THE EMPANGENI DIFFUSER INSTALLATION: 1967 - 1970

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Abstract

The paper describes the course of development of the B.M.A. diffuser installation and associated plant over four seasons. Practical difficulties are described together with the modifications that were made to overcome particular problems, and the reasoning behind the modifications. An attempt is made to indicate the problems remaining in the operation of a percolation bed type diffuser.

Introduction

The B.M.A. diffuser was installed at Empangeni at the start of the 1967 season, to increase crushing capacity and improve sucrose extraction. The diffuser replaced the third and fourth mills of the existing 84 in-6mill tandem, as shown in Figure 1, which is a schematic diagram of the initial installation.

Principal details of the diffuser are given in Appendix A, together with details of the associated equipment.

The diffuser was sized by the manufacturers to achieve an extraction of over 96% on 225 tch of 18% fibre, but the performance, as installed, proved to be unacceptable, and in the seasons that followed substantial modifications were made to it and to the related plant.

The practical difficulties that were and are experienced in operating the diffuser, the modifications that were made to overcome particular problems, and the reasoning behind the modifications are dealt with in roughly chronological order, season by season.

Table I is an attempt to show graphically the modifications made each year of operation.

The 1967 season

Commissioning of the diffuser started about the middle of July, but by then it was already clear that the existing plant was in fairly serious mechanical trouble due probably to excessive involvement of maintenance staff in the diffuser installation work, and also to a number of staff changes. The problems of commissioning, training staff, and integrating the new plant into the existing system were therefore severely aggravated, and it was only towards the end of the year that things started to settle down.

From the very start, the rate of juice percolation in the bagasse bed appeared to be a serious problem. The stage juice would flood over the top of the bed, and because the distribution of cane across the diffuser was rather uneven, it would channel down the valleys and through under the lightly loaded press drum at the end of the diffuser and flood the discharge belt. This belt was so steep that sodden bagasse would not go up, and would choke the diffuser discharge. The quickest method of stopping the flood was to switch off the stage pumps, at the expense of extraction. The press roller at the end of the diffuser was therefore filled with water to provide a more effective seal, and modifications were made to the feed flume to effect an even bagasse distribution.

In the longer term, it was decided to try to reduce the amount of fines being made during preparation, and thereby improve percolation. First the shredder hammers were sharpened and hard-faced as with cane knives, but this had little or no effect, so the shredder was by-passed. The number of knives on the second set was also reduced to improve percolation. Preparation then became very poor and caused severe intercarrier choking, first mill feeding problems, and seriously reduced first mill performance. It was felt that if the knives could be run more slowly, less fines would be generated, while a full set of knives could again be used on the second set to cut the sticks that had been getting through. To achieve this, a 950 hp turbine was installed to drive the second set at any speed up to 550 rpm. Variable particle size from variable speed was the aim. This was in fact achieved, and the diffuser became more manageable.

The pH of clear presswater was being controlled at about 10,5, as recommended by B.M.A. The quality of clear presswater seemed good if a trifle cloudy, but still appeared to be causing blinding of the bed, possibly due to a second flocculation on the diffuser bed near to the point of application.

All presswater liming was stopped and the clarifier was used purely as a settling tank. The larger suspended solids separated out easily, and the diffuser coped reasonably well, but inversion in the clarifier necessitated pH correction and a value of 6,7 was used for settled presswater.

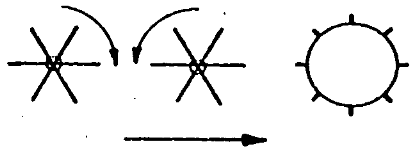
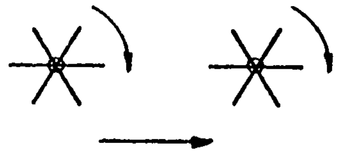
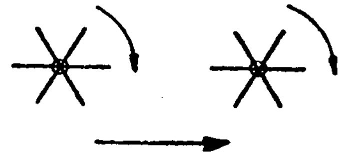
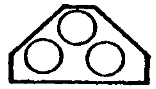
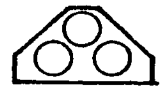
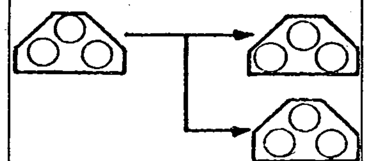
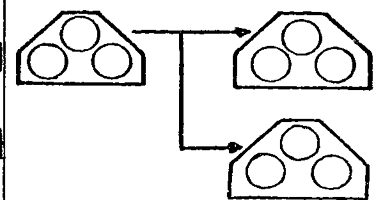
The problem of roller polishing on the drying mills then appeared. The etching of roller surfaces by juice at natural pH had been lost, the bagasse temperature was 60-70°C, and the moisture about 82%. Mill slip became excessive, and this was made worse by the fact that the presswater mud was returned to the last drying mill. Very intensive carbon arcing had to be applied to keep the mill running at all. The season's results are shown in Table II — and are very poor.

The 1968-1969 season

The 1968 off-season saw a number of substantial modifications to the plant, with the following aims:

1. to improve cane preparation;
2. to increase the number of percolation stages;
3. to rationalise the advance of the points of application of stage juices in relation to the target trays under the diffuser screen;
4. to obviate blinding of the bed with fine

TABLE I

	1967	1968	1969	1970
PREPARATION	 48 knives 585 rpm 600 bhp Electric; 48 knives 585 rpm 500 bhp Electric; Searby 1 170 rpm 450 bhp	 48 knives 550 rpm (max) Weir turbine C. 900 hp; 48 knives 550 rpm (max) Weir turbine C. 900 hp.	As 1968	 44 knives; 48 knives
EXTRACTION MILLS	 84" x 43½" Smith	 84" x 43½" Smith	 84" x 44½" Smith	 84" x 44½" Smith
DIFFUSER ALTERATION	as supplied	2 additional stages Feed flume alteration	Presswater screws Clarifier eliminated Windows in side. Thick blanket in maceration carrier. Stage juice sprays.	Scraper conveyor at discharge. Draught juice screen area increased Tray level indicators.
DRYING	 84" x 41½" Smith	 84" x 41½" Smith	 84" x 42" Smith No presswater mud	

screenings from the primary and draught juice streams.

Up to this time the first cane knife had run in the unconventional direction, and both motor loading and cane preparation had been found to be more regular. It was decided to retain this direction of cutting on the first set and to reverse the second set also. The electric drive on the first set was replaced by a 950 hp turbine, so that both knives were then steam driven and running unconventionally. There was a big question mark on how this arrangement would accept cane. The shredder was removed completely.

