Prospects and Advantages of Rotary Filters in Sulphitation Factories

By W. H. FOSTER

Mr. W. H. FOSTER: I was very disappointed to find that there was to be no paper from the Clarification Committee, particularly since our engineering section has been well represented on the Committee last year. I therefore tried to step into the breach and offer a few notes. I compiled this paper with the intention of trying to open up a way to get the engineering section interested in this Committee.

Reviewing the valuable statistical papers presented to this Association in past years by the Clarification and Filtration Committee, I thought a few notes on some experiments conducted at the filter station might prove of use to them, in providing material likely to open up a discussion in this phase of the factory operations. I did not expect to prepare a paper on the subject, and regret the limited time at my disposal has precluded me from giving more than a brief general outline of the more important experimental work carried out at our filter station and the conclusions deduced therefrom.

The amount of sugar lost in our filter cakes —2% on the sugar entering the factory—compares rather unfavourably with that of cane producing countries more favourably situated, and is an indication of the very refractory nature of the product we handle. Although in recent years some considerable progress has been made in reducing the sucrose content of the cake, the method usually adopted—higher dilution of the settlings—does not appear a particularly economical one, more so as few of our factories appear to have a superfluity of steam, subsiding tank or filter capacity.

Uba cane is still a staple variety, and has every appearance of forming at least the major portion of our crop for some considerable time to come, so that we cannot expect any great alteration in the working quality of the juice. The filter press in use is still essentially the same machine as that used by the industry for many years past, and if after such an interval of time, the sugar losses in press cake still remain at their present high level one is forced to the conclusion that better and more improved facilities will be required at the filter station to effect economically, the desired reduction in losses. It is interesting to note in this connection that several companies have given this matter their attention.

In endeavouring to reduce the sucrose content of the cake, due consideration must be given to the economical aspect of the method employed both as (1) process (2) entire factory process (3) as a milling concern (4) and as a joint milling and planting estate. Thus in the latter case the disposal of the muds, which have value as a fertilizer, must be borne in mind when selecting new methods or machinery, while the possibility, though remote, of delivering the cake to the fields in the form of a sufficiently dry pulverised powder comparable to artifical fertilizer has not been entirely overlooked.

An outline of some attempts at reducing the losses at the filter press station are given in support of the argument that improved machinery apparently effects such reduction of losses.

Washing the cake obtained in the sulphitation factories in the press in the usual way gives indifferent results and at times is impracticable. By introducing the wash water through the feed line to the press without interrupting the continuity of flow, better results have been recorded, but the resultant cake is usually wet and sloppy, an undesirable feature as regards our transport facilities. This further means a multiplicity of pumps.

The cost of kieselguhr and other filter aids generally discourage their use in sufficient quantity to secure that ease of filtration desirable.

Double filtration appeared to offer promising results, and has been given an extended trial. The reduction of the sucrose content of the cake appears quite satisfactory, though the recovery of sucrose has been accompanied by the extraction of a considerable amount of impurities, as is evidenced by the depression of the purity quotient of the second filtrate. The results obtained:—

	Double Filtration	Single Filtration
Sucrose in cake % sucrose entering factory	.35	1.51
Sucrose % cake	1.48	6.42
Purity 1st Filtrate	72.1	74.5
Purity 2nd Filtrate	62.9	
Boiling House efficiency (clarified juice)	99.5	99.8

Although the filter press juice was re-clarified, the impurities appear to have passed through to the

boiling house resulting in an increase in time required for the boiling and curing of the lower products which subsequently affected the crushing rate. This lead to the abandonment of the process for the time being.

Dilution and decantation of the settlings had therefore to be accepted as the standard procedure, the separation of the juices as in the Petree process, being retained. The muds from the rich or primary juice are diluted by a mixture with the secondary juice prior to clarification and the resultant settlings again diluted and decanted before pressing. I am given to understand that this practice is favoured by some Australian factories, with the exception that the filter pressing is omitted, the final settling being considered sufficiently exhausted and thickened to run waste—a very happy circumstance indeed.

