PROCESS CONTROL

By P. N. BOYES

Most modern automated plants have instruments recording and controlling process variables. In many cases, 24-hour charts give a detailed picture of performance. Sometimes variables such as pressure, temperature, etc., are only indicated and then it is usual for each section of the plant to have an operation sheet in which the plant operator records hourly readings. This procedure is extremely valuable, not only for the operator himself but also for the process manager who is presented with a complete picture of plant performance during periods when he is unable to be present. The data are usually filed away or averaged and used to check plant performance over a period.

In the case of sugar factories it is usual for pan floor operations to be well recorded and this section of the process is relatively well controlled. Other sections, which may include the juice heaters, clarifiers, mud filters, evaporators, crystallisers and centrifugals, are often not nearly so well controlled. Often only the observations in the shift log-book inform the process manager of performance during the night period.

We decided to introduce a system of control at Tongaat during the 1960 season. First of all we introduced a number of simple routine tests which could be performed by shift personnel. Secondly, we printed operation sheets for each section of the process. We found that one man on each shift was able to record all the information required, as well as performing the additional routine tests. In this way shift overseers were able to get a clearer picture of hour to hour performance and take remedial action where necessary. Each morning the sheets were collected and left in the Process Manager's office, enabling him to study performance over the last 24 hours, on arrival at work. The data were then averaged and published in a weekly report.

In describing the scheme in more detail, it must be realised that it is still open to considerable improvement. Some of the operation sheets are too cumbersome and could probably be improved upon. Nevertheless, it can be said that the scheme has proved extremely useful and personnel at all levels are making use of the data provided.

It seems easiest to discuss each operation sheet in turn and refer to the appendix for the appropriate example sheet.

(*a*) **Juice Heaters** (Appendix I)

It will be seen that the work of each heater is recorded and falls into the categories of primary heating, secondary heating, cleaning, ready for use or off for repairs. Juice heater temperatures and steam pressures are also recorded. If condensate is returned to the boilers this is indicated by the letter B.

(*b*) **Clarifiers** (Appendix II and III)

There are five clarifiers—4 x Bachs and 1 x Rapi-Dorr. It is impossible to compact all the required information on one sheet and so a separate sheet is used for each clarifier. Examples are given for the Bach and the Rapi-Dorr.

In the case of all clarifiers a mud thickening test is carried out by sampling 100 mls. of mud and allowing it to stand for 2 hours. Satisfactory thickening was arbitrarily taken as 96 per cent or more mud. On a number of occasions this test revealed juice mixed with mud either due to overflows or lack of thickened mud.

The clarity of juice from each clarifier was checked regularly using the Kopke colorimeter. This apparatus is cheap, easy to use and although not very accurate enabled settling performance to be checked. Very clear juice gave a reading 35-45 whereas hazy juice was 23-35. The slightest overflow of mud brought the clarity rapidly down to 0-10.

The temperature of juice entering each clarifier was also recorded and provided a check on juice heater performance. It will be noted that due to our gravity settling system some heat is lost from the flash tank to the subsider. Normally the juice enters the clarifier at 96°C.

Further data indicate whether decanting valves are running clear (indicated by a tick) or whether closed due to mixing. Figures for feed valve position and mud pump speeds are of localised interest.

We found that the operation of the Dorr had to be carefully watched and so the number of cocks in the top and bottom compartments running mud were recorded at regular intervals. We have no direct measurement of feed to the Dorr and so record the number of turns the feed valve is opened together with the height of juice over a V-notch weir. The high velocity of approach at the weir precludes the use of the Francis formula for calculating flow.

(*c*) **Mud Filters** (Appendix IVA and IVB)

The Oliver filters also constituted a problem because we have five of them and the data required could not be compressed on one sheet. Data are recorded separately for each filter.

The sucrose in filter cake is recorded hourly by the laboratory and is also recorded on one of the operation sheets. The sample is taken from the carrier.

Bagacillo is measured by diverting the feed to the mingler into a hessian bag for the measured time of one minute. The bag is weighed on a Salter meat scale. From experience we have found that bagacillo can be maintained at the desired figure of 100-120 lbs./min. for 200 t.c.h.

