factory pan, which has a high massecuite. We are therefore arranging to install a stirrer in a factory pan.

You will notice that Mr. Bruijn says in his paper "A draft tube rising with the liquid level would have been better". The Australians have carried out tests using isotopes to trace the circulation in a pan but have had some difficulties. They have found that the circulation was not as expected, and that there are a lot of eddies on the tube plate. To get a better control of circulation, and to try and eliminate these eddies, we have permission from Illovo to install a sleeve inside the down-take of a factory pan, and this sleeve will be raised as the level of the massecuite rises. It will then be interesting to see the effect on impurities of the sugars produced from this pan.

Mr. Rault: From the paper we have just heard it would appear that pan design might have a greater effect on filterability than any other factor we have discussed recently.

Mr. Bruijn: It is not possible at this stage to say what causes the differences in the product from a laboratory pan and a factory pan.

Mr. Fourmond: Does caramelisation affect filterability?

Mr. Alexander: Caramel is made at the refinery but no figures are available as to its effect on filterability.

Mr. Coward: A pan at Entumeni is fitted with a mechanical stirrer and I am sure you would be allowed to carry out tests there.

Dr. Douwes Dekker: The stirrer at Entumeni is in a "C" pan and we would like to apply the test to a first product pan.

Mr. Perk: It would not be a fair test to use the Entumeni pan as the stirrer had to be fitted to it because it would not boil properly in the first place.