COMPARISON OF THE FCB AND SRI CONTINUOUS PANS AT SEZELA

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Abstract

The performance of the SRI (Sugar Research Institute, Australia) and the FCB (Fives-Cail Babcock, France) designed pans were compared at Sezela, particularly in terms of mother liquor purity. Both under test conditions and under normal operation, the SRI pan showed better exhaustion and better natural circulation than the FCB pan. It is also shown that higher evaporation rates do not necessarily result in better pan exhaustion. The effects of changes in some operational conditions are also discussed.

Design Details of the SRI and FCB pans

The FCB pan was designed for European beet sugar factories and was first introduced to the South African Sugar industry at Maidstone mill in 1976 and was the first continuous pan in the industry. A 90 m^3 FCB 'C' pan was installed at Sezela in 1981, and the SRI pan was subsequently installed in 1984 and was, and still is the only Australian designed continuous pan in South Africa. A brief set of details of the two pans is shown in Table 1.

Table 1

Details of the SRI and FCB pans

Design parameter	FCB	SRI
Capacity (m^3)	90	90
heating surface (m^2)	892	900
tube arrangement	horizontal	vertical
tube material	Stainless Steel	mild steel
tube diameter (mm)	30	125
No. of compartments	12	7

Normal Operations

For short periods during the 1986 season the SRI and FCB pans were operated in parallel due to high 'B' molasses stocks. Although the operating parameters were not closely monitored it would be fair to say that both pans were operated in a similar fashion. The results over this period were averaged and are listed in Table 2. The lower exhaustion of the FCB pan led to the testing of both pans under controlled conditions.

Table 2

Average Massecuite and nutsch values during parallel operations

Pan	'C' MCTE		Pan Nutsch	Purity Diff. (MCTE - Nutsch)	Purity Diff. (FCB - SRI)
	Brix	Purity			
FCB	97,3	50,0	37,6	12,4	2,2
SRI	97,6	50,2	35,4	14,8	

Test Procedure

Both pans were operated for a period of one week and the results compared with each other. An attempt was made to keep the calandria and jigger steam pressures, pan vacuum, pan temperature and seed rate the same for both pans.

Test Results

Pan Exhaustion

The operating conditions of the SRI and FCB pans are shown for parallel operation in Table 3 for the period 09/06/87 to 13/06/87.

Table 3

Operating conditions of the two pans

Parameter	SRI	FCB
calandria pressure (kPa g)	30	30
injection steam pressure (kPa g)	−15	−15
Pan temperature (°C)	67	69
Pan vacuum (kPa g)	−92	−93
Seed pump speed (%)	100	100
Evaporation rate (kg/m^2/h)	3,9	5,5

The massecuite brix and purity and the pan nutsch analyses are listed in Table 4 for the test period 09/06/87 to 13/06/87.

Table 4

Seed, massecuite and nutsch analyses

Day No.	Pan	'C' Seed		'C' MCTE		Pan Nutsch*	PTY Diff (MCTE - Nutsch)	PTY Diff (FCB - SRI)
		Brix	PTY	Brix	PTY			
1	FCB	90,4	60,0	97,1	51,4	37,5	13,9	—
	SRI	90,4	60,0	97,0	51,8	34,4	17,4	3,5
2	FCB	90,3	57,6	97,5	53,7	37,0	16,7	—
	SRI	90,3	57,6	96,5	54,8	34,3	20,5	3,8
3	FCB	90,3	54,6	96,3	51,7	36,7	15,0	—
	SRI	90,3	54,6	96,8	51,7	34,8	16,9	1,9
4	FCB	90,7	55,6	95,9	48,7	36,6	12,1	—
	SRI	90,7	55,6	97,5	50,1	33,8	16,3	4,2
5	FCB	90,9	53,6	98,6	47,8	36,7	11,1	—
	SRI	90,9	53,6	97,3	49,6	33,6	16,0	4,9

* Average of 3 analyses

Condensate rates at normal operation

The condensate from the SRI and FCB pans was diverted into a collection tank and a linear weir was used to measure the flow rate. The measured condensate rates of the two pans for a given set of conditions are shown in Table 5 for the periods 09/06/87 to 10/06/87.

