Technology Section

Pak. j. sci. ind. res., vol. 33, no. 7, July 1990

PARAFFIN WAX DEPOSITION FROM WAXY OIL STOCKS

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(Received September 29, 1988; revised February 25, 1989)

The parameters controlling the deposition of paraffin wax from waxy oil stock on to the pipe surface are investigated. It is noticed that the wax deposited, is a function of residence time, wax concentration, type of flow and the temperature of the waxy oils.

Key words: Paraffin wax, Waxy oil.

Introduction

The paraffin wax deposition from waxy oil stocks is one of the serious and long standing problem, in the petroleum industry and has attracted the attention of many earlier workers [1-3]. Major difficulties are faced by the plant operators handling the waxy stocks and by the workers transporting the waxy oil by pipelines. The problem is growing in intensity, since the high quality reserves are being depleted and low grade reserves are being exploited with greater frequency. Therefore, informations and data which will help to provide a better understanding of the problem is, of interest to the designers and the operators of the process plants.

Jessen and Howell [2] studied the effect of flow rates on wax deposition, in steel and plastic coated steel pipes. They have reported an increase in wax deposition with increasing flow rates in the laminar region. Rafikov *et.al.* [3] studied paraffin based petroleum waxes. He had concluded that on rapid cooling many centres of crystallisation arise, which leads to the formation of fine crystals and on slow cooling, crystallization process occurs under more uniform conditions. Patten Cased [4] inserted a cold surface into a well stirred wax solution and had reported that the wax deposition increased asymptotically with time. Eaton and Jessen [5] used 8% wax solution in kerosene and passed it over a chilled copper plate in order to study how the temperature difference between a solution's cloud point and confining surface will affect wax deposition.

Most of the workers had used a solution of wax and kerosene oil for the experimental work. Therefore, it was felt to use locally produced crude oil in order to understand the flow characteristics of crude oil and to provide the data to the refinery engineers for better understanding of the real situation.

Experimental

The experimental apparatus was designed and constructed to simulate deposition of paraffin wax in heat exchangers. Basically, the apparatus consisted of two closed circulation loops and is shown in Fig. 1. The waxy oil was passed on the outside of a 10 mm diameter and 350 mm long copper tube, enclosed in a 30 mm diameter glass tube. The

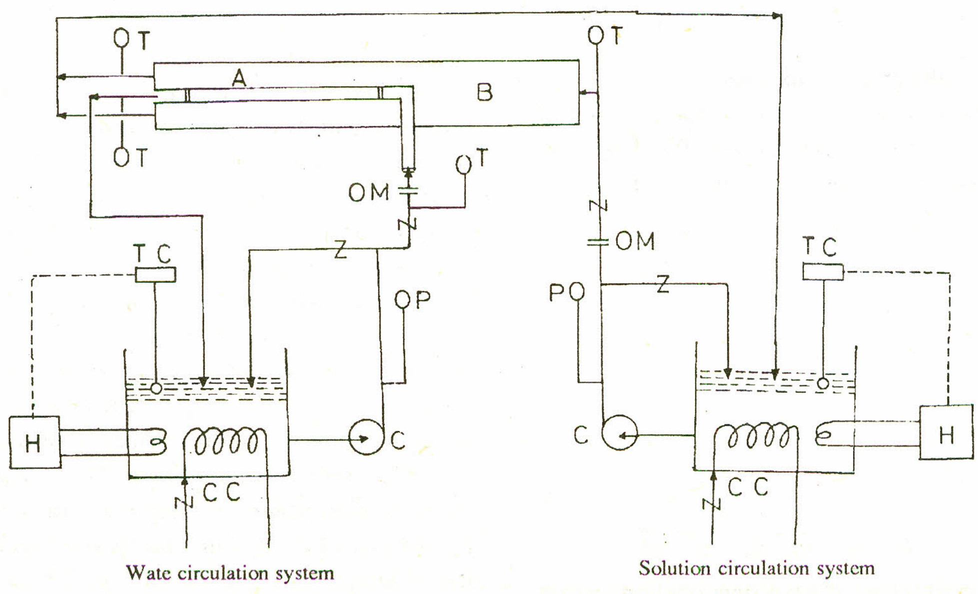

Fig. 1. Experimental apparatus. (A) Experimental copper tube, I.D. 10 mm and length 350 mm; (B) Glass tube I. D. 30 mm and length 750 mm; (C) Centrifugal pumps; (H) Heaters; (TC) Temperature controller; (CC) Cooling coils; (OM) Office meters ;(T) Mercury in glass thermometers; (P) Pressure.

