

A COMPARISON OF FIBREGLASS AND CLASS 'A' EVAPORATION PANS

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Abstract

Evaporation from fibreglass pans painted silver was less than from Class 'A' (metal) pans. Painting the fibreglass pans with dark paint decreased the difference in evaporation but the seasonal differences were not uniform. It was also shown that placing a screen over both types of pans decreased evaporation while lowering the water level in a Class 'A' pan increased evaporation. It was concluded that fibreglass pans should not be used in the sugar industry.

Introduction

The South African sugar industry maintains a network of 29 Grade A meteorological stations throughout the cane belt. One of the standard items of equipment which has been installed at each station is the United States Weather Bureau (USWB) Class 'A' evaporation pan. It is constructed from 22 gge galvanised iron. The pan is 1,22 m in diameter, 0,25 m deep, and has a hook gauge situated in a stilling well. The water in the pan is replenished to the level of the hook gauge each day.

Evaporation from the Class 'A' pan is used to estimate the amount of water lost as a result of evapotranspiration in the field. The pan is therefore particularly valuable in irrigated areas where a soil moisture profit and loss account can be used to determine how much irrigation water is required.

The USWB Class 'A' pans usually last between 36 and 48 months, depending on the standard of maintenance. Because the cost of metal pans has increased in recent years, consideration was given to making the pans out of fibreglass. One modification was necessary and that was the upper edge which had to be strengthened by a small brace facing outwards. The pan would otherwise have been too flimsy and would probably have cracked during cleaning. Fibreglass was considered to be a suitable alternative because very little maintenance would be required, it lasts longer than metal and it costs slightly less than metal.

Methods and Materials

Experiment 1

A fibreglass pan was painted bituminous silver and installed in the meteorological station on a raised pallet at the Experiment Station at Mount Edgecombe. Next to it was the conventional metal pan. Readings were taken for fifty days after which the experiment was terminated and it was found that water evaporated from the fibreglass pan at a rate significantly lower than from the metal pan.

Experiment 2

Seven fibreglass pans and one metal pan, all painted bituminous silver, were mounted on concrete pallets on a level cement-covered strip, and not on a grass sward, which is normal meteorological practice. The experiment was conducted for four weeks and the pans were moved from one position to another every seven days as shown in Figure 1. Readings for the eight pans were taken daily with a single dipper gauge.

After four weeks the differences between the readings of the seven fibreglass pans were negligible. There was however, a consistent difference in the amount of evaporation from the two types of pans. As was observed in Experiment 1 carried out

on the meteorological site at the Experiment Station, evaporation from the metal pan was greater.

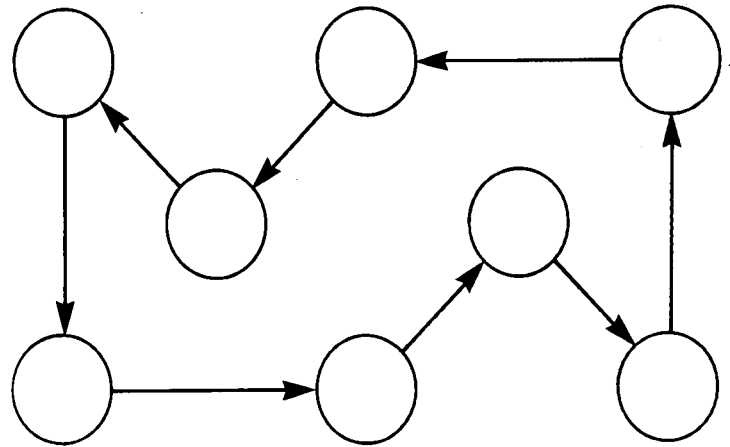


FIGURE 1 Successive positions of seven fibreglass pans and one standard Class 'A' pan in Experiment 2.

