June 7, 1966

G. A. MOYER

CONDITIONING OF CRUDE OIL CHARGE TO CENTRIFUGE FOR ASPHALT IMPROVEMENT

Filed July 5, 1962

3,255,104

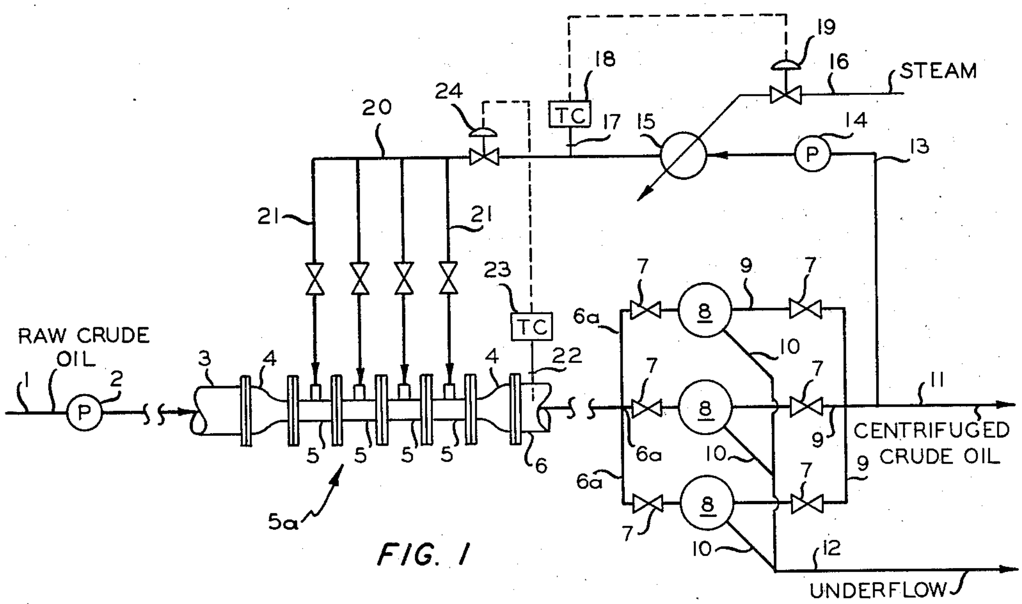

FIG. 1

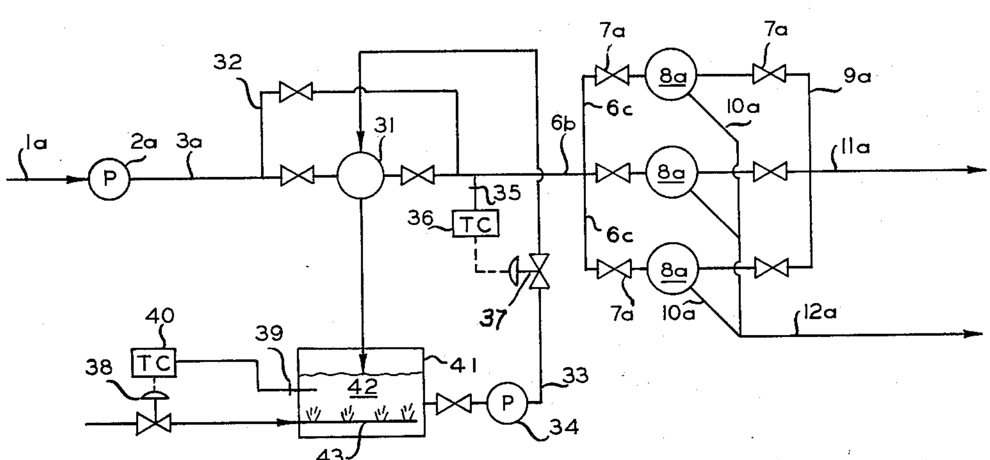

FIG. 2

INVENTOR.
G. A. MOYER
BY Young & Quigg
ATTORNEYS

United States Patent Office

3,255,104

Patented June 7, 1966

3,255,104

CONDITIONING OF CRUDE OIL CHARGE TO CENTRIFUGE FOR ASPHALT IMPROVEMENT

Golden A. Moyer, Bartlesville, Okla., assignor to Phillips Petroleum Company, a corporation of Delaware

