AVAILABLE SAFETY MARGINS OF TIME AND ANTISCALANT DOSE RATE[1]

Mohammad AK. Al-Sofi, Osman A Hamed, Khalid Bamardouf, Abdul Ghani I. Dalvi, Hamed Al-Washmi Mohammad N.M. Kither and Yahya Al-Aseeri

Saline Water Conversion Corporation
P.O.Box 8328, Al-Jubail -31951, Saudi Arabia
Tel: + 966-3-343 0012, Fax: + 966-3-343 1615
Email: rdc@swcc.gov.sa

ABSTRACT

Saline water Conversion Corporation (SWCC), Research & Development Center (RDC) was encountered with a request to establish available safety margins of time and antiscalant dose rate. This request came to RDC from operating plants in order to set limits of available time and for clear identification of operating procedures in case of antiscalant dose rate interruption.

This paper will review past works of scale control in SWCC. Results obtained during the past couple of decades (1981-2000 AD) are cited as background information. Such results include scale control techniques of ball cleaning and antiscalant dose rate optimization and costs. The paper will also describe some preliminary ground work carried out in laboratory and on the 20 kilo liter per day pilot plant MSF distiller available at SWCC-RDC in Al-Jubail.

Laboratory work will show threshold scale formation potentials as a function of time using change in solution alkalinity. In these tests various antiscalant types of polyphosphonate and polymaleic and polycarboxylic acids were dosed into natural seawater and artificially concentrated brine solutions.

On the other hand, operating results of the 20 kl per day MSF pilot plant will be shown at low down to very low antiscalant dose rates. In addition, operating results on pilot plant MSF distiller for limited durations will be discussed while suspending either antiscalant dosing or on-line rubber ball cleaning scale control technique.

[1] Presented in the International Conference on Seawater Desalination Technologies on the Threshold of the new Millennium, Kuwait, November 4-7, 2000.

INTRODUCTION

Saline Water Conversion Corporation (SWCC) has been operating multi stage flash (MSF) distillers from its inception in 1973. During the eighth decade particularly around 1977, it was faced with fast plant deterioration primarily due to poor acid dosing for scale control. Such a situation lead SWCC into converting (first along the Gulf and latter along the Red Sea) its scale control philosophy away from acid and towards chemical additives of alkaline effect on recirculating brine solution [1].

This action was followed by adopting an extensive and widespread antiscalant dose rate optimization program during the ninth decade [2-4]. Later-on during this last decade of the century further works on scale control was planned and these are being executed in successive segments [5-7].

In this paper the results of antiscalant low and extremely low dose rates with and without on-line sponge rubber ball cleaning are shown and discussed.

DISCUSSION

The concept of available margins of time and antiscalant dose rate is being developed through successive (yet complimentary and inter-related) venues. These were (i) chemistry laboratory bench top, (ii) a 20^+ kilo liter per day (klpd) MSF pilot plant and (iii) 22^+ Mega liter per day (Mlpd) MSF commercial plants. Monitoring and trial testing were carried out at top brine temperatures of 90 100°C using polyphosphonate based antiscalant.

Through the works of the last decade it was established that even dose rates of 1 to 3 parts per million (ppm) of seawater make-up to MSF distillers for top brine temperature (TBT) of 90 to 110 °C, respectively, was not only sufficiently safe but to certain level excessive. It was also established that excessive dosing is as bad as (if not worst than) under dosing. This is mainly due to the observed sludge formation which drastically increases as antiscalant dose rate is increased. Moreover, it was established that a 10% additional treatment cost by the use of sponge rubber ball on-line cleaning was quite

primarily swept off any sludge that is formed inside heat exchanger tubes [8&9].

Figures 1 and 2 show schematic diagrams of 20^+ klpd and 22^+ Mlpd pilot and commercial MSF units used in these tests. Figure 3 and 4 show threshold scaling potential tests. Figures 5-8 show pilot MSF trial test performances. Then, the commercial MSF plant trial test performance results are shown in Figure 9.

RESULTS

It is evident from Figures 3 and 4 that there are marked difference in scaling potentials as functions of antiscalant contents.