This practice in our case appears to me to be a rather un-economical way of using water, and consequently steam, for heating and evaporation. To illustrate this, take the case of direct dilution and filtration to obtain a cake of sucrose content 2.5% moisture, 56% purity of contained juice 80 and Brix therefore, 5.3. Assume the settlings 20% weight on cane containing juice 18.8% of 15 brix. Water required to dilute juice to 5.3 brix = 183% on juice settlings or 34.4% on cane. Assuming 1lb. bagasse will give 2.5lbs. steam; 1lb. steam in quad to evaporate 4lbs. water and bagasse % cane 30. The fuel required to remove the dilution water in evaporator alone amounts to 11.5% of the total supply. This though a somewhat exaggerated example, would tend to explain to some extent our present high filter loss.

As we appear to have exhausted the possibilities of bettering the results with the existing presses we considered the prospects offered by, and eventually installed a continuous rotary vacuum filter of the Mauss patented type. This machine operated over a portion of last season. We recognised the fact that these filters could not be regarded as high juice capacity machines and that their usefulness would be greatly increased by working on a thickened sludge. In this respect, however, we have not yet obtained information of a machine likely to meet our requirements.

We decided first to test the possibilities of the vacuum filter as a second filter to the plate and frame machines. The press cakes were broken down to a fairly homogeneous sludge in a suitable machine, with the addition of water, to a solid content of 15 - 19%. The results recorded below compare very favourably to those obtained in the former trial with plate and frame filters.

Sucrose % Press cake	6.2%
Sucrose % Vacuum filter cake	1.6
Moisture % Vacuum filter cake (determined on catch samples)	66.
Purity F. Press juice	80.9
Purity Vacuum filter juice	74.3
Dilution & Wash water used (Calculated as % on cane)	7.8

The estimated loss of sucrose in filter cake in this method of double filtration terms of sucrose in cane is estimated .39% or a reduction of over 1% on the usual figure.

The capacity of the filter on this work is quoted as 12lb. press cake per sq. ft. per hour, or assuming press cake to be 3.5% on cane, 5.38 sq. ft. filtering area per ton cane. This compares very favourably to the filter press figure, in double filtration.

The difference of 6.6 between purity of the first and second filtrate calls for comment and a more detailed knowledge of the physical nature of these impurities is desirable.

As a direct filter, the machine gave quite satisfactory results though the thickness of cake is greatly decreased, being $\frac{1}{8}$ to $\frac{1}{4}$ in. thick. Over an observed run the filter handled settlings at the rate of per sq. ft. per hour minimum, 18.12lbs. maximum 39.2 average 23.6. This latter figure indicates a filtering area of 17 sq. ft. per ton of cane. Wash water to the extent of 5% on weight of cane proved sufficient to reduce the sucrose content of cake to 2.5% with a purity of filtered juice comparable to that from the presses. Moisture of cake is somewhat higher than that of filter press cakes, contents of 70% and over being recorded. The cake, however, is quite firm even at these high moisture contents and affords no greater difficulties in regard to transportation and disposal than does filter press cake.

Since the above tests were made with the object of computing the capacity and costs of an installation of this type of filter the results recorded are rather conservative. Sufficient experience with this machine has not yet been obtained to estimate the maintenance costs etc., but an endeavour was made to estimate the probable recovery of sugar and labour and cloth charges in comparison to the filter press and is shown in the following tabulation of results. These estimates are necessarily rather approximate:—

	Filter Press. Present pract 1929-30 Season.	Filter Press. Double filt. Recorded run.	(Estimated) Vacuum Filter. Double filt.	Direct filt.
Sucrose % cake	5.95	1.48	1.63	2.5
Sucrose lost in cake %	1.47	.35	.39	.75
Recoverable sucrose % Sucrose in cane (S.M.J. S.98 M. 45)		.59	.78	.59
Relative operating costs (Labour and cloth)	1.00	1.25	1.18	.23

The figures for direct filtration with the rotary filter compare well with those of the other methods and are distinctly encouraging, justifying the claim of the continuous rotary vacuum filter to efficiency and economy. Further tests are required to ascertain to what extent the sucrose content may be reduced by increased washing.