Filed July 5, 1962, Ser. No. 207,617
10 Claims. (Cl. 208—177)

This invention relates to treatment of an asphalt-containing crude oil to make the crude oil suitable for production of quality asphalt. In one aspect, it relates to a method and apparatus for treating an asphalt-containing crude oil which normally yields asphaltic products having positive Oliensis spot tests so that the crude oil will yield asphaltic products having negative Oliensis spot tests. In another aspect, it relates to a means and a method for treating by centrifugal separation an asphalt-containing crude oil, which normally yields asphalt products having positive Oliensis spot tests, for production of a crude oil suitable for yielding asphaltic materials having negative Oliensis spot tests. In another aspect, it relates to a centrifuging process for the removal of impurities of crude oil. In yet another aspect, it relates to the separation of solids, semi-solids, and heavy liquid materials, all as impurities from an asphalt-containing crude oil, by centrifugal action, the crude oil normally causing positive Oliensis spot tests in subsequently produced asphaltic products, for the production of asphaltic products having negative Oliensis spot tests.

This invention is also concerned with a method for improving or increasing the amount of crude oil that can be centrifuged per unit of time, the crude oil being a relatively viscous crude oil.

Crude oils which are treated by centrifuging according to this invention are such oils as Rangely, Colorado; Williston Basin, North Dakota; Bowes' Dome, Montana; and Santa Maria, California, crude oils. Crude oils from these areas are merely examples of crude oils suitable for treatment according to this invention.

These crude oils contain one or more of solid, semi-solid, and heavy liquid materials within a range of about 0.5 to about 10 percent on a weight basis. These materials are believed clearly to cause asphaltic products made from crude oils containing them to exhibit positive Oliensis spot tests. These crude oils when centrifuged for the removal of these materials yield asphaltic materials having negative Oliensis spot tests. Because these crude oils are relatively viscous, centrifuging of the oils as received is relatively slow. Thus, to so process such a volume of the crude oil of this type as a refinery charge stock requires a plurality of centrifuges operated in parallel. It is realized that such equipment is relatively expensive not only as items of capital investment but electrical power and steam costs for their operation are also quite high. It has been found by heating the crude oil in a crude oil storage tank in order to make the oil sufficiently fluid for ease of centrifuging that at least a portion of the above-mentioned solid, semi-solid, and heavy liquid materials become dissolved. The dissolving is to such an extent that the asphaltic products produced from the heated oil exhibit positive Oliensis spot tests or in some instances the spot tests are on the borderline between positive and negative. Even this latter type of spot test is unsuitable for specification purposes. It is realized that heating a large volume of oil in a tank results in many instances in overheating of the oil in the immediate vicinity of the heating coil.

An object of this invention is to provide a method and apparatus for removal of solid, semi-solid, and heavy liquid materials contained in many crude oils which materials cause positive Oliensis spot tests on subsequently produced asphaltic products. Another object of this invention is to provide means and method for increasing the rate of centrifuging of such materials from such crude oils. Yet another object of this invention is to provide a relatively simple and inexpensive means and method for increasing the rate of centrifuging of such crude oils for removal of the above-mentioned undesirable impurities. Still other objects and advantages of this invention will be realized upon reading the following description which, taken with the attached drawing, forms a part of this specification.

In the drawing, FIGURE 1 illustrates, in diagrammatic form, an arrangement of apparatus parts for carrying out the method of this invention. FIGURE 2 illustrates alternate means for carrying out the process of this invention.

