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(54) A LUBRICATING OIL

(71) We, SHELL INTERNATIONAL-
ALE RESEARCH MAATSCHAPPIJ N.V.,
a company organised under the laws of The
Netherlands, of 30 Carel van Bylandtlaan, The
Hague, The Netherlands, 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 invention relates to a lubricating oil
with a viscosity index below 90.

Lubricating oils, which in general comprise
hydrocarbon mixtures obtained from crude
mineral oils, can be classified according to a
scheme introduced by the American Society of
Automotive Engineers, which scheme relates
to the viscosity of the lubricating oils at speci-
fied temperatures. According to this so-called
SAE-classification lubricating oils are classi-
fied into two groups, the winter grades and
the normal grades. Each of the two groups is
divided into a number of classes. The classes
of the winter grades are indicated by a num-
ber followed by the letter W, e.g. a 5W, 10W
or 20W oil. The classes of the normal grades
are indicated by a number only, viz. a 20, 30,
40 or 50 oil. Lubricating oils that fall within
one SAE class only are designated as single-
grade lubricating oils e.g. SAE-30, SAE-40,
SAE-50 and SAE-60 oils. Lubricating oils
which comply with both the specification of a
winter grade and that of a normal grade are
designated as multigrade lubricating oils, e.g.
5W/20, 5W/30, 10W/20, 10W/30, 10W/40,
10W/50, 20W/30, 20W/40 and 20W/50 oils.

Multigrade lubricating oils have a viscosity
sufficient for good lubrication even at the high-
est practical operating temperature of the
apparatus in which they are to be used, while
at low temperatures the viscosity does not
increase to a level which makes lubrication
insufficient e.g. at cold starting. This means
that the viscosity/temperature relationship has
to satisfy certain requirements. This relation-
ship is commonly expressed by means of the

viscosity index. (The viscosity indices men-
tioned in this specification refer to values as
determined by means of the ASTM method
D 2270-64).

Lubricating oils and lubricating oil com-
positions may be classified on the basis of their
viscosity index (VI) as low viscosity index
(LVI) oils (VI < 30), medium viscosity index
(MVI) oils (VI varying from 30 to 90), high
viscosity index (HVI) oils (VI varying from
90 to 120), very high viscosity index (VHVI)
oils (VI > 120).

The preparation of HVI lubricating base
oil is normally carried out as fol-
lows. A paraffinic crude mineral oil is
separated by means of distillation under at-
mospheric pressure into a number of distillate
fractions and a residual fraction (the so-called
long residue). The residual fraction is then sub-
jected to a distillation under reduced pressure
to separate it into fractions, for example, into
three distillate fractions and one residual frac-
tion (the so-called short residue).

The vacuum distillate fractions obtained can
be classified according to their viscosities; as
an example may be mentioned that a distilla-
tion yields three vacuum distillate fractions:
a fraction with a viscosity between about 10
and 15 cS at 140°F (further to be called
spindle oil waxy distillate), a fraction with a
viscosity between about 25 and 35 cS at 140°F
(further to be called light machine oil waxy
distillate) and a fraction with a viscosity be-
tween about 50 and 70 cS at 140°F (further
to be called medium machine oil waxy dis-
tillate).

The fractions obtained by distillation under
reduced pressure are normally subjected to a
number of refining process. These refining
processes comprise removal of at least part of
the aromatics and the paraffins (the wax) con-
tained in the oil. So far as the residual frac-
tion is concerned, removal of the asphalt is re-
quired as well. Asphalt is undesirable in
lubricating oils and also interferes in sub-

[Price 25p]

sequent refining processes. The processes for the removal of asphalt, aromatics and paraffins are hereinafter referred to as deasphalting, aromatics extraction and dewaxing.

5 Deasphalting, which in the preparation of a lubricating base oil from a residual fraction normally precedes the aromatics extraction and the dewaxing, is usually carried out with the aid of propane as deasphalting solvent.

10 Aromatics extraction — which is often carried out with the aid of furfural, sulphur dioxide or phenol as the extracting agent — serves to increase the viscosity index and to improve the colour stability and the oxidation stability of the fractions. The aromatic extracts are by-products of HVI lubricating oil manufacture and are of low value. In general they are used as fuel components.