cooled water was passed through the tube and the wax was allowed to deposit on the wall of the copper tube. After the given time, the apparatus was switched off and the copper tube was removed from the assembly and weighed. Net gain in the weight of the copper tube was recorded as paraffin wax deposited. Each run was of 600 sec. duration. The waxy oil and the cooling water were circulated. A long entry section to the glass tube was provided to ensure that the velocity profile in the experimental section had been fully developed before the copper tube was reached.

The temperature of the waxy oil was kept 8° above its cloud point and that of water 8° below the cloud point of the oil. The temperature were maintained constant to 0.5°. The waxy oil flow rates, in all the runs were kept 11.1m^3/secs, such that the Reyonlds numbers were greater than 4000. Thus, the flow conditions were turbulent. The concentration of the paraffin wax investigated was varied upto 13% by weight and the cloud point temperature varied from 19° to 24°.

The characteristics of the waxy oil, supplied by the Attock Oil Refinery and used in the present study are as follows:

1. % of solids in crude oil - traces
2. Salt content kg/1000 barrels - 0.53 kg
3. Wax in crude oil - 5-15%
4. Specific gravity at 15.5° - 0.824
5. API gravity at 15.5° - 40.22
6. Flash point - Flash
7. Kneumatic viscosity at 38.0° - 2.3 C/S
8. Distillation range: IBP = 38°; 10% = 85°; 20%= 123°; 30% = 156°; 40% = 196°; 50% = 248°; 60% = 288°; 70% = 335°; 80% = 393°; FBP = 385°.

Results and Discussions

A plot of paraffin wax deposited per linean meter of copper pipe against time in seconds is shown in Fig. 2. Initially the rate of deposition is high, which gradually tails off and approximately becomes constant as the time increased beyond 24 x 10^2 sec. The drop in paraffin wax deposition rate at higher values of time could be attributed to the thermal insulation by the deposited wax layer and the variation in the amount of paraffin wax particles available for deposition [1,4]. Further the wax deposits were found to cover the deposition tube evenly and the wax layer was firm in nature.

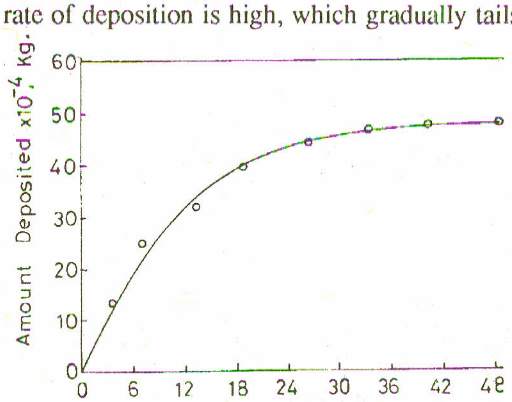

Fig. 2. A typical curve of amount of wax deposited per linear meter of pipe in kg, against time in seconds. Cloud point, 19° and bulk oil temp. = 27°; Wax oil flow rate = 11.1m^3/sec; Cooling water temp. = 11 °.

In Fig. 3 is plotted the paraffin wax deposited per linear meter of pipe against the waxy oil flow rates. It is clear from the results that the wax deposited decreased with increasing flow rates. This can be explained, that as the velocity of the stream increases, the viscous drags exerted by the moving stream tends to remove the accumulation as it exceeds the shear stresses within the deposited wax, thereby, providing the removal mechanism (1). It was also noticed that the paraffin wax deposited at higher flowrates was harder than deposited at lower flow rates.

