Patented Oct. 26, 1937 **2,096,725**

UNITED STATES PATENT OFFICE

2,096,725

PROCESS OF REFINING MINERAL OILS

Chester E. Andrews, Overbrook, and Merrell R. Fenske, State College, Pa., assignors to Röhm & Haas Company, Philadelphia, Pa.

No Drawing. Application June 13, 1935,
Serial No. 26,408

16 Claims. (Cl. 196—13)

This invention relates to the refining of mineral oils and particularly to a process for separating mineral oils into various fractions having different chemical and physical properties. It is applicable to any of the distillates or residues obtained from the crude oil in the usual refining processes.

It is known that petroleum oils of different origins contain various types of hydrocarbons either alone or in admixture with other types. These types are in general paraffinic, aromatic, hydroaromatic or naphthenic, and unsaturated. Of these the paraffinic hydrocarbons are the least reactive, the naphthenes next and the aromatic and unsaturated hydrocarbons are the most reactive.

The value of the more viscous fractions of these oils depends more on the physical than on the chemical properties of the oil, the latter being only important in that they more or less determine the former. One of the principal uses of such oils is in the lubrication of all kinds of machinery and the value of the oil for this purpose depends on its viscosity and particularly on the temperature coefficient of the viscosity. An oil having a high temperature coefficient is not so good a lubricant over a wide temperature range as is one having a lower coefficient. The numerical value of this coefficient varies with oils of various composition and those which have the greatest proportion of paraffinic hydrocarbons have the lowest coefficients.

A practical method of expressing the quality of a lubricating oil in terms of this coefficient is by means of the "viscosity index" which is a function of the viscosities of the oil at 100° and 210° F. (see Dean and Davis, Chem. and Met. Eng. 36, 618, 1929). According to this method an oil having a high viscosity index is more desirable and contains a larger proportion of paraffinic hydrocarbons.

The more viscous fractions of these oils often contain substantial amounts of paraffin wax which crystallizes at low temperatures of operation and these crystals interfere with the flow and lubricating properties of the oil at low temperatures. In order that the components of these fractions of lubricating oil retain at all times, under conditions of use, their mutual solubility, these lubricants are put through a so-called "dewaxing" process. This consists of chilling the fraction down to a temperature where the wax separates out and then filtering out the separated wax. Due to difficulties in operation, this "dewaxing" is an involved problem in petroleum refining and many diluents and selective solvents have been proposed as an aid to its solution. The effectiveness of any process for wax removal is commonly determined by measuring the "pour point" of the oils before and after treatment. This "pour point" of an oil is related to the temperature at which the oil ceases to flow and those of low pour test are most desirable for winter lubrication.

The less viscous fractions of these oils are believed to contain the same types of hydrocarbons as the more viscous fractions, but of lower molecular weight. The gasoline fractions from crude oils of different origins contain varying proportions of the various hydrocarbon types just as the lubricating oil fractions do. Due to the excessive knocking which they cause in the internal combustion engine, the normal paraffins are the least desirable constituents of a fuel suitable for automotive use. No method has as yet been devised for the removal of normal paraffins from a motor fuel, but it has been necessary to add anti-knock agents to those gasolines which contain high percentages of these straight chain hydrocarbons. Many organic compounds, including low boiling fractions from cracking operations, have been proposed and used to counteract the effect of these paraffins.

A high grade kerosene fraction is one which contains a high per cent. of paraffin hydrocarbons. The process of treating kerosene fractions with liquid sulfur dioxide for removal of aromatics is well known to the petroleum industry.

It has now been found that such hydrocarbon mixtures may be separated into fractions by treatment with certain solvents, and in so doing, mixtures having enhanced physical or chemical properties may be obtained.

We have discovered that the lower amines of the aliphatic series, particularly the three methylamines, either alone or in mixtures among themselves or with ammonia, water, methanol, or other liquids, are very effective solvents for removing undesirable hydrocarbons from petroleum fractions, either by extraction or precipitation. Any type of hydrocarbon mixture from gasoline to the most viscous lubricating oil, whether previously treated with sulfuric acid or refined by any other method, may be subjected to treatment with the solvents mentioned above. In all cases the mixture so treated will be separated into fractions having different chemical and physical properties.

