BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

Mill Technology Division

OPEN AREA AND SCREEN RESISTANCE MEASUREMENTS ON FUGAL SCREENS

(CHEMICAL ENGINEERING DEPARTMENT, UNIVERSITY OF QUEENSLAND - MARCH 21-25, 1988)

by

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Bundaberg

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1. INTRODUCTION

Trials carried out at Bingera Mill during 1987 season indicated that the use of wedgewire as a support for the chrome-nickel working screens in BMA K1000 low grade centrifugals led to a 25 per cent decrease in machine capacity compared with that achieved when the conventional woven mesh was used as the means of screen support. This reduction in capacity was attributed to a greater resistance to molasses discharge by the wedgewire backing due to the lower open area available.

Subsequent examination of the results of these trials led us to consider whether the reduced capacity of the machine fitted with the wedgewire backing may have been due to a change in performance of the chrome-nickel working screen rather than the wedgewire backing. It was reasoned that the better support provided by the wedgewire may have led to less slot widening in the working screen and hence a greater resistance to the flow of molasses.

To determine whether the decrease in fugal capacity was due to the working screen or the wedgewire backing supporting it, a series of measurements were carried out on test specimens cut from the top, middle and bottom of segments of chrome-nickel working screens removed from the two trial machines. One of these had been fitted with a wedgewire backing and the other with conventional woven mesh backing.

These measurements, which were carried out by the author at the Chemical Engineering Department of the University of Queensland, included the following :

- Slot width and open area determination
- Photomicrographs of each screen section
- Screen resistance of each specimen

2. DISCUSSION OF RESULTS

2.1 Open area measurements

The slot dimensions required for the calculation of open area of the two used screens and a new chrome-nickel screen were determined using a projection microscope fitted with a lens of 50 magnification. Details regarding the measurements taken and the results obtained are given in Appendix I. A summary of the main results is shown in Table I.

TABLE I

Results of open area measurements

Sample No.	Screen support	Area	Slot length (mm)	Slot width (mm)	% Open area
1	Wedgewire	Top	2.308	0.064	6.71
2	Wedgewire	Middle	2.324	0.063	6.60
3	Wedgewire	Bottom	2.396	0.126	14.19
4	Woven	Top	2.286	0.055	5.79
5	Woven	Middle	2.266	0.060	6.20
6	Woven	Bottom	2.296	0.058	6.15
7	-	Top	1.687	0.056	6.07

Note : Sample No. 7 was a new Cr/Ni screen. All other samples were cut from screens which had been in use for approximately 1300 hours.

The main conclusion to be drawn from these results is that considerable wear had occurred around the bottom of the screen which had been installed over the wedgewire support (sample No. 3). The average slot width in this area (0.126 mm) was double that in the middle and top sections of the screen. This slot widening, coupled with a slight increase in the length of the slots, led to an increase in open area from about 6.7 per cent to 14.2 per cent. It was also quite apparent that the chrome plating had been almost completely eroded away from the nickel base of the screen in this area.

In contrast to the above finding, the screen with the woven mesh backing showed no sign of slot widening and only slight evidence of loss of chrome over the entire screen. This was surprising in view of the screen deformation which had occurred due to the poorer support provided by the woven mesh backing. All that can really be concluded from these measurements of slot dimensions is that the reduced capacity of the machine fitted with the wedgewire backing was not due to differences in open area of the chrome-nickel working screen, and that the restriction to the discharge of molasses therefore probably lies in the backing itself.

2.2 Photomicrographs of screens

Photomicrographs of the various screen sections examined are shown in Figures 1 to 3. These serve as a useful visual record of the condition of the screens at the completion of the trials at Bingera.

The slot widening which occurred at the bottom of the screen installed over the wedgewire backing may be clearly seen in Figure 1. Also evident in Figure 2 is some of the screen deformation caused by the woven mesh backing.

2.3 Screen resistance

The procedure used in determining screen resistance, and the results of these measurements, are presented in Appendix II. A summary of the main results is shown in Table II.

