

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Process for Refining Oils

We, ESSO RESEARCH AND ENGINEERING COMPANY, a Corporation duly organised and existing under the laws of the State of Delaware, United States of America, of Elizabeth, New Jersey, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an improved apparatus and process for producing lubricating oils. It is concerned with combining the process steps of deasphalting, solvent extraction and dewaxing, and relates particularly to the recovery of the solvents utilized in the various process steps. Specifically, it concerns improvements in the recovery of the solvent from the raffinate and extract phases obtained from a solvent extraction treatment, and to the recovery of the deasphalting and dewaxing solvent. More specifically, the invention relates to an efficient heat transfer between hot solvent vapor distilled from the extract and raffinate fractions, from the solvent extraction process, and the relatively cool process streams from the deasphalting and dewaxing steps. The hot extraction solvent vapors are indirectly heat exchanged with the relatively cool deasphalting and dewaxing process streams to vaporize the solvent from the deasphalting and dewaxing streams. Simultaneously, the hot extraction solvent vapors are cooled and condensed.

In lubricating oil refining processes, one of the conventional steps is to selectively extract aromatic hydrocarbons from the lubricating oil by using a solvent which preferentially dissolves aromatics. An example of a suitable solvent is phenol. The phenol is counter-currently contacted with the feed and separates into two phases; a solvent extract phase rich in aromatics and an oil raffinate phase with most of the aromatics removed. The

phenol solvent is subsequently recovered from raffinate and extract phases by high temperature distillation. 45

Heretofore, a large amount of cooling capacity was required to condense the hot phenol vapors from the phenol solvent recovery step. This has resulted in the waste of the heat energy available in the hot phenol vapors, as well as necessitating substantial investment for cooling water and cooling apparatus. 50 55

In the dewaxing and deasphalting plants, most of the dewaxing and deasphalting solvent is recovered by vaporization wherein steam is used as the source of heat.

In accordance with the present invention, the process steps of deasphalting, phenol treating, and dewaxing, are closely integrated by the combination of all the deasphalting and dewaxing solvent recovery systems, and by a phenol hot belt system which transfers the heat from the phenol solvent vapors to the process streams of the deasphalting and dewaxing steps, wherein the solvent is vaporized from the latter streams while simultaneously condensing the hot phenol vapors. 60 65 70

To insure adequate heat in the phenol hot belt during periods of low phenol circulation rate in the phenol plant, phenol solvent can be injected into the extract stream prior to its entry into the phenol extract furnace. 75

Another aspect of this invention is the use of a furnace recycle system whereby hot extract solution from the extract recovery furnace provides heat for the recovery of solvent from asphalt separated in the deasphalting unit. The recovery of solvent from asphalt must be carried out at high temperature to reduce the viscosity of the asphalt solution to prevent foam carryover. Since these temperatures are not generally attainable with steam, a separate furnace has been required in past practice. The use of an extract fur- 80 85

[Price 4s. 6d.]

nace recycle stream obviates the need for a separate furnace.

Further, before heat exchange with the furnace recycle stream, the asphalt solution is preheated by the bottoms from the extract recovery tower. The bottoms from this tower contain the most heat energy when the yield of extract is high; at these times, the extract furnace is at maximum duty and has less available heat for the asphalt solution. Thus, the use of the two exchangers is a balancing factor.

In accordance with this invention, the heat energy available in the hot phenol vapors is utilized to heat the process streams from the deasphalting and dewaxing steps to a temperature at which the solvent can be removed from these streams while simultaneously cooling the hot phenol vapors.

Further, in accordance with this invention, the process steps used to produce refined lubricating oil blending stocks have been integrated into a compact processing plant. The processes are interrelated to obtain maximum process advantage and use of available heat energy and cooling capacity.

Briefly, an integrated lubricating oil plant comprises in combination the following process steps. A solvent deasphalting step in which undesirable asphaltic materials are precipitated and deasphalted oil recovered. After deasphalting, the deasphalted oil is solvent extracted with a solvent which is selective to remove the aromatic components. The removal of aromatic components improves the viscosity index, color, and stability of the refined oil.