Water meters were installed on all filters and gave valuable data but unfortunately the sieves kept choking and after a while each meter developed one fault or another and have now been dispensed with. Most filters used 500-1000 g.p.h of water each depending on the pressure in the water line.

At present we do not record the cake thicknesses nor the actual rotating drum speeds. The latter speeds are merely indicated as fast or slow. All the vacua are recorded on individual filters and on the cloudy and clear vacuum mains. Finally we record the usage of jets and sprays on each filter.

(*d*) **Evaporators** (Appendix V)

We have attempted to compress on one sheet the performance data of three quadruple effect evaporators. Much information is of local interest in that the positions of the juice, steam and condenser water valves are recorded. Vacuum data for the 2nd, 3rd and 4th vessels are given in a rather confined space. Syrup densities are recorded regularly and given in degrees Baume.

(*e*) **Centrifugals** (Appendix VI and VII)

The operating sheets for the centrifugals are divided into (i) the "A" and "B" Batteries; (ii) The "C" Battery consisting of (*a*) 7 off Pott-Cassels, (*b*) 8 off Broadbents. In every case we record the cycle times and the number of the crystalliser being cured at the time of observation. It will be noticed that on the "A" and "B" Batteries, molasses is diluted automatically by a timing device. The reheater on the Broadbent set has a thermometer at each centrifugal and so massecuite temperatures are recorded in order from Machines 1 to 8.

(*f*) **"C" Crystallisers** (Appendix VIII)

In order to follow the curing of each crystalliser we have supplemented the laboratory data sheet with regular readings of cooling and reheating temperature of each massecuite. Also recorded is the number of massecuite being cured and the numbers of empty crystallisers.

(*g*) **Extra Laboratory Work**

The bench chemists determine the solids % mud going to the mud filters each shift from a composited mud sample. We have found over the last year that this figure was normally 3-4 per cent which is extremely low. Occasionally on Sunday nights after a week-end shutdown, the mud solids rose to 6-8 per cent.

The pH of the mud is also recorded each shift and has proved invaluable on occasions for stopping fermentation. Fermentation occurs from time to time due to mud blockage at the outlets from mud compartments.

During the day shift a 24 hourly composited sample of mixed juice is determined for phosphate content. Although a figure of 300 ppm is considered the minimum for good clarification we have observed short periods, when the phosphate content has been lower, without adverse effect on clarification.

Finally a settling test has been devised. This consists of a long glass tube 70 cms. by 3 cms. diameter surrounded by a glass jacket, through which hot water at 95°C is circulated. At present a catch sample of juice to the subsiders is collected and reheated to 95°C in the Laboratory, before pouring into the settling tube. Regular readings during settling are made enabling the settling characteristics to be determined. In practice the figure of most practical interest is the mud volume after 3½ hours settling (i.e., the available time for settling in our clarifiers). At the beginning of the season this figure was 15 per cent, but after a short time rose to 25-30 per cent,—the highest value recorded was 34 per cent. We think that the mud volume depends to some extent on the time that elapses between cutting and crushing of cane and the figure gives a good indication of expected ease of settling.

It is obvious that most operators are involved in obtaining the data outlined above and we have found that deviations from standard figures are quickly rectified. On the whole, the increase in clerical work has taken place without any fuss and we can say that the system will be continued.

In conclusion, I would like to apologise to process staff who are present, because much of what I have said must appear rather obvious to them.

