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SOLVENT REFINING OF HYDROCARBON OIL

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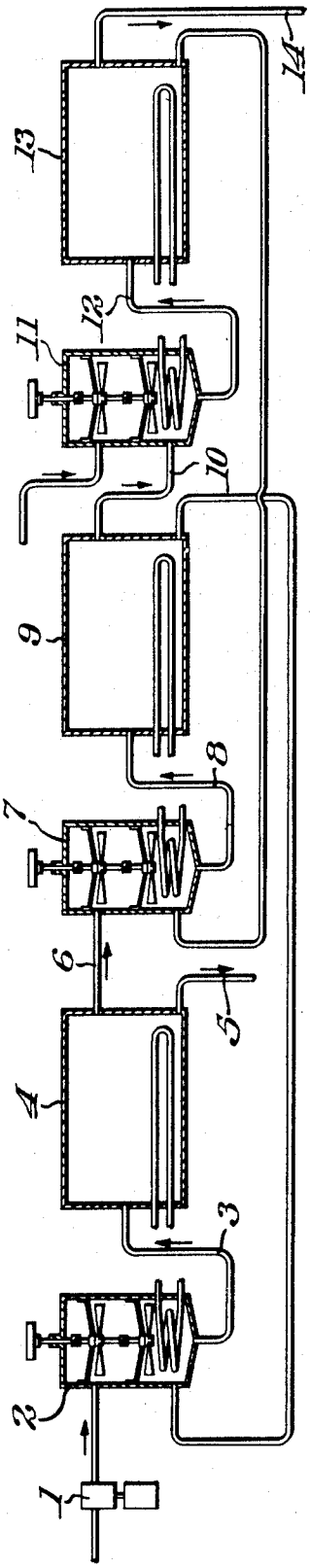


Fig. 1.

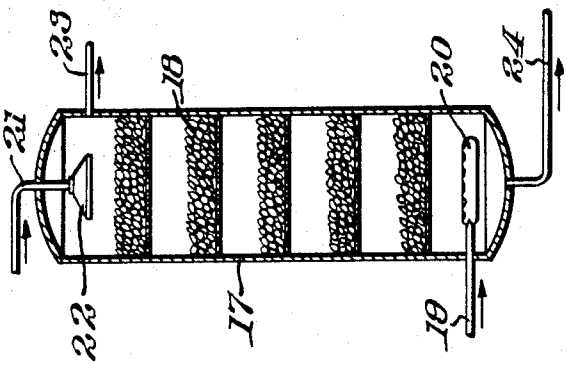


Fig. 2.

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SOLVENT REFINING OF HYDROCARBON OIL

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4 Claims. (Cl. 196—13)

This invention relates to a process of refining hydrocarbon oil, and more particularly to a method of treating mineral oil with a selective solvent having a selective solvent action as between different constituents of the oil.

The invention contemplates a method of treating oil with a solvent liquid having selective action as between naphthenic and paraffinic constituents of the oil wherein the temperature of treatment is varied over a substantial range of temperature. The invention is particularly well adapted to the treatment of lubricating oils with a selective solvent for the production of optimum yields of lubricating oil having a high viscosity index and other desirable qualities.

The method of my invention is particularly applicable to the treatment of oil with selective solvents, such as furfural, nitrobenzene, sulphur dioxide, aniline and the like, all of which possess selective solvent action as between naphthenic and paraffinic constituents of the oil, or, in other words, as between relatively low and relatively high viscosity index constituents.

Solvents of the foregoing type have a relatively high solvent action upon the naphthenic constituents of the oil and a relatively low solvent action upon the more paraffinic type of constituents. There is, however, no clear line of demarcation as to the solubility of those constituents lying intermediate between the relatively high and relatively low viscosity index bodies of the oil. Consequently, when treating oil with a selective solvent of the foregoing type, the extracted portion of the oil remaining dissolved in the solvent after treatment may contain substantial amounts of constituents intermediate in character between the extract and the more paraffinic portion of the oil, and which may be of considerable value as lubricating products. The extracted portion may also include appreciable amounts of relatively high viscosity index material due to the solubility of these constituents in the solvent-extract mixture.

I have found that, by carrying out the extraction of oil with these selective solvents over a graduated range of temperature, it is possible to obtain a more complete separation between the valuable and less valuable constituents of the oil and produce an extract which is substantially free from dissolved valuable constituents. At the same time, by the method of my treatment, it is possible to produce a refined oil portion or raffinate, having superior qualities as regards viscosity index, for example, over that obtained by the ordinary methods of treating with a selective solvent.