The solvent-refined, deasphalted oil is then subjected to a solvent dewaxing step wherein paraffinic waxy material is removed and the pour point of the resulting product reduced. Some of the refined oils can be obtained from a low pour point naphthenic crude; these particular stocks may bypass the dewaxing step.

The principal integrating features of the plant are in combining the solvent recovery systems for the deasphalting and dewaxing process steps and in the heat exchange step between the recovered vapors of the selective solvent and the relatively cool deasphalting and dewaxing solvent-bearing streams.

The present design is flexible enough to handle a complex slate of operations and the design principles are applicable to a broad range of different processing steps. Various lubricating oil fractions may be fed to the above described plant wherein each fraction undergoes one or more of the above process steps in whatever combination is required to obtain a refined lubricating stock having the desired properties of viscosity index, pour point, odor, color stability, etc.

There are two basic types of crude oil employed in lube manufacturing. They are paraffinic and naphthenic crudes. Naphthenic

crudes generally do not require dewaxing; suitable low viscosity index (VI) lube stocks may be made simply by hydrofining a selected fraction, or moderate VI stocks may be manufactured by extracting and hydrofining naphthenic distillates. With paraffinic crudes, however, dewaxing is required to obtain the desired pour point. Depending on the properties desired in the lubricating blending stocks, suitable feeds ranging from 600° F. IBP gas oil fractions to vacuum residual fractions are used which can undergo one or more of the above described process steps.

In order to better understand applicants' invention, a brief description of the various process steps and how they are interrelated will be given.

Deasphalting

The deasphalting process effects a physical separation of very high boiling, viscous lube oils at low temperatures, thus eliminating any thermal cracking which would take place at temperatures high enough to separate the materials by distillation. For example, an asphalt-containing residuum is contacted with 2 to 12 volumes of liquid solvent at 100 to 250° F. The crude residuum and the deasphalting solvent are countercurrently contacted. The overhead phase contains the deasphalted oil and most of the solvent. The asphaltic phase is removed as bottoms and contains a minor portion of the solvent. With a typical feed, asphaltting is carried out at 250—600 psig. The overhead phase will comprise 20—90% of the feed and the rejected bottoms phase will comprise the remainder. The solvent present in the overhead and bottoms fractions is removed by separately heating these fractions and flashing the solvents.

Phenol Treating

A suitable feed, either from the deasphalting step or from another source, such as a vacuum pipestill sidestream, is countercurrently contacted with a solvent, such as phenol, which preferentially dissolves aromatic components. The removal of aromatic components raises the viscosity index and improves oxidation stability and color of the refined oil. The aromatic-rich extract phase will comprise 10—75% of the feed, depending upon the quality desired and the crude source employed. The raffinate phase contains 25—90% of the feed. The majority of the solvent leaves the treating tower with the extract phase, which will consist of 50—95% by volume of the solvent in that phase. The raffinate phase contains 4—25% by volume of the solvent in that phase. The solvent treating tower is operated at a temperature of 100 to 250° F. and a pressure of 0 to 400 psig. The pressure must be sufficient to suppress vaporization in the treat-



deasphalted

ing tower and convey the extract and raffinate phases to the recovery sections, either with or without pumps.

The solvent is recovered from the extract and raffinate phases by distillation. The hot solvent vapors are combined and subsequently used to heat the deasphalting and dewaxing process streams. Simultaneously, the hot phenol vapors are cooled and condensed.

Dewaxing

Hot waxy oil feed, at a temperature above its pour point, from any of the previously discussed process steps or other suitable sources is mixed under pressure continuously with a suitable dewaxing solvent such as propane at dilution ratios in the range of 1/1 to 7/1 of solvent to feed. A small quantity of dewaxing aid (crystal modifier such as Paraflow) may be added to the solvent/feed solution. The word "Paraflow" is a Trade Mark). The mixture is then heated to dissolve any wax crystals present. The mixture is then cooled to about 80° F. and sent to the warm solution drum. The solution is then sent to either of two chillers in which the solution is cooled by autorefrigeration of the solvent. During the chilling, wax crystallizes out of the solution.