TABLE II

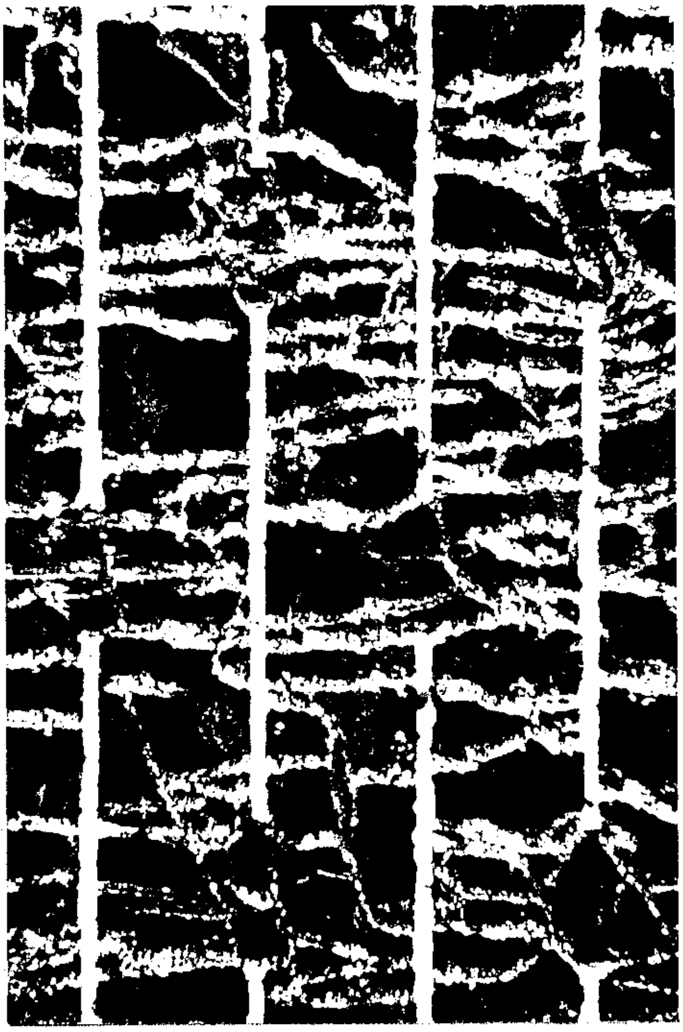
Results of screen resistance measurements

Sample No.	Screen support	Area	Screen resistance (m^{-1})
1	Wedgewire	Top	3.17×10^7
2	Wedgewire	Middle	3.25×10^7
3	Wedgewire	Bottom	2.39×10^7
4	Woven	Top	4.06×10^7
5	Woven	Middle	4.07×10^7
6	Woven	Bottom	3.84×10^7
7*	-	Top	4.44×10^7

* New Cr/Ni screen

The results obtained show that the bottom area of the screen installed in the machine with the wedgewire backing had a much lower resistance to flow through the slots ($2.39 \times 10^7 m^{-1}$) than the upper and middle sections of the screen. This finding was, of course, to be expected in view of the higher open area of the screen towards the bottom (see section 2.1). The resistance of the screen which had been installed over the woven mesh backing was relatively uniform at $3.8 - 4.1 \times 10^7 m^{-1}$ over its entire surface, while the resistance of the top section of a new screen ($4.44 \times 10^7 m^{-1}$) was higher than that of the older sections of screen examined because no slot widening had occurred.

The influence of open area on screen resistance is illustrated in Figure 4. It may be seen that as the open area increased from 5.5 to 6.7 per cent, there was a rapid drop in screen resistance. However, it appears that this decline in resistance levels off, and that above an open area of about 8.0 per cent little further benefit is achieved. It should be pointed out that the increase in open area in this case was due to slot widening, and that a similar response may not be obtained if the increase in open area was due to an increase in the number of slots per unit area rather than a widening of the slots.