In the original arrangement, draught juice was drawn from the first stage of the diffuser, but the pol of the scalding juice was higher than that of draught juice because it made first contact with the cane. This was thought to be exploitable, probably at the expense of a slight increase of suspended solids in mixed juice. A modification was made whereby the original draught juice stream was sprayed on to the maceration carrier and draught juice was drawn from the scalding juice circuit. The screen area of the maceration carrier was considerably increased by inserting perforated plates to assist draining the additional juice. In effect, two stages were added.

Upon examination, it was found that the disposition of the stage distribution weirs in relation to the juice trays at which they were aimed, was very irregular. It was assumed that percolation rate deteriorates as the bagasse bed travels along the diffuser, and by intuition the weirs were set with 2 m advance at the discharge end, gradually reducing to 50 cm at the feed end. At that stage no successful tracing of juice travel through the bed had been achieved.

The arrangement of the mills remained unchanged from the previous season, but numerous changes were made to cane carriers, intercarriers and bagasse carriers.

When crushing started, the first problem to emerge was that of feeding the cane knives. The carriers had insufficient grip on the cane, and this was then provided by welding pieces of small section angle iron to every fourth slat of the cane carriers. Feeding as such ceased to be a problem, except when rocks entering with the cane damaged the knives. Needless to say, knives rotating unconventionally suffer far more damage from rocks and tramp iron than normal knives.

Another problem that emerged was that of knife wear rate. This increases drastically with contra rotating knives and trials with various hard facing materials were undertaken to establish the best material. The knives were then able to last for two weeks provided they had not been physically damaged by rocks.

Knife speeds were varied according to diffuser bed conditions, but were about 300 rpm and 400 rpm respectively for first and second sets.

Preparation was far better from the milling point of view, because the choking of the first intercarrier disappeared, and the vertical chute could once again be fed without problems. The variability of knife speeds did provide variability of preparation.

Extraction from the first two mills without imbibition improved to 57,42% for the season. It should be pointed out at this stage that first mill juice is separately weighed and that first mill extraction figures quoted are true.

Diffuser performance improved tremendously, in spite of the fact that diffuser condition could only be judged by poking a stick into the bed to see how far it would penetrate. Knife speeds were adjusted according to this test, but this was not infallible. The final test was whether the bagasse was dry enough for the conveyor belt. Disaster struck every so often.

The percolation of "clear" presswater was a constant source of concern and flooding. Presswater mud seemed to aggravate the drying mill problem. These two factors made the prospect of eliminating presswater clarification very attractive. But the problem of returning raw presswater on to the diffuser bed was far worse than with "clear" presswater. The idea of mixing it into the bed was then hatched, and the best method was thought to be by means of simple rotating "Archimedean" screws, suspended from above and penetrating the bed. A single experimental unit was built with an hydraulic drive, penetrating to within 16″ of the screen, and was installed before the end of the season. A proportionate quantity of presswater was poured on to the bed immediately before it.

The results were considered sufficiently encouraging to warrant the building of a full set of seven screws to cover the whole width of the diffuser, and the money was made available.

During the season experiments were carried out in measuring percolation angles through the bed, and after various abortive attempts with dyes, a method was perfected using Na Cl and tracing the dose with a Cl determination on the juice from a series of sample points. The method has been reported on by Comrie[1]. The tests indicated that the positioning of the juice distribution trays had been quite well judged.

TABLE II

	1967	1968	1969	1970
Fibre % Cane	17,94	18,21	18,04	18,45
Sucrose % Cane	12,89	13,07	12,93	13,70
Tch	188	189	189	180
Tons Fibre/hr	33,7	34,4	34,1	33,21
Imbibition % Fibre	265	272	285	299
Moisture % Bagasse	55,52	54,94	54,32	54,67
Pol % Bagasse	2,84	1,68	1,77	1,53
L.A.J. % Fibre	48,17	28,45	30,81	24,99
N.S. Ratio	0,80	0,76	0,84	0,85
1st Mill Extraction	52,1	57,4	52,7	54,5
Extraction	90,29	94,53	94,28	95,23
Mech. Time Efficiency	82,86	92,25	91,36	93,20

From Table II it can be seen that the season's results were a tremendous improvement on those of the previous year.

The 1969-1970 season

During the off-season, the only alteration made to the diffuser was the slowing of the maceration carrier chain speed to 4,6 metres per minute so that a continuous bagasse blanket would form, and the additional spray, previously installed, become more efficient.

An extensive cane carrier modification was made in which the head shaft of the auxiliary carrier was repositioned so that the second knife cut "against" it. This resulted in the diameter of the first set having to be reduced to 1,52 m (by shortening knives), and a setting of 2,5 cm from the carrier. This alteration was aimed at eliminating the uncut sticks that had previously still managed to find their way through. Again there was apprehension about the outcome.

There was also an extensive reorganisation of the milling arrangements. It was felt that the slip and final bagasse moisture problems would be reduced if the roller surface speeds were drastically reduced — from 12,2 m per minute to 6,0, if possible. To accomplish this, the second mill was re-positioned after the diffuser as a first drying stage, and the last two mills were paralleled. This was to be accomplished on the feed side by slowing the third mill to allow the feed chute to fill and overflow into the intercarrier feeding the fourth mill, and on the discharge side by using two transverse 48″ conveyor belts. The last two mills were set to crush 16 tons of fibre per hour, each at 6 m per minute.

The stage was set for round three.

Figure 2 is a schematic drawing of the extraction plant after all the major modifications had been completed, and shows the plant as it is today.

Once again the knifing arrangement gave trouble. Under certain conditions the space between the two knife sets would choke badly. At first it was suspected that the second set was ejecting the cane, and therefore a counterweighted baffle arrangement (which floated on the cane blanket) was installed to prevent this, but to no avail. With more careful inspection of the chokes, it appeared that the first set was throwing big bundles of cane over itself, which precipitated the chokes between the knives. In desperation, the whole first knife set was raised 30 cm and the knives lengthened by 15 cm, giving a setting of 18 cm to the carrier. Thereafter the arrangement ran without problem for the rest of the season.

Concerning the diffuser, preoccupation was still with percolation. It was suggested that the juice discharging from the stage distribution weirs, which falls in a continuous sheet, could be causing a classification of bagasse particle sizes in the first 15 cm of the bed, and lifting the fines to the top. It was felt that this would reduce percolation rate, and that a diffuse "rain" of juice would be preferable. After trials with perforated plate, which tended to blind, a spray pipe was developed which successfully made "rain," and one by one the weirs were replaced by sprays. This did not appear to make any significant difference to percolation, but the effect would nevertheless have been difficult to assess.