The operation is arranged so that while one chiller is chilling, the other chiller is being emptied of cold slurry and filled for its next chilling operation. The filter feed drum receives the chilled batches from the chiller from which it continuously feeds one or more filters or centrifuges. The temperature, at which the solution is dewaxed, is 0 to -40° F. The percentage of feed removed as slack wax is 2 to 50 while the yield of dewaxed oil is 50-98% based on feed. The wax and the dewaxed oil solutions are separately heated to recover solvent.

Solvent recovery for the deasphalting and dewaxing plants is combined. The slack wax solution, the dewaxed oil solution, and the deasphalted oil solution each exchange heat with the hot extraction solvent vapors recovered from the raffinate and extract solutions of the solvent extraction step. The dewaxing and deasphalting solvent is flashed and removed from the respective process streams.

The asphaltic solvent mixture from the deasphalting step is heated by a novel extraction solvent pumparound stream wherein the extract solution is cycled between the extract solution furnace and indirectly contacted with the asphalt solution and returned to the extraction solvent extract furnace.

Recovery of solvent from deasphalted oil, dewaxed oil, and slack wax solutions is carried out at a temperature of 140-360° F. and at a pressure of 175 to 300 psig. The solvent from the asphaltic solution is recovered at a

temperature of 400-600° F. and a pressure of 175-300 psig. The extraction solvent is separated from the extract and raffinate phases at a temperature of 450-650° F. and a pressure of 10-100 psig.

Hot Belt Heat Exchange

The hot belt heat exchange system provides the primary integrating feature between the various components of the integrated lube plant. The extraction solvent hot belt which hereinafter will be discussed with phenol as the extraction solvent, provides a means to heat and vaporize the deasphalting and dewaxing solvents. At the same time, the phenol vapors from the recovery towers are cooled and condensed. The heat normally supplied by steam in the solvent recovery sections of the deasphalting and dewaxing plants is now supplied by the condensing phenol hot belt. The integrated plant is sufficiently flexible so that it is not necessary for the entire phenol plant to be running at full capacity for the hot belt to operate. Only the circulation of the phenol is essential.

The various design features and integration of various process steps have resulted in a substantial over-all savings in investment and operating costs. One principal saving has resulted from the integration of the solvent recovery systems and the use of the phenol hot belt. These features have allowed carrying out the described processes with the use of little or no steam for heating purposes. The solvent heating requirements are provided by the phenol hot belt. Residual phenol in the extract and raffinate recovery towers is stripped using a light hydrocarbon gas instead of the normally used steam. Cooling water requirements to condense the hot phenol vapors have been substantially reduced.

The above plant is operated on a variety of feeds and sequence of treating steps so that all of the units involved are normally on stream and in operation at least 90% of the time.

The invention is illustrated in the accompanying drawings. The drawings have been simplified by omitting various pumps, compressors, motors, heat exchangers, etc. which do not form a part of the present invention.

Fig. 1 of the drawings is a schematic flow diagram of the deasphalting and dewaxing plants and the propane recovery system.

Fig. 2 of the drawings is a schematic flow diagram of the phenol extraction unit and phenol recovery system.

Fig. 3 of the drawings is a flow diagram illustrating the phenol hot belt and its relationship to the various heating and cooling services that are provided.

Fig. 1 will describe in detail the deasphalting and dewaxing process steps as well as the combined propane solvent recovery system. The description of the deasphalting

and dewaxing plants will be of feed undergoing only these two treating steps, though it is understood that the feed may have previously undergone other treating steps, that a treating step may be interposed between deasphalting and dewaxing and that the dewaxed oil may be subjected to other treating steps.

A residuum feed, boiling in the range of 900° F. to 1300° F. is fed through line (1) to the top of the deasphalting tower (2) and is countercurrently contacted with an ascending stream of liquid propane introduced through line (134). The contacting is carried out at a temperature of 100 to 160° F. and at 450 to 550 psig. In treating tower (2) the residuum is separated into an asphaltic fraction and a deasphalted oil fraction by the precipitating action of the propane on the asphaltic materials in the feed. The deasphalted oil/propane solution is taken overhead through line (3). Hot phenol vapors in heat exchanger (E-4) heat the deasphalted oil to about 360° F. The heated solution is fed through line (7) to high pressure flash drum (8) and flashed at about 320° F. and 230 psig. The flashed propane from the high pressure flash drum is removed overhead by line (125) which joins line (121). Deasphalted oil together with small amounts of propane are discharged via line 9 to a low pressure flash drum (not shown). Line (121) picks up overhead flashed propane from other high pressure flash drums and is sent to main propane condenser (126).