Accordingly, my invention comprises effecting counter-current treatment of the oil with a selective solvent in a treating zone throughout which a graduated range of temperature is maintained. Advantageously, this comprises progressively decreasing the temperature throughout the treating zone from the point at which the raffinate is removed to the point at which the extract is discharged from the zone. Thus, as the extraction proceeds the oil undergoing treatment is subjected to contact with solvent liquid at progressively increasing temperature. In this way the refined oil or raffinate is removed from the system at relatively high temperature under which conditions the solvent exerts very high solubility for constituents of naphthenic nature, while the extract is removed from the system at a relatively low temperature and at which the paraffinic constituents are substantially insoluble in the solvent liquid.

Reference will now be made to the figures of the accompanying drawing for the purpose of describing the method of my invention in greater detail.

Referring to Figure 1, the oil which is to be treated, such as lubricating oil for example, is drawn from a source not shown by a pump 1 and introduced to a mixer 2 wherein the oil is brought into contact with the solvent liquid, comprising for example, furfural, accumulating from an intermediate point such as the mixer 9 in the treating zone and containing oil relatively rich in naphthenic constituents.

The mixer 2 may comprise a closed vessel provided with stirring means and also with a coil through which either a cooling or heating medium may be conducted for the purpose of regulating the temperature within the mixer to the degree desired.

From the mixer 2, the mixture of oil and solvent is conducted through a pipe 3 to a settler 4 wherein the mixture is subjected to settling. The settling chamber may also be provided with a coil as indicated through which a heating or cooling medium may be circulated for the purpose of maintaining the proper degree of temperature.

As a result of the settling, an upper layer will be formed, comprising partially-refined oil, and a lower layer, comprising the solvent and dissolved oil or extract. The lower layer now rich in extract is removed from the bottom of

this settling chamber through a pipe 5, and the solvent recovered therefrom for reuse.

The refined oil accumulating in the upper portion of the settler is conducted through a pipe 6 to a mixer 7 similar to the mixer 2, already described. This partially-refined oil is here mixed with solvent liquid collecting at the point of raffinate discharge at the settler 13 in the treating zone and relatively lean in dissolved constituents.

From the mixer 7, the mixture of solvent and oil is discharged through a pipe 8 into a settling chamber 9 similar to that already described, and wherein the oil, while at a relatively higher temperature, is subjected to settling.

The bottom layer accumulating in the settler 9, comprising solvent and dissolved oil constituents, is returned to the mixer 2, as already described, for treatment with fresh charge.

The upper layer, comprising relatively more refined oil, is drawn off through a pipe 10 to a mixer 11, wherein it is mixed with fresh or recovered solvent liquid. The resulting mixture is then conducted through a pipe 12 to a final settling chamber 13, wherein the mixture is settled at a still higher temperature. The solvent and dissolved constituents forming the bottom layer in this settling chamber are returned to the mixer 7, already referred to, while the refined oil or raffinate, comprising the upper layer, is withdrawn from the system. Such solvent as remains mixed with the raffinate may be recovered for reuse.

When treating lubricating oil stock, corresponding for example to an oil of 60 or 70 Saybolt Universal viscosity at 210° F. with a solvent comprising furfural, temperatures throughout the treating zone may range from 130° or 150° F. at the extract end of the zone, to about 225° or 300° F. at the raffinate end. Thus, the oil and solvent mixture in the settler 4 may be maintained at a temperature of 150°, that in settler 9 at a temperature of 180° F., while that in the final settler 13 may be maintained at a temperature of around 225° F.

The proportion of solvent to oil used may be varied as desired, but will usually be about one or two parts of solvent to one part of oil.

Instead of employing a series of three or more mixing and settling units, as illustrated in Figure 1, a vertical column type of treating system may be employed, such as illustrated in Figure 2.

As shown in Figure 2, the treating apparatus comprises a vertical tower 17. This tower is provided with nests of packing material 18, as indicated. This packing material may comprise Raschig rings, tile, or other suitable packing material. Instead of packing material of this type, bubble trays may be used, alternately arranged baffles, or sections of screen.

The raw untreated oil is introduced to the bottom of the tower through a pipe 19, terminating in a distributing head 20 located in the bottom of the tower.

