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CONTROL OF SOLVENT EXTRACTION

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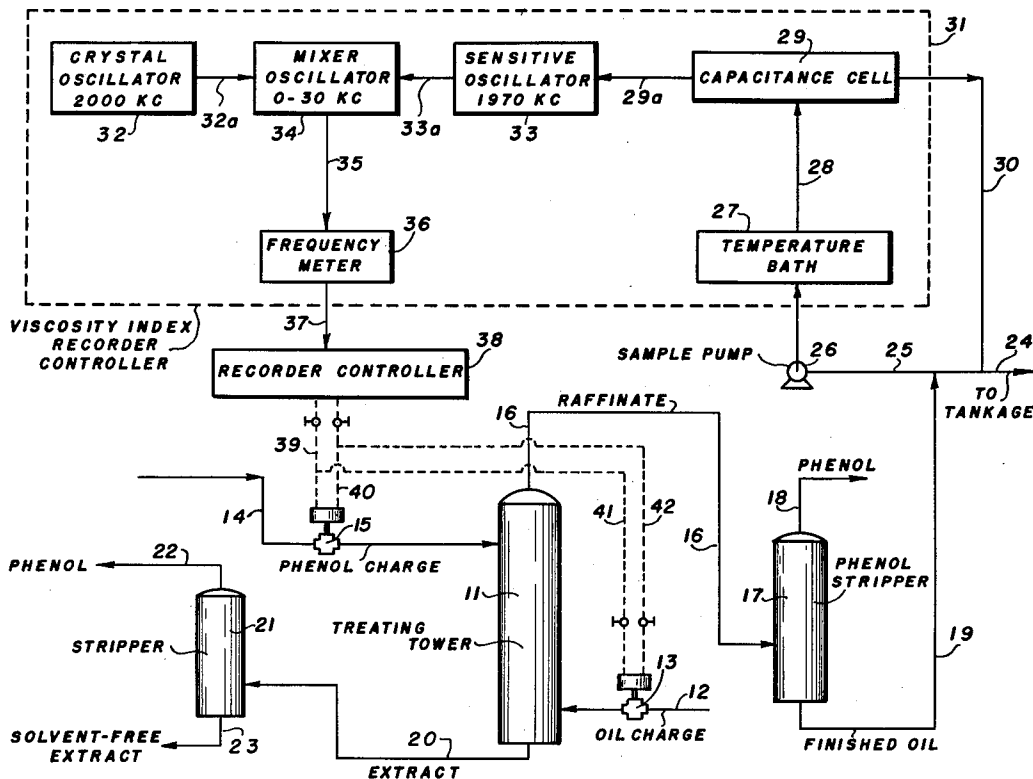


FIG. 1.

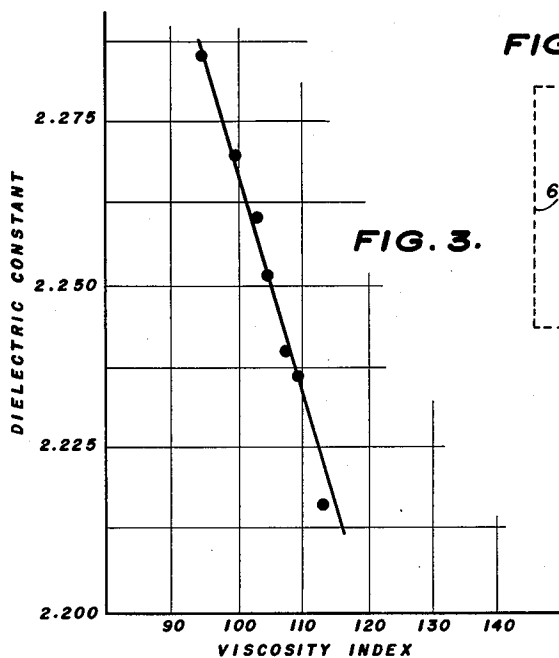


FIG. 3.

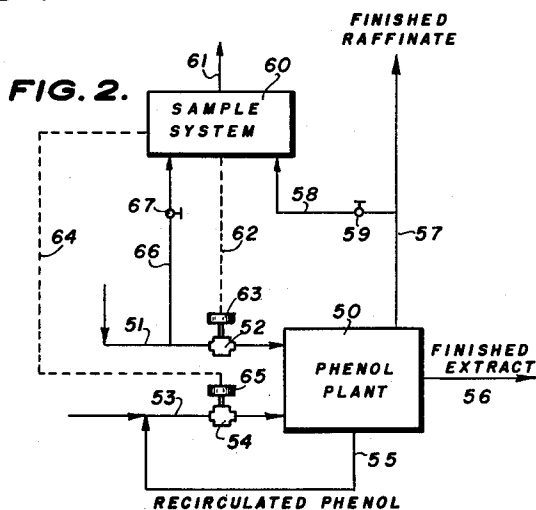


FIG. 2.

