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METHOD OF PREPARING LUBRICATING OILS

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This invention relates to lubricating oils and to the method of preparing the same. More particularly, the invention is concerned with a method for converting high viscosity oils into oils of lower viscosity and is particularly applicable to the treatment of so-called Pennsylvania paraffin base oils.

The development of high powered and high speed automotive engines has necessitated the use of less viscous lubricating oils. The reason for this is two-fold. First, because of the smaller clearances between moving parts and larger surfaces in contact with each other, the friction drag is so great that with viscous oils, the motor cannot be started in cold weather unless more powerful starting equipment is used. Second, the friction loss is so great when using viscous oils that overheating of the motor occurs and fuel consumption is exorbitant.

Not only do the less viscous oils provide easier starting but they also provide superior lubrication. The limit to which the viscosity may be decreased will be determined by the ability of the oil to form a non-rupturable film under the loads to which it is subjected. Generally speaking, it may be said that the less viscous the oil, the better the lubricating qualities thereof, provided the oil has sufficient film strength under operating conditions not to rupture.

As a result of the increased demand for low viscosity lubricants, the supply of high grade oils is reaching the point where it is becoming insufficient to meet demands whereas the more viscous fractions are becoming less and less marketable.

One of the objects of the invention is to convert viscous lubricating oils into less viscous oils.

Another object of the invention is to increase the yield of desired lubricating fractions from crude mineral oils.

A further object of the invention is to prepare lubricating oils having a higher viscosity index number than the stock from which it has been prepared.

Still another object of the invention is to convert bright stock to neutrals.

Other objects of the invention will be apparent from the following detailed description.

In accordance with common refining technology, crude oil is subjected to distillation in a shell still to distill off the naphtha, kerosene,

and gas oil. After the removal of the non-viscous fractions the temperature of the still is gradually raised and steam blown through the oil in increasing amounts to distill off the pressable wax distillate. The temperature is kept below 700° F. and preferably is not permitted to exceed 650° F. By applying a vacuum, lower temperatures may be used. Cracking is avoided as far as possible.

In more modern refineries, pipe stills are used to distill over the light fractions and the wax distillate. By the use of efficient fractionating equipment the various cuts can be separated in a single distillation. When using pipe stills it is possible to utilize higher temperatures since the oil is subjected to the high temperature for a very short period of time. Temperatures up to 750° F., or even 800° F., may be used without causing any substantial cracking of the oil undergoing distillation. Steam and/or vacuum may be also applied to assist the distillation.

The initial distillation of the crude separates the lubricating fractions into a less viscous pressable wax distillate and a non-pressable viscous residuum. In some instances a viscous non-pressable distillate may also be obtained. The residual oil containing the amorphous or non-pressable wax constitutes the cylinder stock. In order to separate this wax it is necessary to subject the cylinder stock to cold settling or centrifuging. The resulting wax free oil constitutes the bright stock.

Where the crude is subjected to higher distillation temperatures, as for example when utilizing pipe still distillation, a deeper cut is made into the crude so that a substantial portion distills over to form a viscous non-pressable distillate. This distillate, like the residuum, may be subjected to cold settling or centrifuging to prepare bright stock.

The amount of pressable wax distillate that can be recovered from the crude is relatively small, amounting to approximately 15 to 20% of the crude. This distillate may be filter-pressed to remove the wax and the resulting pressed distillate reduced with fire and steam to the desired viscosity after proper refining with chemicals. The residuum from the latter operation constitutes the neutrals which today furnish the major part of automotive lubrication. If it is desired to prepare a neutral oil having a viscosity of 180 to

185 seconds (Saybolt Universal) at 100° F., the pressed oil is reduced until it attains this viscosity. This is the stock that is generally marketed for blending with bright stock to furnish different viscosity oils. The amount of such neutrals that may be recovered is approximately 35 to 40% of the pressed distillate. Not only must the lubricant meet certain viscosity specifications but it is essential that it also have minimum fire and flash tests.

