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PREVENTION OF PARAFFIN DEPOSITION AND PLUGGING

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This invention relates to the transportation of fluids containing waxy materials which tend to deposit therefrom and form a coating on the surfaces in contact with these fluids and waxy materials. More particularly, this invention relates to the transportation of wax-containing fluids such as petroleum or crude oil through production conduits, gathering and collecting lines, and the like. Still more specifically, this invention relates to compositions and a method for the prevention of wax plugging or clogging in production or transportation conduits.

In one of its embodiments this invention is concerned with those oil wells which tend to lay down or deposit objectionable paraffinic deposits upon the interior surfaces of the production and/or gathering pipe system. Often in the production of waxy crudes the composition of the produced waxy crude is such that the decrease in temperature and/or pressure which the produced waxy crude oil usually undergoes during production, i. e., upon being elevated through the production tubing or being transported within the gathering system, results in the separation of adherent waxy solids from the produced liquid oil. Frequently in such production and gathering systems cooling occurs through the conduit walls with the result that the separated or precipitated wax tends to stick or deposit upon the inside walls of the conduits handling the produced oil. It has been noted that the wax which separates has a tendency to stick to metal surfaces in contact with the same, particularly ferruginous surfaces such as those of iron or steel pipes, with the result that a layer of waxy materials is deposited thereon. Uusually this waxy deposit layer builds up, progressively increasing in thickness, and in the case of conduits this deposited waxy layer increasingly constricts the flow passage with the result that the flow of fluid therethrough is severely restricted and in some instances eventually completely shut off. Removal of such waxy deposits is difficult and costly.

It is an obpect of this invention to provide a composition and method for inhibiting the tendency of waxy materials to deposit and to stick upon surfaces in contact with the same.

It is another object of this invention to provide a composition and method useful for preventing the formation of wax plugs in production conduits or systems handling a waxy crude oil.

It is another object of this invention to provide an improved method for the prevention of wax deposition and plugging within ferruginous pipes handling a waxy crude.

These and other objects of this invention and how they are accomplished will become more apparent in the light of the accompanying disclosure.

In accordance with this invention wax deposition upon surfaces in contact with waxy materials which exhibit a tendency to stick thereto and to deposit thereon a layer of waxy material is inhibited and/or substantially prevented by the presence of an alkali metal silicate and an organic non-ionic, surface-active agent. Suitable alkali metal silicates include sodium silicate, potassium silicate,

or mixtures thereof, particularly aqueous solutions thereof. Suitable organic non-ionic, surface-active agents include those solid or liquid polyoxyalkylene derivatives of hexitol anhydride partial long chain fatty acid esters. These particular materials are represented by the polyoxyethylene derivatives of sorbitan monolaurate, sorbitan monopalmitate, sorbitan monostearate, sorbitan tristearate and sorbitan oleate. A particularly effective non-ionic, surface-active agent in combination with aqueous sodium silicate is a polyoxyethylene derivative of sorbitan trioleate. In general, the above-identified non-ionic surface-active agents are oily liquids, in some instances waxy solids, and exhibit a specific gravity in the range 1.00–1.3. These above-identified surface-active agents are manufactured by The Atlas Powder Company and are sold under the trade name Tween, e. g. Tween No. 20, 21, 40, 60, 61, 65, 80, 81 and 85. For example, Tween 85 identifies a polyoxyethylene derivative of sorbitan trioleate and Tween 81 identifies a polyoxyethylene derivative of sorbitan monooleate. For the most part these materials are soluble in a hydrocarbon fluid such as toluene and in a polar organic solvents such as ethyl alcohol.

In the practice of this invention there is injected into a conduit containing a fluid, such as a crude oil, from which waxy materials tend to separate with the resultant formation of a waxy layer or deposit upon the surfaces of the conduit in contact therewith, amounts of an alkali metal silicate and an organic non-ionic surface-active agent such as a polyoxyethylene derivative of a hexitol anhydride partial long chain fatty acid ester sufficient to inhibit wax deposition. In a particular application of this invention for the prevention or inhibition of wax deposition on the surfaces of a production string in an oil well producing a waxy crude, there is injected into the well casing the materials in accordance with this invention. Eventually from the casing the particular combination of materials of this invention will flow with the produced waxy crude into the production string so as to intermingle and be produced with the waxy crude thereby preventing wax deposition within the production tubing.

