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PIPELINE TRANSPORTATION OF VISCOUS HYDROCARBONS

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ABSTRACT OF THE DISCLOSURE

A method for the transportation of low-gravity, viscous hydrocarbons through a pipeline involving the use of an aqueous medium containing an alkaline agent and a solubilizing agent.

FIELD OF THE INVENTION

This invention relates to an improved method for transporting viscous hydrocarbons through a pipeline. More particularly, this invention relates to the introduction into a pipeline, with the hydrocarbon, of small amounts of an alkaline agent and a solubilizing agent in an aqueous medium which have the effects of facilitating the movement of the hydrocarbon in a pipeline.

DESCRIPTION OF THE PRIOR ART

The transportation of heavy crudes by pipeline is difficult because of their low mobility and low viscosity. The usual methods to facilitate the flow of heavy crudes have included cutting them with lighter fractions of hydrocarbons. However, the procedure involves the use of relatively large amounts of expensive hydrocarbon solvents to transport a relatively cheap product. The practice also necessarily requires the availability of the cutting hydrocarbon solvents, which in some instances, is inconvenient.

An alternate method is the installation of heating equipment at frequent intervals along a pipeline, whereby the crude is heated to reduce its viscosity and thereby facilitate its transport. Heaters employed for this purpose can be operated by withdrawing some of the crude being transported for use as fuel. However, this procedure may result in the loss of as much as 15 to 20% of the crude being transported.

Other methods to facilitate transport of heavy crudes have employed thermal viscosity breaking, which, however, produces substantial amounts of gas.

It is known that substantial amounts of water may be introduced into a pipeline containing a stream of viscous crude flowing therethrough to reduce the drag on the stream and thus facilitate the flow through the pipeline. This has been done by the addition of water together with crude into the pipeline such that a water-in-oil emulsion is formed.

Since pipelines are relatively expensive installations, it is an economic necessity to operate them under high throughput conditions, if at all possible to do so. However, it is substantially impossible to employ methods described wherein the water wets the inside wall of the pipe and thus reduces the friction which normally occurs between the pipe wall and the body of viscous liquid passing therethrough. Once the water film is destroyed, the viscosity advantages disappears. It is necessary to maintain the operation of a pipeline system such as this under laminar flow conditions (as opposed to turbulent flow conditions), which seriously limits the throughput rate of crude.

Water containing a surface active agent is known to be capable of preferentially wetting the inside wall of the pipe and is capable of facilitating flow through a short length of pipe. However, such water eventually forms an emulsion with hydrocarbons, which has a greater apparent viscosity than the hydrocarbons and which has so much stability that the water is no longer effective for wetting the inside wall of the pipe. Thus, in a long pipeline, such water is of no benefit and may actually decrease the volume of flow obtainable.

I have found low-gravity, viscous crudes can be recovered by contacting the hydrocarbon bearing sand or tar sands with an aqueous carrier containing an alkaline agent and a solubilizing agent as disclosed in my copending and coassigned application for patent Ser. No. 691,196, filed Dec. 18, 1967, entitled Recovery of Low-Gravity Viscous Hydrocarbons, the disclosure of which is incorporated herein by this reference. Further, as disclosed in this copending application, the combination of an alkaline agent and a solubilizing agent results in a beneficial and synergistic effect in improving the mobility of heavy crudes.

Accordingly, it is an object of the present invention to overcome the difficulties of the prior art by providing a transport method whereby highly viscous hydrocarbons can be more easily transported by pipeline, and so be attractive commercially by utilizing a high throughput rate.

SUMMARY OF THE INVENTION

The invention comprises the introduction into a pipeline transporting viscous hydrocarbons of an aqueous medium containing an alkaline agent and a solubilizing agent.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The beneficiating results of the aqueous medium containing an alkaline agent and the solubilizing agent are believed to derive from the wettability characteristics of the alkaline agent and the solubilizing action of the solubilizing agent. These effects cause emulsification of the hydrocarbon which improves its mobility and thus facilitates its transport by viscosity reduction.

The alkaline agent is selected from the group consisting of alkali metal hydroxides and mixtures thereof, the concentration of the alkaline agent being about 0.001 molar to 0.5 molar to give the required alkaline solution.

A variety of solubilizing agents may be used in the method of the present invention and include pyridine, quinoline, closely related derivatives of these, and are understood to include coal tar fractions containing at least one member of the group consisting of pyridine and quinoline, and mixtures thereof.

The solubilizing agent should be present in the treating liquid in sufficient concentration to effect the emulsification of the hydrocarbon materials and maintain them in this state during the passage through the pipeline. Concentrations of from about 0.1% to about 10.0% by volume are usually sufficient, although other amounts may be required in some cases.