In accordance with the present invention the yield of desirable neutral oil from crude oil can be more than doubled by converting a major portion of the bright stock into neutrals. This is accomplished by subjecting bright stock to distillation under light cracking conditions sufficient to reduce the viscosity but not sufficient to materially degrade the lubricating properties thereof. By careful regulation of the distillation of the bright stock, from 60 to 90% thereof can be taken over as a distillate, leaving a viscous residuum which is suitable as an industrial lubricating oil. The overhead distillate, which has a relatively low viscosity compared with the stock from which it is distilled, is blended with pressed oil distillate and/or other lubricating oil distillates of low viscosity in proper proportion to produce a product, which, upon reduction of the blend to desired viscosity, has the desired flash and fire tests.

If an attempt is made to reduce the distillate from the bright stock to the desired viscosity without first blending it with pressed oil or other lubricating oil distillate, the fire and flash tests are too low to meet required specifications. By blending before distillation, not only can a product of satisfactory flash and fire be obtained but the yield of the desired product is materially increased. If the yields of oil of definite viscosity are obtained by distilling the bright stock distillate and the pressed oil separately and these yields compared with the yield obtained by reducing the blend, it will be found that the yield of oil of the determined viscosity will be in excess of 100% based on the amount of bright stock used, assuming that the yield of oil from pressed oil will be the same as that obtained when the pressed oil is distilled separately.

The process may be carried out by first separating crude oil into pressable wax distillate and cylinder stock. This may be done in a shell still with the aid of steam and/or vacuum or in a pipe still in the manner previously disclosed. The cylinder stock, whether it be a residuum or a distillate, is subjected to cold settling or preferably centrifuging in order to remove the non-pressable wax which is contained therein and then chemically treated, filtered, and reduced if necessary. The resulting bright stock is subjected to distillation in either a shell or pipe still in such manner as to lightly crack the stock in order to reduce the viscosity thereof. The distillation step must be carefully controlled in order to get a distillate of the desired characteristics. When distilling in a shell still it is desirable to add a small amount, approximately 10%, of light distillate such as naphtha, kerosene, gas oil or light lubricating oil cuts, to the bright stock in order to start the distillation without obtaining an excessive amount of cracking. The temperature of the still may be gradually raised to approximately 300° F. whereupon steam is introduced in gradually increasing quantities as the distillation proceeds. The rate of distillation is controlled so that the viscosity of the overhead stream coming

off the still ranges between approximately 90 and 120 seconds (Saybolt Universal) viscosity at 100° F. If the resulting distillate is to be used in the preparation of 180 neutral, that is, lubricating oil distillate having a viscosity of 180 seconds S. U. at 100° F., it is preferable to keep the viscosity of the stream at approximately 100 seconds viscosity. The distillation may be continued until the temperature of the still reaches approximately 700° F. but preferably should not exceed 650° F. If the distillation is properly carried out approximately 60 to 90% of the charge may be distilled off, leaving a residue of high flash and viscosity which is suitable as a lubricating oil for industrial use.

The distillation operation is carried out with a view chiefly to reducing the viscosity of the heavy fractions of the bright stock and at the same time maintain a high flash and fire test. If the distillation is properly carried out only a small quantity of light cracked distillate unsuitable as lubricating oil will be formed.

If it is desired to carry out the cracking distillation of bright stock in a pipe still, the distillation is carried out in such manner that the overhead stream will have a viscosity of between approximately 90 and 120 seconds. The heavier material may be recycled through the pipe still and the distillation continued in this manner until approximately 60 to 90% of the charge has been taken overhead. When using pipe still distillation higher temperatures may be employed ranging up to 750° or 800° F. Steam may be used in the vaporizing drum to strip light fractions from the residue. Steam may be also passed through the pipe still together with the oil to aid in the distillation thereof. When using higher temperatures in pipe still operation the heating should be sufficiently rapid to prevent over-cracking of the bright stock.