The solvent used may be a pure amine, a mixture of amines, and mixtures of these with other liquids such as water, ammonia, methanol and other alcohols, monoethyl ether of ethylene glycol, aniline, aromatic hydrocarbons etc. The process is carried out in a closed system, if necessary under pressure, and at a temperature low enough to keep the solvent in the liquid state and to permit the formation of at least two phases. In certain types of operation it may be desirable to cool the mixture of solvent and oil. By lowering the pressure on the system a certain amount of the amines or ammonia will evaporate, thus causing a lowering of the temperature. The solvent thus evaporated can be condensed in a suitable apparatus and returned to the system or used in a subsequent treatment. This internal refrigerating action is advantageous in the process for removal of wax.

These solvents also have the advantage that their selective solubility can be varied to fit any hydrocarbon mixture by changing the percentage composition of the amines in the solvent mixture. They can be removed readily from the final product and recovered practically completely. They form no tarry residues which have little or no value, and are easily handled. No high temperature equipment is required even for the complete removal of the solvent from the final product.

The process may be carried out in any suitable extraction apparatus, such as a series of mixing and settling tanks or in a suitable contacting tower by a counter-current method. In the process for wax removal, any of the conventional types of apparatus may be used with the amines producing a sharper and easier separation of oil from wax.

Whatever the nature of the extraction process, the mixture of hydrocarbons and amines will separate into two liquid phases, one of which will contain a higher proportion of amines than the other. Likewise, one phase will contain a higher proportion of certain hydrocarbon types than the other because in no case is there a sharp line of demarcation in the solubilities of the various hydrocarbon types in the different amine mixtures.

It is also possible to dissolve practically all of the material being treated in the solvent and then by changing the temperature, pressure or composition of the solvent to cause the formation of two phases in which the relative proportions of the various types of hydrocarbon are different.

The two phases which appear are separated, and each is subjected to a distillation process or an equivalent process in order to remove the amines and other solvent in case a mixture is used. The amines with or without the other solvent are then brought back to the liquid state in order to be available for later use with another batch of hydrocarbon. It may be necessary to warm the oil somewhat in order to completely remove the amines, and carrying out this step at reduced pressures also facilitates the complete removal. By washing the oil containing amine with a suitable solvent such as water, methanol and the like, the removal of amine from the oil may also be effected. It is advantageous to remove the amines at somewhat elevated temperatures under pressures sufficient to condense them at temperatures of ordinary cooling water in order to avoid the use of compressors or condensing liquids other than water.

The proportion of solvent to oil used in this process may be varied within very wide limits and will depend on the nature of both solvent and oil, the proportion of material that is to be removed, and the temperature. The same is true of the temperature, specific amine mixture or mixture of amine with other liquids. The composition of the solvent can also be changed so as to meet any desired operating conditions such as temperature, pressure, density etc., as well as to give a product of any predetermined characteristics.

Liquids which may be used with the amines in order to bring about these results are ammonia, water, methanol, isopropanol, ethanol, and other alcohols, aniline, monoethyl ether of ethylene glycol etc. In fact, any solvent which in combination with amines and oil will produce two phases, is more or less suitable. It is immaterial whether the extracted oil exists as a separate phase containing a small percentage of solvent or whether a solvent mixture is used which is not completely miscible and the oil is added and allowed to partition itself between the two solvents according to their selectivity for the various types.

This method is applicable to the entire range of distillates and still residues obtained in the ordinary refining of Pennsylvania, Mid-Continent, California, Texas, Mexico etc. oils, and in every case fractions of varying composition and properties are obtained.

We have also found that lubricating oils which have been extracted by the methylamines respond more readily to clay treatment for color improvement than the unextracted oil even though they may appear to be darker. For a corresponding color improvement there is, therefore, less clay needed for an extracted oil than for an unextracted oil.

The following tables show the results of various extractions with widely varying solvent mixtures on all types of these oils. Increase in viscosity index is accompanied by improvement in many of the other physical properties such as Conradson carbon residues, oxidation characteristics etc., viscosity gravity constant.

In these tables there are in some cases two oils given after the solvent. The upper one is in all cases the residual oil left after extraction, and the lower one the extract. Where only one is given, it is in all cases the residual oil. In those cases where a pressure is recorded it is absolute pressure, and where no pressure is given, it merely means that it was not measured for that particular extraction.

In the tables "Vol." means the ratio of the volumes of amine solvent used per volume of oil being treated. "V. I." indicates Viscosity Index.