Table 5

Condensate rates of the FCB and the SRI pans

Pan	Calandria Press (kPa g)	Jigger Press (kPa g)	Pan Vac (kPa g)	Massecuite		Cond Rate (kg/h)
				Brix	PTY	
FCB	25	−15	−92	96,4	53,7	4960
SRI	25	−15	−92	96,5	54,8	3520

The condensate flow of the two pans is shown graphically in Figure 1 for part of the test period.

Effect of Calandria and Jigger steam on the evaporation rate of the FCB and SRI pans

The calandria and jigger steam pressures were varied for short periods, during which the condensate rate was measured. The effect of calandria and jigger pressure is shown in Table 6.

Table 6

The effect of calandria and jigger pressure on the evaporation rate of the SRI and FCB pans

Pan	Calandria Press (kPa g)	Jigger Press (kPa g)	Pan Vac (kPa g)	Evap Rate (kg/m²/h)	% Increase
FCB	5	−15	−91	3,56	0
FCB	10	−15	−91	4,09	15
FCB	30	−15	−91	5,16	45
SRI	5	−15	−92	3,91	0
SRI	10	−15	−92	4,09	5
SRI	20	−15	−92	4,44	14
SRI	30	−15	−92	4,53	16
FCB	30	Shut	−92	3,73	0
FCB	30	− 5	−92	5,33	43
FCB	30	+ 5	−92	5,87	57
SRI	30	Shut	−91	3,38	0
SRI	30	−15	−91	3,91	16
SRI	30	+25	−91	4,44	31
SRI	30	+50	−91	4,62	37

The effect of calandria pressure on the FCB pan is shown graphically in Figure 2.

Effect of incondensible gas venting on evaporation rate

The incondensible gas outlet of the FCB pan furthest from the steam entrance was connected to the condenser and subjected to negative pressure. The evaporation rate is shown in Table 7 and was maintained for a test period of two hours.

Table 7

Effect of incondensible gas venting on the evaporation rate of the FCB

Calandria Press (kPa g)	Jigger Press (kPa g)	Pan Vacuum (kPa g)	Pan Temp (°C)	Gas Venting	Evap Rate (kg/m²/h)
30	+5	−92	67	Atmoshpere	5,67
30	+5	−93	67	Condenser	6,40

The incondensible gas outlets of the SRI pan were connected to the condenser and no increase in the evaporation rate was recorded.

Discussion of Results

Nutsch Analyses

Under controlled conditions the FCB pan nutsch was always higher, and the difference ranged from 1,9 to 4,9 units in favour of the SRI pan (Table 4). Under normal operating conditions the FCB pan nutsch was always higher, and the average difference was 2,2 units in favour of the SRI pan (Table 2). The test results confirm the observations of the 1986 season.

Evaporation rate

The dryness fraction of the vapour used to boil the pans was taken as 1,0 for the conversion of condensate rate to evaporation rate.

Under normal conditions the FCB pan has a higher evaporation rate than the SRI, as can be seen from Table 3 and 5 and from Figure 1. The drop in condensate rate is clearly