The distillate resulting from light cracking of the bright stock is then blended with pressed oil and/or other light lubricating distillate in proportions suitable to obtain, upon reduction, a resulting oil of the desired viscosity, flash and fire tests. The proportions to be blended will depend on the characteristics of the resulting products desired as well as the characteristics of the materials blended and can be determined from experience. In the preparation of 180 neutral it has been found that a blend of approximately 70% pressed oil and 30% of distillate resulting from the bright stock distillation, will produce a product having the required flash and fire point and viscosity.

Although the invention is applicable to the preparation of neutrals from Pennsylvania, Mid-Continent, Gulf Coast, and California oils, it is particularly suitable in the preparation of neutrals from Pennsylvania or paraffin base oils. As an example of the process as carried out in accordance with our invention, bright stock from Pennsylvania crude, having the following characteristics, was subjected to a light cracking distillation.

TABLE I

Pennsylvania bright stock

Gravity A. P. I.	26/27
Flash point, °F.	530/540
Fire point, °F.	600/610
Vis. at 210° F.	130/140
Vis. at 130° F.	750/775
Pour point, °F.	10/15
Color, A. S. T. M.	6/7

442 barrels of this material was blended with 41 barrels of naphtha prior to charging to the still. The still was fired until the temperature was brought up to approximately 300° F. whereupon steam was introduced into the oil and the temperature slowly raised. The distillation was carried out at such a rate and the temperature and steam increased at such a rate so that a steady overhead stream having a viscosity of between 100 and 110 seconds was maintained. The temperature was carried up to approximately 650° F. The results of distillation were as follows:

TABLE II

	Distillate	Residuum
Bright stock charged, 442 bbls.—		
Yield, bbls.	368	69
Yield, percent.	83.3	15.6
Gravity, A. P. I.	32.4	21.3
Flash point, °F.	155	620
Fire point, °F.	220	695
Vis. at 100° F., S. U.	108	
Vis. at 210° F., S. U.		258
Pour point, °F.	30	20
Color, A. S. T. M.	+5	Brown

The distillate obtained from the distillation of the bright stock was blended with pressed oil having the following characteristics:

TABLE III

Characteristics of pressed oil

Gravity, A. P. I.	36.6
Flash point, °F.	215
Fire point, °F.	280
Vis. at 100° F., S. U.	61

The blend was then subjected to careful distillation with steam in order to prevent cracking and to reduce the blend to a 180 seconds viscosity. The results of the distillation were as follows:

TABLE IV

Total charge, bbls.	453
Pressed oil in charge, bbls.	325
Bright stock distillate in charge, bbls.	128
Yield of 180 neutral, bbls.	268
Gravity, A. P. I.	31.4
Flash point, °F.	415
Fire point, °F.	465
Vis. at 100° F., S. U.	180
Pour point, °F.	35
Color, A. S. T. M.	4½

In another run 222 barrels of bright stock were blended with approximately 10% of naphtha and the blend subjected to a light cracking distillation in a shell still in the manner previously set forth. The results of the distillation were as follows:

TABLE V

	Distillate	Residuum
Bright stock charged, 222 bbls.—		
Yield, bbls.	197	32
Yield, percent.	88.7	14.4
Gravity, A. P. I.	32.2	21.3
Flash point, °F.	110	630
Fire point, °F.	160	700
Vis. at 100° F.	103	
Vis. at 210° F.		254
Pour point, °F.	30	20
Color, A. S. T. M.	4½+	Brown

The distillate prepared from this bright stock was blended with pressed oil and "85" stock. The latter material is a distillate which results in the reduction of pressed oil to 180 neutral and

is used to prepare light lubricants having approximately 85 seconds viscosity. This stock had the following characteristics:

TABLE VI

Characteristics of "85" stock

Gravity, A. P. I.	35.9
Flash point, °F.	305
Fire point, °F.	330
Vis. at 100° F., S. U.	57

The blend was then distilled carefully with steam in order to avoid cracking and the temperature was not permitted to rise in excess of 600° F. The results of the distillation were as follows:

