Report of Committee on Sugar Manufacturing Machinery.

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This Report should have been submitted at the 1928 Meeting, but on account of having very few replies to the questionaire sent out it was decided to postpone the report and to make further attempts this past year. There has been a total of twelve replies. This has made it rather difficult to get at a fair average of South African conditions.

As a basis, we have used figures which are considered as a standard in Hawaii—but realizing that conditions are not the same, we hope that some sort of local standard can be evolved for South Africa. We are therefore submitting figures which we consider might be suitable for our conditions, as an opening for discussion at this meeting.

MILLING PLANT.

Cane Carriers.

Leys Chain 9060 with wooden slats seems to be the most popular, but the steel apron carrier type is now coming into use, especially at those factories where efficient cane knives are being installed.

Cane Knives.

Of the factories reporting seven are equipped with revolving cane knives. The horse-power required to drive is considered by most to be in the neighbourhood of 1½ H.P. per ton of cane. This of course is dependent on the setting of the knife and the number of knives used, but with efficient knives we consider 2 H.P. for close setting and 1½ when knives are used as a leveller only. All factories report a better feed to crushers with higher capacity and two report better extraction.

Milling.

You will see by the sheet the various sizes of plant in each factory.

There are 5 tandems equipped with 1 crusher and 4 mills—2 tandems with 2 crushers and 4 mills—1 tandem of 2 crushers and 5 mills—2 tandems of 2 crushers with 3 mills—2 tandems of 1 crusher and 5 mills—and 2 tandems of 1 crusher and 3 mills.

A variety of combinations.

In length of rolls there are five factories with 66in. rolls, one with 72in. rolls, four of 48in. rolls, three of 60in. rolls, and one of 54in. rolls. Two factories report two sizes on the tandem, and the larger size has been taken for comparison. Three Fulton Double Crushers are being used, one Smith Double Crusher, two Single Crushers equipped with Smith Splitting Rolls, 7 Kraejewski Crushers, and one factory reports a Kraejewski followed by a Splitter.

All factories have not reported size of engines nor have we information re steam pressures to enable the calculation of H.P., but Noel Deerr states that in a fourteen roller plant there should be available at least 100 H.P. for every short ton of fibre crushed per hour.

Every factory reports that with canes of 14 per cent. fibre more could be crushed per hour, and on totalling up this amounts to over 2,000 tons per day, or 50,000 tons per month. A considerable quantity.

Various types of Intermediate Carriers are used, but the most favoured are the Apron Type. The Trough Type of Carrier with drag slats is also used in a few of the factories. Maceration is applied through spray pipes, some by gravity and some by pressure pumps. On factory is equipped with Monel Metal Nozzles screwed into a pipe header.

Boilers.

Boiler heating surface ranges from 140 to 460 square feet of heating surface per ton of cane per hour. Hawaiian standard is 450 with soft canes, but with higher per cent. of maceration. For South African conditions, especially as double curing is necessary in most factories which requires extra pan boiling, 450 square feet is recommended for raw

sugar and 500 square feet for mill whites. Grate area ranges from 1 square foot per 55.1 square feet of boiler heating surface to 1 per 129, the average being about 80. Hawaiian standards range from 1 to 80 to 1 to 100—or 4.5 square feet of grate area per ton of cane per hour. Combustion volume ranges from 1 cubic foot per 2.25 square feet of boiler heating surface to 1 per 8.5 square feet, the average being about 1 to 5.

Hawaii averages 1 to 7.50, or 60 cubic feet per ton of cane per hour.

There are considerable differences in the various figures given. Some factories report sufficient heating surface at below these standards and others report insufficient, so we consider that if the above standards were adopted for our conditions, with efficient operating, satisfactory results would be obtained.

Economisers.

Only two factories report the use of economisers.

Induced Draught.

Most factories are operated with induced draught. Only two factories report the use of preheating the air and report the results as very good. Others have been installed which have not reported to this Committee.

Six factories without economisers report that the feed water is heated by means of exhaust steam in open tanks equipped with coils. One factory passes piping through the flues leading to the chimney and thereby increases the temperature 20°. Note should be made here of the closed system of handling the condensate. Either the Morehead Back to Boiler System or something similar.

Extra fuel is being used by factories to assist the bagasse in some cases. This is due perhaps mostly to the high percentage of moisture in this bagasse.

Juice Scales.