Similarly, actual scaling as shown by overall heat transfer coefficients and fouling factors in Figures 5 to 8 is dependent on antiscalant content, i.e., dose rate. Nevertheless, fouling increases, yet very gradually, with the reduction in antiscalant dose rate. Moreover, the pilot plant operation without ball cleaning showed very gradual rise in fouling factors as shown in Figure 8. It is to be stressed here that during the no ball operation period reported in Figures 7 and 8 seawater turbidity was remaining normal. As an advance phase of this study, Figure 9 shows how well the fouling factors of the brine heaters were maintained while a commercial unit as the one shown in Figure 2 could be operated at a top brine temperature (TBT) of 90°C and antiscalant dose rate of 0.8 ppm.

CONCLUSION

The current dose rates of 1-3 ppm for MSF operation at TBT of 90-110°C is quite safe. Moreover, the above levels are found to be somewhat excessive. On the other hand, it was established that failure of one and up to three days of ball cleaning system in commercial plants is tolerable provided seawater turbidity remains normal.

RECOMMENDATION

1. Further commercial plant testing at antiscalant dose rate of 0.8 ppm and TBT of 100°C.

2. Trial testing operation of commercial plant without ball cleaning.

3. Close monitoring of seawater turbidity during above recommended commercial plant trial operations.

REFERENCES

1. Al-Sofi, M.AK., SWCC Experience in Building MSF Distillation Plants of MSF, Topics on Desalination, SWCC, 1988.

2. Al-Sofi, et al., Performance of 10 X 5.2 MIGD MSF Distillers of Al-Jubail II, 2nd IDA Conference, Bermuda, 1985.

3. Al-Mudaiheem, et al, Al-Jubail Phase-II Construction and Commissioning, Ibid.

4. Al-Mudaiheem, et al, MSF Design Configuration in SWCC along the Gulf Coast, 5th IDA Conference, Washington, DC, USA, 1991.

5. Al-Sofi, et al., Heat Transfer Measurements as Scale Control Parameter, 2nd WSTA Gulf Water Conference, Manama, Bahrain, 1994.