Experiment 3

It was thought that the lower readings obtained from the fibreglass pans were due to the lower thermal conductivity of the fibreglass. Pans were therefore painted two different dark colours to determine whether heat absorption of the fibreglass could be increased. In addition, two pans were covered with a 25 mm chicken wire screen attached to a 10 mm round bar hoop. The screens were laid on top of the pans, following the procedure used by the Department of Water Affairs. Pans need to be screened in areas where game, stock or birds can gain access. The pans were painted, rotated as in Experiment 2 and treated as follows:

- control, standard metal pan, painted silver
- fibreglass pan painted silver
- fibreglass pan painted silver, covered with Department of Water Affairs wire screen
- fibreglass pan painted dark green outside, silver inside
- fibreglass pan painted dark green inside and outside
- fibreglass pan painted black outside, silver inside
- fibreglass pan painted black outside, silver inside with Department of Water Affairs wire screen
- fibreglass pan painted black inside and outside

Pans were repainted at six-weekly intervals if the colour or sheen appeared to have changed. The experiment was conducted for twelve months, readings being taken daily. The total evaporation per month from each pan was used to compare pans and in all cases it was found that the paint increased the amount of evaporation, some more than others, and that screening reduced evaporation.

Experiment 4

Evaporation from the fibreglass pan which was painted black inside and outside was increased to almost the same extent as it was reduced by the screen during the twelve month period. A screen was placed over a pan which was painted black both inside and outside and evaporation was measured and compared with that of two metal pans, one of which had the hook gauge at the normal level and the other where it was 25 mm

lower than usual. After seven months the experiment was terminated because evaporation from the screened fibreglass pan, differed from the amount which evaporated from the standard pan according to the season. In the metal pan in which the water level was maintained at a shallower depth, evaporation was greater than that from the standard pan.

Results and Discussion

Experiments 1 and 2

In Experiment 1 where the fibreglass pan was painted silver and installed in the meteorological site at the Experiment Station during April and May, the results showed that evaporation from this fibreglass pan was 8,2% lower than the evaporation from the standard pan. This can be seen in Table 1.

TABLE 1
Evaporation from a standard Class 'A' pan and a fibreglass pan during April and May

	Standard	Fibreglass
Evaporation (mm)	158,5	145,5
Evaporation (%)	100	91,8

In the second experiment where seven fibreglass pans were compared with the standard pan during July, the results showed that the average difference in evaporation was 6,8% (see Table 2). Evaporation from individual fibreglass pans did not deviate by more than 0,5 mm from the mean on any one day.

TABLE 2

Comparison of mean evaporation from seven fibreglass pans and evaporation from one standard pan in July

	Standard	Fibreglass
Evaporation (mm)	89,2	83,1
Evaporation (%)	100	93,2

Experiment 3

The results in Table 3 show that in all cases dark paint on fibreglass pans increased evaporation. Evaporation from the pan painted black inside and outside was greatest and averaged 108% of the amount evaporated from the standard pan over the twelve month period, and ranged between 111% in February and 103% in May. As was expected, the least evaporation occurred from the pan painted silver both inside and outside, averaging 96% for the year and varying from 100% in summer to 91% in winter. These seasonal variations in the difference between amounts of evaporation are illustrated in Figure 2.