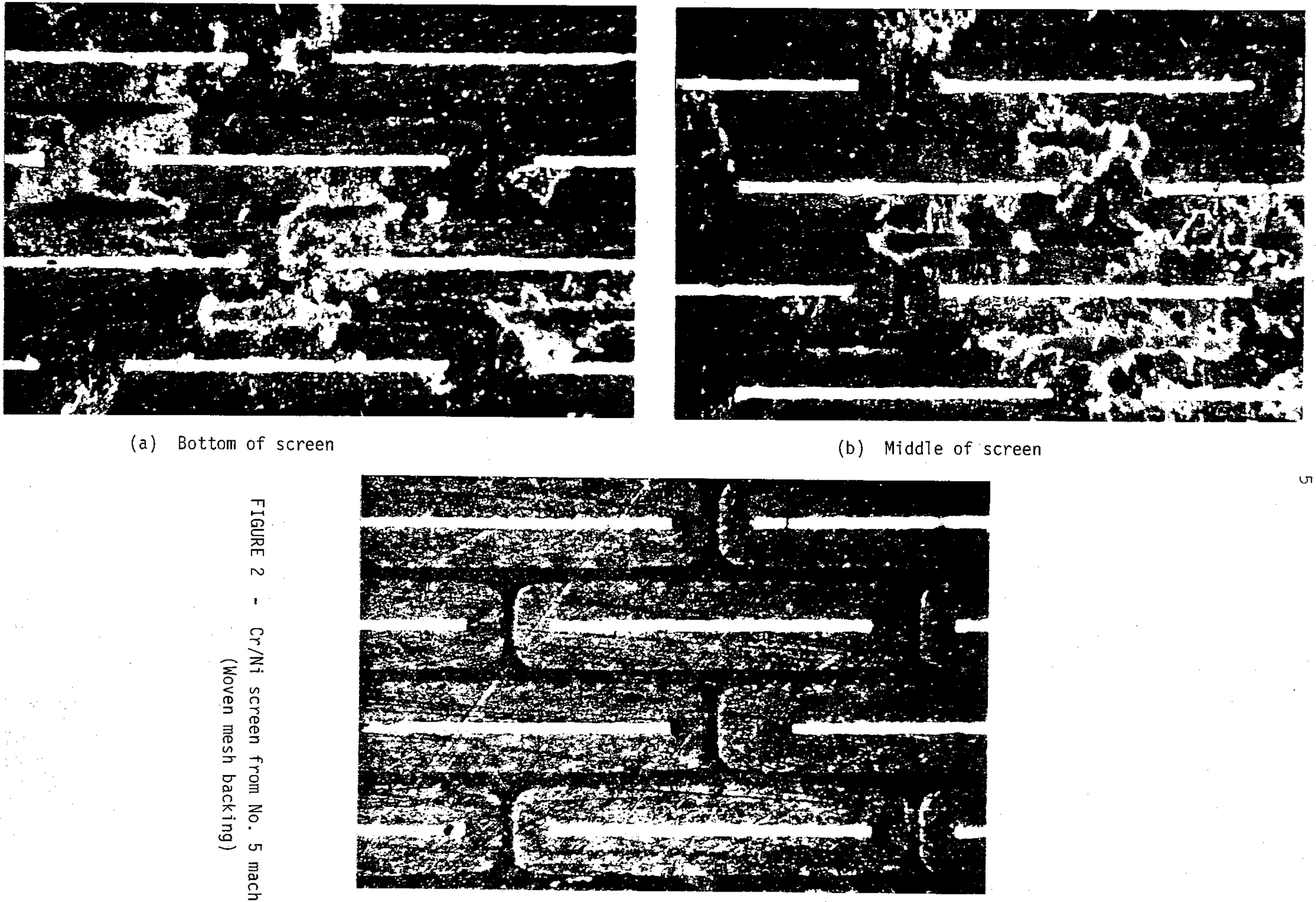


(b) Middle of screen

(a) Bottom of screen

(c) Top of screen

FIGURE 1 - Cr/Ni screen from No. 4 machine
(Wedgewire backing)