20 Dewaxing serves to decrease the pour point of the fractions. Distillate fractions may contain considerable quantities of wax. This wax separates out if the oil is cooled below a certain temperature. On further cooling more wax will separate out until finally the mixture of wax and oil hardly flows any longer, if at all. 25 The lowest temperature observed in a standard laboratory test at which the waxy mixture still flows is called the pour point. In order to avoid difficulties during use of the lubricating oil care should be taken that the pour point of the oil is below the lowest temperature at which the oil is used. Dewaxing may be carried out by cooling in the presence of a solvent. Generally dewaxing is conducted 35 at a temperature which is about 10°C lower than the desired pour point of the dewaxed oil. Consequently, dewaxing of an oil by cooling in the presence of a solvent has to be carried out at about -20°C, because satisfactory lubricating oils generally have a pour point below -10°C. Dewaxing may also be carried out with the aid of urea.

40 A class of lubricating oils with a viscosity index below 90 has now been found which oils have a viscosity and an oxidation performance comparable to those of conventional MVI and LVI oils, by using as a component thereof a specified by-product of HVI lubricating oil manufacture.

50 Accordingly, a lubricating oil with a viscosity index below 90 is provided which comprises (a) an aromatic extract from a deasphalted residue of the vacuum distillation of a paraffinic crude oil (as hereinafter defined), and (b) a vacuum distillate fraction of a paraffinic crude oil.

55 The term "aromatic extract from a deasphalted residue of the vacuum distillation of a paraffin crude oil" when used throughout this specification means the aromatic extract obtained from the residue of the vacuum distillation of an HVI feedstock after deasphalting of that residue. This term is also referred to as the "DAO aromatic extract".

60 65 If desired, the deasphalted residue may

be dewaxed before the aromatics extraction, but in general the deasphalted residue of the vacuum distillation of a paraffinic crude oil is extracted as such, without dewaxing.

70 The extraction of the deasphalted residue may be carried out according to procedures known for this type of extraction, as discussed above, from which the raffinate (if no dewaxing has been carried out) is called waxy bright stock and which after dewaxing yields bright stock, a well-known blend component for the preparation of HVI lubricating oils.

80 The lubricating oil according to the invention can be prepared by blending the DAO aromatic extract with the vacuum distillate fraction of a paraffinic crude oil. These vacuum distillate fractions will be less viscous than the DAO aromatic extract, so that by blending in the right proportions any oil with a viscosity at a certain temperature between the viscosities of the DAO aromatic extract and the vacuum distillate fraction in question at that temperature can be prepared. As vacuum distillate fractions spindle oil waxy distillate, light machine oil waxy distillate and medium machine oil waxy distillate are very suitable. Since the use of the least viscous of these fractions (spindle oil waxy distillate) makes possible the preparation of the lubricating oils according to the invention with the highest amounts of the DAO aromatic extract incorporated, for quality and economic reasons the use of spindle oil waxy distillate as a component of the lubricating oils according to the invention is in particular preferred. If desired, mixtures of two or more vacuum distillate fractions of a paraffinic crude oil may be used.

100 The lubricating oil according to the invention may also comprise small amounts (e.g. less than 40 %w) of aromatic extracts of vacuum distillate fractions.

105 The vacuum distillate fractions in general contain an appreciable amount of wax, which must be removed in order to obtain lubricating oils according to the invention which have a low enough pour point to be used as such, or to have a pour point which is so low that it can be reduced to an acceptable value with the aid of a pour-point depressant. Although it is possible to dewax a lubricating oil according to the invention after incorporation therein of a vacuum distillate fraction as obtained during distillation, it is preferred that the vacuum distillate fraction is dewaxed before being blended with the DAO aromatic extract since this is the more convenient procedure. For that reason dewaxed light machine oil waxy distillate, dewaxed medium machine oil waxy distillate and in particular dewaxed spindle oil waxy distillate are very suitable 125 for being blended with DAO aromatic extract. Mixtures of dewaxed distillate fractions or dewaxed mixtures of distillate fractions may also be used. Although the DAO aromatic extract may be dewaxed before it is incor- 130

porated in the lubricating oils according to the invention, the amount of wax therein in general is not high enough to warrant dewaxing, while moreover dewaxing of DAO aromatic extract is cumbersome.