The asphalt/propane solution is withdrawn from deasphalting tower (2) through line (4) to asphaltic solution/extract oil heat exchanger (E-6A), then through asphaltic solution/phenol extract furnace recycle exchanger (E-6) wherein it is heated to about 540° F. Then it is sent through line (5) to high pressure flash drum (6), wherein it is flashed at a pressure of about 230 psig. A recycle stream from the phenol extract recovery tower (27) (see Fig. 2), exchanges heat with the asphaltic solution in exchanger (E-6) and is cycled back to the extract furnace. This vaporizes the propane, permitting it to be disengaged from the asphaltic material at a low enough asphalt viscosity to avoid carryover.

The flashed propane vapors are taken overhead by line (124) wherein they join line (121) and are conveyed to the propane condenser (126). The bottoms contain the asphaltic constituents and a small amount of propane and are sent to low pressure flash drum (not shown) to recover the small amount of propane remaining. The propane from the low pressure flash drum is also sent to the condenser (126) after being compressed. The asphaltic materials are removed from the bottom of flash drum (6) by line (10) and are subsequently taken to storage for further processing or disposal. The deasphalted oil may

be sent to phenol treatment, hydrofining, or directly to the dewaxing step.

In dewaxing, the deasphalted oil is introduced through line (51) and introduced into mixer (52) wherein liquid propane is added at a pressure of about 350 psig. The mixture of propane and feed is then introduced through line (52A) to waxy solution holdup drum (53) where it is held at a temperature of 140°—160° F. until all of the wax present in the feed has been dissolved. The feed is then cooled to about 80° F. and charged to the warm solution drum (54) from which it is fed alternately to two batch chillers (59) and (59A) via lines 55 and 57 and lines 55 and 56 respectively. Batches of warm solution are cooled by vaporizing some of the volatile propane solvent which is removed overhead by line (128), thereby precipitating some of the wax. The waxy oil/propane solution is thus chilled to final temperatures in the range of 0 to -40° F. The operation is arranged so that while one chiller is chilling, the other chiller is being emptied and filled for its chilling operation. The chilled solution then goes through line (58) to filter feed drum (60). From the feed drum, the crystallized wax, propane solvent and oil are continuously fed through lines (61), (62), and (63) to wax filters (65) and (65A) wherein the precipitated wax is separated from the oil/solvent solution.

Propane vapors from the warm solution drum (54), chillers (59) and (59A), and filter feed drum (60) are throttled to 3 to 5 psig and sent through line (128) to compressor (129). The line (55A) is a vapour balance line to release the pressure should drum (54) be filled.

In carrying out the chilling operation, it was found that crystallization begins in the prechilling stage and that prechilling conditions must be carefully controlled to avoid the formation of fine crystals which rapidly plug filter cloths. The addition of waxy solution holdup drum (53) to provide liquid holdup of the feed/propane solution before prechilling begins provides time for complete solution of the wax in the propane. The initial dilution ratio of solvent to feed is sufficient so that no makeup propane is required during the chilling cycle. The higher dilution ratio plus the holdup time allows solution of the wax to be accomplished at temperatures at or below 140° F.

The chilled solution fed through lines (62) and (63) is separated into wax and dewaxed oil by filters (65) and (65A). The dewaxed oil passes through the filter cloth into a rundown drum, (not shown) and then to the propane recovery system. The wax deposited on the filter cloth is washed by liquid propane. The cake is removed from the filter by blowback gas supplied by line (131). The dewaxed oil solution is removed from the filters



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by line (66) and indirectly contacted and heat exchanged in phenol hot belt heat exchanger (E-5) where its temperature is raised to about 340° F. while simultaneously cooling and condensing the hot phenol vapors.

5 The dewaxed oil solution then enters the bottom of high pressure flash drum (68) through line (67) where it is flashed at a pressure of about 235 psig. The major portion of the propane in the dewaxed oil solution is removed in the high pressure flash drum. The remaining minor portion of the propane in the dewaxed oil is removed in a low pressure flash drum (not shown) operated at about 5 psig. The dewaxed oil, free of propane, is removed through line (73) and sent to storage. The flashed propane is removed through line (123) and joins line (121) and is sent to propane condenser (126).