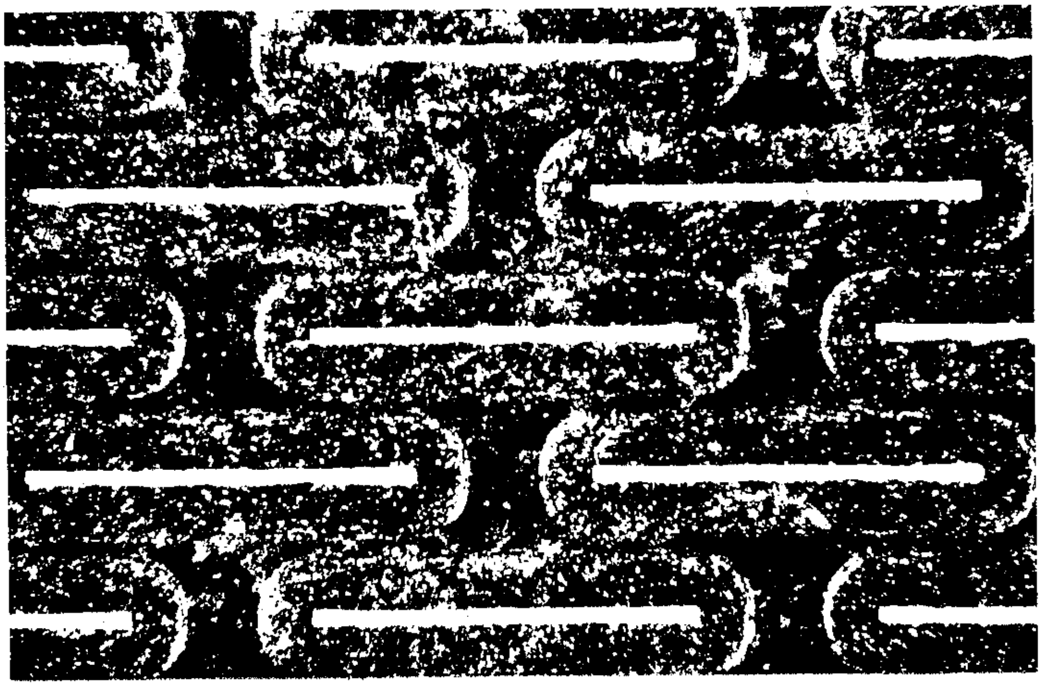


(a) Bottom of screen

(b) Middle of screen

(c) Top of screen

FIGURE 2 - Cr/Ni screen from No. 5 machine
(Woven mesh backing)