It was then decided that a window in the diffuser side plate might give a clue as to what was happening in the bed, and a piece of Perspex 9,5 mm thick by 15 cm wide by 152 cm high was let in, near the feed end. This revealed that the bed was flooded from the screen upwards and that there was a free liquid surface within the bed at all times. As a result of this, four more windows were fitted at different points along the length of the diffuser, and all revealed the same condition, except for the window nearest to the press roller, which showed no liquid level. The presence of this liquid in the bed seemed to indicate a restriction of some sort low down in the bed, possibly right on the screen. A manometer was fitted into a screen perforation to try to establish the hydrostatic head at the screen, but it continually choked and gave no indication. With hindsight, a water purge should have been applied to the connection. Since this was unsuccessful, other means were sought. The slats of the diffuser are approximately 7,5 cm above the screen and do not "wipe" it. Scrapers were therefore fitted to every slat for a length of 9 m over half the width of the diffuser to wipe the screen, and the liquid level was observed in the windows. There was no change. It appeared that the restriction was moving with the bed.

The screws for mixing presswater into the bed were still in the process of fabrication at this stage, and it was suggested that the same objective for which the screws were intended might be attainable by introducing screened presswater at high pressure from beneath the diffuser screen and by disturbing the suspected restriction near the screen. Presswater was pumped at up to 5 bars through a row of nozzles in the diffuser screen. Severe agitation of the bed was achieved, and for the first time unsettled presswater was successfully returned to the diffuser without affecting the percolation at other positions in the bed. In fact, from this time onwards, the presswater clarifier was never used again. Because of fluctuations in the presswater rate from the drying mills, the nozzle pressure fluctuated seriously making the agitation erratic. This arrangement was abandoned when the mixing screws were installed.

Initially the screws had tended to choke because of the damming effect they had on the bed and a consequent bagasse build-up on the upstream side. This was remedied and they have worked admirably ever since. Screening of presswater was also eliminated so that the presswater was returned directly from the mills to the diffuser. The bagasse bed after agitation by the screws rarely showed a percolation problem, although the window showed that there was still a free liquid surface in the bed, a bit lower than before the screws.

With the elimination of presswater clarification, pH correction was done on the stage after (juice flow sense) presswater addition, and to a value such that the pH curve along the diffuser did not dip below pH 6.

L.A.J. % fibre for the season rose to 30,8, due probably to the removal of one pre-diffuser mill and the subsequent drop in primary mill extraction.

De-watering was not such a serious problem as it had been. Roller polishing was not as severe as previously, although bagasse moisture remained high. Elimination of presswater mud and the low surface speed reduced the tendency to polish, but the moisture problem was suspected to be connected with the difficulty of maintaining a setting of 6 mm on an 84 inch mill in view of roller wear. The change was not an unqualified success, as extraction deteriorated, but the ability of the plant to successfully handle higher throughputs influenced the decision to retain these milling arrangements and to look to the diffuser performance for increased extraction.

There had been considerable concern since the start of diffusion with the poor boiling house recovery and in particular with the high non-sucrose ratio, the latter being common with other diffuser factories. During the season a series of tests was set up to establish the effect of operating temperature, pH, and various chemical additions to the diffuser bed, on boiling house performance with particular attention to undetermined loss and non-sucrose ratio. Temperatures and pH higher and lower than normal, and additions of

(a) an enzyme,

(b) a polyelectrolyte flocculant, and

(c) a quaternary ammonium biocide,

were to be tried, each for a two week period. The tests were designed to prove or disprove various theories put forward to explain the observed conditions and obviously some were mere shots in the dark. Unfortunately it was not possible to complete the series and the (c) addition was not tried. However, during the tests undertaken, it was not possible to discern any changes of sufficient magnitude to make any marked effect on either undetermined losses or non-sucrose ratios.

The 1970-1971 season

The 1970 off-season saw comparatively minor changes to the diffuser and associated plant. A unique first cane knife set was installed, on which the knives are articulated. The rotor resembles that of a shredder, but is far more robust, and the knives are bolted to palms which pivot on rods in the rotor. The main purpose of this arrangement was to minimise rock damage to the knives, which had been severe in the preceding seasons. The other purpose was to provide the facility for eventually doubling the number of knives on the set when the diffuser becomes able to cope with very fine preparation. The most significant change was the replacement of the belt conveyor at the discharge of the diffuser with a scraper conveyor, for reasons connected with the new F. & S. diffuser installation. To all intents and purposes, everything else remained unchanged.

In the final analysis, it had been the inability of the belt conveyor at the diffuser discharge to transport very wet bagasse up the 27° incline that had determined the "degree of flooding", or quantity of liquid allowable, in the diffuser bed. The new scraper conveyor was able to handle far wetter bagasse, so that this factor no longer mattered. The knives were run at speeds varying according to the judgement of the operator, who had no yardstick by which to judge the bed condition, and the result was several spectacular avalanches at the discharge, and the failure of the main drive shearing device, all precipitated by bed condition.

Under conditions of poor percolation, the trays under the screens tend to fill up, starting from the discharge end, due to juice returning to the trays from which it was pumped, and the stage pumps then pump considerably more than their normal quantity, so aggravating the flooding position. The same condition can be brought about by the filling of the feed end trays due to the inability of the draught juice pump to cope with an excessive flow. After considerable trouble with flooding due to trays filling from the feed end, the problem was traced to juice overrunning the draught juice screens and returning to the scalding juice circuit, causing an accumulation in the system. Additional screen capacity, available from the old presswater screens, was used and diffuser conditions became far more stable.

It was decided that it was imperative for the operator to know if any tray was full, and therefore simple float switches were fitted to every tray operating a light on the control panel. These level indicators operated for about the last four weeks of the season, and at no time did they indicate that there was any filling of trays under the diffuser. Under these conditions the knife speeds were up to 480 rpm and 550 rpm, the highest to date.

In trying to establish the reason for the occasional filling of the first few trays, an interesting aspect of diffuser bed behaviour was discovered. Under constant conditions of cane quality, preparation, juice and imbibition water flow rates, it would be reasonable to expect a constant difference between the imbibition water and draught juice quantities weighed every hour.

The following table shows typical values, taken from the daily laboratory record sheet for the 6th September 1970:

Time	Imbibition (Tons)	Draught Juice (Tons)	Difference (Tons)
7 p.m.	103	113	10
8	94	155	61
9	98	97	− 1
10	101	111	10
11	99	114	15
12	99	180	82
1 a.m.	101	110	9
2	102	124	22
3	103	82	−21
4	98	122	24
5	99	191	92
6	103	122	19

From these differences it is logical to assume that the conditions in the diffuser bed vary drastically from hour to hour, and that the draught juice pump is unable to cope with these wild fluctuations, hence filling of the trays. The ability to measure these differences could conceivably allow "dynamic hold-up" to be measured in a full scale diffuser.