6. Al-Zahrani, et al., Performance Comparison of Antiscalant Effectiveness, 6th IDA Conference, Yokohama, Japan, 1993.

7. Al-Sofi, et al., Full Decade of Experience in Al-Khobar II MSF without Acid Cleaning, Ibid.

8. Al-Sofi, et al., MSF Operation Modes & Antiscalant Dose Rate Optimization, 3rd IDA Conference, Canne, France, 1987.

9. Al-Sofi, M. AK., et al., Practical Experience in Scale Control in MSF Distillers, 4th IDA Conference, Kuwait, 1989.

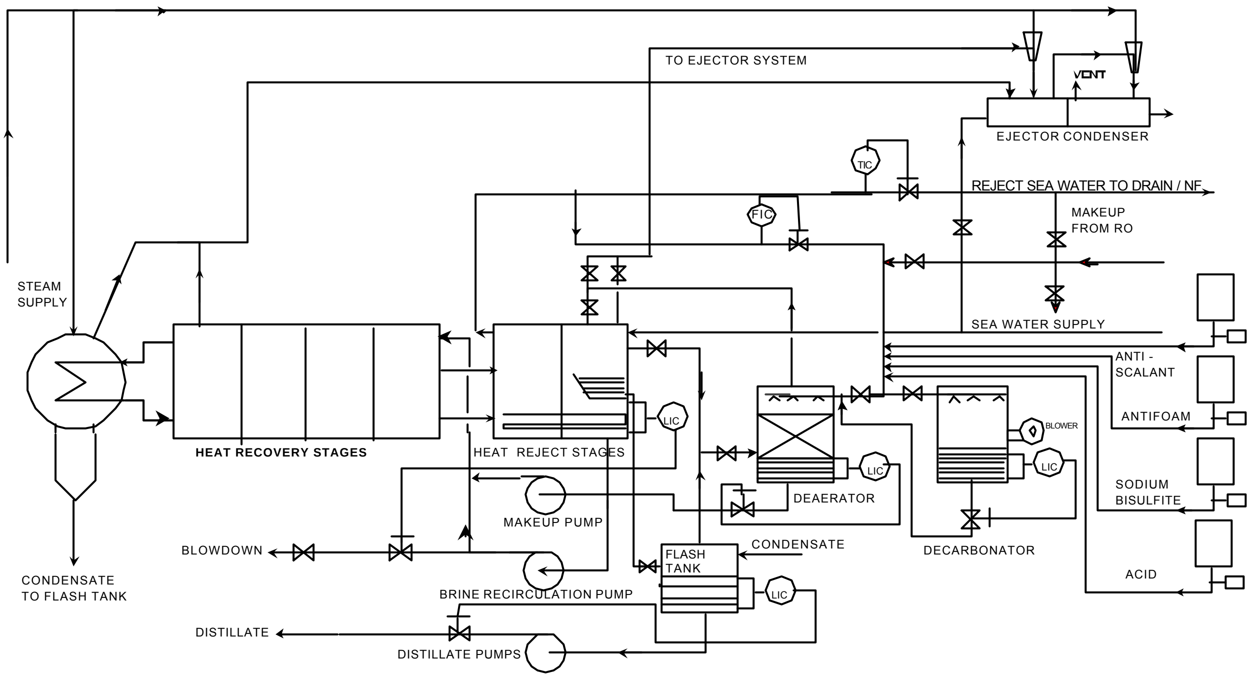

Figure 1 Schematic Diagram of MSF Pilot Plant

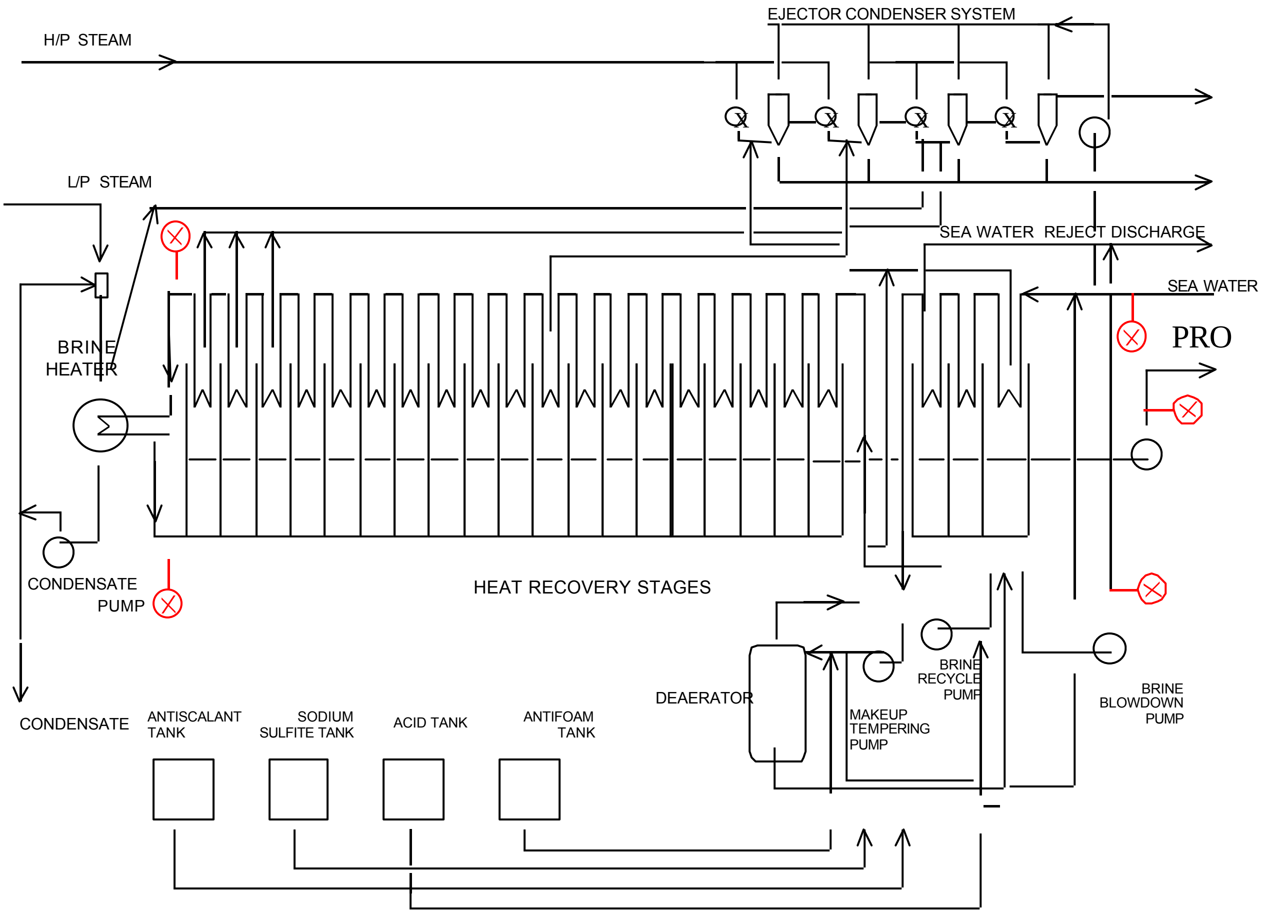

Figure 2 : Schematic Diagram of Al-Jubail MSF Plant Phase-II

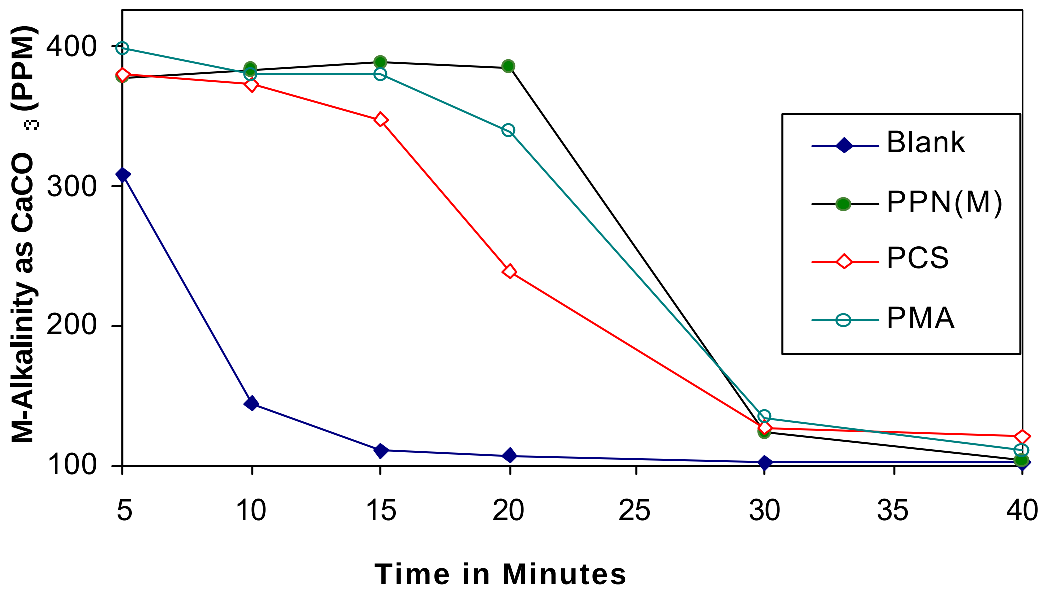

Figure 3. Laboratory test of various antiscalants for their threshold effect at 95°C and 2 ppm concentration