Top of screen

FIGURE 3 - New Cr/Ni screen

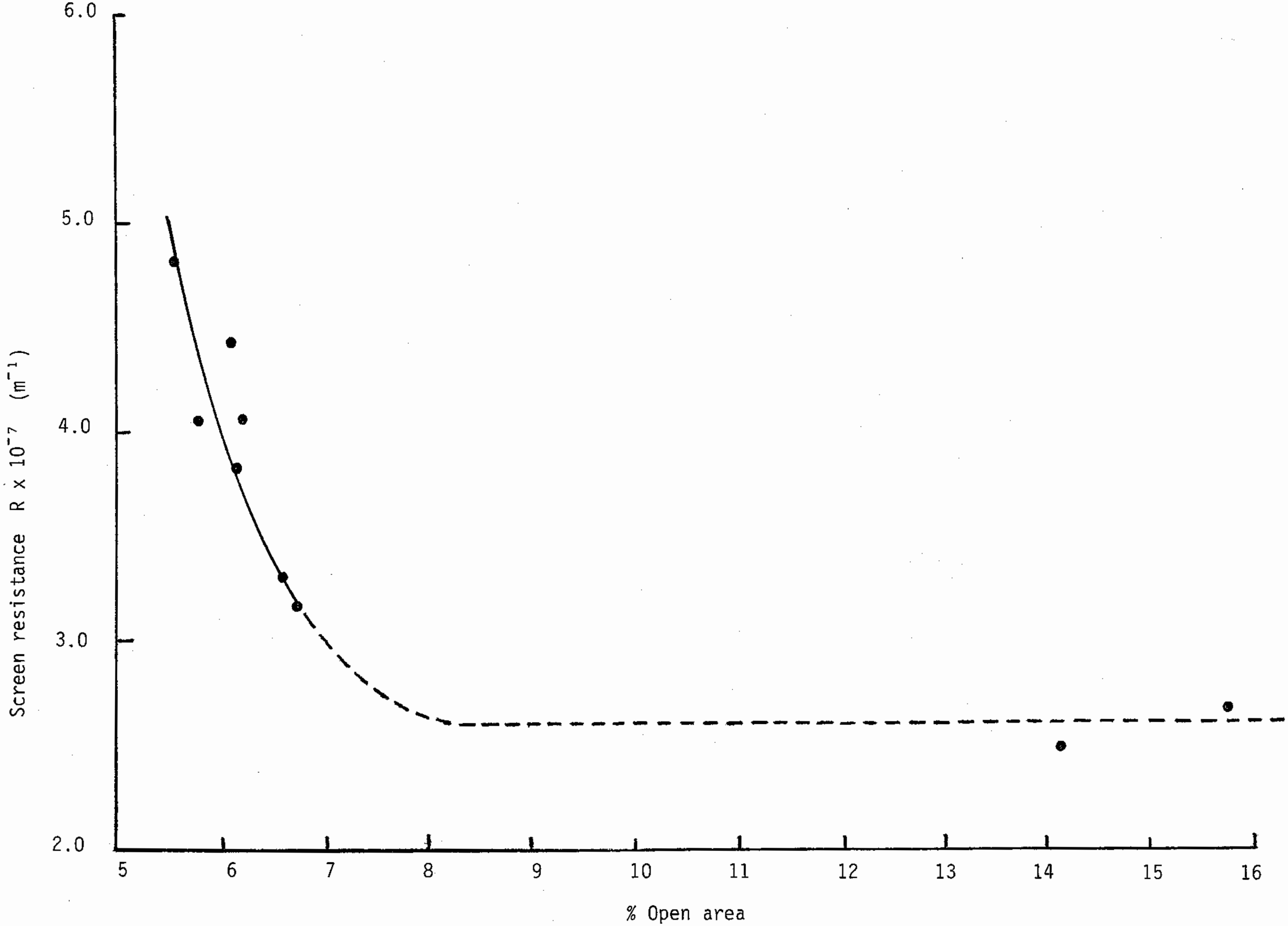


FIGURE 4 - Influence of open area on screen resistance

3. CONCLUSIONS

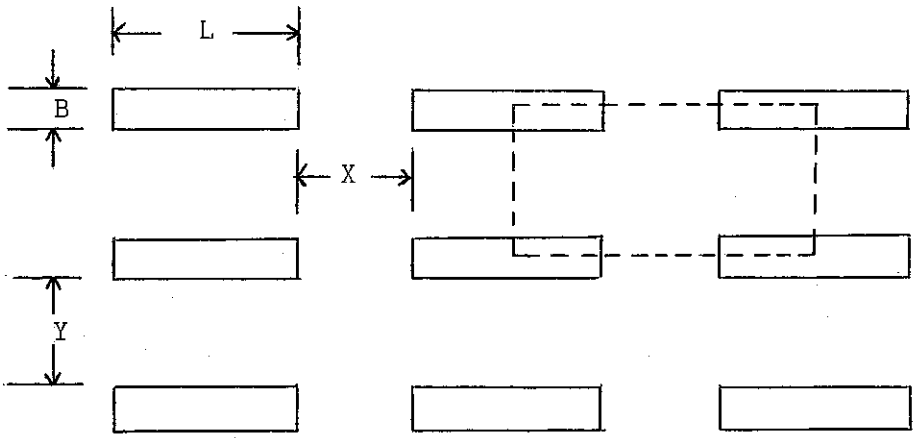
The results of these open area and screen resistance measurements have shown that the chrome-nickel screen fitted over the wedgewire backing would have offered less resistance to the discharge of molasses than the screen with the woven mesh backing. It therefore appears that it was the wedgewire which caused the reduction in fugal capacity in the trials at Bingera. A modification to the wedgewire profile to provide a higher open area will be necessary to overcome this problem.