If the pour point of a lubricating oil according to the invention does not meet the requirements specified, incorporation of a suitable pour-point depressant may decrease the pour point to an acceptable value. Pour-point depressants are well-known, and as examples of the types of compounds which may be used may be mentioned condensation products of chlorinated wax and naphthalene, condensation products of phenol and chlorinated wax, and polymeric pour-point depressants such as polymers of esters of acrylic or methacrylic acid. Very suitable pour-point depressants consist of copolymers of ethylene and an olefinically unsaturated aliphatic monomer containing from 3 to 5 carbon atoms, such as copolymers of ethylene and unsaturated esters, e.g. copolymers of ethylene and vinyl acetate. Most preference is given to polymers containing unbranched aliphatic hydrocarbon side chains with at least 16 carbon atoms, in particular polymers of unsaturated esters, such as polymers of alkyl acrylates or alkyl methacrylates in which the alkyl chains are unbranched and contain 16—22 carbon atoms. Particularly suitable are polymers of alkyl acrylates with unbranched alkyl chains containing 18 or 20 carbon atoms with a number-average molecular weight between 10,000 and 100,000.

The amount of pour-point depressant incorporated in the lubricating oil according to the invention may vary between wide limits. Amounts between 0.01 and 1 %w are preferred.

To the lubricating oils with a viscosity index below 90 according to the invention may be added compounds which are capable of imparting desired properties to the lubricating oil. As examples may be mentioned (besides the pour-point depressants discussed) antioxidants (e.g. phenolic antioxidants); detergents (e.g. calcium petroleum sulphonates, calcium alkylsalicylates, polyamines containing a hydrocarbon chain with at least 50 carbon atoms, such as poly-isobutenyl-tetraethylene-pentamine, reaction products of a polyamine (e.g. tetraethylene-pentamine) and an alkyl-succinic anhydride in which the alkyl group contains at least 50 carbon atoms); EP additives, such as zinc dialkyldithiophosphates and the like.

EXAMPLE I.

The long residue from a paraffinic crude oil originating from the Middle East was vacuum-distilled to yield three distillate fractions, viz. a spindle oil waxy distillate (viscosity 10.2 cS at 140°F), a light machine oil waxy distillate (viscosity 29.5 cS at 140°F) and a medium machine oil waxy distillate (viscosity 56.2 cS at 140°F). The distillate fractions were solvent-dewaxed at -20°C and yielded dewaxed spindle oil waxy distillate, dewaxed light machine oil waxy distillate and dewaxed medium machine oil waxy distillate, with viscosities at 140°F of 11.5, 30.5 and 65.6 cS respectively.

The residue of the vacuum distillation was deasphalted with the aid of propane and the deasphalted oil obtained was extracted with the aid of furfural. The furfural extract obtained is further on in the Examples referred to as DAO aromatic extract.

The deasphalted oil described above was dewaxed at -20°C, and the dewaxed deasphalted oil so obtained was used as a component in some of the lubricating oils according to the invention. Thirty per cent of this dewaxed deasphalted oil consisted of DAO aromatic extract.

Several blends containing DAO aromatic extract and the dewaxed waxy distillate fractions were blended in several proportions in order to give SAE30, SAE40, SAE50 and SAE60 oils, as is seen from Table I.

The dewaxed medium machine oil waxy distillate was extracted with furfural. The extract (medium machine oil furfural extract) was used in the comparative experiment in Table I.

The oxidative properties of the blends were determined with the aid of a method according to which, for 24 hours and at 130°C, 15 l air per hour was passed through the oil, which contained copper and iron wires. At the end of each experiment the sludge content of the oil after 20-fold solution with n-heptane was determined. The results are compiled in Table I.

In Experiment 4, which is a comparative experiment with a lubricating oil not according to the invention, the sludge content was higher than 3 %w, which shows that the oxidative properties of this oil are inferior to those of the lubricating oils according to the invention.