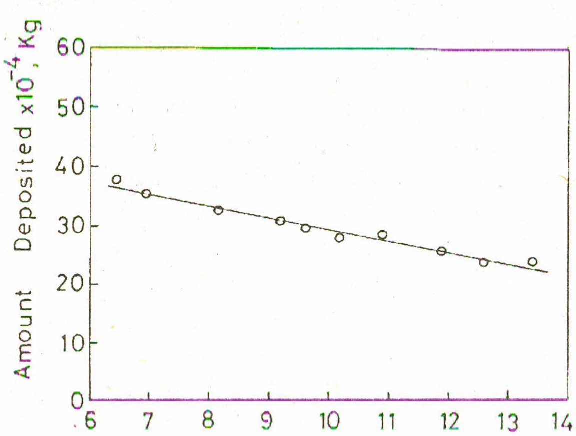

Fig. 3. Amount of wax deposited per linear meter of pipe is ploted against oil flow rates; cloud point 19° and bulk oil temp. 27°; Duration of run = 600 Sec; Cooling water temp. = 11°.

In Fig. 4 paraffin was deposited per linear meter of pipe is plotted against the wax concentration by weight in waxy oil. It is found that the wax deposited increased with increasing concentration. It is thought that as the paraffin wax concentration in the oil solution increases, more wax particles are available for deposition [1]. It was also observed that the degree of firmness of deposition decreased with increasing wax concentration and the wax deposits broke down earlier at higher concentration [5,7]. It is considered that break down would occur when a certain critical thickness is reached, which will give rise to the fluctuating flow conditions [1].

Fig. 5 shows the plot of paraffin wax deposited per linear meter of pipe against various waxy oil temperatures. The temperature of the cooling water was kept constant at 12° and the oil temperature was varied from 27° to 40°. The results show that as the temperature difference between the waxy oil and the water increases, the paraffin wax deposition decreases.

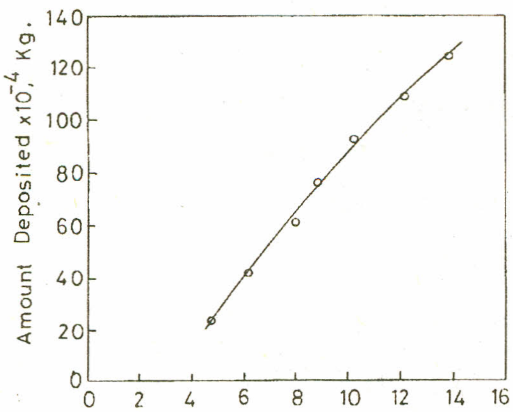

Fig. 4. A typical curve of amount of wax deposited per linear meter of pipe in kg, against different wax concentration by weight percent. Waxy oil flow rate = 11.1 m^3/secs; Duration of run = 600 sec; Conc. of wax (% by wt.) 5, 6, 8, 10, 12, 13.8; Bulk oil temp. °C = 27, 27.7, 29, 30, 31, 32; Cooling water temp. °C = 11, 11.7, 13, 14, 15, 16; Cloud point °C. = 19, 19.7, 21, 22, 23, 24.

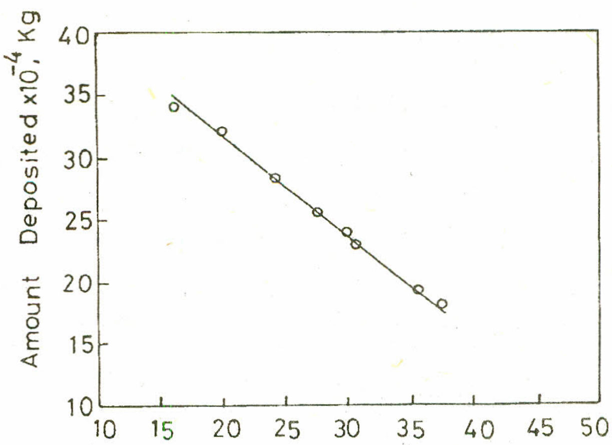

Fig. 5. A plot of amount of wax deposited per linear meter of pipe in kg, against different bulk oil temperatures. Cloud point 19° and cooling water temperature was kept constant at 12°, oil temp. was varied from 27° to 40°; Duration of run = 600 sec.; Waxy oil flow rate = 11.1 m^3/sec.

This drop in wax deposition rate with increasing temperature difference could be attributed to the extra heat added in the waxy oil, which would move the oil away from its cloud point. Hence the process of crystal formation and their deposition on to the surface will be reduced accordingly.

Conclusion

It is concluded from the present study that the wax deposition on to a pipe surface in a flowing system is a function of time, wax concentration and the temperature of the cold surface. The wax deposited increases with the increase of these parameters. The flow rates have adverse effect on the wax deposition.

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