Of the disadvantages of the rotary filter mention must be made of their bulk—the floor space required being much greater than in the case of filter presses. Maintainance, etc., has yet to be arrived at but the impression formed is that it will be heavier than in the case of the filter press station, and may call for a certain amount of skilled labour. The initial cost is high.

The conclusions drawn by the writer may be summarised as follows:—

The washing of cake in the press is admittedly imperfect and at times difficult to effect.

The second operation in double filtration can be carried out more economically with the rotary filter, the machine being particularly suitable to this type of work. The low purity of the second filtrate is an undesirable feature of the process.

Higher dilutions of the settlings coupled with washing in the press is uneconomical in the use of steam and therefore fluctuations in results can be expected.

The solid content of the settlings is rather low for the successful operation of the rotary filter. Should a thickened sludge be possible at low cost the filter offers considerable advantages over the filter press as regards economy in labour and cloth, increased sugar recovery, greater cleanliness.

A prolonged trial extending over at least another season is necessary to ascertain whether the filter can handle at all times the muds drawn direct from the juice settlings.

I may make it a little clearer by saying that so far the experiments last year have shown that the filter can handle the direct settlings, though at times the quantity of juice filtered is very small. Whether it would filter it at all times successfully I am not at present prepared to say.

CHAIRMAN: Mr. Foster's paper opens up very many interesting points of view and it is open for discussion.

Mr. RAULT: I think Mr. Foster is to be congratulated on bringing out this paper which gives us actual factory experience and raises many points that all of us are every day discussing in the mills. When he starts by saying that 2 per cent. of the sugar in the cane is lost in that department it shows how in South Africa we are very backward in that department. When we think that many millowners will spend thousands of pounds in a mill which will recover say 1½ per cent. more extraction—and extraction of juice of very impure nature—from the last bagasse, it seems to us that something ought to be done in the department of filtration where we are losing juice that has actually been taken out, which is a clarified juice. Reading through his paper it seems that the day of the filter press will be coming to an end before long. With conditions as they are to-day, especially with the shortage of labour, another kind of machine will have to be evolved, and probably the filtration will have to be done in machines which are essentially labour-saving appliances. I understand now in some very progressive factories in America that you may not find filter presses at all, the juice or scums from the juice being handled by a machine. The first part of the operation consists in removing as much of the clear juice as possible and leaving a sludge. That sludge can then be handled fairly easily by rotary machines, because machines like those of the Mauss type or Oliver type are not machines for handling enormous capacities of juice; they are simply sludge driers; they are very efficient machines when you consider that they wash the sugar out of the cake and throw the cake away without having to consume a lot of labour, and therein lies a great advantage, but they have to have a lot of juice pushed through. At Natal Estates we have been having some experiments with rotary filters, and we should not consider them, as at first thought, machines that are going to take a lot of juice. The essential part of the work, the essential filtration of the juice, should be made by other types of machines, and I think a machine like the Vallez, which has a high filtering surface, will come to light before long, and these machines need not complete the washing of the cake; that could be done in a very efficient manner such as Mr. Foster speaks of. I can also substantiate part of his statements when he mentions that double filtration extracts very impure juice. We wash the cake to a very low sucrose content in the carbonatation process, and sometimes we are doubtful whether it really pays us to do the final washing on account of the amount of impurities taken away by the last washing. In the Refinery you know the last washes of the char are so full of solids and organic matter it does not pay very often to work them. It may be so also with the juices. I have a few tests here which I can give for example, figures showing how impure the last particles of juice are in a mill washing. For example, the first part of your press or Mauss filter gives you—I am talking of lime salts now—.60 lime salt % Brix. The wash of it is about 8 Brix, in that case the lime salts goes up to .91, and in the last wash, which is from 5 Brix to 1 Brix, it gives you an amount of lime salts of 2.8, also the colour seems to be taken back again.