10 The slack wax/propane slurry is removed from wax filter and fed through line (69) to phenol hot belt exchanger (E-2) where it is indirectly heated to about 320° F. with hot phenol vapours, which are thereby cooled and partially condensed. The warmed wax solution is fed through line (70) to high pressure flash drum (71) wherein the propane is flashed at a pressure of about 235 psig. Substantially all of the propane is removed. The slack wax is withdrawn from flash drum (71) by line (72) and can be subsequently further processed to recover the wax, cracked to make lighter products or used as fuel. The propane from the high pressure flash is removed from flash drum section (71) through line (122) and joins line (121) and is sent to propane condenser (126). The propane vapors in line (121) are condensed in condenser (126) and sent to propane accumulator drum (132).

35 The same compressor (129), condenser (126), storage drum (132), knockout drum (not shown) and associated piping are used for the dewaxing and deasphalting plant propane circulation systems. The propane recovery system takes vapor streams at about 3 to 5 psig. from the low pressure flash drums (not shown), chillers (59A) and the filter feed drum (60) and filters (65) and (65A) sends them to propane compressor (129). In the compressor, the pressure is raised from 3 to 230 psig.

40 The compressor discharges, through line (130) to condenser (126), along with vapors from high pressure flash drums (6), (8), (68) and (71) introduced through line (121) is condensed by condenser (126) and introduced into propane accumulator storage tank (132) through line (127). Liquid propane from storage (132) is recycled through lines (133) and (134) to deasphalting tower (2) and through line (135) to dewaxing propane mixer (52).

55 In describing Fig. 2 of the drawing, a feed which is only phenol extracted will be discussed. Feed enters the bottom of phenol

treating tower (22) through line (21) and is countercurrently contacted with liquid phenol fed into the top of the tower (22) through line (103). The feed is first heated to a temperature of about 200° F. by heat exchanger (not shown). A raffinate phase is removed overhead through line (24). The extract phase is removed from the bottom of phenol treating tower (22) through line (23). The extract phase contains most of the phenol solvent and extracted aromatic hydrocarbons. The overhead raffinate stream contains a minor amount of phenol solvent and most of the nonaromatic hydrocarbon components. The phenol treating tower (22) is operated at a temperature of about 200° F. and a pressure of 100—300 psig.

70 The raffinate stream is heated to about 400° F. by passage through phenol hot belt heat exchanger (E-3) wherein it is indirectly contacted with hot phenol vapors. It is then fed to furnace (E-8) through line (35) where it is heated to 650 to 750° F. It is then sent to raffinate phenol recovery tower (37) through line (36), wherein vaporized phenol solvent is separated from the raffinate. Phenol solvent recovery is maximized by stripping with light hydrocarbon gases introduced into raffinate recovery tower (37) through lines (31) and (32). The hot phenol vapors leave tower (37) via line (82) at a temperature of about 435° F. and a pressure of about 50 psig. and are subsequently combined with the phenol solvent vapors from tower (27) in line (83). Line (83) leads to the phenol hot belt system. In the hot belt system, the hot phenol vapors are cooled and condensed and finally discharged into the phenol accumulator drum (102).

85 The raffinate, free of phenol solvent, is removed by line (38) and fed through line (39) to a raffinate storage tank or through line (38A) to a hydrofining reactor and/or a dewaxing step. The phenol extract fraction from phenol treating tower (22) is removed from the bottom of the tower through line (23) and heat exchanged in phenol hot belt heat exchanger (E-1) with hot phenol vapors. Its temperature is raised to about 400° F. and its is then sent through line (25) to extract recovery tower furnace (E-7) where it is heated to about 600° F., partially vaporizing the phenol. The partially vaporized phenol and extract phase is fed through line (26) to extract recovery tower (27). Hot phenol vapors are taken overhead through line (81) where they are combined with the vapors from raffinate recovery tower (37) in line (83). Below the point where the feed is introduced, a stripping gas is introduced into extract recovery tower (27) through lines (31) and (33) to strip any remaining phenol from the extract. The bottoms product is discharged at a temperature of about 500° F. from tower (27) through line (30) and consists mostly

of aromatic components. This product is sent to storage after suitable heat exchange.