Figures 3-6 show the curves of lost absolute juice against tons of cane per hour, and lost absolute juice against imbibition per cent fibre, for the period preceding September when the draught juice screen area was increased, and from then on to the end of the season. Figure 3 shows fairly severe scatter of the points, whereas Figure 4 shows a fairly good correlation, and therefore strong independance of lost absolute juice on cane rate. Figure 5 shows a better correlation before September than does Figure 6, indicating less dependence on imbibition rate under improved operating conditions.

Results for the season, again in Table II, show a remarkable improvement in overall performance, with L.A.J. % fibre of 24,99.

The lost absolute juice % fibre figure from the curve in Figure 4 for the crushing rate in the 1969/1970 season indicates a figure of 28%, as compared with the figure obtained of 30,8%.

During the course of the season, the very high non-sucrose ratio again caused considerable concern, and towards the end of the season two further tests were run consecutively. In the first, leucosan was dosed at the rate of 50 ppm on draught juice into the middle stage of the diffuser. After three weeks this was stopped and immediately thereafter the practice of emptying the diffuser of juice and bagasse before every long stop, was adopted. Results of the tests are shown in Table III.

TABLE III

Week No.	Test	Rain fall m.m.	Suc. % Cane	Mix. J Purity	Purity Diff. FEJ to Mix. J.	Purity Diff. M.J. to Cl. J.	N.S. Ratio	Mol. 85° Brix % Cane	Tons N.S. in M.J.	Tons N.S. in C.M/c Stock	Syr. Suc Variance calc'd —weighed
16	Nil	—	14,65	84,4	−2,6	1,6	0,80	4,12	652	178	+ 60
17	Nil	7,6	14,76	83,3	−2,3	1,1	0,86	4,59	698	202	+ 59
18	Nil	7,7	14,51	83,2	−1,6	0,4	0,84	4,52	648	208	− 3
19	Nil	—	14,75	83,9	−2,7	1,0	0,86	4,45	703	226	− 60
20	Nil	—	14,76	83,7	−2,6	1,2	0,88	4,57	648	202	+ 35
21	Nil	—	15,10	82,4	−2,7	1,6	0,89	5,28	755	192	− 37
22	Nil	56,1	14,27	82,4	−2,7	1,9	0,83	4,71	680	192	− 73
23	Leucosan added	119,0	14,08	83,4	−2,0	0,8	0,87	4,55	482	190	− 22
24	at 50 ppm on	54,0	12,68	82,6	−2,0	1,4	0,83	4,10	429	181	+ 8
25	draught juice.	6,0	13,30	83,4	−2,0	1,7	0,84	4,15	622	216	− 71
"	No Leucosan										
26	added.	4,0	13,09	83,4	−2,0	1,4	0,86	4,20	604	294	−350
27	Diffuser empty	36,3	12,06	82,1	−2,0	2,4	0,75	3,72	597	202	−283
28	during shut-	47,0	11,62	81,7	−1,9	2,6	0,78	3,71	487	223	−114
28	down	36,0	11,92	81,2	−2,0	2,3	0,71	3,72	602	230	−358
	"										

All the figures tabulated show a distinct change in pattern for the better, corresponding with the test period and particularly with emptying of the diffuser. It should be pointed out that the effect of deterioration in juice retained in the bed during weekly stops would not in itself be sufficient to influence weekly results to any marked extent. There is, of course, a strong possibility that climatic conditions caused the change which accidentally coincided with the test period.

Regardless of the reason, the results seem sufficiently interesting to warrant further investigation.

General discussion

The development work undertaken at Empangeni has been aimed at obtaining maximum sucrose extraction, but always with a very close look at both sucrose and non-sucrose recovery in the boiling house. The two major factors affecting diffuser performance appear to be retention time and fineness of preparation, while the factors affecting the boiling house, and in particular, the non-sucrose ratio, remain tantalizingly elusive.

As will have been seen from the description of the development programme, a major concern has been with cane preparation. The object has always been to achieve an acceptable percolation rate with the finest possible preparation, and the line of thought pursued from the start has been to achieve the smallest particle size with the least percentage of fines.

Ironically, one of the factors which led to the decision to instal a diffuser at Empangeni, the poor cane quality, has in fact possibly caused the biggest problem in maintaining acceptable percolation. Empangeni cane has probably some of the highest percentages of extraneous matter, in the form of leaves and trash, actually being fed into a mill anywhere in the world. It is fairly obvious that the disintegration of the dry leaves during preparation produces a powdery substance which very easily clogs the diffuser bed. The emphasis has therefore been on slow speed preparation with sharp knives, rather than on high speed disintegration with blunt hammers, as found in shredding.

The quantative assessment of fineness of preparation has been a problem. Screening results are not easily reproducible and in any case suffer from being usually controlled by the largest dimension of a particle and not by the smallest, as we would wish. Markham[2] has reported good correlation between displaceability index and particle size, and this has been confirmed by Rein[3]. Routine displaceability index tests have been carried out at Empangeni for three seasons; however, little correlation has been observed between these results and diffuser performance. This may be due either to the inability of the D.I. tests to establish the quantity of fines produced from dry leaves, or due to the sampling method being unrepresentative. The latter possibility is being eliminated this season.

The first problem in operating the diffuser is that of determining the limit of the fineness of preparation as a control criterion. In the present state of the art at Empangeni, the consequence of excessive fineness is excessively slow percolation and hence flooding. The term "flooding" has been loosely used to describe at first channelling over the top of the bed, then fluidity of the bed, determined by poking a stick into it, and now the height of the free liquid surface from the screen as seen through a window. The trouble resulting from slow percolation manifests itself in two ways. Under certain conditions, the bagasse bed cannot support the press roller which then sinks and dams bagasse and juice, and under certain conditions juice channels through under the press roller and inundates the conveyor. A purged manometer through a screen perforation may successfully measure the juice level in the bed. It may then remain to correlate this level with the troublesome conditions for it to become a good control criterian. This measurement, if successful, would determine the "acceptability" of the percolation rate under fixed conditions of preparation.

The next step is surely to determine the factor limiting percolation rate, or more simply, the reason for the presence of the continuous juice "phase" in the bed. The liquid phase may be due to progressive compaction of the bed from its own weight, or to a layer at the screen. An attempt is being made to determine the height of the restriction from the screen by means of the purged manometer, also visually, but the measurement of percolation rate as such is difficult in a full-scale unit under dynamic conditions. A flow meter on a stage pump would probably show increasing rate with deteriorating percolation rate. However, if an improvement could be made to percolation rate, this should show a comparative advance in the curve of the distribution of juice from a particular spray pipe in the trays below the screen. This curve is conveniently plotted by using NaCl as a tracer and Figure 7 is typical. It may became possible to compare percolation times, calculated from these curves, rather than rates, however, the procedure is somewhat cumber-of which is probably the cane itself. The curve in some.

