United States Patent Office

2,927,078

Patented Mar. 1, 1960

2,927,078

PREVENTION OF PARAFFIN DEPOSITION

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No Drawing. Application January 29, 1957
Serial No. 636,853

8 Claims. (Cl. 252—8.3)

This invention relates to the transportation of waxy fluids through conduits. More particularly, this invention relates to the transportation of waxy crudes or waxy petroleum products and the like or other liquids which tend to deposit waxy materials on the interior surfaces of conduits transporting the same, such as crude pipe lines, well flow lines, petroleum product pipe lines and conduits and the like.

Various methods have been proposed for eliminating waxy deposits within the interior of pipe lines and the like. One of these methods includes introducing rock salt or similar water-soluble solid abrasive material into the pipe line during the transportation of waxy liquds therethrough to abrade or wear away the waxy deposits from the walls thereof. This method, however, is objectionable for a number of reasons, one of which is that the solid particulate material introduced thereinto might cause malfunctioning of the valves and other apparatus associated with the pipe line.

Another objection to the methods proposed heretofore is that these methods only are directed to the elimination of the symptoms of the trouble (removal of wax deposits) and do not eliminate or directly attack the basic cause (build-up of wax deposits).

Accordingly, it is an object of this invention to provide a method for inhibiting the laying down and/or buildup of waxy deposits within transportation lines or conduits employed in the transportation of fluids, such as waxy crudes and waxy petroleum products, which tend to deposit and/or build up layers of waxy materials on the surfaces of the conduits in contact with said fluids.

Another object of this invention is to provide an improved and relatively simple method for inhibiting the deposition and/or build-up of waxy deposits within pipe lines and the like employed in the transportation of waxy crudes and waxy petroleum products.

Another object of this invention is to provide a method for treating transportation conduits and pipe lines in such a manner so as to inhibit the deposition of waxy materials thereon when the thus-treated conduits or pipe lines are employed in the transportation of waxy crudes and the like.

Still another object of this invention is to provide a conduit specifically treated so that wax deposition thereon is inhibited.

How these and other objects of this invention are achieved will become apparent with reference to the accompanying disclosure. In at least one embodiment of the practice of this invention at least one of the foregoing objects will be achieved.

In accordance with the present invention wax separation or wax precipitation from waxy liquids, such as waxy crudes and waxy petroleum products stored and/or transported within a conduit or pipe line and the like, is not prevented but rather wax deposition upon the surface of the conduit or pipe line in contact with these waxy liquids is inhibited, thereby tending to avoid the build-up of a waxy layer within said conduits. In the practice of this invention those waxy materials which otherwise would

build-up deposits within a conduit or pipe line carrying the same, tend to be continuously moved along or transported with the waxy liquids within the conduit. The foregoing is accomplished in the practice of this invention by introducing into the pipe line or conduit employed for the transportation and/or movement of waxy liquids an effective amount of a non-ionic alkyl aryl polyether alcohol. Benefits of the practice of this invention are also obtainable by pre-treating a conduit, pipe line, well flow or crude gathering line with a surface active, non-ionic alkyl aryl polyether alcohol prior to employing the thus-pretreated conduit for the transportation of waxy liquids.

An alkyl aryl polyether alcohol particularly suitable in the practice of this invention is a nonyl phenol-ethylene oxide adduct sold under the trade name Triton X–100 by Rohm & Haas Company. Triton X–100 is a non-ionic, liquid nonyl phenol-ethylene oxide adduct containing approximately 10 mols of ethylene oxide per mol of nonyl phenol. This material is a transparent, pale, amber, viscous liquid, slightly hydroscopic and water-soluble. Another suitable alkyl aryl polyether alcohol is manufactured and sold by the Jefferson Chemical Company under the trade name Jefferson Surfonic N–95. This material, like Triton X–100, is also an alkyl aryl polyether alcohol, namely, a nonyl phenol-ethylene oxide adduct. Other non-ionic water-soluble alkyl aryl polyether alcohols are also suitable in the practice of this invention. These other materials, like Triton X–100 and Jefferson Surfonic N–95, might be made from an alkyl phenol wherein the alkyl group contains from 5–12 carbon atoms and an alkylene oxide wherein the alkylene proportion thereof contains from 2–5 carbon atoms.

The amount of alkyl aryl polyether alcohol employed in the practice of this invention should be effective to inhibit wax deposition. A suitable effective amount is in the range 0.00050% to 0.05000% by volume of the resulting admixture, preferably in the range 0.00100%–0.01000% by volume, more or less.

The following experiments are indicative of the practice of this invention. A Texas crude was weathered to remove the more volatile hydrocarbon constituents therefrom. Paraffin wax was then dissolved in the weathered crude in an amount to yield a hydrocarbon fluid containing 3% by weight paraffin. The paraffin containing crude was then pumped through chilled pipes. In one series of tests, a so-called "continuous method," a constant pressure was maintained on the test system. In another series of tests, a so-called "slug flow method," the same constant pressure was maintained throughout the test save that every half hour the test pressure was doubled for about one minute. Tests were made both in the presence and in the absence of the wax deposition inhibiting surfactant agent, namely, the alkyl aryl polyether alcohol (Triton X–10). Set forth in accompanying Table I are the times required for the flow through the test apparatus to cease due to the plugging of the test flow path within the test apparatus caused by wax deposition. The initial flow rate through the test apparatus was 900 ccs. per minute.