A.G. Noble,
Research Officer.

APPENDIX I

RESULTS OF OPEN AREA MEASUREMENTS ON FUGAL SCREENS (CHEMICAL ENGINEERING DEPARTMENT, UNIVERSITY OF QUEENSLAND MARCH 21-25, 1988)

Screen configuration



Results of open area measurements

Sample No.	Backing screen	Area	No. of meas.	L (mm)	B (mm)	X (mm)	Y (mm)	% Open area
1	Wedgewire	Top	30	2.308	0.064	0.628	0.686	6.71
2	Wedgewire	Middle	30	2.324	0.063	0.630	0.688	6.60
3	Wedgewire	Bottom	30	2.396	0.126	0.550	0.596	14.19
4	Woven	Top	30	2.286	0.055	0.646	0.686	5.79
5	Woven	Middle	30	2.266	0.060	0.682	0.684	6.20
6	Woven	Bottom	30	2.296	0.058	0.638	0.680	6.15
7	-	Top	30	1.678	0.056	0.810	0.566	6.07
8	Wedgewire	Bottom	10	2.392	0.138	0.540	0.576	15.77
9	Woven	Bottom	10	2.258	0.054	0.678	0.696	5.54

Note : (i) Sample No. 7 was a new Cr/Ni screen. All other samples were cut from screens which had been in use for approximately 1300 hours.

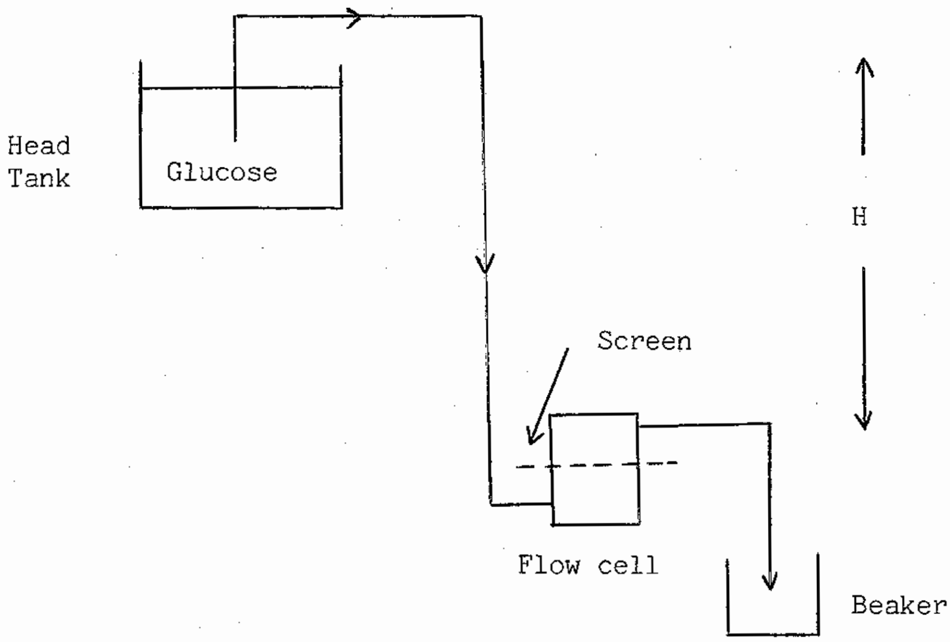
(ii) $$\% \text{ Open area} = \frac{L.B}{(L + X)(B + Y)} \cdot 100$$