In the practice of this invention it is preferred to continuously add the alkali metal silicate and the organic non-ionic surface-active agent to the waxy fluids from which wax deposition occurs. The particular combination of materials of this invention may be added separately or in admixture. Usually an amount of each of the added materials in the range 0.001–1 percent by weight, preferably in the range 0.01–0.5 percent based on the fluid from which wax deposition occurs, is satisfactory. More or less of each of the above components may be added if desired. It is preferred however in the practice of this invention to employ substantially equal amounts by weight of the alkali metal silicate and the organic non-ionic surface-active agent.

The following is explanatory of the practice of this invention and the advantages to be derived therefrom. One percent by weight of a high melting point paraffin wax derived from Dayton Crude, which wax was found to separate from the Dayton Crude in the field and cause severe line plugging, was added to Dayton Crude. It had been found in actual tests that the addition of 1 percent of this high melting point paraffin wax to the Dayton Crude produced a waxy fluid which would deposit paraffin therefrom and yield reproducible results.

The resulting waxy fluid containing the 1 percent high melting point paraffin wax was heated to 45° C. and pumped at a rate of about 1000 cc. per minute through a ¼ inch I. D. steel tubing 9 feet long. A 5-foot section of this tubing was immersed in a water bath maintained at a temperature in the range 30–32° C. That section of the tubing immersed in the water was in the form of

an elongated coil, the turns in the coil being made by 90-degree elbows. The pressure on the pump circulating the waxy fluid through the tubing was measured by means of a mercury manometer having a maximum capacity of 10.0 cm. of mercury. During the tests the relative effectiveness of the additives tested was determined by measuring the time required for the tubing to plug with deposited wax, plugging being considered complete when the pressure on the pump discharge exceeded the capacity of the manometer. During the tests the alkali metal silicate employed was added as a 2 percent water solution of sodium silicate. The waxy fluids undergoing tests were prepared by adding thereto 500 cc. of 2 percent sodium silicate solution and/or 10 cc. of the particular polyoxyalkylene derivative of a hexitol anhydride partial long chain fatty acid ester being tested. The resulting test fluids were stirred vigorously while being heated to 45° C., stirring being continued throughout the duration of the experiment in order to insure adequate mixing of the silicate solution, the crude oil and the organic non-ionic surface-active agent.

The results of the foregoing described experiments may be summarized as follows:

A. Repeated runs on the Dayton Crude alone plus added high melting point paraffin wax produced plugging in about 3–4 hours.

B. When 500 cc. of water alone were added to the waxy Dayton Crude the time required for plugging was increased to about 5½ hours but the system showed no tendency to purge itself when the pressure began to increase.

C. With 500 cc. of water plus 10 cc. of Tween 85 (a polyoxyethylene derivative of sorbitan trioleate having a specific gravity in the range 1.00–1.05 and exhibiting solubility in toluene and ethyl alcohol), added to the waxy Dayton Crude the plugging time was about the same as mentioned in A, but there was a tendency for the system to purge itself of any deposited paraffin wax as the pressure within the system increased. Accordingly, this combination of water and Tween 85 imparted self-purging properties to the system undergoing tests.

D. The addition of sodium silicate alone (500 cc. of 2 percent aqueous solution) to the waxy Dayton Crude merely increased the time required for plugging but no self-purging action was indicated by the system.

E. The addition of 500 cc. of a 2 percent aqueous sodium silicate solution and 10 cc. of Tween 85 to 7 liters of the waxy Dayton Crude completely eliminated plugging. It was noticed that the nature of the deposited wax was changed from a hard crystalline waxy material, such as was deposited in the tests described in A, to an amorphous waxy material. Each time the pressure in the system increased the deposited waxy materials would slough off the wall of the tubing and be carried out of the system. The above-described test was carried out for more than 21 hours' duration without plugging the system.

In view of the above tests it is apparent that the combination of the materials of this invention not only inhibit wax deposition but also impart to the system in which they are present self-purging or self-cleaning properties such that eventually any deposited waxy materials slough off and are carried along in the fluid stream.

As will be apparent to those skilled in the art in the light of this disclosure, many modifications, alterations and changes are possible without departing from the spirit and scope of this invention.

