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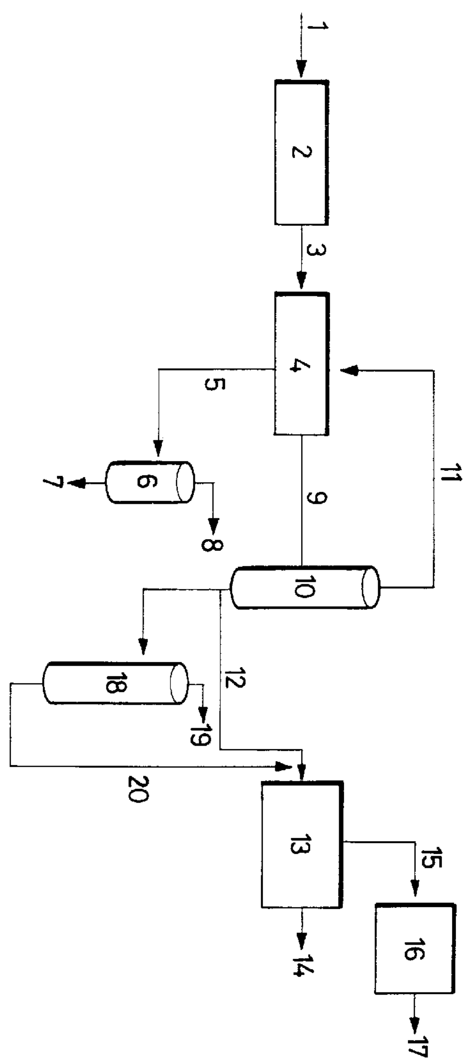
(54) Procedure used to generate electric energy from used oils and other petroleum residues

(57) Procedure used to generated electric energy from previously used oils and other petroleum residues, consisting on subjecting the previously used oils or residues (1) to an extraction process (4) with an aliphatic solvent, obtaining a fuel (9-12) that is then fed to a gas turbine (13) or diesel engine to which an electric generator is (14) coupled.

The hot engine or turbine combustion exhaust gases (15) exchange heat in the thermal system (16) before being released into the atmosphere (17).



EP 0 757 091 A1

Description

This invention refers to a procedure used to generate electric energy from used oils and other petroleum residues, using a diesel powered motor driven generator or a gas turbine fed with clean fuel, obtained from used oils or other petroleum residues, through extraction using a paraffin oil.

The procedure object of the invention includes the treatment of petroleum residues and particularly of previously used oils, solving by way of extraction, using solvents, the considerable environmental problem posed by those residues when they are used without having been properly cleaned or whenever the processes used for their treatment or recycling produce contamination. The procedure does furthermore integrate a cogeneration system that enables the efficient production of electric energy and takes advantage of the thermal energy, even for the treatment of the residues themselves.

As is already well known, lubrication oils lose their characteristics through being used to lubricate motors or other machines, becoming residues that, because of their composition, have been legally classified as toxic and dangerous. Activities such as petroleum refining, and the storage, transportation and handling of hydrocarbons generate substantial amounts of oil residues, with problems similar to those posed by used oils.

These residues are viscous oils, dark colored, which, besides their basic petroleum originated hydrocarbons, do also contain water, sediments and contaminants. In the case of lubricant oils, they furthermore contain oil degradation by-products, additive left overs and metal compounds (Zn, Pb, etc.) and even solvents.

Its contents of water, sediment, metal and other contaminants make it impossible for these residues to be used directly as fuels for the conventional generation of electric power using steam boilers and turbines, as they cause problems in the storage vessels, conduits, burners and tube nests, as well as contamination by heavy metals of the gases coming off smoke stacks. In any case, the energy yield attainable using steam generation systems and condensation turbines are low and do not justify their prior cleansing.

The use of these residues as fuels for systems of greater energy efficiency, such as for instance diesel engines or gas turbines, demand their prior cleansing, as they would otherwise damage those machines fairly quickly

The cleansing of these residues using sedimentation, filtering or centrifugation systems, even when preceded by heating with flocculant or demulsifying additives, make it possible to eliminate the water and the sediments but does not remove the metal components, which prevents their use as fuel for diesel engines or gas turbines.