Table I

Test	Hours Flow	Percent Improvement
Paraffin containing weathered crude, Continuous Flow Method	3.5	
Paraffin containing weathered crude, Slug Flow Method	5.0	40
Paraffin containing weathered crude+Triton X–100, Continuous Flow Method	10.0	185
Paraffin containing weathered crude+Triton X–100, Slug Flow Method	11.5	230

As the test data in Table I indicates, wax deposition or build-up of waxy layers within the test conduits was greatly inhibited by introducing into the waxy test fluid an alkyl aryl polyether alcohol, such as Triton X–100.

Further, in order to definitely prove the advantages of the practice of this invention actual field trials were carried out. The field trials were concerned with the flow lines of a producing well. The test well chosen was a well which had previously required paraffin cutting every two days. Previous to the test the well produced substantially none or only a negligible amount of water. Prior to the test the well flow line was steam cleaned, washed with a caustic (NaOH) solution and then opened at each end and found to be free of paraffin. Following these preparations 5 gallons of Triton X–100 were mixed with 20 barrels of water to yield an aqueous solution containing an alkyl aryl polyether alcohol in an amount in the range 0.1–1% by volume, actually 0.6% by volume. This solution was pumped through the flow line to treat the flow line, actually a steel pipe. The well was then put back on production and treated with a pint of Triton X–100 through a lubricator each day for at least 90 days. During this treatment no other means of paraffin control was used on the well.

After three months the flow line was broken open in several places and upon inspection was found to be clean and free of any paraffin deposits.

Other field experiments with actual producing wells were then carried out in view of the marked success of this first field experiment. These additional experiments were carried out on two other wells. One of these wells produced only a slight amount of water, 0.01–5.0% vol., whereas the other well produced a substantial amount of water, 5.0–40.0% vol. or more. The flow lines from these wells were similarly treated as set forth hereinabove. Again, after three months the flow lines from these other two wells were broken open and found to be substantially clean and free of paraffin deposits.

Still another well was treated in substantially the same manner as set forth hereinabove. This well had a history of producing relatively large amounts of paraffin or wax in the crude. After a period of at least six months the flow line of this last well was broken open and also found to be substantially free and clean of paraffin.

As indicated hereinabove, in the practice of this invention the non-ionic surfactant material alkyl aryl polyether alcohol can be added to the waxy fluids undergoing treatment in a substantially continuous or intermittent manner.

Further, as indicated hereinabove, there has also been provided by the practice of this invention a conduit which is particularly useful for the transportation of waxy crudes. A conduit prepared or treated in accordance with this invention exhibits a property of inhibiting the build-up of waxy deposits thereon. This conduit is prepared in accordance with the teaching of this invention by pretreating the conduit, such as a ferruginous pipe or steel pipe, after cleaning to remove waxy deposits therefrom by caustic or other suitable means, with a relatively concentrated solution of a non-ionic alkyl aryl polyether alcohol, such as an aqueous solution containing the desired alkyl aryl polyether alcohol in an amount in the range 0.05%–10.0% by volume, usually in the range 0.1–1.0% by volume. The thus-treated conduit can then be employed for the transportation of waxy crudes and the like, the treatment serving to inhibit the deposition of wax thereon when employed in the transportation of waxy petroleum liquids and the like.

In the practice of this invention free water should be present within the conduit or pipe line being treated to inhibit wax deposition. The water may be present or introduced within the conduit or pipe line as an aqueous film wetting the surfaces thereof, or as free water extraneously added, if necessary, to the crude oil or petroleum product being transported. The water may be introduced into the conduit in the form of an aqueous solution of the alkyl aryl polyether alcohol. The amount of water present need only be sufficient to yield free, undissolved water or an aqueous solution of the alkyl aryl polyether alcohol within the conduit being treated, at least in an amount greater than that sufficient to saturate the crude oil or petroleum product being transported within the conduit.

As will be apparent to those skilled in the art many modifications, substitutions and alterations are possible in the practice of this invention without departing from the spirit or scope thereof.

I claim:

1. In the transportation of petroleum through a conduit wherein the petroleum contains waxy materials which tend to build up objectionable deposits of said waxy materials upon the surface of said conduit in contact with said petroleum, a method of inhibiting the build up of said deposits on the surface of said conduit by introducing into said conduit into admixture with said petroleum a minor amount of a nonyl phenol-ethylene oxide adduct in the presence of free water, said amount of said adduct being in the range 0.00050%–0.05000% by vol. based on said admixture.

2. A method in accordance with claim 1 wherein said petroleum is crude oil.

3. A method in accordance with claim 1 wherein said adduct is added in an amount to comprise 0.00100%–0.01000% by volume of said admixture.

4. A method of inhibiting the deposition of waxy materials upon a surface in contact with a petroleum fluid which tends to deposit said waxy materials on said surface which comprises initially wetting said surface with an aqueous solution of a nonyl phenol-ethylene oxide adduct prior to contacting said surface with said petroleum fluid, said solution containing said adduct in an amount in the range 0.05%–10.0% by vol.

5. A method in accordance with claim 4 wherein said nonyl phenol-ethylene oxide adduct has an ethylene oxide to nonyl phenol mol ratio of about 10:1.

6. A method of inhibiting the deposition of waxy materials on the interior surface of a conduit carrying a waxy, water-containing crude oil which tends to deposit a layer of waxy materials on the interior of said surface which comprises during the flow of said crude oil through said conduit introducing into said conduit an amount of a nonyl phenol-ethylene oxide adduct sufficient to inhibit the deposition of said waxy materials on the interior surface of said conduit, said amount of said adduct being in the range 0.00050%–0.05000% by vol. based on the resulting admixture.

7. A method in accordance with claim 6 wherein said adduct is continuously introduced into said conduit into admixture with said crude oil therein.

8. A method in accordance with claim 6 wherein said adduct is intermittently introduced into said conduit into admixture with said crude oil therein.

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