

# A REVIEW OF THE CARTER CLARIFIER

By R. A. CARTER.

Experiments were first carried out on a clarifier of about 8-gallon capacity. This small machine gave very satisfactory results, and it was decided to install one of 1,500 gallons capacity for factory trials.

The settling area of this unit was 36 square feet, and the

available gallons capacity per square foot of settling area 41.7 gallons.

The following figures were obtained on hourly runs, taken during the normal working of the factory.

	No. 1. Co.281.	No. 2. Muddy.	No. 3. Co.281. Hill cane.	No. 4. P.O.J. Muddy.	No. 5. P.O.J. Co.281.	No. 6. P.O.J. Muddy.	No. 7. P.O.J. Muddy.	Average of tests 1 to 6.
Total gallons input ... ..	1,267	1,123	1,340	1,311	1,364	1,420	1,617	1,340
Total gallons of clear juice ... ..	1,170	979	1,230	1,183	1,287	1,260	1,410	1,185
Total gallons scums ... ..	97	144	110	128	77	160	207	119
Percentage of scums ... ..	7.65	12.81	8.21	9.00	5.65	11.27	12.81	9.00
Percentage of clear juice ... ..	92.35	87.19	91.79	91.00	94.35	88.73	87.19	91.00
Gallons per square foot settling area ...	35.2	31.2	37.2	36.4	37.9	39.45	44.9	36.2
Gallons per 100 gallons in clarifier ...	84.4	74.9	89.2	87.3	90.9	94.6	107.7	86.9

*N.B.*—No. 7 was a special test in which the clarifier was forced. The test was run over a period of one hour; towards the end of the hour the mud level commenced to rise, and the rate of inflow was reduced in order to keep it down. The juice was brilliant and the average density of the mud was 15° Beaumé at 50° centigrade.

Comparative temperature tests between clear juice from settling tanks and clarifier prior to logging, were as follows:—

Number of readings ... ..	15
Incoming juice ... ..	210.8° F.
Outgoing from clarifier ... ..	202.1° F.
Settling tanks ... ..	191.8° F.

The scums ranged from 10° Beaumé at 44° C. to 13° Beaumé at 55° C. from the clarifier. The average over a series of tests was 11.85° Beaumé at 51° C., as against an average of 8.50° Beaumé at 55° C. for scums from the settling tanks.

The juice leaving the clarifier was in all cases very light in colour and free from all suspended matter, having a pH of 7.4 from a tempered juice of 7.6 pH.

On the results achieved with this pilot plant the company decided to instal a larger unit of 11,000 gallons capacity. This unit had a diameter of 15 feet, parallel sides 7 feet 6 inches and cone 7 feet 6 inches deep.

This clarifier operated for a couple of weeks prior to closing down for the 1943-1944 season, and results appeared to be very satisfactory. The quality of the juice was excellent, and consistency of the mud good. Unfortunately the necessary facilities for the accurate determination of the quantity of juice handled were not available, but over a short period a rate of 7,000 gallons per hour was registered.

It is doubtful whether this unit as it exists can cope with more than 5,000 gallons per hour efficiently.

When the two larger units were installed, it was noticed that the three units worked most efficiently at a crushing rate not exceeding 75 tons per hour, and maceration of 30 to 35 per cent.

The total quantity of juice passing through the units, including Oliver filter-returned juice, was in the region of 18,750 gallons per hour. The juice distribution at this rate would be as follows:—

	1. 11,000 gallons.	2. 18,000 gallons.	3. 18,000 gallons.
Gallons per hour ... ..	4,500	7,125	7,125
Settling area—square feet ... ..	177	255	255
Gallons per sq. ft. settling area ...	25.5	27.9	27.9
Gallons per sq. ft. settling area available ... ..	62.2	70.6	70.6
Gallons per 100 gallons in clarifier	41.0	39.5	39.5

These figures are a long way below the results achieved by the original pilot plant, and it is only after running a season with these units that the weak points have been discovered.