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1

2,737,469

CONTROL OF SOLVENT EXTRACTION

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7 Claims. (Cl. 196—14.42)

The present invention is directed to a method for controlling a lubricating oil extraction system. More particularly, the invention is directed to the control of an operating variable in the solvent extraction of lubricating oil. In its more specific aspects, the invention is concerned with the precise operation of a solvent extraction process in response to variations in viscosity index of the solvent-free raffinate.

The present invention may be briefly described as a method for controlling solvent extraction of a lubricating oil fraction in which a selected amount of the lubricating oil fraction is charged into a solvent extraction system and contacted under extraction conditions with a sufficient amount of a selective solvent. Under the extraction conditions, raffinate phases and extract phases are formed from which solvent is removed. At least a portion of the raffinate phase is then flowed at a substantially constant temperature through a capacitance cell of a dielectric constant meter. There is obtained from the cell a signal which is a measure of the viscosity index of the solvent-free raffinate. This signal is then employed to change a process variable, such as the amount of the said lubricating oil fraction or the amount of the solvent employed. Thus when the viscosity index of the raffinate varies, it is possible to control the operation of the desired viscosity index of the raffinate.

It is contemplated in the practice of the present invention that the lubricating oil fraction charged to the system and the solvent-free raffinate will be passed alternately through the capacitance cell to obtain signals from said cell which will be employed to control an operating variable. By alternately obtaining signals which are measures of the viscosity indexes of the feed and the solvent-free raffinate, it is possible to obtain precise operations and to determine the efficiency of the operation.

The feed stock to the process of the present invention may be a lubricating oil fraction from a crude petroleum, such as crude petroleum from the Mid-Continent fields, the Panhandle field of Texas, or the Coastal lubricating oil fractions. The California type crude oils and those from the Pennsylvania oil fields also contain lubricating oil fractions which may be charged to our process.

The dielectric constant meter employed in the practice of the present invention has been well described in the literature and further detailed description does not appear necessary. For example, in *Analytical Chemistry*, vol. 23, page 1750, December 1951, Thomas, Faegin and Wilson have described a dielectric constant meter for continuous determination of toluene which is readily adaptable to the practice of our invention. Similar apparatus will be found in the literature which is reviewed by Thomas et al. supra.

The solvent employed in our invention may be any selective solvent which will separate predominantly paraffinic and naphthenic constituents from predominantly aromatic constituents, such as found in lubricating oil fractions. Solvents, such as phenol, furfural, nitrobenzene, methyl ethyl ketone and the like, may suitably be

2

used. We prefer, however, to use phenol which gives entirely satisfactory results.

The apparatus employed in our operations includes a suitable recorder-controller of which many are available on the market. For example, the Brown Instrument Company recorder-controller may be employed or the so-called Foxboro Dynalog Recorder may be used, such as manufactured by the Foxboro Company, Foxboro, Massachusetts.

The invention will be further illustrated by reference to the drawing in which:

Fig. 1 is a flow diagram showing the adaptation of apparatus for controlling the phenol extraction of lubricating oil;

Fig. 2 shows a flow diagram of a simplified sample system embodying our invention; and

Fig. 3 shows a correlation between the viscosity index and the dielectric constant value.

Referring now to the drawing, numeral 11 designates a treating tower of a solvent extraction system, such as one employing phenol as a selective solvent. There is charged into the system by line 12 a lubricating oil fraction, such as a Coastal lubricating oil fraction, obtained from a source not shown. Arranged in line 12 is a control valve 13 which controls the flow of oil charged through line 11. There is introduced into the top of treating tower 11 by way of line 14 a sufficient amount of phenol which is introduced through a control valve 15 arranged in line 14. Conditions are adjusted in treating tower 11 to obtain by way of line 16 a solvent raffinate which is introduced thereby into a solvent stripper 17 which is provided with means to adjust the temperature to allow the removing, by way of line 18, of the phenol contained in the raffinate. The raffinate free of phenol is withdrawn by line 19 to be further handled as will be described. The solvent extract is withdrawn from tower 11 by way of line 20 and introduced into a solvent stripper 21 which is similar to solvent stripper 17. The conditions are adjusted in stripper 21 to remove by line 22 the phenol contained in the extract and to recover by line 23 the solvent-free extract.