APPENDIX I—JUICE HEATERS

DAY: MONDAY DATE: 7/11/60

Time	Primary	°F.	Press	Second	°F.	Press	Off for Cleaning	Off for Repair	Leaking	Clean	Condensed Water
7 a.m.	9, 10	172 170	psig. or" Hg +½ 0	4, 6, 7	230	psig. 6, 5½, 9½	5			2, 3	5, 6, 7 B
8 ,,											
9 ,,	9, 10	172 172	+0−1	4, 6, 7	230	4½, 5, 7	5			2, 3	4, 6, 7 B
10 ,,	,,	174 174	−2−3	,,	230	1½, 4, 3				2, 3, 5	4, 6, 7 B
11 ,,											
12 noon	,,	198 195	+¾+1	,,	230	6½, 5, 8				,,	,,
1 p.m.	,,	164 164	−4−6	,,	225	2, 3½, 4				,,	,,
2 ,,					225						
3 ,,	,,	171 162	−5−6	,,	225	3½, 4, 4½				,,	,,
4 ,,											
5 ,,											
6 ,,	9, 10	169 162	−3−4	4, 6, 7	225	4½, 5½, 6½				2, 3, 5	4, 6, 7 B
7 ,,	,,	170 168	−4−3	,,	225	5, 5½, 6½				,,	,,
8 ,,											
9 ,,	,,	171 171	−3−3	,,	225	5, 5, 6½				,,	,,
10 ,,	,,	174 171	−1−1	,,	225	7½, 5, 6				,,	,,
11 ,,											
12 m.n.											
1 a.m.	9, 10	168 166	−1−1	4, 6, 7	225	5, 5, 7				2, 3, 5	4, 6, 7 B
2 ,,											
3 ,,	,,	166 166	−2−2	,,	225	4, 3, 6				,,	,,
4 ,,	,,	168 168	0−1	4, 5, 7	230	5, 7½, 6	6			2, 3	4, 5, 7 B
5 ,,											
6 ,,	,,	166 165	−4−5	,,	225	2½, 6, 5	6			,,	,,

APPENDIX 2—BACH No. 1

DAY: WEDNESDAY DATE: 28/9/60

Time	Juice Inlet Valve	Kopke Clarity	Mud Thickness	Speed Mud Pump	Decanting Valves						Test Pipe	Ingoing Juice Temp.	Clear Juice pH.
					1	2	3	4	5	6			
7 a.m.			98										7.5
8 ,,			98										7.4
9 ,,	2¾	30		3	Shut	Shut	√	√	√	√	Mud	94°	7.3
10 ,,	,,	33	98	,,	√	√	√	√	√	√	,,	93°	7.3
11 ,,													7.4
12 noon	,,	31	98	,,	√	√	Shut	√	√	√	,,	92°	7.3
1 p.m.	,,	25		,,	Shut	√	Shut	√	√	√	,,	92°	7.3
2 ,,			99										7.3
3 ,,													7.3
4 ,,			97										7.3
5 ,,													7.3
6 ,,	2¾	22		3	Shut	√	√	√	√	√	Mud	94°	7.3
7 ,,	2¾	15		3	√	√	√	√	√	√	,,	92½°	7.3
8 ,,			97										7.3
9 ,,	2¾	25		3	√	√	√	Shut	Shut	Shut	,,	92½°	7.4
10 ,,	2¾	36	97	3	√	Shut	√	√	√	√	,,	91½°	7.4
11 ,,													7.4
12 m.n.			98										7.2
1 a.m.	2¾	23		3	√	√	√	Shut	√	Shut	Mud	93½°	7.3
2 ,,			98										7.3
3 ,,	2¾	21		3	√	√	Shut	Shut	√	√	,,	93°	7.2
4 ,,	2¾	33	99	3	√	√	Shut	√	√	√	,,	94°	7.4
5 ,,													7.3
6 ,,	2¾	31		3	√	√	√	√	Shut	√	,,	92°	7.4

APPENDIX 3—DORR CLARIFIER

DAY: MONDAY DATE: 14/11/60

Time	Inlet Valve	Height Over Weir Ins.	MUD LEVEL		Kopke Clarity	MUD THICKNESS		Pump Speed Bottom	DECANTING VALVES								Over-flow
			Top	Bottom		Top	Bttm.		NORTH 1	NORTH 2	NORTH 3	NORTH 4	SOUTH 1	SOUTH 2	SOUTH 3	SOUTH 4	
7 a.m.	2½	5¼	7	7	34	98	98	2	√	√	√	√	√	√	√	√	√
8 „						98	98										
9 „	2½	5⅜	7	6	33			2	√	√	√	√	√	√	√	√	√
10 „	2½	5⅛	7	5	32	98	99	2	√	√	√	√	√	√	√	√	√
11 „																	
12 noon	2½	5¼	6	6	34	98	98	2	√	√	√	√	√	√	√	√	√
1 p.m.	2½	5⅜	6	6	36			2	√	√	√	√	√	√	√	√	√
2 „						96	97										
3 „	2½	6	5	6	37			2	√	√	√	√	√	√	√	√	√
4 „						92	95										
5 „																	
6 „	2½	5¾	5	5	40	98	98	2	√	√	√	√	√	√	√	√	√
7 „	2½	6¼	5	5	38			2	√	√	√	√	√	√	√	√	√
8 „						97	97										
9 „	2½	6¼	5	6	45			2	√	√	√	√	√	√	√	√	√
10 „	2½	6	6	5	41	97	97	2	√	√	√	√	√	√	√	√	√
11 „																	
12 m.n.																	
1 a.m.	2½	5¾	6	6	37			2	√	√	√	√	√	√	√	√	√
2 „						97	98										
3 „	2½	5¾	6	8	35			2	√	√	√	√	√	√	√	√	√
4 „	2½	5⅞	5	8	36	98	99	2	√	√	√	√	√	√	√	√	√
5 „																	
6 „	2½	5¾	6	8	35			2	√	√	√	√	√	√	√	√	√