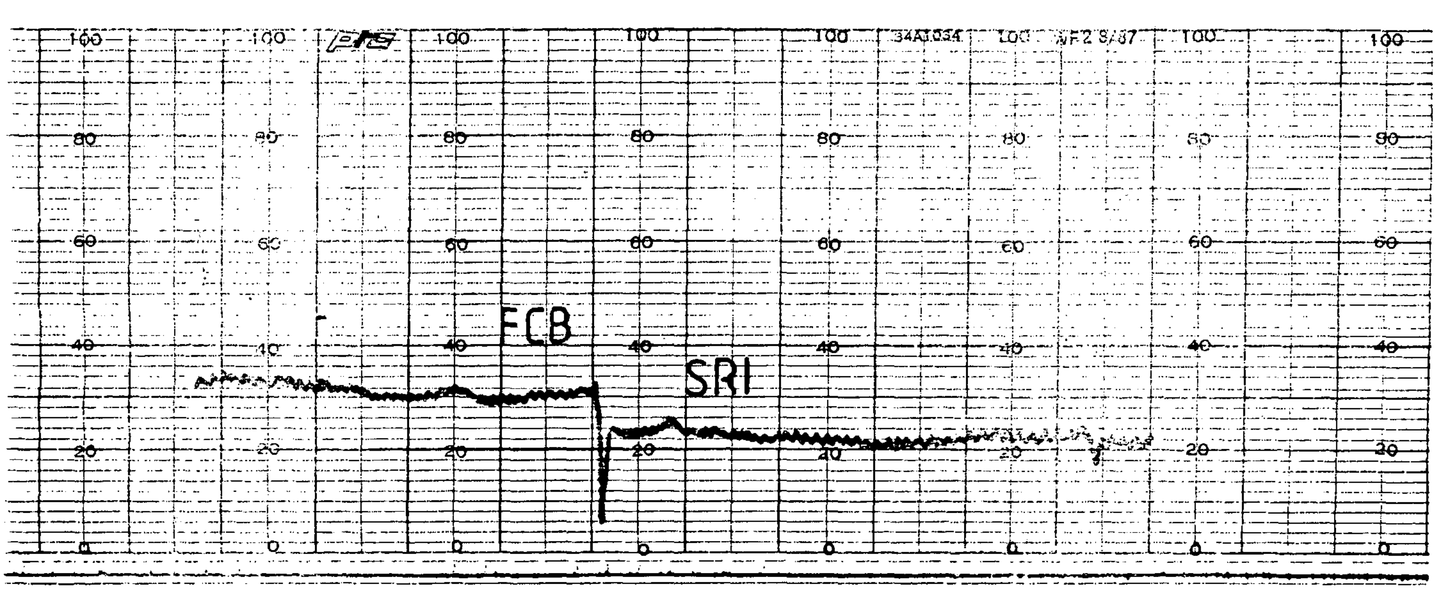

FIGURE 1 Condensate flow rate of the FCB and SRI pans under normal operating conditions (50% = 8 t/h).

seen in Figure 1 as the condensate into the tank was switched from the FCB to the SRI pan. Under normal operation the FCB returned an evaporation rate of 5,5 $kg/m^2/h$ which is in line with the findings of Munsamy[2] and Bachan[1] at Gledhow, Illovo and Sezela. The SRI returned an evaporation rate of 3,9 $kg/m^2/h$.

Effect of calandria and jigger steam on evaporation rate

The increase in calandria pressure from 5 to 30 kPa g increased the evaporation rate of the FCB pan from 3,56 to 5,16 $kg/m^2/h$ which represents an increase of 45% (Figure 2). Also from Figure 2 it can be seen that a sudden increase in calandria pressure resulted in a "flood" of condensate, and a sudden decrease resulted in a "drought" of condensate. This could imply that the condensate in the FCB pan requires steam pressure for drainage and at low pressures considerable amounts of condensate collect in the tubes. The increase in calandria pressure from 5 to 30 kPa g increased the evaporation rate of the SRI pan from 3,91 to 4,53 $kg/m^2/h$ which represents an increase of only 16%.

The increase in jigger pressure form 100% closed to a manifold pressure of 5 kPa g, increased the evaporation rate from 3,73 to 5,87 $kg/m^2/h$ on the FCB pan, which represents an increase of 57%. The increase in jigger pressure from 100% closed to a manifold pressure of 50 kPa g, increased the evaporation rate of the SRI from 3,38 to 4,62 $kg/m^3/h$, which represents an increase of only 37%. The above results show that increases in calandria and jigger pressures had a larger effect on the FCB than the SRI pan (Table 6). This could imply that the SRI has better natural circulation than the FCB pan.

Effect of incondensible gas venting

The connection of the incondensible gas outlet furthest away from the steam inlet to the condenser, produced the highest recorded evaporation rate of the FCB at 6,40 $kg/m^2/h$, and this was maintained for a test period of two hours. The increased evaporation rate, it is believed, is due to the fact that when the incondensible gas vent was connected to the condenser, negative pressure was applied to the steam chest furthest away from the steam inlet, which resulted in increased steam velocities and thus better "sweeping" of the condensate from the tubes. Connecting the SRI pan incondensible gas outlets to the condenser made no difference to the evaporation rate. This again emphasises the poor condensate drainage of the FCB pan.