The finished oil, that is the solvent-free raffinate in line 19, is divided into two portions, one portion of which flows through line 24 to tankage, not shown, while the other portion passes by way of line 25 through the pump 26 and then into a constant temperature bath 27 which is suitably held at a temperature of 120° F. The exact temperature for the bath 27 is unimportant so long as it is higher than the temperature of the stream in line 25 or atmospheric temperature. For our operation the temperature may range from 100° to 150° F. Thereafter the oil flows from the bath 27 by way of line 28 into a capacitance cell 29 of a dielectric constant meter 31 of the type referred to before. The oil leaving the capacitance cell 29 then flows by way of line 30 back into line 24 for routing to tankage.

The dielectric constant meter generally indicated as 31, within the confines of the dotted line, is provided with a crystal oscillator 32 operating at 2000 kc. and which may be termed as a first oscillator. The output from the capacitance cell 29 passes through a sensitive oscillator 33 which is operated at 1970 kc. The output from oscillators 32 and 33 are fed into a mixer oscillator 34 which operates from 0 to 30 kc. and the output from the mixer oscillator which represents the difference in frequency between the fixed oscillator 32 and the variable oscillator 33 is fed by conductor 35 into the frequency meter 36 and thence by conductor 37 into a recorder-controller 38 of the type mentioned. The capacitance cell 29 and the oscillators 32, 33 and 34 are connected by conductors 29a, 33a and 32a.

The recorder-controller of the type mentioned may then be used to control a process variable in response to the

output signal from the frequency meter. By suitably connecting leads 39 and 40 to valve 15 as indicated, the amount of phenol charged to tower 11 may be varied or, if desired, the amount of oil charged through line 12 may be controlled through electrical leads 41 and 42 connecting the recorder-controller 38 to valve 13. In this manner it is possible for us to control the operation of the treating tower 11 precisely.

To illustrate further our operations, reference will be had to Fig. 2 in which a phenol plant 50 is shown schematically as a block in the diagram. Fed to phenol plant 50 by way of line 51 controlled by valve 52 is a lubricating oil fraction of the type illustrated which is to be solvent extracted. Phenol or the like solvent is introduced into solvent extraction plant 50 by line 53 controlled by valve 54. Phenol is recirculated from the stripping sections of plant 50, not shown, by line 55 which feeds back into line 53. The solvent-free extract is removed from solvent extraction plant 50 by line 56 while the finished solvent-free raffinate is removed by line 57. A branch line 58 controlled by line 59 introduces the solvent-free raffinate to a sample system 60, such as the capacitance cell 29 and its associated parts of Fig. 1. The oil after passing through the sample system 60 is removed therefrom by line 61 to be further disposed of as may be desired or fed back into line 57 when the raffinate is passed through the system 60. By means of a recorder-controller, not shown, a signal is passed by way of conductor 62 to the motor 63 of the valve 52 which will allow the flow of feed stock into the plant 50 to be varied at will. Likewise, by means of a conductor 64 connected to the motor 65 of the valve 54, it is possible to vary the flow of phenol into the plant 50 in response to the changes in viscosity index of the raffinate. Alternately to the flow of the raffinate, it is possible in our operation to flow a portion of the feed oil from line 51 by way of line 66 controlled by valve 67 into the chamber system 60 and outwardly therefrom by line 61 and, if desired, back into line 53. By this means, it is possible to determine the efficiency of the solvent extraction system by having viscosity index determinations of both the feed and the raffinate. It is also possible to vary the control on the feed stock by having the viscosity index determined and a signal output obtained from the feed stock.

In order to illustrate our invention further a number of raffinates were obtained of known viscosity indexes. These raffinates were fed through an apparatus, such as generally indicated as 31 in Fig. 1 and 60 in Fig. 2, to obtain a dielectric constant value of each of the raffinates of known viscosity index as compared to the recorder reading on the recorder-controller. These data are shown in the table and plotted graphically in Fig. 3.

Table 1

Sample	Viscosity Index	Recorder Reading	Dielectric Constant
Raffinate 1.....	95	609, 610	2.285
Raffinate 2.....	100	574	2.270
Raffinate 3.....	103	549	2.260
Raffinate 4.....	105	522	2.251
Raffinate 5.....	107	491, 495	2.240
Raffinate 6.....	110	487, 487	2.236
Raffinate 7.....	114	437	2.216

Thus it is shown that as the viscosity index varies, the dielectric constant also varies and the recorder reading varies directly therewith with the dielectric constant. Thus the output from the recorder-controller may be used to control a process variable on the viscosity index of the solvent raffinate.