Vacuum distillation, after subjecting previously used oils to a thermal treatment, is a very costly process in terms of investment and operation, employed to manufacture basic lubricant oils and which yields levels of efficiency of around 70%, which imposes a penalty upon the later generation of electric power, even when using highly energy efficient systems. It does furthermore produce a toxic and dangerous residue.

A similar situation is that represented by vacuum distillation of previously used oils preceded by tar removal using propane, a procedure also used to obtain basic oils for lubricants, although in this case yields are somewhat higher (75%0.

By way of U.S. Patent 4,151,072 is already known a procedure to eliminate the metal components of previously used oils using ammonium phosphate treatments, although this procedure requires pressure, temperature and reaction time conditions that make the project more expensive. The inclusion of the treatment using ammonium phosphate in a traditional centrifugation scheme preceded by hot treatment using flocculant and demulsifying additives has been described for the preparation of a fuel for diesel engines (Spanish patent 9200563). Given that residue contaminants are not fully removed, this process is therefore limited to naval engines designed for heavy duty work and fuels with a variable specification, and even so a greater frequency of breakdowns and a higher maintenance cost would be expected as a consequence of feeding these recycled fuels into those engines. A toxic and dangerous residue is furthermore produced.

This invention proves that the extraction of petroleum residues, and specifically from previously used oils, using paraffinic solvents, such as propane, effected under proper conditions, such as those described below, make it possible to obtain fuels with a level of quality high enough for diesel engines or gas turbines, at the same time that it achieves a simple separation of the water and of the toxic components that did contaminate the residue, further becoming these latter components inert in an asphaltic fraction; and that the usage of the heat generated by the motor or turbine combustion gases to fulfill the heating requirements of the solvent extraction stage, makes it possible to achieve a highly efficient integrated thermal system that brings about a reduction of process costs as a whole.

The procedure object of the invention is therefore based on the following innovative contributions:

1) The treatment of petroleum residues, including used oils, with paraffinic solvents, and particularly with propane, make it possible to break up the emulsions and suspensions of the residue, without requiring the addition of flocculant or demulsifying residues, so that the three stages: extract, water and fraction separate very easily through a simple decanting process. This makes it possible to implement a technical-industrial process avoiding the use of complex equipment or centrifugal machines. From the extract is then recovered a clean fuel with a surprisingly high yield, greater than 85% that of

the starting oil and very often greater than 90%.

2) The asphaltic fraction, in the case of the oils and other residues also classified as toxic and dangerous, acts as an inert rendering element, encompassing the contaminants and forming a product that is not lixiable when employed for paving or building purposes, which makes it therefore possible to obtain an inert and useful product that represents, in the case of previously used oils, approximately only 10% of the starting toxic and dangerous product.

3) The fuel, once separated from the solvent (and, as the case may be, of other light products that the starting product may have contained), and without undergoing further treatment, can be used as fuel for diesel engines and gas turbines, having already removed the water, metals, asphalt and any other contaminants contained in the original residue and which would otherwise prove harmful for the above machines.

4) The coupling of the diesel engines or gas turbines, fed by the previously mentioned fuel, to electric generators and the use of the heat given off by the combustion gases for the separation of the paraffinic solvent used in the extraction process, constitute a highly efficient integrated procedure to produced electric energy and to decontaminate petroleum residues.

In the case of used oils and other toxic and dangerous residues, the components that confer upon them the characteristics of toxicity and danger are also rendered inert.

The procedure object of the invention is integrated by a first stage in which the residue is subjected to a extraction using an aliphatic solvent, that solves fractions that are useful for fuel and separate emulsified water that contained the residue and an asphalt that brings together the contaminants in an inert fashion. The water may be cleaned using conventional systems, whereas the asphalt, not being lixiable, may be employed for paving and other building applications. In the second stage of the procedure, the fuel, once separated from the solvent, is then fed to a cogeneration system such as, for instance, a diesel engine coupled to an electric generator, whereas the heat energy given off by the exhaust gases or from the cooling of the engine elements is also recovered.