In one embodiment of this invention, I provide a low MTD (low mean temperature difference) heat exchange for the crude oil between the crude oil storage tank and the centrifuges. In this embodiment, I heat to a relatively low temperature a portion of the processed and impurity-free crude oil and then mix this slightly heated impurity-free crude oil with the original crude oil prior to centrifuging in such a manner as to provide turbulent and thorough mixing of the oil with the heated recycle oil. In this manner, a small volume of recycle oil, free from impurities, is heated and obviously impurities cannot redissolve in this oil because they are not present. Then, upon mixing this slightly heated oil with the original raw crude oil in a turbulent mixing manner, direct heat exchange is rapid and without substantial dissolving of the impurities desired to be separated out by centrifugal action. In another embodiment, this invention involves heat exchanging the entire volume of raw crude oil with water heated to a temperature such as will not dissolve the impurity in the crude oil upon heat exchange therewith.

It has been found that upon heating the crude oil to a temperature of 200° to 300° F. to reduce its viscosity to such an extent that centrifuging is rapid, the impurities desired to be removed from the crude oil dissolve in the crude oil and are not subject to removal in the centrifuge. Upon heating the oil to a relatively high temperature, the purification step by centrifuging is ineffective. This heated oil when cooled by heat exchange precipitates the above-mentioned impurities so slowly that centrifuging is ineffective. Thus, according to this invention, the crude oil is very gently heated, that is, to such a relatively low temperature that the desired impurities are not redissolved and can be removed from the crude oil. Yet the crude oil is heated to a slightly higher degree than its average storage temperature so that centrifuging is considerably more rapid than the oil not so heated.

In FIGURE 1, reference numeral **1** identifies a conduit passing the raw crude oil from a crude oil storage tank, not shown, to a pump **2** which charges the crude oil through a conduit **3**, a reduced diameter mixing conduit **5*a***, and subsequent centrifugal apparatus. Conduit **3** connects the outlet of pump **2** with the large diameter end of a pipe reducer **4**, the small diameter end of which is connected to the first conduit **5**.

The outlet end of mixing conduit **5*a*** is connected with the small diameter end of another reducer **4** which is connected to the large diameter conduit **6** for passage of the material to a plurality of centrifuges **8**. Several branched conduits **6*a*** are provided with valves **7** and are connected to the several centrifuges as shown. Outlet conduits **9** lead processed crude oil from the several centrifuges to an outlet or disposal conduit **11**. The several outlet conduits **9** are also provided with manually operable valves **7** as shown. Conduits **10** lead the underflow, that is the impurities processed from the crude oil, from the several centrifuges and the combined material passes through a conduit **12** for such disposal as desired.

A recycle conduit **13** is connected at one end with the conduit **11** and is provided with a pump **14**, a heat exchanger **15**, a motor valve **24**, and terminates as a manifold conduit **20**. From this manifold conduit **20**, several branched conduits **21** lead to a plurality of pipe T's each connected with a separate section **5** of the mixing conduit *5a*. A thermocouple **17** is inserted into conduit **13** just downstream from heat exchanger **15** as regards direction of flow of oil. A temperature controller **18** regulates the rate of steam flow in conduit **16** by manipulation of motor valve **19**. The motor valve **24** just downstream of thermocouple **17** is manipulated by the temperature controller **23** in response to a temperature as sensed by thermocouple **22** in conduit **6**.

In actual operation, the thermocouple **22** senses the temperature of the mixed and warm oil and manipulates motor valve **24** by way of controller **23** to maintain the crude oil in conduit **6** at a desired predetermined temperature. This temperature obviously is intended to be sufficiently high to promote increased centrifuging in the several centrifuges and yet not so high as to dissolve the impurity in the crude oil. The temperature controller **18** manipulates motor valve **19** to regulate the rate of flow of steam from conduit **16** to heat exchanger **15**, in response to the temperature of a heated recycle oil to provide properly heated oil for passing through manifold **20** and branched conduit **21** to the several mixing T's.