We claim:

1. In the transportation of a fluid through a conduit, wherein said fluid contains waxy materials which tend to deposit and build up obectionable deposits of said waxy materials on the surface of said conduit in contact with said fluid, the improvement which comprises injecting into said fluid being transported through said conduit substantially equal amounts of an alkali metal silicate and a non-ionic, surface-active polyoxyalkylene derivative of a hexitol anhydride partial long chain fatty acid ester, said amounts being sufficient to prevent a build-up of objectionable deposits of said waxy materials on the surface of said conduit.

2. A method in accordance with claim 1 wherein said alkali metal silicate is sodium silicate.

3. The method in accordance with claim 1 wherein said alkali metal silicate is sodium silicate in the form of an aqueous solution thereof.

4. The method in accordance with claim 1 wherein said non-ionic surface-active derivative is a polyoxyalkylene derivative of sorbitan trioleate.

5. The method in accordance with claim 1 wherein said non-ionic surface-active derivative is a polyoxyethylene derivative of sorbitan trioleate.

6. The method in accordance with claim 1 wherein equal amounts of said alkali metal silicate and said non-ionic surface-active derivative are injected into said fluid.

7. The method in accordance with claim 1 wherein said surface of said conduit is a ferruginous.

8. The method in accordance with claim 1 wherein said fluid is a hydrocarbon fluid such as a waxy crude oil.

9. The method in accordance with claim 1 wherein said alkali metal silicate and said non-ionic surface-active derivative are each injected into said fluid in an amount in the range 0.001–1 percent by weight based on said fluid.

10. The method in accordance with claim 1 wherein said alkali metal silicate is sodium silicate and wherein said non-ionic surface-active derivative is a polyoxyethylene derivative of a hexitol anhydride partial long chain fatty acid ester, said sodium silicate and said polyoxyethylene derivative being injected in equal amounts by weight.

11. The method in accordance with claim 10 wherein each of said amounts of sodium silicate and said polyoxyethylene derivative is in the range 0.001–1 percent by weight based on said fluid.

12. The method in accordance with claim 1 wherein said non-ionic surface-active derivative is a polyoxyalkylene derivative of sorbitan monooleate.

13. The method in accordance with claim 1 wherein said non-ionic surface-active derivative is a polyoxyalkylene derivative of sorbitan monostearate.

14. The method in accordance with claim 1 wherein said non-ionic surface-active derivative is a polyoxyalkylene derivative of sorbitan monopalmitate.

15. A composition of matter suitable for injection into a fluid which contains waxy materials which tend to build up objectionable deposits of said waxy materials upon surfaces in contact therewith whereby the formation of said waxy deposits is inhibited, comprising an alkali metal silicate and a non-ionic surface-active polyoxyalkylene derivative of a hexitol anhydride partial long chain fatty acid ester, the weight ratio of said alkali metal silicate to said polyoxyalkylene derivative being about 1:1.

16. A composition in accordance with claim 15 containing equal amounts by weight of sodium silicate and a non-ionic surface-active polyoxyethylene derivative of a hexitol anhydride partial long chain fatty acid ester.

17. A composition in accordance with claim 16 wherein said derivative is a polyoxyethylene derivative of sorbitan trioleate.

18. A composition of matter suitable for injection into a hydrocarbon fluid which tends to deposit a layer of waxy materials upon ferruginous surface in contact with said fluid whereby the deposition of said waxy materials is inhibited, consisting essentially of substantially equal amounts by weight of a polyoxyethylene derivative of a hexitol anhydride partial long chain fatty acid ester and an alkali metal silicate.

19. A composition in accordance with claim 18 wherein said polyoxyethylene derivative is a polyoxyethylene derivative of sorbitan trioleate and wherein said alkali metal silicate is sodium silicate.

(References on following page)

5

References Cited in the file of this patent

UNITED STATES PATENTS

1,892,205	De Groote	Dec. 27, 1932
2,533,878	Clarke et al.	Dec. 12, 1950
2,753,303	Barker	July 3, 1956

6

OTHER REFERENCES

PQ Silicates of Soda, pamphlet pub. by Philadelphia Quartz Co., page 6.

Atlas Spans and Tweens, pamphlet pub. June 1945, by Atlas Powder Co., of Wilmington, Delaware, page 17.