Conclusions and Recommendations

Under test and normal operating conditions the SRI pan produced better exhaustions than the FCB pan. The FCB pan had a higher evaporation rate than the SRI pan but this did not result in better massecuite exhaustion.

When the FCB pan was first introduced into the industry the emphasis was on ways and means of increasing the evaporation rate of the pan, because it was believed that a high evaporation rate would produce good pan circulation and a resultant good exhaustion. This does not seem to be the case with the FCB pan. The SRI at lower evaporation rates produced better pan exhaustions than the FCB.

The effect of changes in calandria and jigger pressures was always greater on the FCB than the SRI pan. This shows that the SRI pan has better natural circulation. It is believed that the evaporation rate of the FCB pan can be improved by improving the condensate drainage, by providing better "steam sweep" inside the tubes. Another way of improving drainage would be to tilt the pan to provide a slight decline, and by changing the tube arrangement from a two pass steam system to a single pass. A second advantage of tilting would be the easier passage of massecuite from cell 1 to 12.

The evaporation rate of the SRI pan can be improved by the use of higher calandria and jigger pressures.

REFERENCES

1. Bachan, L. Private Communications with SMRI.
2. Munsamy, SS (1982). The Re-assessment of the FCB Continuous 'C' pan at Gledhow and Preliminary Report on the FCB 'B' pan at Illovo. SMRI Technical Report No. 1315.

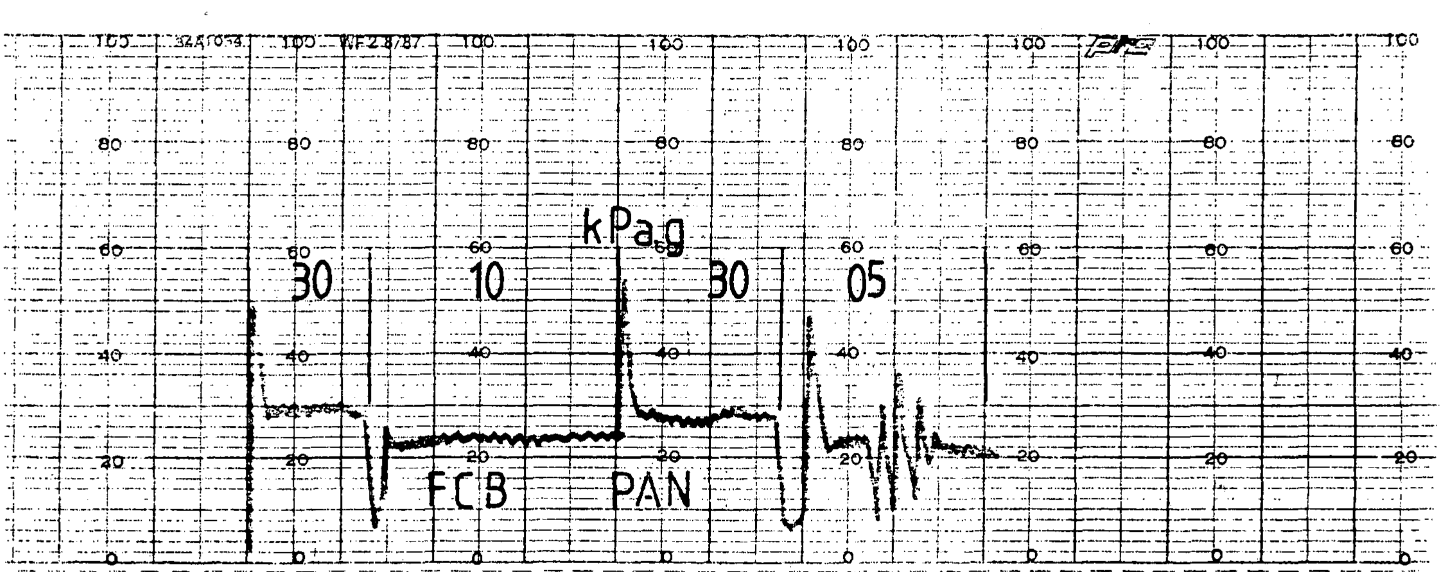

FIGURE 2 The effect of different calandria pressures on the condensate rate of the FCB pan (50% = 8 t/h).