The curve in Figure 4 shows the best correlation between L.A.J. % fibre and tch yet, and corresponds with the period of the most regular diffuser operating conditions to date; knife speeds and imbibition rates were very regular, and the fuzz from switching off stage pumps because of flooding, and from flooding because of the juice screens, was absent.

Of the very large number of people who made both mental and physical contributions to the development of the installation, special mention should be made of members of Hulett's Research and Development, and Technical Management Departments, as well as the Chairman and members of the Mutual Diffusion Control Committee. The pool of knowledge and experience thus available to the Empangeni staff was considerable.

REFERENCES

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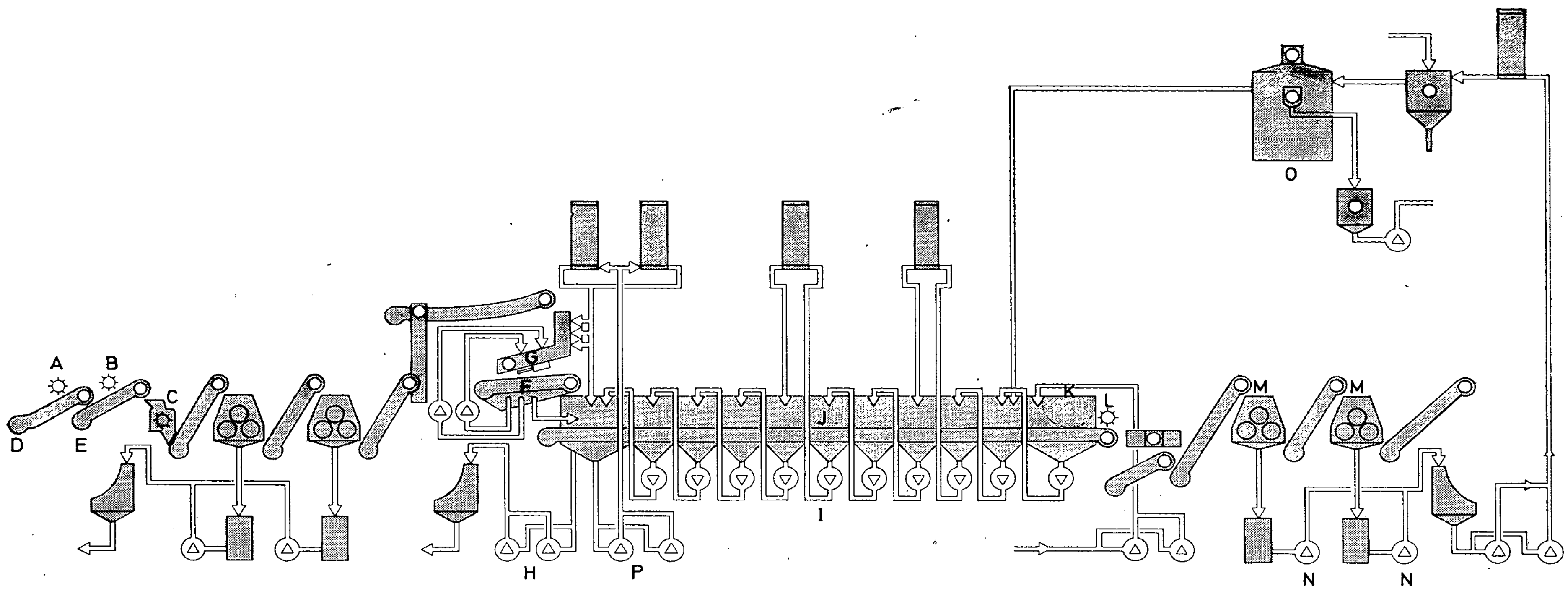

FIGURE 1: Schematic of original diffuser installation.

LEGEND

A: First cane knife. **B**: Second cane knife. **C**: Shredder. **D**: Auxiliary carrier. **E**: Main carrier. **F**: Maceration carrier. **G**: Feed flume. **H**: Draft juice pumps. **I**: Stage pumps. **J**: B.M.A. diffuser. **K**: Press roll. **L**: Discharger. **M**: Drying mi.ls. **N**: Raw press water pumps. **O**: Press water clarifier. **P**: Scalding juice pumps.

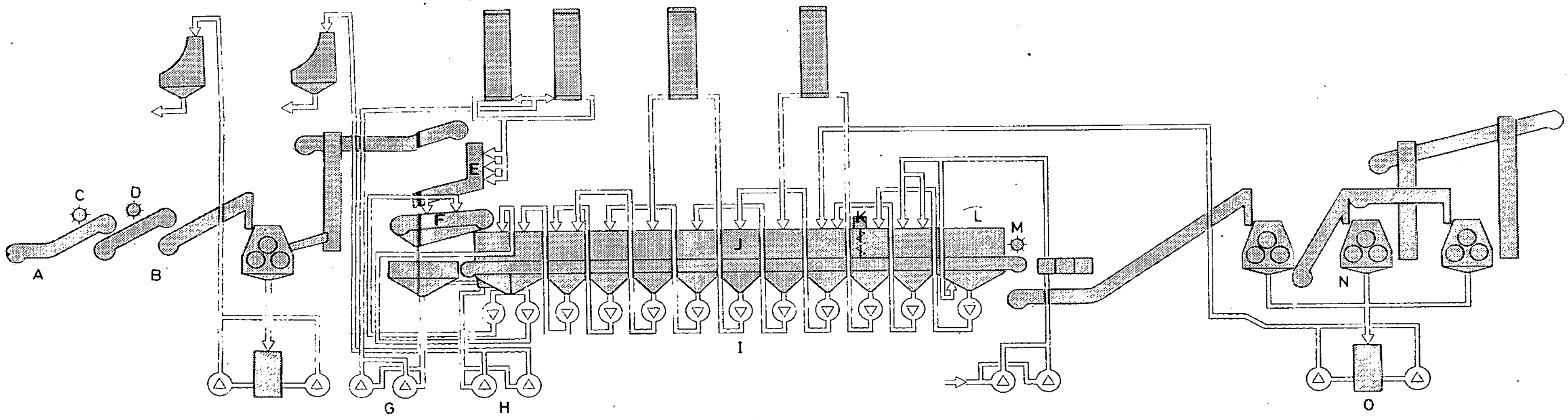

FIGURE 2: Schematic of diffuser installation at present.

LEGEND

A: Auxiliary carrier. **B**: Main carriers. **C**: First cane knife. **D**: Second cane knife. **E**: Feed flume. **F**: Maceration carrier. **G**: Scalding juice pumps. **H**: Draft juice pumps. **I**: Stage pumps. **J**: B.M.A. diffuser. **K**: Screws. **L**: Press roll. **M**: Discharger. **N**: Drying mills. **O**: Raw press water pumps.