TABLE I

Exp. No.	1	2	3	4	5	6	7	8	9	10
SAE Class	30				40			50		60
DAO aromatic extract, pbw	53	26	38		50	64	40	75	60	85
Dewaxed de-asphalted oil, pbw		27	15		15					
Dewaxed spindle oil waxy distillate, pbw	47	47	47	41.4	35	36		25		15
Dewaxed light machine oil waxy distillate, pbw							60		40	
Medium machine oil furfural extract, pbw				58.6						
Viscosity at 210°F, cS	11.4	12.2	11.9	11.0	15.5	14.7	14.9	19.5	19.8	25.5
VI	57	87.5	68	29.5	61.5	48	64	42	45	28
Sludge, %w	2.5	1.2	1.9	3.4	1.6	2.1	2.6	1.7	2.2	1.6

EXAMPLE II.

To blend consisting 75%w. DAO aromatic extract and 25 %w dewaxed spindle oil waxy distillate (lubricating oil 8 in Table I) were added three pour-point depressants, viz. a polymer of C₁₈-alkyl acrylate with a number average molecular weight of 25,000 (additive

A) and two commercial copolymers of ethylene and vinyl acetate (additive B and C). As is seen from Table II, which shows the pour points of the blends in °C determined according to ASTM D 97, the pour point is decreased to an appreciable extent, in particular by the polyacrylate.

TABLE II

Additive	A	B	C
Amount of additive, %w			
0	+18	+18	+18
0.2	-3	0	0

EXAMPLE III.

The long residue from a parafinic crude oil originating from the Middle East, which was different from the crude oil described in Example I, was vacuum-distilled to yield three distillate fractions (a spindle oil waxy distillate, and light machine oil waxy distillate and a medium machine oil waxy distillate); the spindle oil waxy distillate obtained had a viscosity at 140°F of 10.0 cS. The spindle oil waxy distillate was dewaxed at -20°C yielding a dewaxed spindle oil waxy distillate with a viscosity of 11.2 cS at 140°F and a pour point of -12°C.

The residue of the vacuum distillation was deasphalted with the aid of propane, and the deasphalted oil obtained was extracted with the aid of furfural to yield a DAO aromatic extract.

Lubricating oils according to the invention were prepared by blending the dewaxed spindle oil waxy distillate and the DAO aromatic extract, and the oxidative properties of the blends were investigated with the aid of the method described in Example I. Table III shows the results.

TABLE III

SAE class	60	50	40	30
DAO aromatic extract, pbw	75	70	60	50
Dewaxed spindle oil waxy distillate, pbw	25	30	40	50
viscosity at 210°F, cS	24.3	21	15.8	12
VI	60	64	67	70
Sludge, %w	0.2	0.3	0.3	0.4

EXAMPLE IV.

Several pour-point depressants were added in different amounts to lubricating oils prepared by blending the dewaxed spindle oil waxy distillate (dewaxed at -20°C) and the DAO aromatic extract as used in Example III. As pour-point depressants were used the additives A, B and C described in Example II and an additive D consisting of a polymer

of C₂₀-alkyl acrylate with a number average molecular weight of 60,000.

The results are listed in Table IV, in which the pour points are given in °C. It is seen that with all blends the pour points can be reduced to an attractive value. If the spindle oil waxy distillate is dewaxed at temperatures higher than -20°C, additive A gives rise to somewhat lower pour points than additive B.

TABLE IV

Additive		—	A		D		B		C	
Concentration of additive, %w			0.05	0.1	0.05	0.1	0.05	0.1	0.05	0.1
DAO. aromatic extract, pbw	dewaxed spindle oil waxy distillate, pbw									
85	15	+33	+3	+3	+12	+9	+15	+3	+15	+15
75	25	+30	+6	+3	+6	+6	+3	0	+6	+6
65	35	+15	0	0	+3	+3	0	0	+3	+3
55	45	+9	0	-3	-3	-3	-6	-6	-6	-6
75	25*	+30	+9	+6			+12	+12		
75	25**	+27	+6	+3			+9	+9		

* This dewaxed spindle oil waxy distillate was obtained by dewaxing the spindle oil waxy distillate. at 0°C.