The original oils had the following characteristics:

	Viscosity		V. I.
	210°	100°	
Distillate oil A	45.1	185.5	95
Distillate oil B	55.3	577	15.2
Residual oil A	157.2	2692	95.4
Residual oil B	107.4	1820	72.5

TABLES

Distillate oil A

Solvent	Percent amine	Temp. ° C.	Vol.	V. I.	Viscosity		Yield	Press. atm.
					210° F.	100° F.		
Monomethylamine	100	−18	5	103	45.0	176.4	*Percent* 77	
				66	47.0	251.0		
Monomethylamine		−12	2.4	101.5	44.9	177.2	85	
Dimethylamine				63.0	47.6	268.0		
Mixed amines	100	0	2	100.7	45.2	181.7	60	1.0
				91.0	45.5	196.0		
Monomethylamine	80	30	1.9	99.6	45.1	180.9	90	7
Ammonia				80.6	46.2	220.0		
Monomethylamine	62	0	6.7	100.2	44.9	178.1	93	
Ammonia								
Monomethylamine	50	25	8.4	104.8	45.1	176.3	65	
Isopropanol								
Monomethylamine	84	25	1.8	100	45.1	180.8	79	
Ethanol								
Dimethylamine	54	30	1.5	99.6	45.1	181.3	91	
Ammonia								
Trimethylamine	53	30	2.8	99.2	45.0	180.3	90	
Ammonia				75.0	46.4	231.0		
Monomethylamine	83	30	1.6	101.9	45.1	179.4	91	3
Methanol				71.7	47.6	255.6		
Monomethylamine	69	10	6.0	102.7	44.9	175.0	90	
Methanol				67.0	47.5	259.0		
Monomethylamine	70	0	5.8	101.0	44.9	176.9	81	
Methanol				58.0	48.1	285		
Dimethylamine	25	25	8	101.6	44.8	174.9	84	
Methanol				49	48.2	300		1
Dimethylamine	50	25	2	100.4	45.0	179.0	86	
Methanol				70.0	46.5	237		1.3
Trimethylamine	42	30	2.3	99.9	44.9	178.6	88	
Methanol				66	47.0	252		
Mixed amines	25	25	4	99.5	45.0	179.9	94	1.6
Methanol								
Dimethylamine	91	25	3	102.0	45.0	179.2	80	
Water				77	46.2	223		1.3
Dimethylamine	91	50	3.4	99.9	45.1	181.0	60	
Water				88	45.4	197.0		1.6
Dimethylamine	83	50	3	98	45.0	181.3	94	
Water								1.6
Dimethylamine	83	100	2.6	99.5	45.1	181.4	92	
Water								8
Trimethylamine	90	30	4.8	97.1	45.1	183.8	75	
Water				84	45.9	210		
Monomethylamine	80	25	2.1	101.0	45.1	180.0	87	
Ammonia								
Monomethylamine	80	25	3.5	101.9	45.0	177.6	75	
Ammonia				76.0	46.2	226		
Monomethylamine	95	25	3.0	101.3	45.0	178.1	86	
Water								
Dimethylamine	61	25	2.4	99.4	45.2	183.1	80	
Ammonia				82	45.4	203		

Residual oil A

Monomethylamine	100	0	2	97.4	161.5	2725	93	
Monomethylamine	80	30	2.3	97.3	162.3	2756	93	
Ammonia				60.3	116.6	2355		
Monomethylamine	95	30	4.3	99.3	180.3	3145	59	
Methanol				83.5	118.6	1945		
Monomethylamine	80	30	4.6	100.8	197.5	3556	44	
Ethylacetate				85	121.5	1997		
Monomethylamine	95	30	4.3	97.4	161.5	2724	98	
Water								
Monomethylamine	79	30	2.5	98.4	169.3	2901	84	
Ammonia benzol				76.6	115.9	2009		