A portion of the phenol extract phase introduced into extract recovery tower (27) is recycled through line (28), heat exchanger (E-6), and line (29) back to extract furnace (E-7). This extract recycle at a temperature of about 600° F. exchanges heat with the asphalt/propane solution from the deasphalting step, heating that stream to a temperature of about 540° F. Additional heat energy is obtained by heat exchange of the asphalt/propane solution with the extract bottoms in line (30) in heat exchanger (E-6A) as shown in Figure 2.

Cool condensed phenol vapors from the phenol hot belt system are collected and are fed through line (101) and stored in a phenol accumulator drum (102) at about 275° F. and about 25 psig.

The thus refined feed can be dewaxed and/or hydrofined or sent to storage.

Fig. 3 is a schematic flow diagram of the phenol hot belt system. The combined overheads from the raffinate and extract recovery towers of the phenol treating plant are introduced to the hot belt system through line (83) at about 430° F. and at about 50 psig. The phenol hot belt exchangers are in parallel to minimize the pressure drop between the phenol recovery towers (27 and (37) and the phenol accumulator drum (102) (Fig. 2). The hot phenol vapors are distributed through line (84) and are collected in line (98) after passing through the various heat exchangers, (E-1) through (E-5). The hot belt system consists of five heat exchangers, (E-1) through (E-5), and a phenol bypass line (86).

The heat exchangers provide the following services:

Heat exchanger (E-1) receives hot phenol vapors through line (85) and discharges them through line (95) and the cooled and condensed phenol vapor is collected in line (98). In cooling the hot phenol vapor through heat exchanger (E-1), the feed to phenol extract recovery tower (27) is heated from about 180° F. to about 400° F., prior to entering extract furnace (E-7).

Heat exchanger (E-3) receives hot phenol vapor through line (87); cooled phenol vapor is removed through line (96). The feed to the phenol raffinate recovery tower is heated in exchanger (E-3) from about 200 to about 400° F. prior to entry into raffinate furnace (E-8).

Heat exchangers (E-2) and (E-5) receive hot phenol vapor through line (88) which splits into lines (90) and (92). Line (90) provides the hot phenol vapor for heat exchanger (E-2) wherein slack wax/propane solution is heated from about 140° F. to about 320° F. The cooled phenol vapor leaves through line (91).

Heat exchanger (E-5) receives hot phenol vapor through line (92) and heats dewaxed oil/propane solution from about 140° F. to about 340° F. The cooled phenol vapors are withdrawn through line (93) and are combined in line (94) with the cooled phenol vapor from line (91).

Heat exchanger (E-4) receives hot phenol vapor through line (89) and heats deasphalted oil/propane solution from about 170° F. to about 360° F. The cooled phenol vapors are removed from exchanger (E-4) by line (97).

When the phenol plant is running at low circulation rates, makeup phenol is sent to the hot belt by injecting phenol into the phenol extract stream prior to its entry into the phenol extract furnace (E-7). This insures that enough heat is available in the hot phenol vapor to flash propane from the deasphalted oil, dewaxed oil, and slack wax solutions in the high pressure flash drums. In the event that excess heat is available in the phenol hot belt system, part of the hot phenol bypasses the heat exchangers via line (86). Condensed phenol vapors are collected from the various heat services and the bypass line, and pass into line (98) and are fed through line (99) into hot belt trim cooler (100) wherein the temperature of the condensed phenol is reduced to about 275° F. and fed through line (101) to the phenol accumulator drum (102) (see Fig. 2).

It is obvious from the above description of the invention that substantial savings have been made by cooling the hot phenol vapors by heat exchange with cool dewaxing and deasphalting process streams and by concomitantly heating the latter streams to remove propane solvent.