APPENDIX 4a—OLIVER FILTERS

DAY: WEDNESDAY DATE: 13/7/60

FILTER No. 2 FILTER No. 3

Time	Filter No.	Speed	Vacuum "Hg		Water		Water to Filters		Filter No.	Speed	Vacuum "Hg		Water		Water to Filters		Suc. % Cake	Bagacillo lbs./Min.
			Clear	Cl'dy	Spray	Jets	Meter Reading	Galls.			Clear	Cl'dy	Spray	Jets	Meter Reading	Galls.		
7 a.m.							331000								334940		1.1	
8 ,,																	1.4	
9 ,,																	2.2	
10 ,,	2	Fast	10, 12	13, 13	2	10	333540	2540	3	Slow	12, 12	11, 10	2	10	337030	2090	0.9	106
11 ,,																	1.0	
12 noon	2	Fast	11, 13	14, 14	2	10	335310	1770	3	Slow	12, 13	11, 9	2	10	338410	1380	2.2	60
1 p.m.																	1.1	
2 ,,	2	Fast	11, 11	13, 13	2	10	337400	2090	3	Slow	10, 11	10, 9	2	10	340090	1680		118
3 ,,																	3.0	
4 ,,																	2.0	
5 ,,		Steaming	5.10	—5.40													1.3	
6 ,,	2	Fast	6, 6	12, 12	2	10	341800	4400	3	Slow	9, 10	9, 8	2	10	344140	4050	1.3	109
7 ,,																	1.6	
8 ,,	2	Fast	8, 9	12, 11	2	10	343710	1910	3	Slow	10, 11	10, 10	2	10	345720	1580	1.4	119
9 ,,																	2.1	
10 ,,	2	Fast	9, 7	10, 11	2	10	345360	1650	3	Slow	10, 11	10, 9	2	10	347090	1370	1.9	113
11 ,,																	1.7	
12 m.n.	2	Fast	11, 10	13, 13	2	10	347760	2400	3	Slow	12, 12	10, 10	2	10	349070	1980	1.9	105
1 a.m.																	0.7	
2 ,,	2	Fast	11, 10	12, 13	2	10	34936	1600	3	Slow	11, 11	10, 10	2	10	350350	1280	0.7	111
3 ,,																	1.5	
4 ,,	2	Fast	10, 10	13, 13	2	10	350870	1510	3	Slow	11, 11	10, 10	2	10	351580	1230	1.2	115
5 ,,																	1.8	
6 ,,	2	Fast	10, 11	13, 13	2	10	352920	2050	3	Slow	12, 13	11, 10	2	10	353280	1700	1.6	117

APPENDIX 4b—OLIVER FILTER No. 1

DAY: WEDNESDAY DATE: 13/12/60

Shift No.	Time	Speed	Vacuum		Water		Vacuum-Mains		Water Pressure	Bagacillo lbs./min.	Suc. % Cake
			Clear	Cloudy	Sprays	Jets	Clear	Cloudy			
1	7 a.m.										1.9
	8 ,,	Fast	11, 9	13, 11	2	8	20½	14	30	98	2.2
Average										122.0	2.5
3	9 a.m.										1.9
	10 ,,	Fast	11, 10	14, 12	2	8	20	14	30	110	2.9
	11 ,,										3.6
	12 noon	Fast	11, 12	14, 11	2	8	19½	14	31	144	2.7
	1 p.m.										2.6
	2 ,,	Fast	11, 11	13, 12	2	8	19½	14	31	122	3.0
	3 ,,										3.3
	4 ,,	Fast	11, 11	11, 11	2	8	19½	14	29	116	3.2
Average										123	2.9