Specific example

In one instance, the temperature of the crude oil flowing through conduit **3** was 40° F. and the volume of oil flowing was approximately 8,770 barrels per day. Conduit **3** was a six-inch diameter pipe. The mixing conduit *5a* comprised a plurality of four pipe T's of 3-inch diameter with 1-inch diameter side inlets. The temperature of the crude oil issuing from the downstream end of the mixing conduit *5a* was 65° F. and its volume was approximately 10,550 barrels per day. This oil was filtered in centrifuges **8** and approximately 1,780 barrels per day were removed from the centrifuged oil and passed through conduit **13** under the influence of pump **14**. The oil rate in conduit **13** was 52 gallons per minute and conduit **13** was a 2-inch pipe. This oil was heated with steam in exchanger **15** to a temperature of about 177° F. Oil heated to this temperature was approximately equally divided in manifold **20** and the respective portions passed at high velocity through one-inch pipe conduit **21** to the one-inch inlets of the several pipe T's **5**. With 8,770 barrels per day of oil flowing through a 3-inch diameter mixing section *5a*, flow therein was very turbulent. This turbulent flow thoroughly and rapidly mixed the 177° F. oil with the 40° F. raw oil. Thus with this rapid mixing with the heated oil of a relatively medium temperature impurities in the raw crude oil were not redissolved.

In the embodiment illustrated in FIGURE 2, conduits *1a*, *3a*, *6b*, *6c*, *9a*, *10a*, *11a*, and *12a* correspond to pipes **1**, **3**, **6**, *6a*, **9**, **10**, **11** and **12**, respectively, of FIGURE 1. Pump *2a* corresponds to the pump **2** of the FIGURE 1. Conduit *3a* discharges the raw crude oil from the storage tank, not shown, to a heat exchanger **31** in which warm water at about 112° F. is circulated. This water indirectly heat exchanges with and warms the crude oil from about 40° F. to about 65° F. with the water outlet temperature being about 92° F. A body of water **42** is provided in tank **41** which is provided with a conduit **43** with openings for distribution of steam for heating the water. Flow of steam in conduit **43** is regulated by a motor valve **38** as manipulated by temperature controller **40** in response to the temperature as sensed by a thermocouple **39**. This heated water is passed through conduit **33** by a pump **34** and the rate of flow is regulated by temperature controller **36** manipulating motor valve **37** in response to temperature as sensed by a temperature sensing device such as a thermocouple **35** in conduit *6b*. A by-pass conduit **32** is connected with conduit *3a* and conduit *6b* around heat exchanger **31** in case it is ever necessary to repair, clean or otherwise maintain the heat exchanger.

In the instant FIGURE 2, for heating 8,770 barrels of crude oil per day from 40° to 65° F., 117 gallons of water per minute at 112° F. are passed through conduit **33** which is a three-inch diameter conduit. Conduits *3a* and *6b* are six-inch conduits. Tank **41** is a 10-barrel tank in which the water is heated to the above-mentioned 112° F. by steam at the rate of 1070 pounds per hour from conduit **43**.

For treating the above-mentioned volumes of raw crude oil as regards heating, heat exchanger **15** and heat exchanger **31** have a duty of 1,170,000 B.t.u.'s per hour. In the embodiment of FIGURE 1, the centrifuge and impurity-free crude oil issues from the centrifuges at a temperature of about 65° F. and the portion of this oil cycled through conduit **13** is heated from 65° F. to about 177° F. in exchanger **15**. The above-mentioned 1,170 barrels per day of processed or centrifuged crude oil pass through conduit **13** for heating purposes represent approximately 20% of the 8,770 barrels per day of raw crude oil filtered in this operation.

The three-inch diameter mixing conduit *5a* in one instance is approximately 30 feet in length with the several mixing T's **5** being separated by small length of 3-inch pipe. The T's **5** can be sections of pipe provided with flanges and 1-inch diameter side inlets.

Other suitable mixing means than that illustrated and described can, if desired, be employed.

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

The process of this invention is equally applicable to filtration of such crude oils by conventional filters as to the centrifugal separation herein described.

I claim:

1. In a process for removing particulate solid to semi-solid material from a relatively cold crude oil containing same wherein a first stream of said crude oil is passed thru a centrifuging zone to separate same into a second stream of oil of substantially lower concentration of said material than said first stream and a third stream of oil of substantially higher concentration of said material than said first stream, the improvement comprises the steps of:

(1) passing a fourth stream of centrifuged crude oil substantially free of solid to semi-solid material and lighter than said first stream into said first stream upstream of the centrifuging zone at a substantially higher temperature than the temperature of said first stream but below a temperature which causes said material to go into solution in the stream resulting from step 2;

(2) rapidly mixing said first and fourth streams to raise the temperature of the oil of said first stream to lower the viscosity thereof without dissolving said particulate material; and

(3) passing the resulting less viscous stream of oil from step 2 thru the centrifuging zone to separate same into said second and third streams.