** This dewaxed spindle oil waxy distillate was obtained by dewaxing the spindle oil waxy distillate at -10°C.

WHAT WE CLAIM IS:—

1. A lubricating oil with a viscosity index below 90 comprising (a) an aromatic extract from a deasphalted residue of the vacuum distillation of a paraffinic crude oil (as hereinbefore defined), and (b) a vacuum distillate fraction of a paraffinic crude oil.
2. A lubricating oil according to claim 1, in which the vacuum distillate fraction is a spindle oil waxy distillate.
3. A lubricating oil according to claim 1, in which the vacuum distillate fraction is one that has been dewaxed prior to blending.
4. A lubricating oil according to any one of the preceding claims in which a pour-point depressant is incorporated.
5. A lubricating oil according to claim 4, in which the pour-point depressant is a copolymer of ethylene and an olefinically unsaturated aliphatic monomer containing from 3 to 5 carbon atoms.
6. A lubricating oil according to claim 5, in which the pour-point depressant is a copolymer of ethylene and vinyl acetate.
7. A lubricating oil according to claim 4, in which the pour-point depressant is a poly-

mer containing unbranched aliphatic hydrocarbon side chains with at least 16 carbon atoms.

8. A lubricating oil according to claim 7, in which the pour-point depressant is a polymer of alkyl acrylates or alkyl methacrylates in which the unbranched alkyl chains contain 16—22 carbon atoms.

9. A lubricating oil according to claim 8, in which the pour-point depressant is a polymer of alkyl acrylates with unbranched alkyl chains containing 18 or 20 carbon atoms, with a number-average molecular weight between 10,000 and 100,000.

10. A lubricating oil according to any one of claims 4 to 9, in which the amount of pour-point depressant is between 0.01 and 1 %w.

11. A lubricating oil according to claim 1, substantially as described with reference to the Examples.

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TABLE IV

Additive		—	A		D		B		C	
Concentration of additive, %w			0.05	0.1	0.05	0.1	0.05	0.1	0.05	0.1
DAO. aromatic extract, pbw	dewaxed spindle oil waxy distillate, pbw									
85	15	+33	+3	+3	+12	+9	+15	+3	+15	+15
75	25	+30	+6	+3	+6	+6	+3	0	+6	+6
65	35	+15	0	0	+3	+3	0	0	+3	+3
55	45	+9	0	-3	-3	-3	-6	-6	-6	-6
75	25*	+30	+9	+6			+12	+12		
75	25**	+27	+6	+3			+9	+9		

* This dewaxed spindle oil waxy distillate was obtained by dewaxing the spindle oil waxy distillate. at 0°C.

** This dewaxed spindle oil waxy distillate was obtained by dewaxing the spindle oil waxy distillate at -10°C.

WHAT WE CLAIM IS:—

1. A lubricating oil with a viscosity index below 90 comprising (a) an aromatic extract from a deasphalted residue of the vacuum distillation of a paraffinic crude oil (as hereinbefore defined), and (b) a vacuum distillate fraction of a paraffinic crude oil.
2. A lubricating oil according to claim 1, in which the vacuum distillate fraction is a spindle oil waxy distillate.
3. A lubricating oil according to claim 1, in which the vacuum distillate fraction is one that has been dewaxed prior to blending.
4. A lubricating oil according to any one of the preceding claims in which a pour-point depressant is incorporated.
5. A lubricating oil according to claim 4, in which the pour-point depressant is a copolymer of ethylene and an olefinically unsaturated aliphatic monomer containing from 3 to 5 carbon atoms.
6. A lubricating oil according to claim 5, in which the pour-point depressant is a copolymer of ethylene and vinyl acetate.
7. A lubricating oil according to claim 4, in which the pour-point depressant is a poly-

mer containing unbranched aliphatic hydrocarbon side chains with at least 16 carbon atoms.

8. A lubricating oil according to claim 7, in which the pour-point depressant is a polymer of alkyl acrylates or alkyl methacrylates in which the unbranched alkyl chains contain 16—22 carbon atoms.

9. A lubricating oil according to claim 8, in which the pour-point depressant is a polymer of alkyl acrylates with unbranched alkyl chains containing 18 or 20 carbon atoms, with a number-average molecular weight between 10,000 and 100,000.

10. A lubricating oil according to any one of claims 4 to 9, in which the amount of pour-point depressant is between 0.01 and 1 %w.

11. A lubricating oil according to claim 1, substantially as described with reference to the Examples.

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