1970 Season

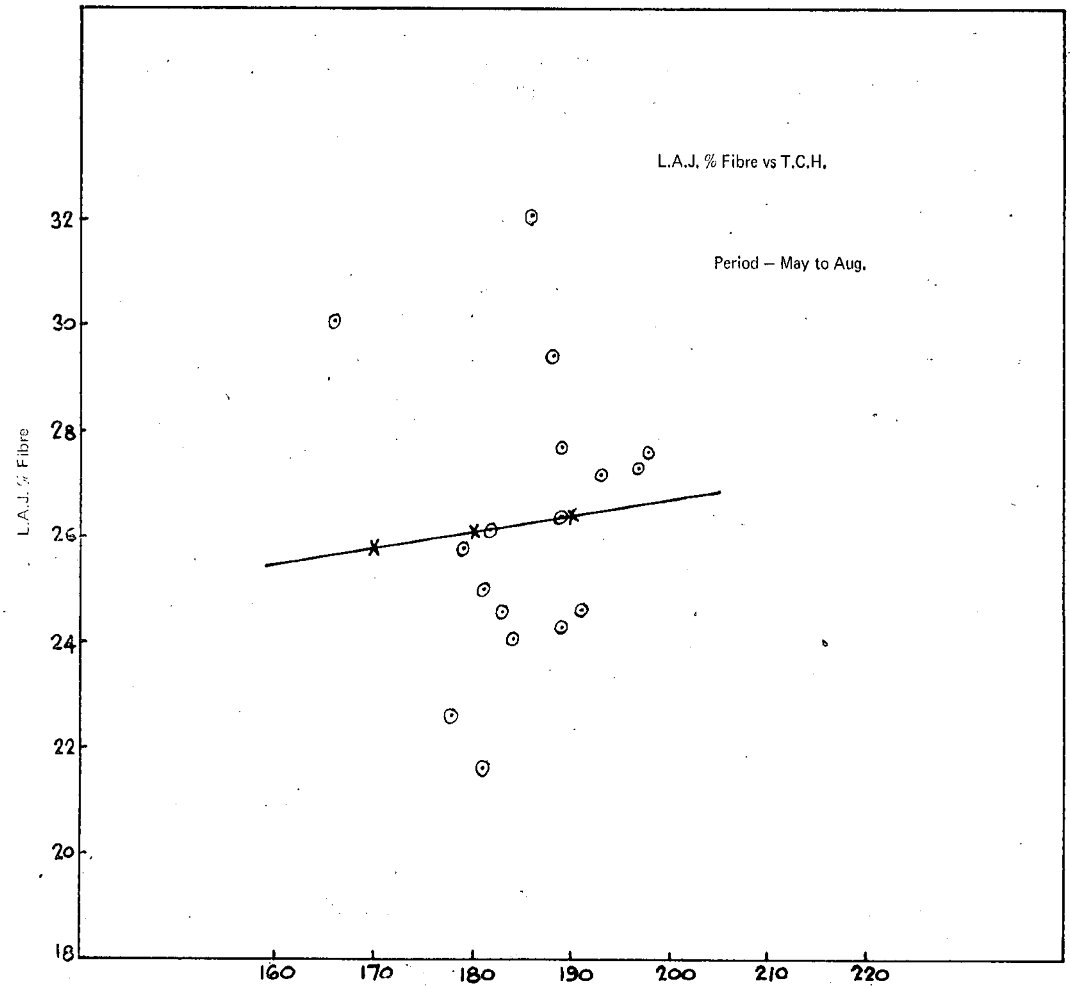

Fig. 3

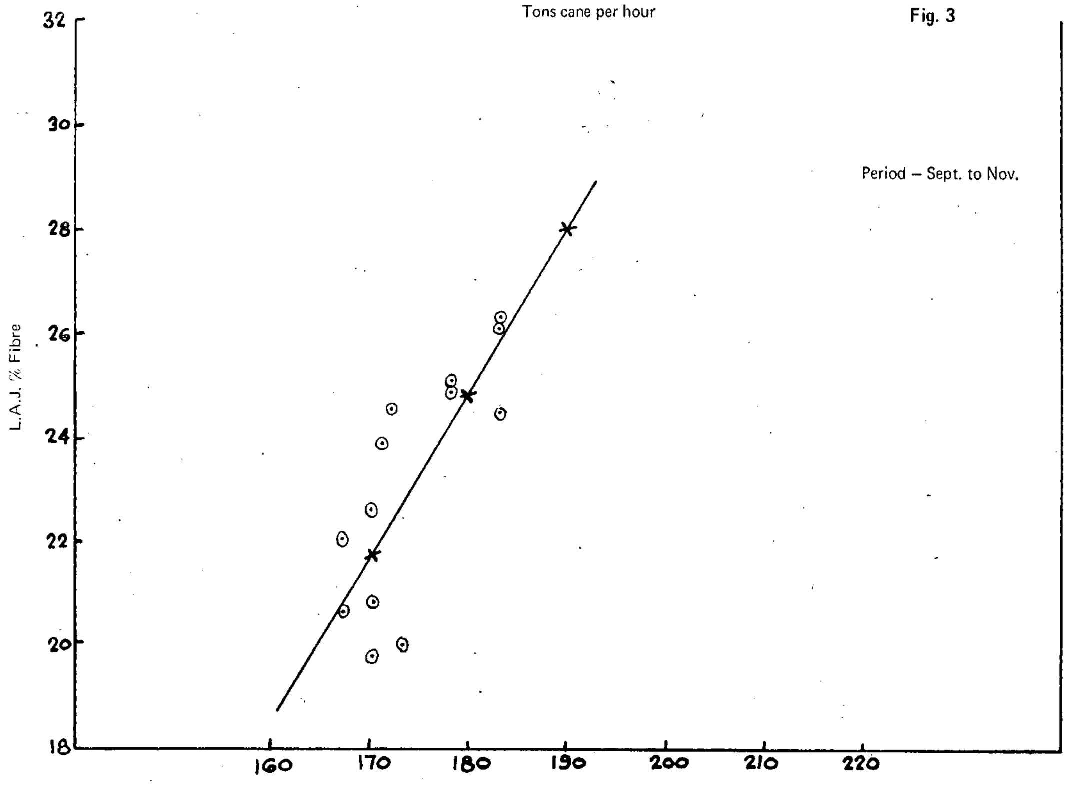

Fig. 4

1970 Season

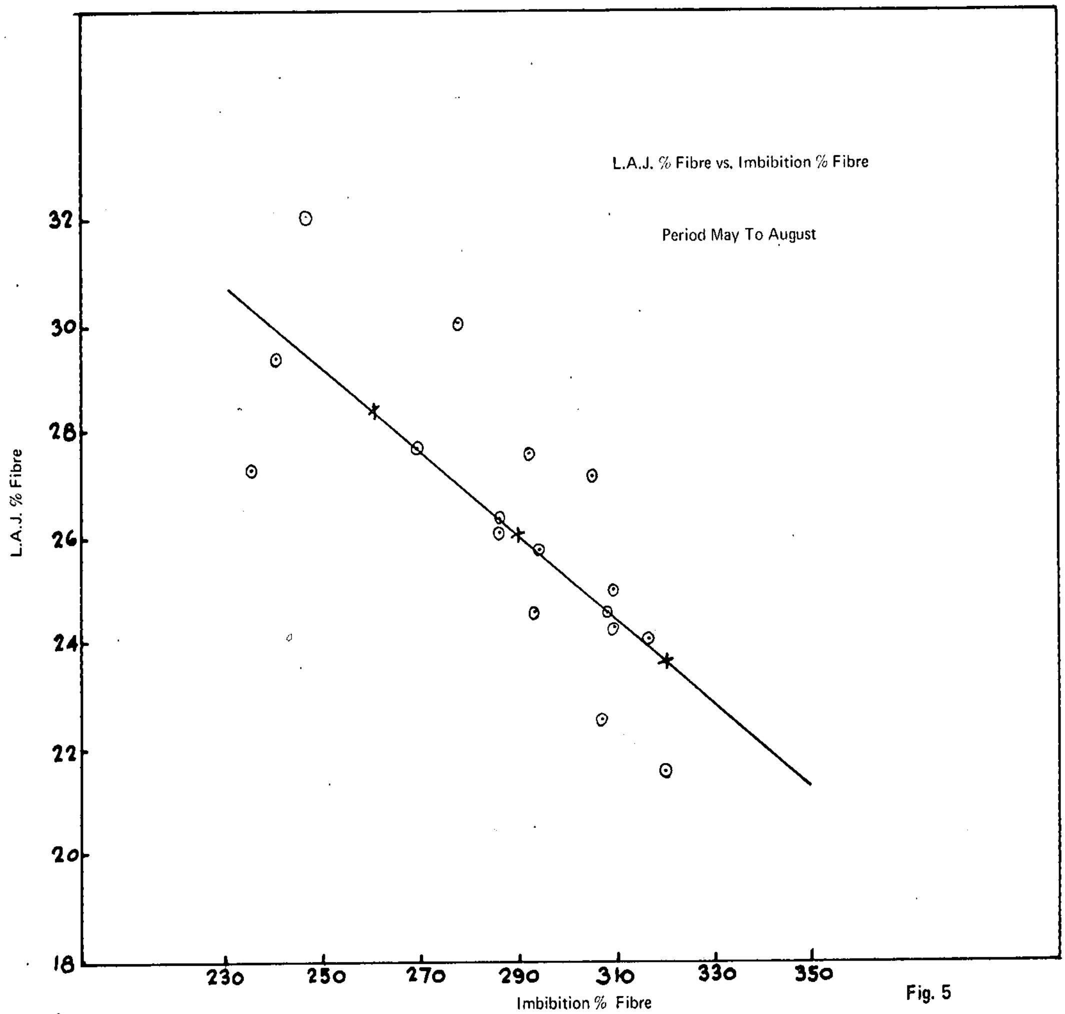

Fig. 5

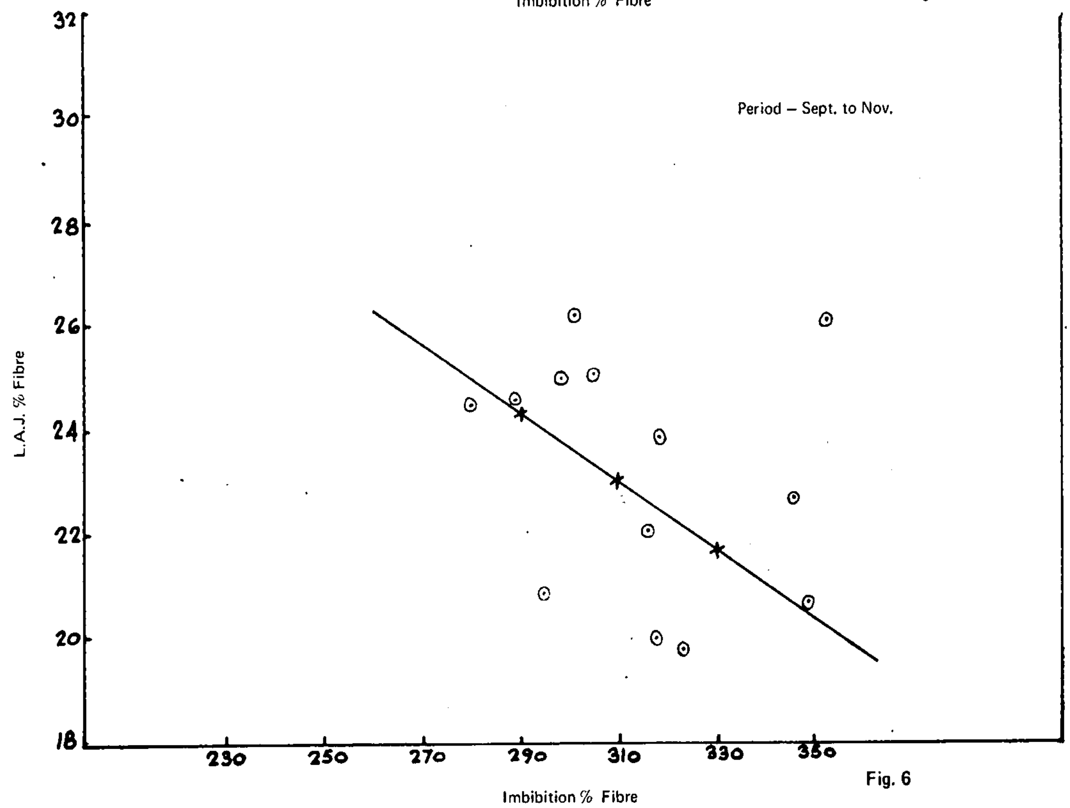

Fig. 6

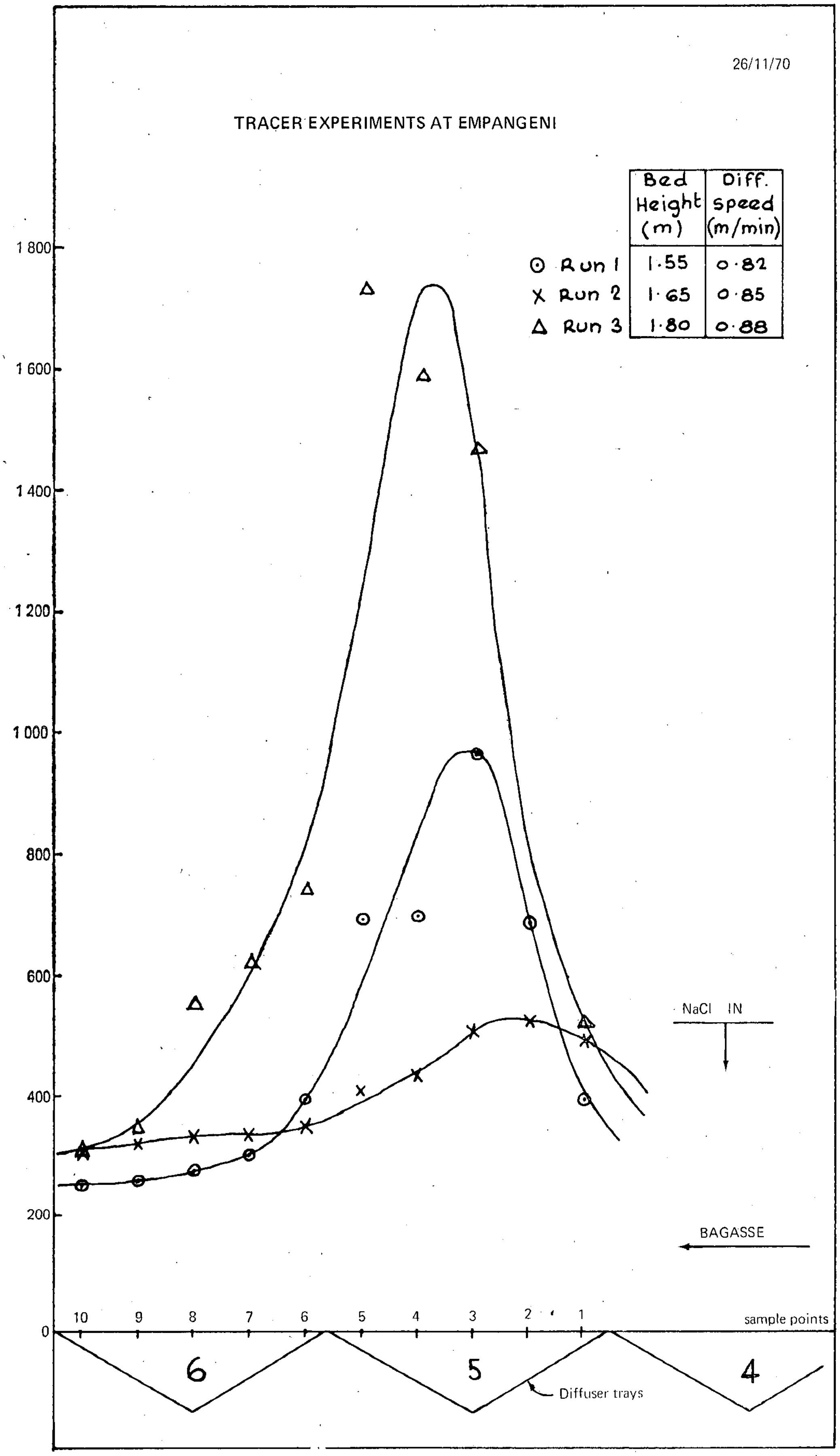
26/11/70
TRACER EXPERIMENTS AT EMPANGENI
Bed Height (m)
Diff. speed (m/min)
Run 1 1·55 0·82
Run 2 1·65 0·85
Run 3 1·80 0·88
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
NaCl IN
BAGASSE
10 9 8 7 6 5 4 3 2 1
sample points
6
5
4
Diffuser trays

Fig. 7

Appendix A

The B.M.A. diffuser at Empangeni

Principal details of the diffuser were as follows:

Main diffuser:
- Length 35,37 m
- Width 4.8 m
- Screen area 169,8 m^2 (nominal)
- Blanket depth 2 m (max.)
- Chain speed 1,5 m/min (max.)
- Press roller 4,8 m × 3 m dia. water loaded and driven by the bagasse blanket
- Number of stages 10
- Distribution of stage juice by weir
- Scalding juice rate 11,250 l/min.

Masceration carrier:
- Screen area 18,9 m^2
- Chain speed 15 m /min (fixed)

Presswater clarification:
- Wedge wire screen 3,66 m × 1,6 m × 1,5 mm aperture
- Bach subsider 136 000 l
- Mud returned to final mill

Cane knives:
- 1st set: 48 knives 1,83 m o.d. 585 rpm 448 kW slip-ring motor cutting unconventionally against cane) 20 cm setting