WHAT WE CLAIM IS:—

1. An improved process for refining lubricating oil fractions and for vaporizing, condensing and recovering vaporizable solvents used in conjunction with said refining process which comprises a solvent deasphalting step in which a deasphalted oil/solvent phase and an asphalt/solvent phase are separated; a selective aromatic solvent extraction step which produces an extract phase and raffinate phase which are separately heated to a temperature at which the hot extraction solvent vapours are removed; and a solvent dewaxing step in which a dewaxed oil/solvent phase and a slack wax/solvent phase are separated; the deasphalting and dewaxing solvent being removed by heating the separated phases and flashing the solvent therefrom, and the hot extraction solvent vapours being cooled and condensed by indirect heat transfer with the relatively cool deasphalted oil/solvent phase, the dewaxed oil/solvent phase and the slack wax/solvent phase, simultaneously heating said phases and vaporizing deasphalting and dewaxing solvent therefrom; and separating,



of aromatic components. This product is sent to storage after suitable heat exchange.

A portion of the phenol extract phase introduced into extract recovery tower (27) is recycled through line (28), heat exchanger (E-6), and line (29) back to extract furnace (E-7). This extract recycle at a temperature of about 600° F. exchanges heat with the asphalt/propane solution from the deasphalting step, heating that stream to a temperature of about 540° F. Additional heat energy is obtained by heat exchange of the asphalt/propane solution with the extract bottoms in line (30) in heat exchanger (E-6A) as shown in Figure 2.

Cool condensed phenol vapors from the phenol hot belt system are collected and are fed through line (101) and stored in a phenol accumulator drum (102) at about 275° F. and about 25 psig.

The thus refined feed can be dewaxed and/or hydrofined or sent to storage.

Fig. 3 is a schematic flow diagram of the phenol hot belt system. The combined overheads from the raffinate and extract recovery towers of the phenol treating plant are introduced to the hot belt system through line (83) at about 430° F. and at about 50 psig. The phenol hot belt exchangers are in parallel to minimize the pressure drop between the phenol recovery towers (27 and (37) and the phenol accumulator drum (102) (Fig. 2). The hot phenol vapors are distributed through line (84) and are collected in line (98) after passing through the various heat exchangers, (E-1) through (E-5). The hot belt system consists of five heat exchangers, (E-1) through (E-5), and a phenol bypass line (86).

The heat exchangers provide the following services:

Heat exchanger (E-1) receives hot phenol vapors through line (85) and discharges them through line (95) and the cooled and condensed phenol vapor is collected in line (98). In cooling the hot phenol vapor through heat exchanger (E-1), the feed to phenol extract recovery tower (27) is heated from about 180° F. to about 400° F., prior to entering extract furnace (E-7).

Heat exchanger (E-3) receives hot phenol vapor through line (87); cooled phenol vapor is removed through line (96). The feed to the phenol raffinate recovery tower is heated in exchanger (E-3) from about 200 to about 400° F. prior to entry into raffinate furnace (E-8).

Heat exchangers (E-2) and (E-5) receive hot phenol vapor through line (88) which splits into lines (90) and (92). Line (90) provides the hot phenol vapor for heat exchanger (E-2) wherein slack wax/propane solution is heated from about 140° F. to about 320° F. The cooled phenol vapor leaves through line (91).

Heat exchanger (E-5) receives hot phenol vapor through line (92) and heats dewaxed oil propane solution from about 140° F. to about 340° F. The cooled phenol vapors are withdrawn through line (93) and are combined in line (94) with the cooled phenol vapor from line (91).

Heat exchanger (E-4) receives hot phenol vapor through line (89) and heats deasphalted oil/propane solution from about 170° F. to about 360° F. The cooled phenol vapors are removed from exchanger (E-4) by line (97).

When the phenol plant is running at low circulation rates, makeup phenol is sent to the hot belt by injecting phenol into the phenol extract stream prior to its entry into the phenol extract furnace (E-7). This insures that enough heat is available in the hot phenol vapor to flash propane from the deasphalted oil, dewaxed oil, and slack wax solutions in the high pressure flash drums. In the event that excess heat is available in the phenol hot belt system, part of the hot phenol bypasses the heat exchangers via line (86). Condensed phenol vapors are collected from the various heat services and the bypass line, and pass into line (98) and are fed through line (99) into hot belt trim cooler (100) wherein the temperature of the condensed phenol is reduced to about 275° F. and fed through line (101) to the phenol accumulator drum (102) (see Fig. 2).