The solvent is introduced to the top of the tower through a pipe 21 terminating in a similar distributing head 22 within the top of the tower. The refined oil or raffinate is withdrawn through a pipe 23 from the top of the tower advantageously at a point above the distributing head 22, while the extract portion with the bulk of the solvent is withdrawn from the bottom of the tower through a pipe 24.

In practicing the invention with the tower type of treating zone, I have found it of advantage to produce the desired temperature differential within the tower by introducing the oil to the bottom of the tower at a low temperature, for example, at around 80° or 90° F., while introducing the solvent to the top of the tower in a heated condition, for example, at a temperature of around 250° or 300° F. The oil can, of course, be introduced at much lower temperature, as for example, around 0° F. or lower. In this way, there is a progressive decrease in the temperature of the liquid throughout the tower and towards the bottom, at which point the bulk of the solvent and extract material is being removed. The temperatures actually employed will depend of course upon the particular selective solvent being used.

If a selective solvent such as acetone is used and which is of lighter gravity than the oil being treated, then the flow through the treating tower may be reversed, so that the solvent is introduced to the bottom of the tower while the oil is introduced at the top.

The employment of a high temperature at the raffinate end of the treating zone results in an increase in the gravity and viscosity index of the refined oil. At high temperatures, the solvent has a high solvent effect upon the naphthenic as well as upon the more paraffinic or intermediate constituents. On the other hand, by maintaining a low temperature at the extract end of the treating zone, substantially no paraffinic or intermediate constituents remain dissolved in the solvent due to their lower solubility in the solvent at the relatively lower temperatures prevailing therein. In this way, there results an increase in the yield of refined oil together with an appreciable increase in viscosity index.

While, in the foregoing example, treatment of lubricating oil with furfural as the selective solvent has been described, it is contemplated that the invention is adapted to the treatment of other types of hydrocarbon oil and also with selective solvents other than furfural. This method of treatment may be employed with such other mineral oil fractions as naphtha or kerosene, etc., or it may be used in treating wax-bearing oils, or oils derived from distillate or residual sources.

It is also contemplated that, in many instances, it may be desirable to employ a less selective, modifying solvent liquid in admixture with the selective solvent liquid. As already indicated, the selective solvents other than furfural may comprise nitrobenzene, liquid sulphur dioxide, aniline, etc. Suitable modifying solvents which may be employed in admixture with these solvent liquids may comprise the homologs of benzene, such as benzol and toluol. When using a modifying solvent, such as benzol, it may be mixed with the selective solvent in the proportion desired, and the resulting solvent liquid mixture employed in the same manner as when using an undiluted selective solvent, as described above. The use of a suitable modifying solvent permits effecting the desired degree of extraction with relatively less of the selective solvent liquid.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In the countercurrent extraction of hydro-

carbon oil with a selective solvent to form raffinate and extract phases respectively rich in paraffinic and non-paraffinic constituents and wherein the oil and solvent move countercurrently through an extraction zone, the steps comprising introducing the solvent at a temperature at which it exerts substantially complete solvent action on the non-paraffinic constituents of the oil to said extraction zone at a point adjacent the point of raffinate phase discharge therefrom, and introducing the feed oil to said zone at a point more remote from the point of raffinate phase discharge and at a temperature substantially below that of the entering solvent such that a temperature differential of around 75° F. or more is maintained within said zone between the points of solvent and oil introduction.

2. The method according to claim 1 in which the selective solvent comprises furfural.

3. In the countercurrent extraction of hydrocarbon oil with a selective solvent to form raffinate and extract phases respectively rich in paraffinic and non-paraffinic constituents and wherein the oil and solvent move countercurrently through an extraction zone, the steps comprising introducing a solvent comprising furfural at a temperature around 225 to 300° F. to said zone at a point adjacent the point of raffinate phase discharge therefrom, and introducing the feed oil at a temperature of around 130 to 150° F. to said zone at a point more remote from the point of raffinate phase discharge such that a substantially large temperature differential is maintained within said zone between the points of solvent and oil introduction.

4. In the countercurrent extraction of hydrocarbon oil with a selective solvent to form raffinate and extract phases respectively rich in paraffinic and non-paraffinic constituents and wherein the oil and solvent move countercurrently through an extraction zone, the steps comprising introducing the solvent to said zone at a point adjacent the point of raffinate phase discharge, introducing the feed oil at a point more remote from the point of raffinate phase discharge, and maintaining the temperature in said zone at the point of oil introduction thereto 75° F. or more below the temperature at the point of solvent introduction.

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