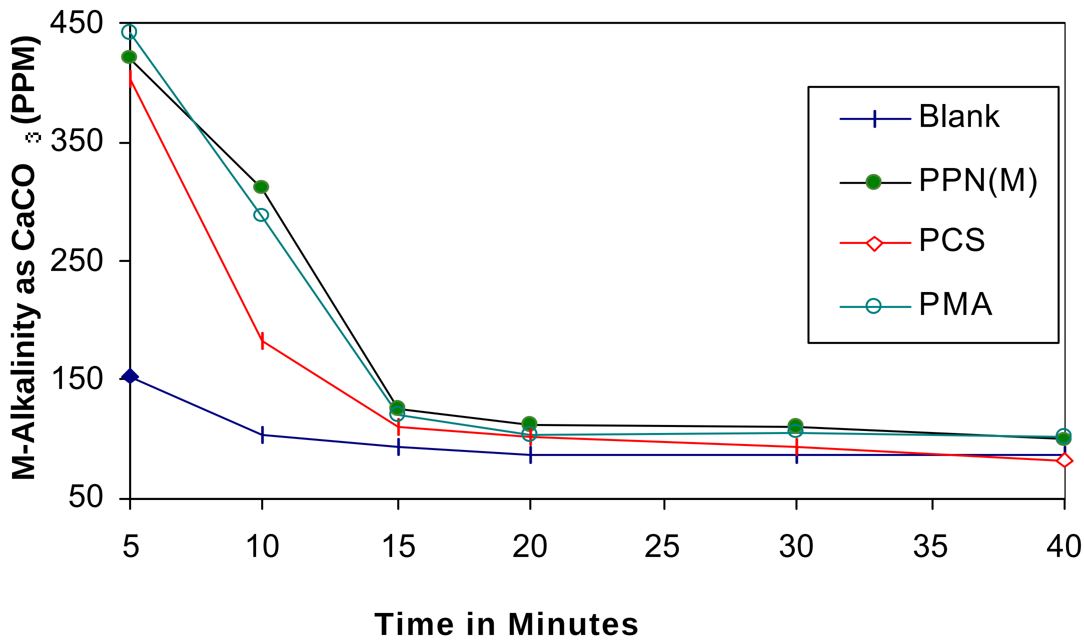

Figure 4 : Laboratory test of various antiscalants for their threshold effect at 110°C and 2 ppm concentration

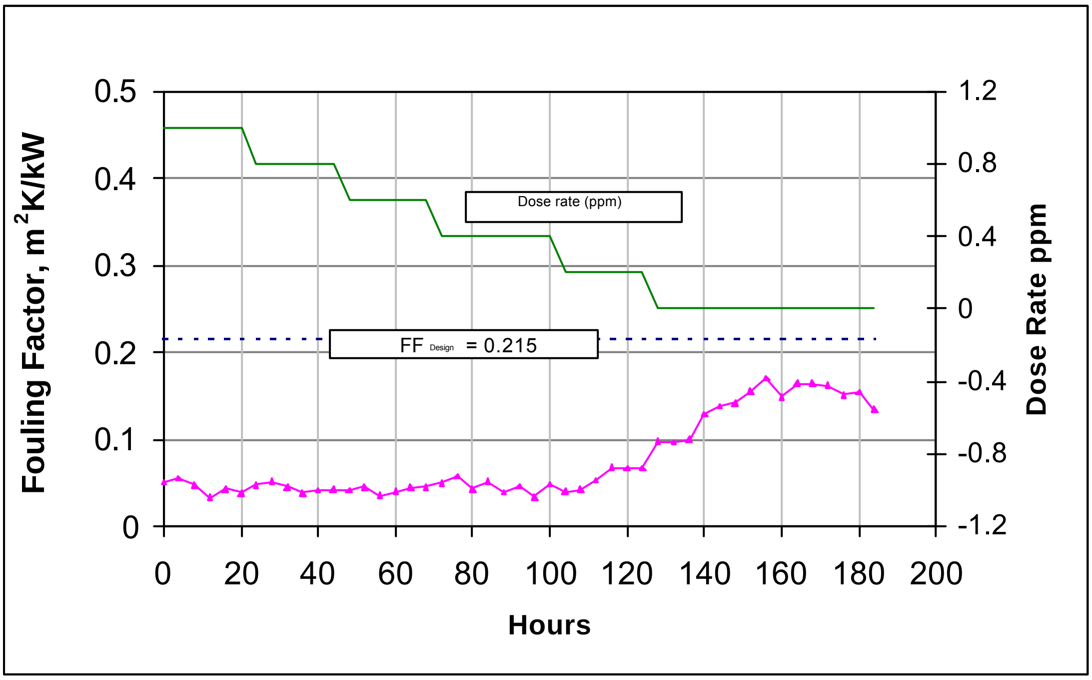

Figure-5: Impact of antiscalant dose rate reduction on the overall heat transfer coefficients of the pilot plant brine heater.