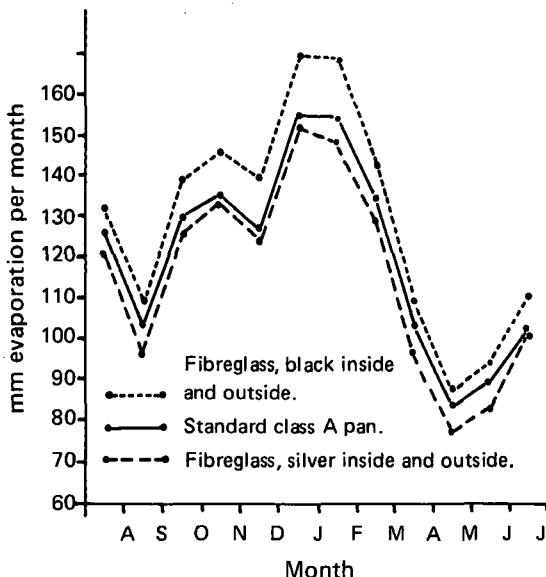


FIGURE 2 Monthly evaporation from different pans

Evaporation from the other pans ranged between these extremes. As can be seen in Table 3, evaporation from the pans did not differ consistently from the amount lost from the standard pan, being higher during some months and lower in others. Evaporation from the two screened pans was approximately 8% lower than from the unscreened pans. The results are shown in Figure 3.

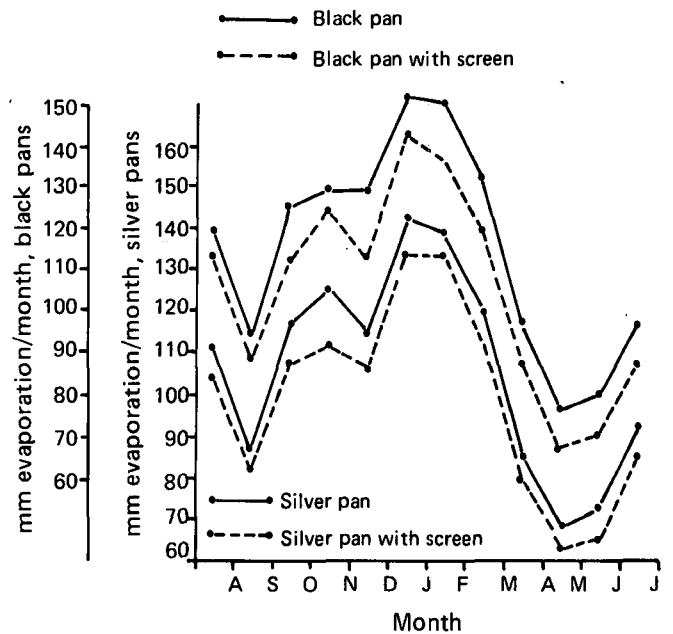


FIGURE 3 Monthly evaporation from screened and unscreened pans

Experiment 4

The results in Table 4 show that during a seven month period, total evaporation from a black screened pan differed from the control by only 0,4%, but the difference ranged between +3,5% in February and -8,7% in June.

The differences between standard and fibreglass pans again showed a seasonal variation, evaporation being higher from the fibreglass pan during the summer months and from the standard pan in winter.

Total evaporation from the metal pan in which the water level was maintained at a shallower depth was 7,1% more than the control, and the difference ranged between +8,7% and +4,2%.

TABLE 4

Evaporation from a standard Class 'A' pan, a fibreglass pan painted black and covered with a screen, and a standard pan in which the water level was kept 25 mm lower than normal

	Standard pan	Black fibreglass pan with screen	Standard pan with lower water level
Jan mm	166,8	169,8	180,5
% of standard		101,8	108,2
Feb mm	164,4	170,2	175,5
% of standard		103,5	106,9
Mar mm	132,4	133,6	140,9
% of standard		100,9	106,4
Apr mm	160,5	162,6	174,5
% of standard		101,3	108,7
May mm	106,9	103,5	114,9
% of standard		96,8	107,5
Jun mm	90,3	82,4	94,1
% of standard		91,3	104,2
Jul mm	97,8	92,9	103,4
% of standard		95,0	105,7
Total mm	919,1	915,0	984,0
% of standard		99,6	107,1