Mr. BEHRENS: If the filtering is bad there is something wrong in the working of the other parts of the factory. You cannot put down a hard and fast rule of how far you can wash off the cake. That wants some experience; that is what our mills are very short of. They have to introduce it; it will come in time all right, double filtration and double sulphitation. The filtration is the right thing, but it is a difficult thing to get the precipitate to filter well. The washing off of the cake will take some time before the factories get into the way of it. It is the main part of a raw sugar factory.

Mr. POUGNET: I think it would be a good thing if we could show how much sugar is lost. It would be useful to know which is the most economical process to be adopted with the Uba cane in Natal.

CHAIRMAN: When I was on the Rand some time ago I paid a visit to a meeting of the S.A. Chemical Institute, and the discussion appeared to turn on the subject of filtration. As you know, the science of filtration has been very highly developed on the Rand where they have such enormous volumes of sludge to deal with in the extraction of gold. It was suggested to me then that they considered that the Sugar Industry of Natal was rather conservative, shall I say, in adhering almost entirely to the use of plate and frame filters, and they are of opinion that if the matter was sufficiently studied we should find that continuous filters would probably suit our conditions. I do not know sufficient about it from the factory point of view to discuss it at the time, but I am very glad to see the matter has been taken up in this excellent paper by Mr. Foster. Certainly there is enormous room for improvement as Mr. Rault has pointed out. In the paper I read to you yesterday you will notice that the average loss of sucrose in press cake per cent. of sucrose in cane in Natal is in the neighbourhood of 2 per cent. and in Java it is only ½ per cent. That shows that there is considerable room for improvement in that direction; an improvement which I am sure will be brought about by such work as Mr. Foster is initiating.

Mr. BEHRENS: It entirely depends on the working of the factory; if you produce a precipitate which will filter well you can bring the washing off down to ½ per cent., sometimes below that. It all depends on the working of the factory.

Mr. WICKES: I would like to endorse Mr. Rault's thanks to Mr. Foster for the able paper he has given us. I have recently been over to Queensland, and they are taking a very active interest now with regard to rotary filters over there, and I had some interesting discussions with several of the people in the sugar business. While their losses are something similar to Java they still recognise there can be no bigger improvements in that direction. Their success so far as I could see was due to their organisation. The more powerful groups in Australia carry out the tests from the scientific branch, and when they are satisfied that results are worth while following up they then instal any process or alterations they decide on in a factory, and it is eventually adopted by their mills, and within a few months it is followed up by the others. From what I could see of their organisation over there that is the way in which they have overcome so many of these troubles. With regard to filtration, which is a very big thing out here, might I suggest that a committee be appointed from this Association to go into this thing much on the same lines as this question of sulphur dioxide in the sugar was dealt with. I think we can get some very valuable information by next year if such a committee be appointed.

CHAIRMAN: Do you think that could be dealt with by the existing committee on Clarification and Filtration?

Mr. WICKES: It would appear by, shall I say Mr. Foster's remarks about the lack of interest taken by the Committee, that there must be something wrong in the lack of interest, and I see so few engineers at this meeting. I can only put it down to the fact that the time is wrong. Would it not be possible to have this meeting put forward by six weeks or so and give the engineers a chance of attending?

Dealing with that subject, that the present Committee take it on, seeing that they have not been able to write up a paper for this meeting, I don't see that they will be any happier placed with the same personnel for the next year. I would certainly suggest it would be worth while trying next year to have this meeting earlier in March. I know three or four of my engineer acquaintances have no hope in life of attending this conference at this time of the season.

Mr. BIJOUX: Mr. Foster seems to condemn the filter press on the ground that it is uneconomical. I would like to know whether he was using hot or cold water. We found by using hot water that the recovery went up 2 to 3 per cent.

Mr. FOSTER: I think you would have to remove the water in any case whether you used hot or cold water. I have merely illustrated the amount of steam required to remove water in the evaporator without introducing the question of the amount of steam required to raise that water from zero to boiling point.