- 2nd set: 48 knives 2,13 m o.d. 585 rpm 373 kW slip-ring motor cutting conventionally (with the cane) 2,5 cm setting

Shredder:
- Searby type 6 rows 28 hammers/row 1 200 rpm

Main carrier control:
- Constant cane volume metering device operating a hydraulic torque converter in main carrier drive.

Mills:
- Smith mills fitted with vertical chutes and gear driven underfeed rollers, 2 in series before and 2 in series after the diffuser.

Juice scale:
- Separate Servo Balans scales for primary (1st mill) and draught (diffuser) juices.

Discussion

Mr. Hulett (in the chair): The information on diffusion contained in this paper is invaluable, particularly as more and more diffusers will be used in the sugar industry.

The Empangeni diffuser is supposed to be a percolation type and, as you have heard, the main problem is percolation. From observation through windows in the side of the diffuser it is clear that the liquid level runs at the top of the bagasse so there is a solid tank full of water, with the screen blocked off.

I think the diffuser should be converted to a continuous counter-current type and fortunately its design lends itself to this. By pumping all the fall-out forwards we could obtain a water flow in the opposite direction. The leaking bottom can be continuously cleared with a bilge pump and put back at the top and it might also be necessary to provide some agitation in the tank. The discharge is a problem but could be solved with an elevator.

Mr. Renton: You apparently are saying that we should have a liquid phase instead of a solid phase diffuser. Experiments have shown that there are some advantages in a liquid phase diffuser but we are worried about the long juice retention times involved and also channelling becomes a problem.

Mr. Ashe: I notice that D.S.M. screens have been done away with in the press water so that everything is being returned to the diffuser.

Mr. Renton: Originally the tailings from the screens were also put back into the diffuser at the feed end, so in fact less re cycling is being done.

Dr. Matic: In table 3, an increase in purity between mixed juice and clear juice of 2,5 is recorded during shut-down. This is not usually found in ordinary milling and indicates that with diffusion there is better juice clarification. There is also a drop in non-sucrose ratio.

Mr. Renton: It does not seem possible that the mere emptying of the diffuser could be responsible for such a difference in the figures, particularly if the last column is consulted, namely, the difference between made syrup and calculated syrup.