All factories under the Fahey Agreement are equipped with some plant for weighing the mixed juice. The majority are using Howe Scales. One reports the use of the Maxwell Boulonge Scale as satisfactory; another reports the use of the Richardson Automatic Juice Scale, the results of which are not stated.

Juice Heaters.

Horizontal and vertical heaters are both in use. The vertical heater seems to be more popular because of easy cleaning and drainage. Some have no preference and others prefer the horizontal.

The square feet of heating surface per ton of cane ranges from 16 to 89, the average being 58. Hawaiian standard is 35. Juice heater heating surface though is dependent on various factors. Percentage mixed juice on cane, exhaust steam pressure, initial and final temperatures of juice and the liability of scale.

Noel Deerr states: With clean heaters and a travel of 250 feet per minute, steam pressure at 5 lbs., it is possible to heat one ton of juice per hour from 80° F. to 212° F. with 10 square feet of heating surface. The efficiency falls rapidly, and there should be installed 40 square feet per ton cane per hour. These figures are based on countries working with lime only as a defecating agent, consequently there is very little scale formation in comparison with us. We would recommend 60 square feet per ton of cane per hour for single heating. Those factories using a system of clarification which requires a double heating of the juice would require more depending on the cooling off of the juice in the various stages of the process. As an average an increase of 25 per cent. would be necessary.

Sulphur Boxes and Burners.

Towers are in use in most places and seem to be the most favoured. One factory reports that a combination of tower and box is the most desirable. Every type of furnace seems to be operating. At Factory No. 8 a rotary furnace is operating which gives a large burning area but with a very thin film of liquid sulphur. This is operating very satisfactorily.

Clarifiers and Subsiders.

Most factories are operating with open tanks, some being equipped with coils; two factories are operating the Dorr Clarifier and one the Petree Clarifier. The relation of volume in cubic feet per ton of cane ranges from 1 to 40 to 1 to 723—(I think there must be an error in calculating in the last figure)—the average being 1 to 92 in the ordinary rectangular tanks. It will be noted that there is a large volume of juice in process by those factories using Deerr clarifiers. Hawaiian standard is 72 cubic feet per ton of cane per hour. We would recommend 100 cubic feet as a South African standard.

Filter Presses.

The mud settling tanks range from 16 cubic feet per ton of cane per hour to 60, the average being 40.5. This would be a fair standard to adopt for South African conditions. Rather than spend money on settling tanks, it would be more profitable to spend it on filtering area.

The filtering area in square feet per ton of cane ranges from 40 to 286, the average being 107. The Hawaiian standard is 120 square feet, with from 2.5 per cent. to 3 per cent on soft canes. Here in South Africa, where 5 per cent. to 6 per cent. press cake on cane is the average and with canes of such difficult filtering muds—we seem to be under capacity except in one or two factories. Under these conditions we recommend that the South African standard should be 180 square feet as a minimum. This will allow for the washing of the cake to a low sucrose content.

A number of factories are using the Mnotjus and are finding them satisfactory. Some factories prefer centrifugal pumps for this type of work. Those factories using the Peck Strainer have found reducting in the quantity of muds and have found relief at this station.

Pre-Evaporators.

Only one factory reports the use of a pre-evaporator; another is installing one for the coming season. Both are using the vapours for heating the raw juice in juice heaters. The factory having one in use has reported an increase of 8 per cent. in the crushing rate. Number 16 factory has 83 square feet heating surface per ton of cane per hour, and No. 14 is installing 108. Hawaiian standard is 80 square feet.

Evaporators.

Four factories report the use of triple effects and eight report the use of quadruple effects. One factory is using an extra vessel in conjunction with a quadruple—being then a quintruple effect. The average for triple effect plant is 248, not including those factories equipped with pre-evaporators. Hawaiian standards is 250 for triple effect and 300 for quadruple effect. According to the answers submitted in reply to question as to what we considered necessary in each case, we could adopt the same standard. Question No. 9 was asked as a subject for discussion, as to whether the benefits of a quadruple were not over-emphasised as to conditions in this country where very heavy scaling is formed in the tubes of the last body. Horizontal steam pumps are used chiefly for the extraction pumps, though in those factories where electric power is available, centrifugal pumps are coming into use with good results.

Vacuum Pumps.

All factories except one report the use of dry air pumps—slow motion type. The cubic feet displacement per minute per ton of cane per hour ranges from 13, which appears extremely low, to 350, which is exceptionally high. The average is 51. Hawaiian standard is 35 cubic feet. This figure will vary, of course, depending on local conditions as regards the source of supply and the temperature of the injection water, also to the number of air leaks there may be in the system.