According to another characteristic of the invention, the heat of the exhaust gases is used to separate the aliphatic solvent from the fuel by distillation, as well as for other purposes within the productive process. Generally, although not necessarily, this heat transfer is effected through the intermediate production of steam or of a thermal fluid.

The procedure object of the invention does also allow the use of a gas turbine coupled to an electric generator, in lieu of the diesel powered engine, which is particularly suitable whenever there is a substantial consumption of heat energy of high thermal value in the area where the procedure is installed, or whenever the capacity of the plant is large, and a combined cycle (gas turbine and steam turbine in series) is therefore justified.

Finally, the heat generated by the exhaust gases coming off the motor or the gas turbine may be exported by the plant and used in applications in which its high thermal level may represent an added advantage, whereas heat energy at a lower thermal level may at the same time be imported to cover the services required by the plant.

The environmental problem posed by previously used oils and other similar residues is solved through the application of the procedure object of the invention, given that the contaminants that confer toxicity to the residue are removed from the fuel during the extraction process and are rendered inert in the form of a non lixiable asphalt which may then be used for paving.

Furthermore, the procedure object of the invention achieves an optimal energy usage thanks to the high fuel yield obtained from the extraction of the residue and to high electric and thermal efficiency of the cogeneration system, which makes it possible to used the heat contained within the exhaust gases given off by the machines to cover the requirements of the process and/or other uses.

On the other hand, as against the already known processes of vacuum distillation of the residue, whether preceded by other treatments or not, the procedure object of the invention has the advantage of requiring a lesser capital investment, less ongoing costs and producing a greater yield.

As against the traditional physical-chemical treatment systems, the invention offers the advantage of achieving a cleaner and purer fuel (given that not only metal particles are removed, but asphaltic compounds and other contaminants are also reduced) which allows its use as fuel for diesel engines and gas turbines, without incurring into any penalties because brought about by increased machinery breakdowns and greater machine maintenance costs, at the same time that treatment conditions (temperature and treatment time) are reduced and high material yields are maintained.

As against the previously mentioned already known processes or systems, the invention offers the advantage of not producing toxic or dangerous residues, as it renders them inert in the form of an asphaltic component, which is non lixiable.

The characteristics of the invention are described below with reference to the enclosed figure that represents the scheme followed by the procedure.

The petroleum residues 1, and, more specifically, the previously used oils, are first subjected to a coarse cleaning and screening process, passing it through a screen 2 or similar screening method. The coarsely cleaned residues 3, are then treated with an aliphatic solvent, preferably propane, in the extraction facility 4.

The extraction process is advantageously effected putting the solvent and residue in contact in a continuous and counter current fashion, using the equipment usually employed for this operation, such as the extraction column without filling, fitted with plates; or with filling; or with agitated compartments, etc. The extraction process may also be effected discontinuously or in systems in which the liquid solvent injected produces the agitation. The solvent is used in 2:1 to 20:1 volume ratios in respect of the oil and frequently between 5 and 10.

The temperatures may oscillate between 5 and 50°C although temperatures of between 5 and 30°C are generally used. The pressure tends to be that corresponding to the solvent steam pressure, in the case of propane, between 8 and 12 atmospheres at temperatures between 15 and 30°C.

The non extracted product 5 is then taken to the decanter 6, where water 7 and the asphaltic compounds 8 are separated.

Extract 9 is then taken to a distillation column 10 where the propane 11 is taken through its upper section to be then recycled to the extraction system 4 and where the fuel 12 is taken through its lower section.

The fuel powers a diesel engine or a gas turbine coupled to a generator 13 that produces electric energy 14, whereas the hot engine exhaust or turbine combustion gases exchange heat in the thermal system 16 before being released to the atmosphere 17.

