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STUDIES ON THE SOLIDIFICATION OF BUNKER FUEL CONTAINING WAXES

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

This research was undertaken to clarify the solidifying behavior of bunker fuel containing wax, which was obtained from East Indies crude oil. The purpose of the research was also to investigate the dopes for lowering the pour point, and to revise the testing method for pour point determination of bunker fuel.

The pour point of bunker fuel containing waxes differs remarkable depending on the temperature at which the oil was treated before the determination and a maximum pour point is obtained when the oil was preheated to between 40°C to 60°C. The reason of this phenomena was accepted to be the influence of asphalts contained in the fuel which serves to change the crystallizing habits of the waxes.

Aluminum stearate was chosen as the dope for lowering the pour point, and it was found to have a marked effect on bunker fuels having a maximum pour point below about 15°C; in other words, containing less than 3% of waxes in the fuel.

The pour points of bunker fuels were revised so as to express the maximum pour point by determining 5 points according to the temperature to which the oil had previously been heated such as 30°C, 40°C, 50°C, 60°C, and 70°C.

I. INTRODUCTION

In war time the source of bunker fuel was displaced from California to East Indies crude oil, and it was projected to prepare a low freezing bunker fuel by deforming its paraffin wax using a cracking plant, since the capacity of available dewaxing plants was not sufficient to supply the bunker fuel.

The topped residue of an East Indies crude, having a pour point of about 40°C, was cracked to lower its pour point using a Dubbs cracking plant at the 2nd Naval Fuel Depot. From the experiments reported herewith it was defined that the maximum pour point of the cracked residue must be below 15°C and the product, after adding 1% of aluminium stearate, was used as bunker fuel.

II. DETAILED DESCRIPTION

A. Experimental Method

Several typical hydrocarbons such as n-heptane, cyclohexane, benzene, cetane, and deasphalted Tarakan crude oil were used as solvents and paraffin wax having a melting point of 57°C was dissolved in them in varying proportions. For each wax-containing solution, the relation between the pour point of the solution and the temperature at which the wax crystallized out from the solution by cooling was measured. The crystallizing temperature was measured by finding the break in the cooling curve of the solution as it was cooled from outside of the vessel at constant speed. There was good agreement between the pour point and crystallizing temperatures, as shown in Table I(B)13 for the case of n-heptane solution.

It was concluded from these results that the pour point of the solution is not the solidifying temperature of the solution but is that of the wax deposited from the solution, which causes the whole system to solidify.

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In the above experiments there was no influence of temperature history on the pour point determination, but when the oils contained some bituminous matter such as asphalt, the pour point was markedly influenced by the temperature history of the oil.

For example, the pour point of 3% and 5% wax solutions of deasphalted Tarakan crude is 21°C and 25°C, respectively, independent of the temperature to which the oils had been heated before the determination, but in the case of un-deasphalted Tarakan crude oil, the same solutions gave the following pour points according to the temperature preheated.

Preheated Temperature	20°C	30°C	40°C	50°C	60°C	70°C	80°C
3% Wax Solution	6	19	-3	-30	-25	-24	-24
5% Wax Solution	26	16	23	13	11	12	12

On the contrary, the crystallizing temperatures of the same solutions were not influenced by the preheated temperature as shown below:

Preheated Temperature	30°C	40°C	50°C	60°C	70°C	80°C
3% Wax Solution	21	24	22	24	23	22
5% Wax Solution	26	27	26	26	27	26

From the above experiments it was supposed that the paraffin waxes in those oils preheated to higher temperatures would be deposited out in crystallized form and remain in suspension which causes the low pour point. On the contrary, when the oils preheated to comparatively lower temperatures were cooled, the paraffin waxes dissolved in the oil would be deposited out in colloidal form and the whole system will solidify.

This consideration is also justified by microscopic observation of the solidified oils as shown in Fig. 1(B)13.

Figure	Composition	Pour Pt. (°C)	Preheated at (°C)	Photographed at (°C)
A	Tarakan Crude Oil+5% Wax	12	100	15
B	Tarakan Crude Oil+5% Wax	26	30	15
C	Deasphalted Tarakan Crude Oil+5% Wax	25	100	15

These preheating effects which influence the pour point of bunker fuels remain for a fairly long time as shown by the following experiment.

A bunker fuel having a maximum pour point of 8°C was preheated to 100°C for one hour and allowed to stand at room temperature of 25 to 30°C for varying time intervals, and the pour points of the oil were determined as follows:

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Pour Point	Time of Standing
-30°C	immediately after cooling
-25°C	1 day
-16°C	5 days
-18°C	11 days
-6°C	38 days

It was also observed that to eliminate the preheating effect on the oil it must be cooled to solidify and allowed to stand for at least one day at room temperature.

When 0.5% of aluminum stearate was added to some bunker fuels and the effects as a pour point depressant were tested, the following results were obtained at different preheating temperatures:

Example 1, Bunker fuel containing about 5% of wax.

Preheat temp. (°C)	20	30	40	50	60	70	80
Pour pt.	-16	-18	-21	-21	-13	-10	-13
Pour pt. with 0.5% Al-st.	7	7	15	12	-10		

Example 2, Bunker fuel containing about 3% of wax.

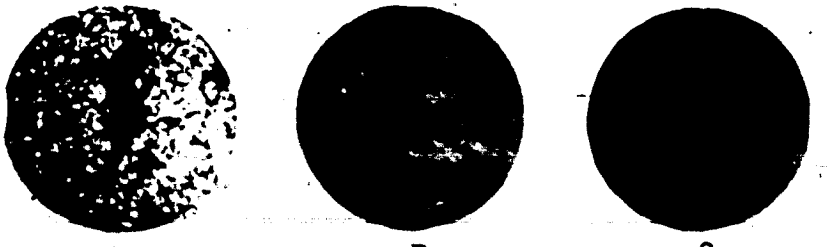
Preheat temp. (°C)	20	30	40	50	60	70
Pour pt. without Al-st.	-4	12	13	8	6	
Pour pt. with 0.5% Al-st.		-20	-19	-14		

Example 3, Deasphalted bunker fuel containing about 3% of wax.

Preheat temp. (°C)	20	30	40	50	60	70
Pour pt. without Al-st.	17	18	19	18	19	17
Pour pt. with 0.5% Al-st.	-7	-5	-4	-5	-5	-6

III. CONCLUSIONS

It was concluded that aluminum stearate has a remarkable effect in lowering the pour points of bunker fuels containing less than about 3% wax, which corresponds to fuels having a maximum pour point below about 15°C.



A x50 B x50 C x50

Figure 1(B)13

MICROSCOPIC OBSERVATIONS OF SOLIDIFIED OIL

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Table I(B)13
POUR POINTS AND CRYSTALLIZING TEMPERATURES OF SOLUTIONS OF WAX IN N-HEPTANE.

		Pour Point (°C)	Crystallizing Temp. (°C)
n-Heptane Only		below -60°	-
Wax Solution %	1	-25	5
	3	5.5	14.2
	5	14.0	17.5
	10	21.0	23.1
	20	28.0	29.1
	30	32.0	34.1
	50	38.5	40.0
	70	45.0	46.5
	90	53.0	54.2
	100	57.0	58.8