Residual oil A—Continued

Solvent	Percent amine	Temp. ° C.	Vol.	V. I.	Viscosity		Yield	Press. atm.
					210° F.	100° F.		
							Percent	
Monomethylamine	80	30	2.5	97.8	170.4	2957	83	
Ammonia methylcyclohexane				78.7	113	1877		
Dimethylamine	62	30	3.1	97.4	166.2	2850	89	
Ammonia				71.8	104.9	1773		
Dimethylamine	83	0	4.2	99.2	182.2	3220	80	
Ammonia								
Dimethylamine	73	0	7.3	98.9	174.6	3013	76	
Ammonia								
Dimethylamine	89	0	2.0	97.4	169.7	2945	80	
Methanol								
Dimethylamine	95	25	3	98.5	175.7	3067	80	
Water				85.4	116	1829		2
Dimethylamine	95	50	2	97.2	165.6	2852	88	4
Water								
Dimethylamine	96	30	2.1	97.2	163.9	2818	91	
Water				75.2	117.0	2071		
Trimethylamine	78	0	2.5	97.2	170	2973	83	
Ammonia				89	121.5	1890		
Trimethylamine	60	0	2.2	97	160.0	2805	90	
Methanol								
Trimethylamine	75	0	3.6	99.6	189.0	3408	56	
Methanol				90	129.7	2118		
Monomethylamine	80	25	3.8	99.9	177.2	3045	73	
Monoethyl ether of ethylene glycol				77	113.8	1943		
Monomethylamine	60	25	4.0	101.1	159.4	2518	82	
Aniline				64	156.0	3958		
Monomethylamine	91	25	8.0	101.2	183.0	3119	70	
Ethanol				78	114.1	1917		
Monomethylamine	91	25	7.5	101.2	196.0	3477	61	
Isopropanol				83	113.8	1822		

Distillate oil B

Dimethylamine	81	0	2.3	22.8	57.3	611	65	
Methanol				−5	53.8	567		
Dimethylamine	67	10	5.5	33.9	61.2	698	26	
Methanol				3	54.5	572		
Monomethylamine	87	0	4.8	36.4	58.3	611	68	
Ammonia				−26	55.1	669		

Residual oil B

Dimethylamine	81	0	2.0	81.2	135.6	2524	34	
Methanol				65.4	88.5	1320		
Dimethylamine	70	0	9.5	80.4	134.8	2523	64	
Ammonia								

Texas solar

Methanol	50	25	1.3	62	50.2	327	87	
Dimethylamine								
Methanol	50	25	4.0	72	49.7	297	61	
Dimethylamine				13	54.9	559		
Original oil				52.5	50.9	359	100	

California distillate

Methanol	50	25	1	−31	56.3	731	76	
Dimethylamine				−152	67.5	1866		
Methanol	50	25	3	−10	56.5	679	33	
Dimethylamine				−90	58.6	1024		
Original oil				−48	56.6	791	100	

Complete inspection data

Solvent	Percent amine	Temp. °C.	Vol.	V. I.	Viscosity 210° F.	Viscosity 100° F.	Yield	Press. atm.	Gravity A. P. I.	Sp. Gr.	Visc./Grav. constant	Color
Distillate oil A												
							Percent					
Methanol	56	25	2	100.0	45.0	180.2	94	1.5	30.4	0.8739	0.819	4½
Monomethylamine				22.0	50.9	415			19.9	0.9343	0.882	8+
Ammonia	75	25	2.1	101.0	45.1	179.7	85	7.0	30.4	0.8744	0.819	4½
Monomethylamine				65.0	46.6	243			25.2	0.9029	0.851	8+
Residual oil A												
Ammonia	86	25	2.1	96.5	159.9	2724	94		25.2	0.9034	0.814	7½
Monomethylamine				58	121.5	2618						8+
Methanol	86	25	2.0	97.3	158.2	2639	94		25.4	0.9000	0.809	7½
Monomethylamine												
Methanol	93	25	2.0	98.1	162.5	2724	90		25.5	0.9016	0.811	7½
Monomethylamine				65.0	115.8	2251			21.8	0.9223	0.845	8+
Original distillate A												
				95	45.1	185.5			29.6	0.8782	0.823	4½
Original residual A												
				95.4	157.2	2692			25.6	0.9006	0.809	7½

From these tables it is obvious that a wide choice of conditions is open to the operator, but in every instance a lubricating oil of increased viscosity index is obtained. Thus, the operator can choose any particular set of conditions consistent with the desired result.

A sample of gasoline from which the light naphtha had been removed was extracted with a water-monomethylamine mixture containing 50 volume per cent. amine The extract portion had a refractive index of 1.4554, and the raffinate of 1.4388. Since it is generally known that the straight chain paraffins are the most undesirable constituents of a superior or high "knock rating" motor fuel, and further, that for a given boiling point the normal paraffins are among the compounds having the lowest refractive index it is obvious that a motor fuel of improved knock rating has been produced in the extract portion. Since gasoline is a relatively volatile hydrocarbon mixture, we prefer to use an amine-ammonia solvent mixture in order to facilitate the removal of solvent by distillation at low temperatures thus preventing the loss of gasoline. We have also found that the presence of the methylamines, particularly dimethylamine and monomethylamine in gasoline in small quantities greatly increases or improves the knock rating of the fuel. Thus, by extracting a gasoline with a mixture of dimethylamine and ammonia and by removing not quite all of the solvent, a fraction can be produced that has been improved on two counts, namely, it will contain a smaller proportion of hydrocarbons of poor detonating qualities and will also contain an active anti-knock agent.