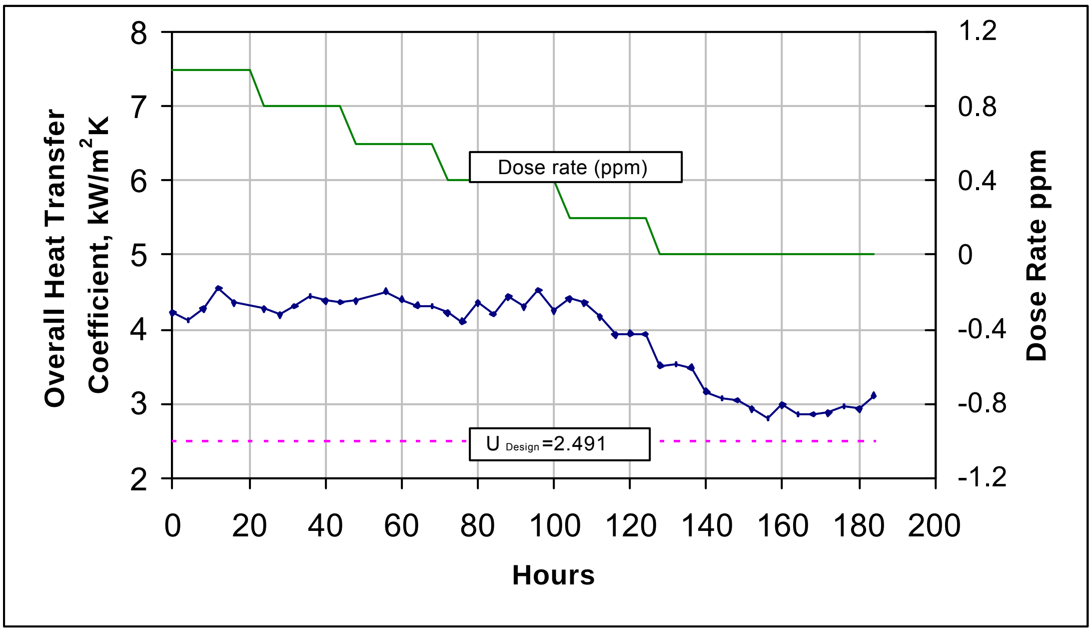

Figure 6 : Impact of antiscalant dose rate reduction on the fouling factors of pilot plant brine heater.

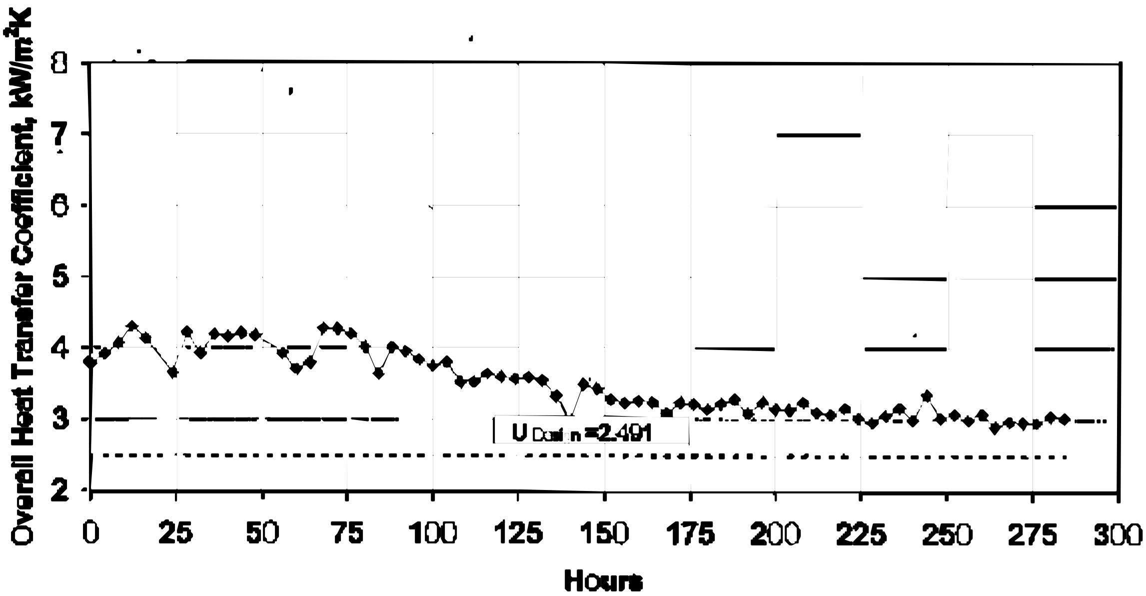

Figure 7 : Impact of no-ball operation on the overall heat transfer coefficients of the brine heater.