THURSDAY

Shift No.	Time	Speed	Vacuum Clear	Vacuum Cloudy	Water Sprays	Water Jets	Vacuum-Mains Clear	Vacuum-Mains Cloudy	Water Pressure	Bagacillo lbs./min.	Suc. % Cake
2	5 p.m.										2.6
	6 ,,	Fast	11, 11	10, 12	2	8	19¼	14	28	102	2.3
	7 ,,										2.8
	8 ,,	Fast	11, 12	11, 12	2	8	19½	14	28½	134	2.9
	9 ,,		Wash	ing and	Steaming						4.3
	10 ,,	Fast	11, 12	12, 12	2	8	20	14½	29	110	3.5
	11 ,,										3.3
	12 midnt.										2.9
Average										116	3.1
1	1 a.m.										2.3
	2 ,,	Fast	11, 12	13, 12	2	8	20	14	30	124	3.4
	3 ,,										2.3
	4 ,,	Fast	11, 12	12, 11	2	8	20½	14	31	120	2.8
	5 ,,										2.9
	6 ,,	Fast	12, 11	12, 11	2	8	20	14¼	30	112	2.9

APPENDIX 5—EVAPORATORS

DAY: SUNDAY DATE: 18/12/60

Time	Juice Inlet			Steam			Fletcher Tailpiece °C	Cond. Water			Vac. 2nd, 3rd, 4th Vessels			Baume Syrup		
	Fletcher	Hage-mann	McNeil	Fletcher	Hage-mann	McNeil		Fletcher	Hage-mann	McNeil	Fletcher	Hage-mann	McNeil	Fletcher	Hage-mann	McNeil
7 a.m. 8 ,,	1½	1	1½	3	7	3½	47	4	3½	5½	4 10 26½	0 10 25	10 17½ 26	30	28	27
9 ,, 10 ,,	1½	1	1½	1¾	5¼	3	44	4	3½	5½	5½ 11 26½	0 12¼ 24½	10 17¾ 26	30	26	27
11 ,, 12 noon	1½	1	1½	2½	5½	3	45	4	3½	5½	4¾ 10½ 26½	0 12 24½	10½ 18 26	31	26	27
1 p.m. 2 ,,	1½	1	1½	2	5½	2½	44	4	3½	5½	5¼ 11 26¾	0 11 25½	10 18 26¼	30	28	28
3 ,, 4 ,,	1½	1	1½	2½	5	3	45	4	3½	5½	4¼ 10 26½	0 12 25	12 19¼ 26½	30	28	27
5 ,, 6 ,,	1½			3½			45	4			3½ 10 26½			31		
7 ,, 8 ,,	1½	1	1½	2½	5½	1½	43	3½	3½	5½	4½ 9½ 27	0 11 26	13½ 20½ 27	30	31	25
9 ,, 10 ,,	1½	1	1½	3½	7	3	44	3½	3½	5½	3 8 27	0 9½ 25½	12½ 19 27	29	31	24
11 ,, 12 m.n.	1½	1	1½	2½	6	1½	43	3½	3½	5½	4 9 27	0 10½ 25½	9½ 17 27	31	29	26
1 a.m. 2 ,,	1½			2			42	3½			6 10¾ 27			28		
3 ,, 4 ,,	1½	1	1½	2	5	2½	41	4	3½	5½	5½ 10 27¼	0 11½ 26	13¾ 20½ 27	31	33	26
5 ,, 6 ,,	1½	1	1½	2¼	4	3	42	4	3½	5½	5½ 10¼ 27	0 11¾ 26	14½ 20½ 27	29	31	26