APPENDIX II

SCREEN RESISTANCE MEASUREMENTS

(CHEMICAL ENGINEERING DEPARTMENT, UNIVERSITY OF QUEENSLAND MARCH 21-25, 1988)

The general arrangement of the apparatus is shown below :



The screen resistance is given by the expression :

$$R = \frac{\Delta p . A}{Q . \mu} \qquad \text{.............................. (1)}$$

where
- R = screen resistance (m^{-1})
- Δp = pressure drop across screen (Pa)
- A = screen area (m^2)
- Q = fluid flowrate ($m^3.s^{-1}$)
- μ = fluid viscosity (Pa.s)

Now $\Delta p = \rho g H$ .... (2)

where
- ρ = density of glucose = 1 365.2 $kg.m^{-3}$
- g = 9.8 $m.s^{-2}$
- H = head of glucose = 0.800 m

$$\therefore \quad \Delta p = 1\ 365.2 \times 9.8 \times 0.800$$
$$= 10.703 \times 10^3 \text{ Pa}$$

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (0.073)^2}{4}$$

$$= 41.85 \times 10^{-4} m^2$$

$$\therefore \quad \Delta p.A = (10.703 \times 10^3) \times (41.85 \times 10^{-4})$$
$$= 44.792 \; m^3.s^{-2}$$

$$\therefore \quad R = \frac{44.792}{Q.\mu} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

The glucose flowrate (q) was measured in $g.min^{-1}$ in these tests.

$$\therefore \quad Q = \frac{q}{1000 \times 60 \times 1365.2}$$

$$= \frac{q}{8.1912} \times 10^{-7} m^3.s^{-1}$$

$$\therefore \quad R = \frac{44.792}{Q.\mu} = \frac{366.90}{q.\mu} \times 10^7 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

The first step in carrying out a measurement of screen resistance was simply to clamp the screen in the flow cell and start syphoning glucose over from the head tank. The temperature and flowrate of the glucose were determined after steady state had been attained. Duplicate readings were carried out on each of the nine segments of screen.

The viscosity/temperature relationship for the diluted glucose solution used in these tests was determined using a Contraves viscometer.

The results obtained were as follows :

$$\mu = 8.78 - 0.28 \; T$$

where μ = viscosity (Pa.s)
T = temperature (°C)

The results of the screen resistance tests are summarised in the following table.

Results of screen resistance measurements

Sample No.	Backing screen	Area	q ($g.min^{-1}$)	T (°C)	μ (Pa.s)	R x 10^{-7} (m^{-1})
			61.25	24.2	2.00	3.00
1	Wedgewire	Top	56.35	24.4	1.95	3.34
					Average	3.17
			59.73	24.4	1.95	3.15
2	Wedgewire	Middle	56.13	24.4	1.95	3.35
					Average	3.25
			87.28	25.0	1.78	2.36
3	Wedgewire	Bottom	85.18	25.0	1.78	2.42
					Average	2.39
			53.85	25.0	1.78	3.83
4	Woven	Top	48.17	25.0	1.78	4.28
					Average	4.06
			52.73	25.0	1.78	3.91
5	Woven	Middle	48.71	25.0	1.78	4.23
					Average	4.07
			55.66	25.0	1.78	3.70
6	Woven	Bottom	51.81	25.0	1.78	3.98
					Average	3.84
			48.69	25.0	1.78	4.23
7	-	Top	44.36	25.0	1.78	4.65
					Average	4.44
			77.78	25.0	1.78	2.65
8	Wedgewire	Bottom	76.55	25.0	1.78	2.69
					Average	2.67
			43.15	24.8	1.84	4.62
9	Woven	Bottom	39.70	24.8	1.84	5.02
					Average	4.82

Note : Sample No. 7 was a new Cr/Ni screen. All other samples were cut from screens which had been in use for approximately 1300 hours.