2. The improvement in claim **1** wherein said fourth stream is obtained by recycling a substantial portion of said second stream thru a heat exchange zone before passing same into said first stream.

3. The improvement of claim **2** wherein the volume and temperature of the fourth stream are controlled so as to heat said first stream to a temperature of at least 40° F. and not substantially above 70° F.

4. The improvement of claim **1** wherein said fourth stream is injected at several spaced points along the line of flow of said first stream.

5. A process for removing particulate solid to semi-solid material from a crude oil containing same, said crude oil being at a temperature of not more than about 40° F., which comprises the steps of:
(1) intimately mixing with said stream of crude oil a second stream of oil at a substantially higher temperature than 40° F., said second stream of oil being a portion of the third stream of step 2 and substantially free of solid to semi-solid material and lighter than said crude oil, to raise the temperature of said stream of crude oil to a selected temperature in the range of 40 to 70° F. and substantially above its original temperature;
(2) passing the resulting heated mixed stream of step 1 thru a centrifuging zone so as to separate said mixed stream into a third stream of lighter oil having a relatively low concentration of said material and a fourth stream of heavier oil having a relatively high concentration of said material; and
(3) recovering said third stream as a product of the process.

6. The process of claim 5 including the step of:
(4) recycling a portion of the third stream of step 2 thru a heater into the stream of crude oil of step 1 as said second stream at several points along the line of flow of said stream of crude oil.

7. Apparatus for removing solid to semi-solid material from crude oil, comprising in combination:
(a) mixing means for mixing separate first and second liquid streams having separate inlets for said streams;
(b) a centrifugal separator downstream of the mixing means of (a) connected by conduit therewith;
(c) an effluent line leading from the separator of (b) for a lighter stream of liquid;
(d) an effluent line leading from the separator of (b) for a heavier stream of liquid;
(e) a recycle line connecting the effluent line of (c) with one of the inlets of the mixing means of (a); and
(f) heating means in said recycle line.

8. The apparatus of claim 7 including:
(g) a motor valve in the recycle line of (e);
(h) temperature sensing and transmitting means sensitive to the temperature in the conduit of (b); and

(i) a temperature controller responsive to the temperature transmitting means of (h) in actuating control of the motor valve of (g).

9. The apparatus of claim 8 wherein the heating means of (f) is an indirect heat exchanger having a hot fluid line leading thereinto and including:
(j) a motor valve in said hot fluid line;
(k) temperature sensing and transmitting means responsive to temperature in the recycle line of (e) downstream of said heat exchanger; and
(l) a temperature controller responsive to the temperature transmitting means of (k) in actuating control of the motor valve of (j).

10. Apparatus for removing solid to semi-solid material from crude oil comprising in combination:
(a) a centrifugal separator having a feed inlet line and a pair of effluent lines for a heavier and lighter stream;
(b) means in the feed inlet line of (a) for mixing a heating fluid with the feed therein;
(c) a line connected with the effluent line for lighter fluid of (a) and with the means of (b) for supplying heating fluid thereto;
(d) means in the line of (c) for controlling the temperature of the fluid therein; and
(e) means in the line of (c) for controlling the flow rate of fluid therethru in response to the temperature of the effluent liquid in the feed inlet line of (a) intermediate the heating means of (b) and the separator of (a).

References Cited by the Examiner

UNITED STATES PATENTS

1,515,742	11/1924	Manville	165—36
2,524,859	10/1950	Van Dongen	208—39
2,899,373	8/1959	Steeves	208—39
2,915,298	12/1959	Hamlin et al.	165—36
3,013,961	12/1961	Hemfort et al.	208—39

DELBERT E. GANTZ, *Primary Examiner.*

DANIEL E. WYMAN, *Examiner.*

H. LEVINE, *Assistant Examiner.*