The solvent extraction may be conducted at a temperature in the range from 175° to 200° F. In solvent extraction of lubricating oil fractions, such as those of the Coastal and Panhandle type, temperatures may suitably range from 190° to 200° F. Good operations may be obtained at 195° F.

The solvent to oil ratio may suitably be in the range from 1.5 to 3.5 volumes of solvent per volume of oil. When phenol is the selective solvent, the solvent to oil ratio may suitably be in the range from 2 to 3.5 volumes of phenol per volume of oil. Good results may be obtained using phenol as the selective solvent with a phenol to oil ratio of 2.5.

Our invention has been used successfully in commercial operations in controlling the phenol extraction of lubricating oil fractions such as those described before. Our invention is of considerable advantage and utility in that more precise separation of the low viscosity index from the high viscosity index fractions is possible than heretofore.

In such selective solvent operations as described herein, it is to be understood that the solvent extraction systems will encompass all auxiliary equipment necessary to obtain precise separations and the solvent extraction operations will include means for inducing reflux and the equipment will include suitable intimate contacting equipment to obtain mixing and contact of the solvent with the oil.

The nature and objects of the present invention having been completely described and illustrated, what we desire to claim as new and useful and to secure by Letters Patent is:

1. A method for controlling the solvent extraction of a lubricating oil fraction to obtain precise separation of low viscosity index fractions from high viscosity index fractions in which a selected amount of said fraction is charged into a solvent extraction system and contacted under extraction conditions including a temperature in the range from 175° to 200° F. with a sufficient amount of a selective solvent to form a raffinate phase and an extract phase and in which solvent is removed from said phases which comprises flowing at least a portion of said solvent-free raffinate at a substantially constant temperature through a capacitance cell of a dielectric constant meter, obtaining from said cell a signal which is a measure of the viscosity index of said solvent-free raffinate, and employing said signal to change a process variable in said system.

2. A method in accordance with claim 1 in which the solvent is phenol.

3. A method in accordance with claim 1 in which the process variable is the amount of lubricating oil fraction charged to the system.

4. A method in accordance with claim 1 in which the process variable is the amount of selective solvent.

5. A method for controlling the solvent extraction of a petroleum lubricating oil fraction to obtain precise separation of low viscosity index fractions from high viscosity index fractions in which a selected amount of said lubricating oil fraction is charged into a solvent extraction system and contacted under extraction conditions including a temperature in the range from 175° to 200° F. with a sufficient amount of phenol to form a raffinate phase and an extract phase and in which phenol is removed from said phases which comprises flowing at least a portion of said phenol-free raffinate at a substantially constant temperature through a capacitance cell of a dielectric constant meter, obtaining from said cell a signal which is a measure of the viscosity index of said solvent-free raffinate and employing said signal to vary the amount of phenol in response to changes in the viscosity index of said raffinate.

6. A method for controlling the solvent extraction of a petroleum lubricating oil fraction to obtain precise separation of low viscosity index fractions from high viscosity index fractions in which a selected amount of said lubricating oil fraction is charged into a solvent extraction system and contacted under extraction conditions including a temperature in the range from 175° to 200° F. with a sufficient amount of phenol to form a raffinate phase and an extract phase and in which solvent is re-

5 moved from said phases which comprises flowing at least a portion of said phenol-free raffinate at a substantially constant temperature through a capacitance cell of a dielectric constant meter, obtaining from said cell a signal which is a measure of the viscosity index of solvent-free raffinate and employing said signal to vary the amount of the lubricating oil charged in response to the viscosity index of the solvent free raffinate.

7. A method for controlling the solvent extraction of a lubricating oil fraction to obtain precise separation of low viscosity index fractions from high viscosity index fractions in which a selected amount of said lubricating oil fraction is charged into a solvent extraction system and contacted under extraction conditions including a temperature in the range from 175° to 200° F. with a sufficient amount of a selective solvent to form a raffinate phase and an extract phase and in which solvent is removed from said phases which comprises alternately flowing at least a portion of said solvent-free raffinate and said lubricating oil fraction at a constant temperature through a capacitance cell of a dielectric constant meter, obtaining from said cell signals which are a measure of the viscosity index of said lubricating oil fraction and said

solvent-free raffinate and employing said signals to vary the amount of said lubricating oil fraction charged to said system and the amount of said solvent.

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