Mr. RAULT: With reference to the diminution in scums I notice that the calculation of Mr. Foster was based on 18 per cent. of the juice. Herein lies the essential difference between our conditions and Australia's conditions probably. I think that there when they are doing the dilution they have such a small quantity of dirty liquor that finally they are able to throw it away without passing it through a press. Mr. Wickes may correct me if I am wrong, but I think they only reject about 6 gallons of juice per ton of cane. The Australian mills produce about 200 gallons of juice per ton of cane, so that this figure of 6 to 8 in 200 means only 3 or 4 per cent. as against the present figure given by Mr. Foster of 15 to 20. Until the last two or three years most of the mills have been using a heavier quantity of chemicals bringing the sulphitation process more in line with the carbonatation process, the good results of which are obtained by heavier chemicals. I would like to ask my friends whether they have

remarked in the last few years, with this heavier treatment of chemicals in the juice, they found that the amount of muddy juice has diminished, because if you can throw off say 90 per cent. of clear juice you are on a good road to diminish these losses, and that is why I would like to have the experience of other people who are on the sulphitation process.

Mr. POUGNET: About the amount of sugar lost being 2 per cent., there is one thing we must not forget; we only grow Uba here; the other countries have different canes altogether and the juice is entirely different. The filtering is much easier. Anybody who has been in other places where they grow seedlings finds that the treatment of juices and filtering is very much simpler than in this country. Uba never comes to the mills as clear as the other canes. Then you get the cane wax, too. All these impurities put together are bound to interfere with your filtering and make it more difficult.

Mr. FOSTER: I think we have the Uba with us and have got to recognise that it is the staple variety. If we are not going to progress with our machinery I think we can carry on with our present losses. If you wish to improve the work we have to get improved machinery to do it with. That was my object.

Mr. DYMOND: I think this problem must be considered from two angles, and improvements in machinery are to my way of thinking of secondary importance. We have in this country two main types of scums, those derived from the carbonatation process and those from defecation. In the first the addition of an eminently suitable type of filtering medium renders the scums easily filterable. Under such conditions the second step is the search for a mechanical device whereby the filtration is improved and the cost reduced. In defecation there is nothing standard in the quality of the scums obtained. Last year I was given the opportunity of visiting all the sugar factories in Natal and Zululand, and one of the facts which struck me was that not one factory treats its juices in the same way as any other. Some use very small quantities of chemicals, others comparatively larger amounts. Some use phosphoric acid, others do not, while the filtering area per ton of cane is, to put it mildly, extremely variable. The result of these conditions has resulted in the practice of what might be termed the " easiest way out of it "—the boiling up of scums. The best illustration of this bad practice is in the Petree process, where the heating is so efficient and prolonged that little or no trouble is experienced in subsequent filtration. The consequence of this practice has been frequently stressed in the past. The first step in this problem of filtration is to evolve a standard efficient method of clarification, as we attempted to do in the SO_2 report, and when once this has become standard practice by all means let us concentrate on improvements in machinery for what would then become a standard type of scum.

Mr. FOSTER: I think there is very little comment to be made on what Mr. Dymond has said as regards boiling scums, and I think that it has already become a recognised fact in the industry that it is not the most economical way of seeking easy filtration. However, at the same time in endeavouring to improve our clarification methods and so seeking an easier filtering scum, is it not advisable to look round for a machine which will offer a greater saving of labour than the filter press, and at the same time handle the product more easily? That is my whole contention on the subject. Admittedly we have not got to the right stage of clarification yet, but at the same time there is nothing to prevent us investigating the properties of various machines.

Mr. RAULT: There is a point that has not been stressed in our discussions, that is the economy in cloths, which is quite a big expenditure. Although Mr. Dymond is right in his contention that we ought to improve clarification, yet we know that apart from the improvement in filtrability the fact of getting another type of filter might produce other economies such as cloth. Filter presses generally are very wasteful in cloth, whilst those who have experience with the new system of filtration, know that we need not open them as often as with the filter presses, and therein lies economy. The cloths last much longer. We have proved at Mount Edgecombe that the rotary filter uses very much less cloth than the filter press.