APPENDIX 6—"A" AND "B" CENTRIFUGALS

DAY: THURSDAY DATE: 20/10/60

Time	Cryst. Curing	"A" BATTERY CURING CYCLE				Cryst.	"B" BATTERY CURING CYCLE				TEMPERATURE	
		Time Secs.	Water Secs.	Steam Secs.	Dil. Water Secs.		Time Secs.	Water Secs.	Steam Secs.	Dil. Water Secs.	Reheat Water °F.	M/C. °F.
7 a.m.												
8 ,,	6	80	10		30	9	150	30	70	70	155	115
9 ,,												
10 ,,												
11 ,,	Stopped					Stopped						
12 noon												
1 p.m.												
2 ,,	5	80	10		30	12	180	30	90	70	140	120
3 ,,	4											
4 ,,												
5 ,,	6	80	10		30	7	180	30	90	70	146	120
6 ,,	5											
7 ,,												
8 ,,	4	80	10		30	8	180	30	90	70	148	120
9 ,,	6											
10 ,,												
11 ,,	5	80	10		30	9	180	30	90	70	175	120
12 m.n.												
1 a.m.	4											
2 ,,	6	80	10		30	11	180	30	90	70	160	120
3 ,,	5											
4 ,,	4											
5 ,,	6	80	10		30	12	180	30	90	70	163	118
6 ,,												

APPENDIX 7—CENTRIFUGALS "C" / BROADBENTS

DAY: FRIDAY DATE: 8/7/60

Time	Cryst. Curing	POTT-CASSELS Curing Cycle Time Secs.	POTT-CASSELS Curing Cycle Water	POTT-CASSELS Curing Cycle Steam	Temp. Reheat Water °C	BROADBENTS Temperature M/C. °C	BROADBENTS Curing Cycle Time Secs.	BROADBENTS Curing Cycle Water	BROADBENTS Curing Cycle Steam
7 a.m. 8 ,, 9 ,,	23	320	No	Yes	144 148	119, 120, 122, 110 110, 109, 109, 109	600	No	Yes
10 ,, 11 ,, 12 noon	23	240	No	Yes	144 144	126, 120, 119, 111 108, 109, 111, 110	600	No	Yes
1 p.m. 2 ,, 3 ,,	24	240	No	Yes	140 146	119, 113, 112, 106 105, 104, 104, 103	600	No	Yes
4 ,, 5 ,, 6 ,,	24	240	No	Yes	146 144	124, 118, 116, 110 108, 108, 110, 105	600	No	Yes
7 ,, 8 ,, 9 ,,	25	240	No	Yes	146 145	122, 114, 110, 104 102, 104, 106, 106	600	No	Yes
10 ,, 11 ,, 12 m.n.	26	240	No	Yes	148 146	122, 118, 116, 108 104, 108, 110, 110	600	No	Yes
1 a.m. 2 ,, 3 ,,	26	240	No	Yes	146 146	116, 113, 115, 106 106, 108, 109, 107	600	No	Yes
4 ,, 5 ,, 6 ,,	26	240	No	Yes	149 148	128, 122, 122, 112 110, 112, 118, 118	600	No	Yes

APPENDIX 8—"C" CRYSTALLISERS

DAY: SUNDAY DATE: 11/9/60

Time	Temp. Reheat Water	Reheating and °F	Cooling and °F	Curing	Empty Crystallisers
7 a.m.					
8 ,,	140°	22 × 100, 23 × 106, 24 × 94	13 × 113, 14 × 119	21	19 × 20
9 ,,					
10 ,,					
11 ,,	143°	23 × 107, 24 × 97, 25 × 100	13 × 110, 14 × 116	22	20, 21
12 noon					
1 p.m.					
2 ,,	131°	24 × 100, 25 × 100, 26 × 105	13 × 106, 14 × 111	23	20, 21, 22
3 ,,					
4 ,,					
5 ,,	138°	24 × 103, 25 × 102, 26 × 109	13 × 102, 14 × 107	23	20, 21, 22
6 ,,					
7 ,,					
8 ,,	140°	25 × 104, 26 × 113, 13 × 100	15 × 115, 16 × 123	24	20, 21, 22, 23
9 ,,					
10 ,,					
11 ,,	140°	26 × 116, 13 × 100, 14 × 106	15 × 110, 16 × 118	25	20, 21, 22, 23, 24
12 m.n.					
1 a.m.					
2 ,,	160°	26 × 118, 13 × 100, 14 × 110	15 × 106, 16 × 112	25 Finishing in mixer	21, 22, 23, 24, 25
3 ,,					
4 ,,					
5 ,,	140°	13 × 103, 14 × 112, 15 × 107	16 × 107, 17 × 117	26	22, 23, 24, 25
6 ,,					

Mr. E. T. J. Dedekind asked the author which clarifier gave the clearer juice, the Bach or the Door?