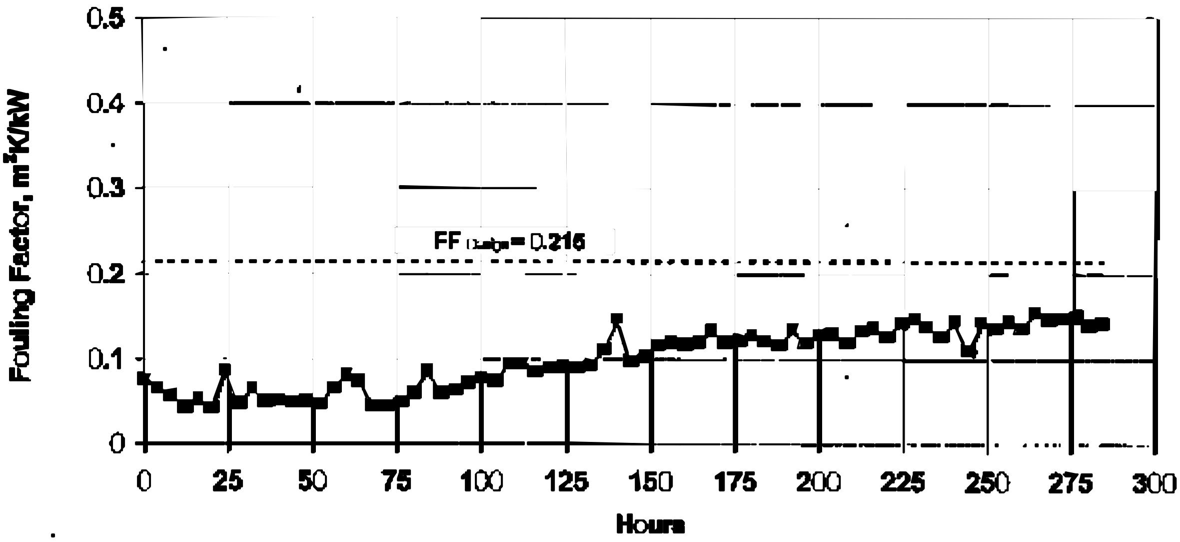

Figure 8 : Impact of no-ball operation on the fouling factor of the brine heater.

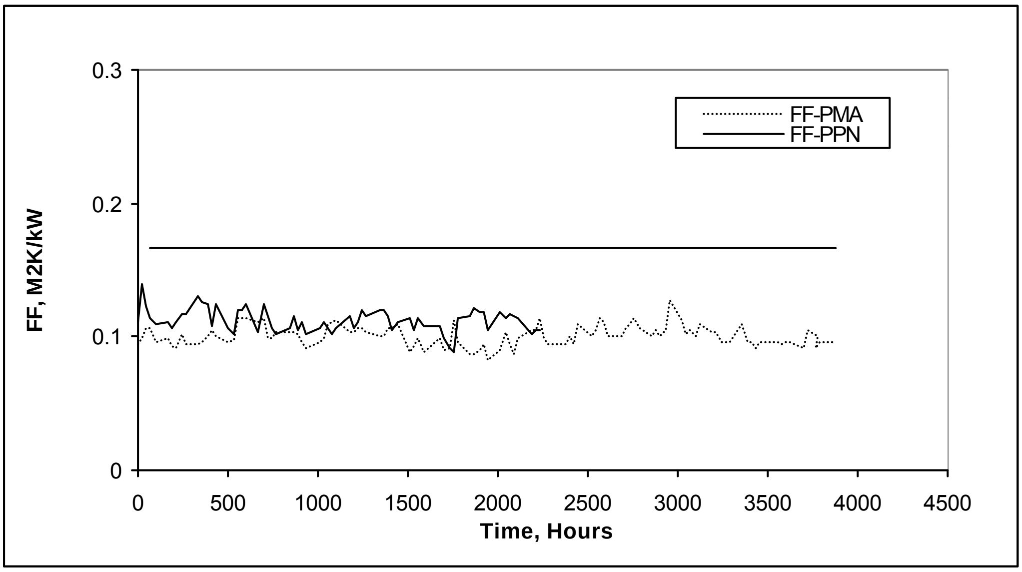

Figure 9 : Brine Heater Fouling Factor in Al-Jubail II Distiller