TABLE VII

Total charge, bbls.	429
Pressed oil in charge, bbls.	233
Bright stock distillate in charge, bbls.	96
"85" stock in charge, bbls.	100
Yield of 180 neutral, bbls.	204
Gravity, A. P. I.	31.3
Flash point, °F.	420
Fire point, °F.	460
Vis. at 100° F.	187
Pour point, °F.	35
Color, A. S. T. M.	5+

In order to determine the yield of the 180 neutral from the bright stock distillate, the various oils which were blended were separately distilled in order to determine the amount of 180 neutral that could be obtained from each fraction individually. The fractions were distilled down to 180 viscosity bottoms and also were distilled to 420° F. flash point bottoms. The results were as follows:

TABLE VIII

	Bright stock distillate	Pressed oil	"85" stock
Percent of 180 vis. bottoms.	86	36.5	7
Flash point °F. of 180 vis. bottoms.	375	440	440
Percent of 420° F. flash point bottoms.	80	40	10
Vis. of 420° F. flash point bottoms.	249	165	139

If in Table IV the yield of 180 neutral from the pressed oil is assumed to be 36.5% as determined according to Table VIII, the yield of 180 neutral from the bright stock distillate will be over 116%. This unusual result may be accounted for by the fact that a portion of the pressed distillate which is ordinarily too light for 180 neutral replaces lighter fractions such as kerosene, naphtha, and gas oil in the bright stock distillate and as a result the yield of neutrals from the pressed oil is actually greater than is obtained by straight distillation of pressed oil.

Likewise, if we assume that the "85" stock will yield 7% of 180 neutral and the pressed oil will yield 36.5%, the yield of 180 neutral from the blend shown in Table VII, based on the bright stock distillate, will be over 117%. On this basis the yield of 180 neutral attributable to the bright stock distillate, will be approximately 100% based on the bright stock from which the bright stock distillate was prepared.

Although the invention has been described in connection with the preparation of 180 neutral, it will be understood that the invention is applicable to the preparation of lubricating oils of other viscosities. This material was selected since it is the stock that is generally marketed for the purpose of blending with bright stock to pre-

pare the standard oils that are distributed to the public for use in automotive engines. The Pennsylvania Grade Crude Oil Association specifications require that the viscosity of the neutrals be at least 180 seconds at 100° F. Saybolt Universal and that the flash point be not less than 420° F. The blend of bright stock distillate, pressed oil, and "85" stock given above were selected in order to prepare neutrals meeting these specifications.

One of the unusual results of the invention is that the viscosity index of the resulting 180 neutral is in excess of the viscosity index of bright stock, pressed oil, or "85" stock used in the preparation thereof. For example, a product produced by blending 70% of pressed oil and 30% of bright stock distillate prepared in accordance with this invention, had a viscosity index (Dean & Davis) of 112, and a product prepared by blending 92.5% of "85" stock with 7.5% of bright stock distillate, had a viscosity index of 108, whereas the bright stock originally used had a viscosity index of approximately 99, the pressed oil had a viscosity index of approximately 105, and the "85" stock had a viscosity index of 100 to 105. If the pour point of the bright stock used in preparing the neutrals is sufficiently low, the pour point of the neutral prepared by distilling the blend will be sufficiently low to meet commercial requirements. For example, if bright stock having a pour point of 10° F. is used, the resulting neutral will have a pour point of approximately 25° F. In the products that have been prepared in accordance with this process it has been found that the pour point of the finished neutral is approximately 15° F. above the pour point of the bright stock used in the preparation thereof when prepared from a blend of approximately 30% bright stock distillate and 70% pressed oil distillate. The pour point will be correspondingly lower when smaller proportions of bright stock distillate are used. The characteristics of the neutrals prepared in accordance with this invention are in every respect at least equal to neutrals prepared from straight pressed oil distillate and in some respects are superior thereto.

It will be evident that it not necessary to use bright stock and pressed oil or other distillate from the same crude for blending. It is therefore possible for a refinery to utilize the entire stocks of bright stock and pressed oil for the preparation of neutrals since if an excess of bright stock accumulates it can be treated in accordance with the process and blended with pressed oil which can be purchased, whereas if an excess of pressed oil accumulates bright stock can be purchased cheaply and converted into more valuable neutrals.