Mr. P. N. Boyes replied that the Kopke clarity readings were only approximate and were used only as an indicator. There was always a small difference between the Bach and the Dorr and this usually in favour of the Dorr. However the difference decreased as the Season progressed and there could be no real significance attached to this difference.

Mr. T. Covas said that tests made in Mocambique at Luabo indicated no difference in clarity as between the Bach and the Rapi-Dorr.

Mr. E. T. J. Dedekind referred to the Appendix 2 of the paper and asked if better results would not have been obtained by employing a higher temperature than the 93°C, indicated and remarked that the low clarity at 7 p.m. was not indicated by the position of the decanting valves.

Mr. P. N. Boyes said that better results could probably be achieved by a higher temperature than that recorded. The trouble probably arose from a faulty recording of the secondary juice temperature because if true flashing to 212°F was achieved this should automatically result in a higher temperature. This point however served to illustrate the purpose of a control system in being able to pin-point faults of this nature.

There was unfortunately a certain over-lapping in time between readings and clarity readings did not always conform to the recorded valve positions. However the recordings did give a picture of what had been done by the operators over the 24-hour period.

Mr. Rault asked why a figure of 3½ hours was selected as time for settling.

Mr. Boyes replied that the average settling time in the plant was 3½ hours. The laboratory test figure for this period was given in order to simulate plant conditions. In individual laboratory tests however, it was frequently found that settling had been completed in a much shorter time. The subsequent decrease in mud volume was small in relation to time. In view of hindrance effects in the settling tube, care must be taken when making a comparison between settling rates in the laboratory with those in the plant.

Dr. Douwes Dekker (in the Chair) pointed out that the actual time for settling of mud was much longer than that calculated from the overall capacity figure. He asked why at Tongaat liming was carried out to 7.1 to 7.2 pH and what was the pH of the syrup? He asked further if there was any decoposition of mud due to fermentation. He also stated that a retention figure should be included for the filters.

Mr. Boyes replied that the syrup pH was approximately 6.8 but clear juice pH was not kept constant, and for a period Tongaat had operated at 7.0 to 7.1 pH. Reducing sugar-sucrose ratios had indicated loss and it was considered more prudent to work at a slightly higher pH. At one time, due to special circumstances, Tongaat was even working at 7.8 pH.

He felt he had made an error in referring to decomposition as fermentation as he had no proof whether this decomposition was due to fermentation or to chemical reaction.

A retention figure was not included because of the difficulty of obtaining such a figure. It required, in his method of working it out, a knowledge of bagacillo ratio in feed to the filters as compared with that in the filter cake. This could only be worked out from time to time by conducting special tests and could not be included in the run-of-the-mill figures.

Mr. E. T. J. Dedekind asked why Tongaat selected a figure of 100-120 lbs. of bagacillo for 200 tons of cane per hour.

Mr. P. N. Boyes replied that this was based on work he had done six years ago and the results were incorporated in a paper he had read at the 1956 Congress. He had found it was necessary to have 50 per cent bagacillo to percentage solids in feed. Independently, a manufacturer was advising ½ lb. bagacillo per ton cane per hour. In general the figure would depend on local conditions and in particular on the particle size distribution of the bagacillo used.

Mr. Rault, Dr. Douwes Dekker and **Mr. Perk** discussed the lime-solid contents of the clear juice and the subsequent increase in quantity of molasses and a possible increase in molasses purity.

Mr. Rault asked Mr. Boyes to elaborate on working at a pH of 7.8.

Mr. Boyes said this had been done temporarily as an extreme measure in an attempt to maintain production under conditions of refractory juices. In response to Mr. Perk he agreed that the main reason was to obtain a better retention at the filters. Although in theory this procedure was objectionable, in practice it had to be done to maintain rate of production and prevent mud passing over.

In answer to another question he said no chemical additions were made because the phosphate content of the juice was 300-310 p.p.m., which was adequate for sufficient floc formation.