Mr. POUGNET: Did you dilute the scums first or try to wash the cake before filtration?

Mr. FOSTER: Both. We attempted to wash the scums, but while at times we did have fairly satisfactory results, at others it was rather difficult. The standard practice so far as I can gather appears to be a heavy dilution before filtration. On the rotary filter you do all your washing on the machine.

Mr. BIJOUX: I believe the idea of diluting the scums before sending it to the press is very good.

Mr. POUGNET: With regard to washing, very often the water finds its way through one way and forms a sort of channel and does not wash it all. It would be far more advantageous to wash the scums before than to do it in the cake.

Mr. BECHARD: Mr. Foster gave 2 per cent. loss on filter press. This figure is the loss on filter press cake, not loss at the filter press station. There is rather more sugar lost at the filter press station than is shown in the cake. There is the sugar in the wash water; there is the leakage in the frames, in the bursting joints, also the waste when the press is opened. These are not counted in the

losses in filter press cake. The loss at the filter press station actually is very much higher than anybody imagines.

Mr. POUGNET: What we lose in leakage is what we reckon as undetermined losses. Other mechanical losses are included in undetermined losses, which are mostly due to mechanical losses.

Mr. FOSTER: I think you will find that the losses suggested by Mr. Bechard are very considerable indeed. Where you have a more or less strict control of the factory and it is possible to weigh your product going through from mixed juice, clear juice, to syrup, you will trace up rather a surprising amount of unaccounted sugar, and it proves Mr. Bechard's contention that you have a very heavy mechanical loss, which I think does principally occur at the filter station. A reduced mechanical loss is one of the advantages of a rotary vacuum filter.

Mr. JACOBS: There is one aspect of vacuum filters that has been overlooked; it opens up a new field for research. We have had plate and frame filters for many years, and we have got to the limit of our research there. But with vacuum filters we have a new field opening up for further research. I have had some experience with vacuum filters, but unfortunately my tests have been upset with mechanical difficulties not altogether directly connected with the filter. In one test which I carried out with an Oliver filter—which is of the same type as the one referred to by Mr. Foster—with an exceedingly small amount of washing water, we reduced the sucrose in the cake over an average of 24 hours to .8 per cent., which is a very considerable improvement on anything that has ever been done in filter presses. In this experiment a small amount of bagasse dust was used as filtering medium.

Mr. BEHRENS: You must bear in mind that if you introduce a medium that will absorb a certain amount of sugar at the same time, that reduced the amount of loss but in the wrong direction. You don't recover that which is in the medium.

Mr. BECHARD: I would like here to make a reference to a subject bearing on this point. I refer to the forced diffusion process of Dr. Naudet. Very little is heard of this process out here, but it is proving very satisfactory in Egypt. The whole idea is to place the primary bagasse in a diffuser and to force the treated juice through this bagasse until it is clear. The bagasse then passes on to ordinary diffusion, while the juice is ready for evaporation. A recovery of over 96 is said to be the result if we consider that this recovery is sucrose in clear juice % sucrose in cane. It means a long step forward, and I think it is well worth while considering.

CHAIRMAN: With regard to the question raised by Mr. Wickes as to the date of the meeting, I must admit that according to our Constitution we are directed to hold this meeting in March every year. The difficulty has been that most of the factories closed very late this season, in December and even some in January, and as you know the work of most of the technical committees is entirely at a standstill during the crushing season, all the members being otherwise engaged. It is only possible to devote much attention to the work of this Association after the mills have closed down, and that has given us very little time this year and accounts for the delay in holding this meeting. We have followed the custom of holding it immediately before Easter, which appears to be a convenient time. It is very unfortunate that we have not a better attendance, particularly of the Engineering members, but that I feel is not altogether due to the time of the meeting, but the fact remains that we have so little of engineering interest in our agenda this year. However, I hope there will be an improvement in that direction next year.