A sample of kerosene was extracted with a methanol-monomethylamine mixture yielding an extract having a refractive index of 1.4741 and a raffinate with one of 1.4474. As in the case of the extraction of gasoline, an improved kerosene is recovered from the raffinate portion since it has a lower refractive index and, therefore, a higher content of paraffin type hydrocarbons.

A mixture containing 49 wt. per cent toluene and 51% methylcyclohexane was extracted with an 87 volume per cent monomethylamine-13% water mixture. The extract portion was 63.5% toluene and the raffinate portion was 46% toluene.

A cyclohexane-benzene mixture containing 16.5% of the former on extraction with a mixture of methylamines and water gave an extract analyzing 11% cyclohexane and a raffinate analyzing 21% cyclohexane.

A normal heptane-toluene mixture, containing 42 mol. per cent of the former on extraction with a mixed methylamine-water mixture, yielded an extract containing 10.5 mol. per cent heptane and a raffinate containing 43.3 mol. per cent heptane.

Similarly the amine solvent mixtures have a selective solubility for olefins over paraffins.

Besides separating hydrocarbon mixtures according to type, the amine solvent mixtures also produce separation according to molecular weight or viscosity. When a sample of oil is vaporized during a distillation, separation is brought about according to molecular weight or viscosity. This is because, in general, the higher the boiling point, the higher is the viscosity and molecular weight. However, separation according to type does not usually occur to any degree by distillation in the case of an extremely complex hydrocarbon mixture such as a lubricating oil. This fact is shown by measuring the viscosity index of a Pennsylvania neutral and bright stock. It will be found that they are practically identical.

A mixture of normal paraffins in the range of approximately 16–18 carbon atoms per molecule, and an equal volume of normal heptane was extracted with a mixed amine-water solvent. The extract portion contained 35% of the high molecular weight paraffins, and the raffinate 55% of the high molecular weight compounds. This property of the amine solvent mixtures to produce separation according to molecular weight we have termed a "fractionating process".

The following examples show how the methylamines aid as a diluent, internal refrigerant, and selective solvent for oil in a dewaxing process:

The solubility of paraffin wax in naphtha, in benzene-acetone solution containing 65% benzene, and in dimethylamine, was determined at 7° C. The first two solvents have been used for dewaxing purposes commercially. The wax was found to be six times as soluble in the naphtha and three times as soluble in the benzene-acetone solution as it was in the dimethylamine. The methylamines also possess the advantage of being less dense so that when they are added to the oil, the specific gravity of the solution is greatly reduced and the wax can settle out more easily. In the case of the first two solvents the cooling was brought about by the use of external refrigerants, but with the dimethylamine its internal refrigerating action caused by evaporation was used to maintain the desired temperature.

A sample of Pennsylvania cylinder stock having a pour point of 70° F. yielded oils on treatment with dimethylamine having pour points of 45° F., 35° F., 25° F., and 15° F., depending on the amount of dimethylamine present and the temperature to which the mixture was cooled.

Similar treatment on a Pennsylvania wax distillate of 70° F. pour point produced easily oils of −5° F. pour. We have found that with monomethylamine alone the mixture of solvent and wax distillate on sufficient cooling separates into one solid and two liquid phases. We prefer to keep the concentration of the di- and trimethylamines in the solvent or diluent sufficiently high so that only one liquid phase is formed on cooling thus facilitating the removal of the wax from the oil.

The foregoing data are given by way of illustration only and not as a limitation, since the invention may be otherwise practiced within the scope of the appended claims.

In the claims, the term "methylamine" is employed to include monomethylamine, dimethylamine and trimethylamine, mixtures of any two of them or mixtures of all three or mixtures of these and suitable proportions of other liquids. By suitable proportions we mean the addition of quantities of other liquids to the methylamines to obtain the desired operating conditions, such as temperature, solvent to hydrocarbon ratio, density, pressure, etc., and to obtain products with the desired properties, such as hydrocarbon type or molecular weight, viscosity, volatility, gravity, viscosity index, carbon residue, oxidation characteristics, color, knock rating, pour point, melting point, penetration and the like.