An improved method for transporting viscous hydrocarbons is thus realized wherein a limiting amount of an alkaline water solution containing small amounts of a solubilizing agent is incorporated and transported through a pipeline. It is highly desirable to maintain an oil-in-water type emulsion, but at the same time adjust the constituents of the emulsion such that the oil and water phases separate rapidly at the terminal of the pipeline.

An aqueous medium containing the alkaline agent and a solubilizing agent is introduced into the pipeline with the viscous hydrocarbons, in the range of from about 5.0% to 30.0% by volume. The medium is dispersed through the hydrocarbons and functions to reduce the internal surface tension of the flowing heterogenous fluids and thus effects a reduction in the viscosity of the hydro-

carbons, thereby improving the mobility of the fluids and facilitating the flow thereof.

Emulsions are mechanical mixtures of two immiscible liquids, one of them being dispersed in the other in the form of droplets. Their apparent viscosities are functions of the continuous phase and the interaction of the dispersed droplets. Generally, the viscosity of the emulsion is greater than that of its continuous phase. In the case of a water-in-oil emulsion, the viscosity of the emulsion increases as the volume fraction of the water is increased to about 60–75%. Further increase in water contents results in sharp drop in viscosity to a value comparable with water. This reduction is related to the inversion of the emulsion from a water-in-oil type to an oil-in-water type.

The addition of quinoline to the water and the adjustment of the alkalinity inhibit the formation of water-in-oil emulsions, but do form oil-in-water emulsions which characteristically have lower viscosities than the hydrocarbons.

The following described experiments demonstrated that substantial viscosity decreases were obtained for emulsions of a crude containing varying concentrations of the aqueous medium containing 0.02 molar sodium hydroxide and approximately 0.5% by volume of quinoline. The viscosities, reported in Table I, were measured on a Saybolt viscometer. Measurements using other viscometers, as the Fann V-C viscometer or a Brookfield viscometer, substantiated these results.

TABLE I

Volume percent of Crude	Volume percent of Aqueous Medium	Temp., ° F. (Approx.)	Viscosity, centistokes
100	0	72	----------
90	10	75	~400–500
80	20	74	~275
70	30	76	~55
60	40	77	~17
51.3	48.7	71	~10
41.3	58.7	71	~6
30.6	69.4	71	~4
25.5	74.5	72	~3
20.4	79.6	71	~2
15.4	84.5	72	~1–2
0	100	72	<1

In accordance with this invention, it has been found that emulsions having minimum viscosity, capable of breaking rapidly upon standing, and requiring a minimum of power to transport them are produced by maintaining a proportion of water of between about 5.0 and 30.0% by volume of the mixture of oil and water, and incorporating therein about 0.1 and 10.0% of a solubilizing agent in the aqueous medium. Since the viscosity is a straight line on the viscosity Fisher/Tag blending chart, any addition of the aqueous medium above the inversion point will lower the viscosity, but because the viscosity is a log

log function, the greatest reduction occurs at the lower concentrations of the aqueous medium. The inversion of the emulsion to undesired water-in-oil types does not occur under operating conditions to any appreciable extent. Hydrocarbons transportation by this process is facilitated through the effects of the drastic viscosity reduction which accompanies the formation of an oil-in-water emulsion.

This process could be combined also with the heating of the pipeline to take advantage of the viscosity reduction that accompanies an increase in temperature, whereby the ability to flow is improved as a result of the mobility improvement.

The usefulness of a particular aqueous medium with a paticular hydrocarbon can be determined in the laboratory by the use of low-speed stirring apparatus, by observing the emulsification and thence measuring the viscosity reduction.

Failure of the water to markedly reduce the viscosity indicates that more of the alkaline water solution is required.

Although the entire range of useful proportions cannot be described numerically, it can be said that any of the agents described which is effective to reduce viscosity can be employed in proportion of 0.1% to 10.0% by volume with respect to water.

The above described method is not to be limited to petroleum-derived hydrocarbons but may be applicable to other materials which are subject to emulsification.

I claim:

1. In the transportation of viscous hydrocarbons by pipeline, the improvement comprising forming of an oil-in-water emulsion in said pipeline to enhance the mobility of said hydrocarbons and so facilitate transportation thereof by introducing into said pipeline with said hydrocarbons an aqueous medium comprising an alkali metal hydroxide and from about 0.1% to about 10.0% by volume of a solubilizing agent selected from the group consisting of pyridine, quinoline, and mixtures thereof, said aqueous medium being added in an amount in the range of 5.0 to 30.0% by volume with reference to the total volume of said hydrocarbons and added aqueous medium.

2. The process of claim **1** wherein said alkali metal hydroxide is contained in the aqueous medium in amounts in the range of from about 0.001 molar to about 0.5 molar.

3. The process according to claim **2** wherein said alkali metal hydroxide is sodium hydroxide.

4. The process according to claim **1** in which said solubilizing agent is pyridine.

5. The process according to claim **1** in which said solubilizing agent is quinoline.

References Cited

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