The thermal system 16 may be a heat exchanger used to generate steam or to heat a thermal guild or directly a process fluid. In the case of steam generation, it may impulse a condensation turbine forming a combined cogeneration cycle. Heat may be obtained from the motor driven generator 13, or from the system 16, in the form of steam, hot water or thermal fluid , which may later be used to service the process, and particularly the distiller 10 and the striper 18.

The stripper 18 may be optionally used whenever residues are contaminated with solvents or light petroleum fractions, separating, through its upper section 19, the solvents or light compounds of the stabilized fuel 20.

<u>EXAMPLE</u>

Following the invention procedure, 300 liters (262 kg) of previously used engine oil, already screened to remove any gross solids, were introduced into a discontinuous extractor, where is was placed in close contact with 2 m^3 of liquid propane at 25°C and 11 atmospheres, during 10 minutes.

It was left to decant during 5 minutes and then the propane solution was taken off the upper section whereas the asphalt and water mixture was taken through the lower section. Propane evaporation left 238 kg of fuel oil with a yield of 91% by weight.

The lower stage, not extracted, was then decanted, separating 8 kg of water 3% by weight and 16 kg of asphalt compound ∗6% by weight).

The fuel thus obtained in various extraction procedures is fed at a rate of 200 kg/hour into a four stage diesel engine, with six cylinders and 1.1 MW azt 500 rpm, coupled to a 500 rpm and 6,300 V three phase alternator. 990 kwh/hour were measured at the outlet terminals once the system was properly stabilized, that is to say, a specific consumption of 202 gr of fuel per kwh produced or 222 gr of used oil per kwh produced.

Claims

1. Procedure used to generate electric energy from previously used oils and other petroleum residues, characterized in that the previously used oils or residues are subjected to an extraction process using an aliphatic solvent, from which is obtained a fuel that is fed to a gas turbine or diesel engine to which an electric generator is then coupled.

2. Procedure as claimed in claim 1, characterized in that, after the extraction stage, a solvent rich phase is decanted, which is later subjected to distilling in order to separate the solvent from the refined fuel; an aqueous stage that corresponds to the already emulsified water that did contain the residue; and an asphaltic stage that incorporates the inert rendered contaminants.

3. Procedure as claimed in claims 1 and 2, characterized in that the extraction process is effected using liquid propane as solvent, at temperatures between 5 and 50°C and pressure levels that correspond to the steam pressure (approximately 7 and 20 atmospheres at already mentioned temperatures), employing a ration of solvent to residue between 2 to 1 and 20 to 1 per volume.

4. Procedure as claimed in claim 2, characterized in that the residue is a previously used oil and the temperature range is between 5° and 30°C and the solvent ration is between 3 to 1 and 10 to 1.