It is obvious from the above description of the invention that substantial savings have been made by cooling the hot phenol vapors by heat exchange with cool dewaxing and deasphalting process streams and by concomitantly heating the latter streams to remove propane solvent.

WHAT WE CLAIM IS:—

1. An improved process for refining lubricating oil fractions and for vaporizing, condensing and recovering vaporizable solvents used in conjunction with said refining process which comprises a solvent deasphalting step in which a deasphalted oil/solvent phase and an asphalt/solvent phase are separated; a selective aromatic solvent extraction step which produces an extract phase and raffinate phase which are separately heated to a temperature at which the hot extraction solvent vapours are removed; and a solvent dewaxing step in which a dewaxed oil/solvent phase and a slack wax/solvent phase are separated; the deasphalting and dewaxing solvent being removed by heating the separated phases and flashing the solvent therefrom, and the hot extraction solvent vapours being cooled and condensed by indirect heat transfer with the relatively cool deasphalted oil/solvent phase, the dewaxed oil/solvent phase and the slack wax/solvent phase, simultaneously heating said phases and vaporizing deasphalting and dewaxing solvent therefrom; and separating,

condensing and collecting the vaporized de-asphalting and dewaxing solvent and collecting said condensed extraction solvent.

2. A process according to claim 1 wherein a portion of the solvent extract phase is recycled from the extract heating step and indirectly heat exchanged with the separated asphalt/solvent phase from deasphalting step and then returned to the extract heating phase, whereby the asphalt/solvent phase is heated to a temperature at which the de-asphalting solvent is removed from the asphalt/solvent phase by flashing and without excessive foaming.

3. A process according to claim 1 or 2 in which the dewaxing and deasphalting solvents are propane.

4. A process according to any of claims 1 to 3 in which the selective aromatic solvent is phenol.

5. A process according to claims 3 or 4 wherein the propane separated from the respective deasphalted oil/solvent phase, asphalt/solvent phase, dewaxed oil/solvent phase and slack wax/solvent phase is combined, cooled, condensed, compressed and collected in a common propane solvent system.

6. A process for refining lubricating oil fractions and for vaporising, condensing and recovering vaporisable solvents substantially as herein described.

7. An improved apparatus for use in a process as claimed in any of claims 1 to 6 which comprises a solvent deasphalting tower, a selective solvent extraction tower and a solvent dewaxing tower; two distillation means in combination with each of said treating towers; connecting means communicating between an overhead product and a bottoms product taken from each of said treating towers to each of one of the two distillation means associated with each of said treating towers, the distillation means associated and in communication with each of the three treating towers each having a means for removing an overhead vapour product and a bottoms liquid product; conveying means for the overhead vapour products from both the distillation means of the second of the three treating towers and heat exchange means such that the said combined overhead vapor pro-

ducts are in indirect heat exchange contact with the overhead product streams from each of the first and third treating towers and the bottom product from the third treating tower at points between said first and third treating towers and the distillation means.

8. Apparatus according to claim 7 wherein the two distillation towers in combination with the second treating tower each have an overhead line which lines are joined, the joined line being in indirect heat exchange relationship with the overhead and bottoms product lines of said second treating tower which overhead and bottoms product lines are in communication with one of said two distillation towers at points between said second treating tower and distillation towers.

9. Apparatus according to claim 7 or 8 where in the bottoms product line from the second treating tower which is in communication with one of the distillation towers, combined therewith, is further in heat exchange relationship by an indirect heat exchange means at a point between said second treating tower and said distillation means with the bottoms product of the first treating tower.

10. Apparatus according to claims 7, 8 or 9 in which the distillation means in combination with the first tower comprises two high pressure distillation drums.

11. Apparatus according to any of claims 7 to 10 in which the distillation means associated with the third tower comprises two high pressure distillation drums.

12. Apparatus according to claims 9 to 11 wherein said bottoms product line is further in heat exchange relationship and in communication with bottoms recycle stream line which connects the solvent extract recovery distillation tower and the extract distillation furnace.

13. Apparatus for use in a process as claimed in any of claims 1 to 6 substantially as hereinbefore described with reference to the accompanying drawings.

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