The residuum remaining from the distillation of the bright stock is a heavy lubricating oil of poor color. By filtering through clay the color of the residuum may be improved so that it has a dark green fluorescence and the product is valuable as an industrial oil because of its high flash and fire tests. If a high quality of lubricant is not required, the oil may be used without filtration.

It will be evident from the foregoing that the process above described is valuable for converting less valuable viscous oils into valuable and desirable lighter lubricating oils.

What is claimed is:

1. The method of increasing the yield of neutral oil from wax-bearing crude mineral oils which comprises distilling the oil to separate it

into a pressable wax distillate fraction and cylinder stock, removing the wax from each fraction, subjecting the dewaxed cylinder stock to a light cracking distillation until the major portion thereof is distilled over, blending the distillate from the last mentioned distillation with the pressed wax distillate, and reducing the blend to desired viscosity.

2. The method of preparing lubricating oil which comprises subjecting dewaxed residuum, from which pressable wax distillate has been separated, to a light cracking distillation until the major portion of said dewaxed residuum is distilled over, blending distillate from said distillation with dewaxed wax distillate and reducing the blend to the desired viscosity.

3. Method according to claim 2 in which from 60 to 90% of the dewaxed residuum is distilled off.

4. Method according to claim 2 in which the stream of distillate is maintained at a viscosity of about 90 to 120 seconds Saybolt Universal at 100° F. during the distillation of the dewaxed residuum.

5. The method of preparing lubricating oil which comprises subjecting bright stock to a light cracking distillation, maintaining the distillate stream at a viscosity of approximately 90 to 120 seconds Saybolt Universal at 100° F. during said distillation, distilling overhead approximately 60 to 90% of the charge, blending a minor portion of the distillate with dewaxed distillate, and reducing the blend to the desired viscosity.

6. The method of preparing lubricating oil which comprises blending a minor portion of a distillate, resulting from the light cracking of bright stock under such conditions that the distillate stream is maintained at a viscosity of 90 to 120 seconds Saybolt Universal at 100° F., with a major portion of pressed wax distillate, and reducing the blend to the desired viscosity.

7. The method of preparing neutral oil having a viscosity approximately 180 seconds Saybolt Universal at 100° F. which comprises blending approximately 30% of a distillate, resulting from the light cracking of bright stock under such conditions that the distillate stream is maintained at approximately 100 seconds Saybolt Universal at 100° F. during the cracking and distilling operation, with approximately 70% of pressed wax distillate, and reducing the blend until the residuum attains the desired viscosity.

8. The method of preparing lubricating oil from paraffin base crude which comprises subjecting the crude oil to non-cracking distillation in order to distill off the pressable wax distillate, dewaxing the residuum and the wax distillate, subjecting the dewaxed residuum to light cracking distillation to obtain a further quantity of distillate, blending said last-mentioned distillate with said dewaxed wax distillates, and reducing the blended distillates to the desired viscosity.

9. Method in accordance with claim 8 in which a major portion of the residuum is distilled off during the light cracking distillation.

10. Method in accordance with claim 8 in which a minor portion of distillate from light cracking of residuum is blended with a major portion of dewaxed wax distillate.

11. Method in accordance with claim 8 in which the light cracking distillation of residuum is carried out in the presence of steam and a major portion of the residuum is distilled off.

12. Method in accordance with claim 8 in which the residuum is mixed with a light hydrocarbon

oil and subjected to light cracking distillation in the presence of steam.

5 13. The method of preparing lubricating oil which comprises subjecting paraffin base bright stock to a light cracking distillation at temperatures between 650° and 800° F., regulating the distillation so that the stream of condensate is maintained at a viscosity of from 90 to 120 sec-

onds Saybolt Universal at 100° F. until the major portion of the bright stock distills over, blending the distillate with a major portion of dewaxed wax distillate, and reducing the blend to the desired viscosity, flash, and fire tests. 5

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