The liquids used with the methylamine consist of a variety of substances, which, mixed together with the amines and the mixture to be treated, produce two phases under any practical operating conditions and do not react with the methylamine or the mixture to be treated. Thus it is seen that a variety of substances which in themselves have insufficient solvent action selective characteristics to be used alone, may now be used along with the amines as effective solvents.

In addition to these features, these methylamine solvents have many other desirable properties, such as low boiling point, low freezing point, low density, low viscosity, solubility in organic as well as in inorganic substances, availability, chemical stability, non-corrosive to ordinary materials of construction, easy detection and estimation, etc. The low boiling point permits easy removal, the avoidance of the high temperatures and possible thermal decomposition of the products; the low density and viscosity permit easy and rapid separation of the phases; the low freezing allows them to be used over a wide temperature range for a great variety of purposes; the easy solubility in various substances permits the removal of amines by washing, and facilitates handling and storage; their chemical stability insures low losses, as well as the avoidance of contamination; their inertness to ordinary materials of construction permits low cost of plant installation and operation and their ready analysis and detection avoids losses in handling, storage and processing.

The use of the methylamines in dewaxing petroleum oils is claimed in our application Serial No. 155,432 filed July 24, 1937.

We claim:

1. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with methylamine so that at least two phases form, separating the phases and removing the methylamine from said phases.

2. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with liquid methylamine in a closed system so that at least two phases form, separating the phases and removing the methylamine from said phases.

3. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with a solvent containing methylamine and ammonia in a closed system so that at least two phases form, separating the phases and removing the methylamine and ammonia from said phases.

4. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with a solvent containing methylamine and a liquid which is not a solvent for the hydrocarbons so that at least two phases form, separating the phases and removing the solvent from the phases.

5. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with a solvent containing methylamine and water so that at least two phases form, separating the phases and removing the solvent from the phases.

6. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with a solvent containing methylamine and a liquid which is a solvent for the hydrocarbons so that at least two phases form, separating the phases and removing the solvent from the phases.

7. The process of separating mixtures of hydrocarbons into fractions of different compositions comprising mixing said hydrocarbon mixture with a solvent containing methylamine and methanol so that at least two phases form, separating the phases and removing the solvent from the phases.

8. The process of separating petroleum oils into fractions having different chemical and physical properties which comprises mixing said petroleum oils with methylamine so that two phases form, separating the phases and removing the methylamine.

9. The process of separating petroleum oils into

fractions having different chemical and physical properties which comprises mixing said petroleum oils with a solvent containing methylamine and ammonia so that two phases form, separating the phases and removing the methylamine and ammonia.

10. The process of separating lubricating oils into fractions one of which has a higher viscosity index and the other a lower viscosity index than the original oil which comprises mixing the oil with methylamine so that two phases are formed, separating the phases and removing the methylamine.

11. The process of separating lubricating oils into fractions one of which has a higher viscosity index and the other a lower viscosity index than the original oil which comprises mixing the oil with a solvent containing methylamine and ammonia so that two phases are formed, separating the phases and removing the methylamine and ammonia.

12. The process of separating lubricating oils into fractions one of which has a higher viscosity index and the other a lower viscosity index than the original oil which comprises mixing the oil with a solvent containing methylamine and a liquid which is not a solvent for the lubricating oil so that two phases are formed, separating the phases and removing the solvent.

13. The process of separating lubricating oils into fractions one of which has a higher viscosity index and the other a lower viscosity index than the original oil which comprises mixing the oil with a solvent containing methylamine and water so that two phases are formed, separating the phases and removing the methylamine.

14. The process of separating lubricating oils into fractions one of which has a higher viscosity index and the other a lower viscosity index than the original oil which comprises mixing the oil with a solvent containing methylamine and methanol so that two phases are formed, separating the phases and removing the methylamine.

15. The process of separating kerosene into fractions having different chemical and physical properties, which comprises mixing said kerosene with methylamine so that at least two phases form, separating the phases and removing the methylamine from said phases.

16. The process of separating gasoline into fractions having different chemical and physical properties, which comprises mixing said gasoline with methylamine so that at least two phases form, separating the phases and removing the methylamine from said phases.

CHESTER E. ANDREWS.
MERRELL R. FENSKE.