Regarding the consistency of the mud at this and even higher crushing rates, it has been possible at times to lay off one Oliver filter for a period of 12 hours per day, and there have even been occasions when crushing cane at the rate of 85 tons per hour that both filters had to be shut down for at least an hour, in order to accumulate sufficient scums to start them up again.

In direct contrast to this, there have been periods when particularly muddy canes (such as only Umfolozi can produce after floods) have been crushed. The juice from this cane only settles in ordinary subsidisers in the ratios of 25 per cent. clear juice and 75 per cent. muds. Under these conditions, the best clarifier in the world would probably show very poor results.

It is now proposed to instal a second compartment in each clarifier, without increasing the original volume.

Experience has shown us that with clean cane the mud level in the 15-foot diameter clarifier very rarely rises to the level of the first test cock, which is placed 1 foot above the cone, and never above the second test cock, which is 2 feet above the cone.

This means that the muds have completely settled out by the time the juice level reaches the top of the cone. In support of this statement, it may be pointed out that the juice running out of the bottom test cock is invariably clearer than that coming from the top of the clarifier. In view of these facts, it is obvious that the space in the clarifier above the first test cock is redundant—i.e. more than 50 per cent. of the total volume of the clarifier; therefore it is quite safe to say that a clarifier of 5,500 gallons can cope with the same quantity of juice per hour as the present design of 11,000 gallons.

As a point of interest, the volume of the clarifier up to the first test cock is 3,870 gallons, and this volume can handle 4,500 gallons of juice per hour with ease. The settling area would remain the same, the gallons of juice per square foot of settling area would also be constant, but the gallons of juice per 100 gallons in clarifier would rise from 41 to 116 and reduce the time factor for juice retention in the clarifier from 2 hours 25 minutes to approximately 52 minutes. Instead of working on this low volume, it is proposed to divide the existing clarifier into two equal parts, each section to operate independently of the other.

The installation of stirrers can be made optional, although it would probably be a better policy to empty and wash out periodically a compartment.

Basing calculations on 5,500 gallons capacity, the working capacity of the unit would be increased by approximately 100 per cent. This will mean that although the gallons per square foot of settling area will remain constant, the gallons per 100 gallons in clarifier would be doubled, i.e. the 15-foot diameter

larifier would handle 80 gallons per 100 gallons in clarifier, and the 18-foot diameter clarifier would handle 78 gallons per 100 gallons in clarifier. Thus giving three clarifiers of a total capacity of 47,000 gallons capable of dealing with approximately 80 per cent. of their capacity in juice per hour, which amounts to 37,600 gallons.

Gallons per hour, per 100 gallons in clarifier, can be expressed as volume of juice handled per cent. capacity of clarifier.

	15 feet.	18 feet.	15 feet. 2-com- partment	18 feet. 2-com- partment
Total volume of clarifier in gallons ... ..	11,000	18,000	11,000	18,000
Total sq. ft. of settling area	177	255	354	510
Available gallons per sq. ft. settling area ... ..	62.2	70.6	31.1	35.3
Quantity actually handled per sq. ft. settling area ...	25.5	30.4	25.5	30.4
Total gallons juice input per hour ... ..	4,500	7,125	9,000	14,250
Total gallons clear juice per hour ... ..	3,960	6,270	7,920	12,540
Total gallons scums per hour	540	855	1,080	1,710
Percentage scums ... ..	12.0*	12.0*	12.0*	12.0*
Gallons input per 100 gallons in clarifier... ..	41.0	39.5	82.0	79.0

\* This figure is estimated.

Even if the gallons per 100 gallons in clarifier is reduced to 70 gallons per 100 gallons in clarifier, the three clarifiers at Umfolozi could handle  $47,000 \times \frac{70}{100} = 32,900$  gallons of juice per hour, which can be considered very satisfactory. Although concrete facts regarding ratios of mud to clear juice cannot be obtained, an assurance can be given that the figure is by no means excessive.