TABLE 3
Monthly evaporation from different pans in Experiment 3

	Pan 1 control	Pan 2 silver	Pan 3 silver screened	Pan 4 green out silver in	Pan 5 green in and out	Pan 6 black out silver in	Pan 7 black out screened	Pan 8 black in and out
Aug mm % of control	116,4	110,9 95,3	103,3 88,7	117,9 101,3	118,2 101,5	117,5 100,9	112,3 96,5	121,8 104,6
Sep mm % of control	93,0	87,2 93,8	83,1 89,3	93,4 100,4	96,1 103,3	94,2 101,3	88,9 95,6	99,0 106,5
Oct mm % of control	119,8	117,4 98,0	107,4 89,6	122,4 102,2	123,1 102,8	125,3 104,6	111,6 93,2	128,8 107,5
Nov mm % of control	125,2	124,9 99,7	110,7 88,4	128,3 102,5	130,1 103,9	129,2 103,2	123,6 98,7	135,5 108,2
Dec mm % of control	116,8	115,4 98,8	105,9 90,7	121,2 103,8	124,0 106,2	128,9 110,4	112,2 96,1	128,9 110,4
Jan mm % of control	144,8	141,6 97,8	132,5 91,5	153,1 105,7	153,3 105,9	151,7 104,8	142,5 98,4	159,6 110,2
Feb mm % of control	143,8	138,1 96,0	133,0 92,5	152,3 105,9	150,0 104,3	150,7 104,8	135,6 94,3	159,0 110,6
Mar mm % of control	123,6	120,1 97,2	111,5 90,2	132,5 107,2	130,8 105,8	131,9 106,7	120,3 97,3	134,4 108,7
Apr mm % of control	93,1	85,6 91,9	80,0 85,9	98,8 106,1	94,6 101,6	96,6 103,8	88,0 94,5	99,2 106,6
May mm % of control	74,2	67,8 91,4	62,6 84,4	73,0 98,4	76,2 102,7	75,8 102,2	67,9 91,5	76,7 103,4
Jun mm % of control	79,9	73,7 92,2	65,2 81,6	75,1 94,0	79,2 99,1	80,1 100,3	70,6 88,4	84,1 105,3
Jul mm % of control	93,3	92,7 99,4	84,6 90,7	96,4 103,3	93,6 100,3	97,0 104,0	86,8 93,0	101,1 108,4
Annual total	1323,9	1275,4	1179,8	1364,4	1369,2	1378,9	1260,3	1428,1
Average %		96,3	89,1	103,1	103,4	104,2	95,1	107,9

Conclusion

The results of all of the experiments show that evaporation from fibreglass pans painted bituminous silver, which is normal practice for metal pans, was less than the evaporation from metal pans. This was probably due to the different thermal conductivities of the different materials, and the water in the fibreglass pan therefore did not receive as much heat through the side wall as was received by the water in the metal pan. Evaporation was increased by painting the pan a dark colour and thereby increasing the absorption of radiant energy, but unfortunately the effect of this varied seasonally.

The brace on the upper lip of the fibreglass pans possibly caused readings on rainy days to be inaccurate especially when heavy rain fell, despite the fact that the tip tapered down- and outwards.

Placing a screen over the fibreglass pans caused apparent evaporation to decrease by approximately 8%. The measurement of evaporation may be inaccurate if the screen interferes

with the amount of rain falling into the pan. It has been suggested (Mukammal¹) that a screen generally causes evaporation to be underestimated on rainy days.

The water level in pans was obviously important, since a 25 mm reduction in the water level caused evaporation to increase by 7%. This is a reason why measurements made in SASA metal Class 'A' pans do not agree exactly with those made in Department of Water Affairs metal Class 'A' pans on the same sites. The level of the water in Department of Water Affairs pans is read daily, off a scale fixed to the side of the pan, but the water in the pan is replenished only after the water level has dropped by about 50 mm, which could take four days or longer.

The seasonal variation in the differences between evaporation from standard Class 'A' pans and fibreglass pans was sufficient to preclude the latter being introduced, despite the practical advantages that would have been gained.

REFERENCES

1. Mukammal, E. I. (1961). Evaporation pans and atmometers. *Proc. Hydrol. Symp. No. 2, Dept. of Northern Affairs and National Resources, Toronto.*