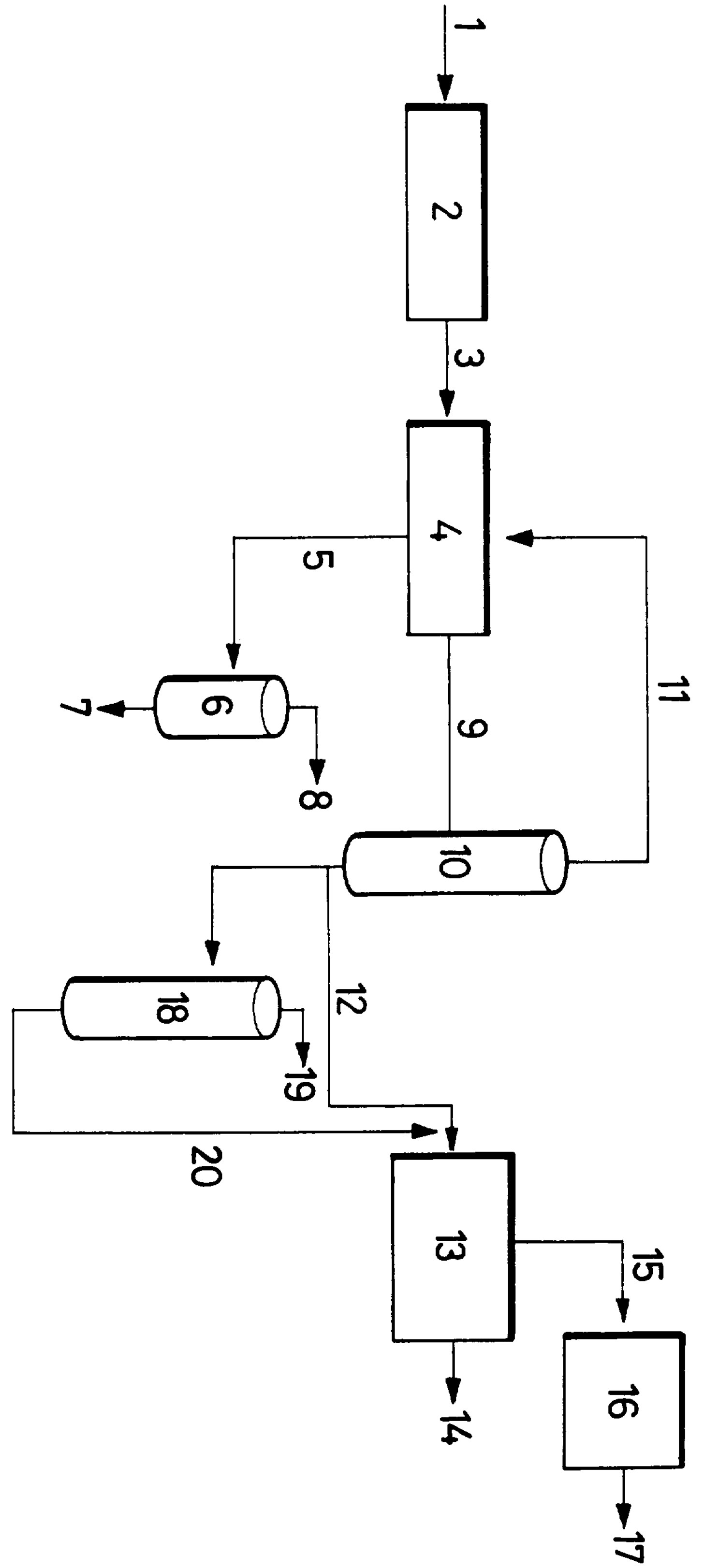
5. Procedure as claimed in claims 1 and 2, characterized in that the residue is an oil residue obtained through centrifugation or through any other system used to separate water and solid matter from oily sludge, emulsions, contaminated petroleum products and the like.

6. Procedure as claimed in claims 1 and 2, characterized in that the already refined fuel is subjected to a stripping process designed to remove any possible solvents or light compounds that contaminate the original residue.

7. Procedure as claimed in the preceding claims, characterized in that the heat energy generated by the turbine or the engine, and specifically that given off by their exhaust gases, is used to cover the requirements of the extraction process, particularly for the distilling of the propane and, if applicable, for the stripping of the fuel, whether directly applied or through steam or an intermediate fluid.

8. Procedure according to previous claims, characterized in that the heat energy given off by the turbine exhaust gases is used, at least partly, to generate steam that, at least partly, is then introduced into a condensation turbine coupled to a generator, whereas a portion of the of heat energy given off by the exhaust gases is used in the extraction process, either directly or using steam generated by it.

9. Procedure as claimed in claim 1, characterized in that the aliphatic solvent consists of propane.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EUROPEAN SEARCH REPORT

Application Number
EP 96 50 0112

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
P,A	WO-A-95 21902 (INTERLINE RESOURCES INC.) * claims 1-3,6,19,20 * * page 12, line 23 - page 13, line 3 * ---	1-4,6,9	C10L1/00 C10G21/00
A	DATABASE WPI Section Ch, Week 8718 Derwent Publications Ltd., London, GB; Class H06, AN 87-127159 XP002018423 & JP-A-62 070 487 (NIPPON MINING KK) , 31 March 1987 * abstract * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
C10L C10G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 November 1996	De Herdt, O

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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