It may be of interest to know that at Amatikulu the 18-foot clarifier has been coping with 8,000 gallons of juice per hour, and it has even handled as much as 10,000 gallons per hour for an 8-hour period under the writer's supervision. In these cases the figures for gallons of juice per square foot of settling area, and gallons per 100 gallons in clarifier, were as follows:—

	8,000 gallons per hour.	10,000 gallons per hour.
Gallons/sq. ft. settling area ... ..	31.4	39.2
Gallons/100 gallons in clarifier ... ..	44.4	55.5

One of the main features about the juice from the Carter clarifier is that it has a very light colour and an average Kopke clarity of between 45 and 50. It is quite a common occurrence for the Kopke clarity to maintain a figure of well over 100° for a few hours. The drop in pH values from tempered juice to clarified juice is normal, generally 0.2 pH.

One feature worthy of mention is that the usual amount of scaling-up in evaporation tubes, as experienced with ordinary subsidars, was greatly reduced, thus increasing the efficiency of these vessels considerably.

The evaporation capacity is as follows:—

One quadruple effect	15,000 sq. ft. heating surface.
One quadruple effect	8,500 sq. ft. heating surface.
Making a total of	23,500 sq. ft. heating surface.

Assuming the two sets to be in use all the time for both 1943 and 1944 seasons, the amount of water evaporated per square foot of heating surface up to the periods ending 19th February, 1944, and 17th February, 1945, respectively, are 3.85 lbs. for 1943 season and 4.52 lbs. for the 1944 season.

The tons of water evaporated per hour for the same periods are 44.10 tons for 1943, and 53.13 tons for 1944.

Another feature, which can be attributed largely to the quality of juice put out by the clarifiers, is the fact that the amount of chemicals required for clarification can be considerably reduced.

	1943 season.	1944 season.
Lbs. lime per ton cane... ..	4.027	3.246
Lbs. sulphur per ton cane ... ..	1.727	1.116
Lbs. phosphoric per ton cane ... ..	0.358	0.028
Purity of mixed juice ... ..	84.45	84.80
Boiling house recovery ... ..	88.7	88.5

The average increase in temperature of clarified juice ex-clarifier, as compared with juice from settling tanks, is approximately 20° F.; the juice entering the clarifier at 212° F. comes out at 203° F., while that of the settling tanks drops to 183° F., thus increasing the demand for steam necessary to bring it up to boiling point.

The writer wishes to express his thanks to the Umfolozi Co-operative Sugar Planters, Ltd., for their assistance and co-operation in enabling the writer to carry out this work.

Mr. ELYSEE said the Carter Clarifier had been of good assistance to them during the war period. There were, however, a few difficulties which he thought could be rectified. They had normally been running through the clarifier 8,000 gallons of juice an hour; but they found the distribution of the juice was not satisfactory, as some of the pipes got clogged up with solid matter and heavy precipitate. They had adopted the practice of stopping the clarifier for a moment and rushing through water in the hope of clearing the pipes, but even so they generally found that at the end of the week only one or two pipes were working. He thought the Beaume figure was rather an unreliable one; and he had therefore determined the solids per cent. mud coming from the clarifier and found it to be two to three per cent., whereas they used to get four per cent. from the old defecators.

Mr. CARTER said they had the same trouble to start with. The pipes did clog up, but it was easily overcome by having them on an incline and withdrawing the juice below the level of the pipes. In this paper he had drawn attention to the fact that the water evaporated per hour had gone up considerably from 1943 to 1944; but that was not entirely due to an increase in the temperature of the juice leaving the clarifier. The reason for it was partly due to increased boiler efficiency. It was remarkable that the juice colour was so excellent, even when crushing cane from other areas, and in spite of using very small quantities of chemicals.

Mr. BOOTH encouraged the author to persist in the work on his clarifier, and hoped that we soon would have comparable results from factories using other types of clarifiers. The present drawbacks of the clarifier seemed to be only mechanical and should be rectified in course of time and experience.

The PRESIDENT said the Carter Clarifier had apparently only been put in actual factory use in 1943, and must still be considered in its experimental stage, but he thought there were considerable prospects ahead of it.