Noel Deerr states:

Cubic feet displacement per minute.

	Per sq. ft. H.S.	Per lb. of Vapour.	Per ton cane per hour.
Quadruple	0.05—0.075	1.5—2.0	15—20
Triple	0.07—1.00	1.5—2.0	20—25
Pans	0.5 —1.00	1.5—2.0	15—20

Pans.

Calandria pans are mostly used, although a number of coil pans are being used, and the calandria pans are mostly favoured for various reasons, especially faster boiling. For low grade work there seems to be no great preference for either one or the other. The average combined heating surface per ton of cane per hour is 66 square feet. The Hawaiian standards are:—

1st and 2nd Sugars	sq. ft. H.S.	40
	cubic ft.	40
Low Grades	sq. ft. H.S.	20
	cubic ft.	20
Total	sq. ft. H.S.	60
	cubic fet.	60

According to the replies received on this question these standards would be sufficient for our conditions in spite of the extra boiling which is necessary on account of double curing and the nature of our syrups and molasses.

Crystallizers and Hot Room Tanks.

For 1st and 2nd sugars this ranges from 70 cubic feet to 407 cubic feet per ton of cane per hour, the average being 300. For 3rd sugars only three factories report, and these are 74—160 and 118.

For low grades this ranges from 40 to 600 cubic feet per ton of cane per hour, the average being 258.

Hawaiian standards are 300 total cubic capacity. Mr. Barnhart, in the Hawaiian Technologists' Reports of 1925, states: "The capacity required depends upon many factors and may be found from

$$\text{Cubic feet per ton cane per hour} = \frac{3\ P\ D\ H \times (S-J)(s-M)}{J \times (s-j)(S-M)}$$

in which

P—Cane polarization.
D—Number of days in crystallizer (including time for filling, emptying and cleaning).
H—Number of hours factory grinds per week.
S—Gravity purity of shipping sugars.
J—Gravity purity of syrup.
M—Gravity purity of final molasses.
s—Gravity purity of second sugars.
j—Gravity purity of second molasses.

Water cooled crystallizers are now coming into use which, of course, will eliminate the time element in the above formula.

Syrup Tanks.

The capacity in syrup tanks ranges from 15 cubic feet to 175 cubic feet per ton of cane per hour, the average being 82.

Blow-ups, Re-Melts and Washes.

The capacity ranges from 13 to 200 cubic feet per ton of cane per hour, the average being 94. Hawaiian standards for pan supply tanks is 100 cubic feet per ton of cane per hour divided in the proportion of 50 for syrup and re-melts, etc., and 50 for molasses.

For white sugars more capacity would be required than for 96 test sugars.

Centrifugals.

For those factories manufacturing raws the total sieving area for all sugars range from 5.0 to 10.5 square feet per ton of cane per hour, the average being 7.31.

For those factories manufacturing mill white sugar, the total sieving area for all sugars ranges from 4.02 to 9.59 square feet per ton of cane per hour, the average being 7.35 square feet. There does not appear to be much difference between those factories producing raws and those mill whites, for the reason that most factories producing raws are double curing part of their raw sugar massecuites.

With regard to linings, most factories are using the slotted lining; some are using perforated linings in the pre-curers, and others the slotted type. One factory reports the use of spiral woven linings. Hawaiian standards are:

1st and 2nd Massecuite	2.5 sq. ft.
Low Grades	5.0 sq. ft.
Total of	7.5 sq. ft.

We would recommend for South African standard Raws with Single Curing:—

1st and 2nd Sugars	2.5 sq. ft.
Low Grades	5.0 sq. ft.
Total	7.5 sq. ft.

Raws with Double Curing and Mill Whites:—

1st and 2nd Sugars—Precurers	2.5
2nd Curing	2.5
Low Grades	5.0
	10.0

No single factory has had any experience with the use of mechanical discharges for centrifugals.

Sugar Room.

Platform scales are being used throughout for drying sugars. Automatic scales are recommended by certain factories for the best method of weighing sugars, and others state that these are unreliable, and the best method is by means of the platform scale.

Water Service Pumps.

The average for all factories reporting is approximately 3,500 gallons per minute per ton of cane per hour. There are eight factories using centrifugal pumps, one factory has duplex pumps and another is fortunate enough to have a gravity supply.

Six factories are using direct river supply and four factories are using dams. Two factories have dams with a make up from a river supply.