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(54) **Method and apparatus for the thermal treatment of heavy fuel oil.**

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Description

The present invention relates to a method and apparatus for the thermal treatment of heavy fuel oil, for example a method and apparatus to recover lighter products and to utilise the heavier products, and such a method comprises supplying the heavy fuel oil to a vacuum distillation unit operating at a sub-atmospheric pressure, withdrawing a heavy gas oil and any other contained lighter fractions as a top product, and withdrawing a vacuum residue as a bottom product.

In modern oil refineries the reduced crude from a crude oil topping still is commonly passed to a unit referred to as a vacuum unit, where, under sub-atmospheric pressure, heavy gas oil is flashed out and separated from the heaviest petroleum fraction, commonly called vacuum residue. When cooled to atmospheric temperatures this residue is a very viscous fluid.

The heavy gas oil is usually recovered for subsequent use as feedstock in cracking processes and is generally accepted as being more valuable than reduced crude.

When it is required to market vacuum residue as a fuel, it is either necessary to blend in lighter more valuable fractions, such as cracked recycle oil or to process it in a process unit such as a visbreaker, or a combination of both so that it may be readily pumped through pipework at ambient temperature. All these solutions result in further expense.

It is an object of the present invention to utilise the vacuum residue as a fuel without the expense and waste of incorporating lighter fractions and/or visbreaking the vacuum residue.

According to the invention, there is provided a method for the thermal treatment of heavy fuel oil characterised by withdrawing a gas oil stream from the distillation unit, subjecting this stream to mild thermal cracking conditions in which the temperature of the stream is raised whereby a portion of the waxes present are cracked, and introducing the heated stream into the feedstock inlet stream, thereby recycling the stream to the distillation unit, and by supplying the vacuum residue directly to fuel burning means where combustion of the vacuum residue is effected and the heat released is used to generate power. Thus, the vacuum residue is burned to release energy and the energy is used to generate power.

The method may be particularly suitable in situations where a power station receives fuel oil, delivered by water or served by a connecting pipeline from an oil refinery. In such cases, the method according to the invention is preferably carried out on or close to the power station premises and preferably as close to the boilers as is practically possible. The techniques may be allied to other large consumers of heavy oil fuels such as cement manufacturers.

Thus, reduced crude or heavy fuel oil to typical power station specifications may be received at the power station and supplied to a vacuum still to separate out those pertroleum fractions lighter than vacuum residue. The vacuum residue may then be at a sufficiently high temperature, e.g. between 200 and 375°C such that it readily flows through pipework and can be effectively burnt in the power station boilers.

The separated heavy gas oil and lighter fractions which are recovered may be returned to the originating oil refinery or may be marketed as a more valuable product than the fuel oil feedstock received at the power station.

Transportation economies could also be realised since a ship bringing the fuel to the power station could return with the recovered gas oils as ballast.

Once the vacuum residue has been separated, any subsequent pipework, intermediate storage and burner systems should preferably be provided with appropriate insulation and heat tracing to keep the fuel hot.

Thus, a considerable benefit of the method of the invention is that it is possible to save that energy which would otherwise be consumed in visbreaking the vacuum residue or alternatively to conserve more valuable lower boiling petroleum fractions so that they may be put to more useful applications.

Preferably the method includes the steps of withdrawing one or more fractions from the column and heat-exchanging these streams against the feedstock inlet stream to the column.

A characteristic of many crude oils is that wax components tend to concentrate in the heavier gas oil fractions recovered in a vacuum unit. This impairs the fluid flow characteristics of the recovered heavy gas oil, especially at ambient temperature. A method of measuring this characteristic is a well known test to determine the pour point of the fluid. Pour points greater than 25°C are generally unacceptable. It is quite common for recovered heavy gas oil to have a pour point value greater than 25°C.

It is well known that wax tends to accumulate in the heavier gas oils recovered in vacuum stills and invariably results in pour points greater than 25°C. Clearly, this will be unacceptable when that fraction has to be shipped or transported at ambient temperature.

There are several well established processes for removing these waxes. One example is solvent extraction though this can be quite expensive. Another process entails subjecting the heavy gas oil to mild thermal cracking conditions which may break down a substantial proportion of the wax.

It is therefore a further object of the present invention to improve the fluid flow characteristics of recovered heavy gas oil and vacuum residue by reducing the wax content.

Therefore, the heat supplied to the system to enable the vacuum column to operate is also used to subject a portion of the fuel oil, namely the heavier gas oil fraction, to mild thermal cracking conditions. This is carried out by withdrawing a stream of heavy gas oil from near the base of the vacuum column and passing this stream through a heater. This heated stream is then mixed with

the feedstock inlet stream to the column. No additional heat may be required to be introduced into the system.

Thus, there may be provided a process which separates out heavy gas oil and lighter fractions from a reduced crude or heavy fuel feedstock and simultaneously subjects the heavier recovered gas oils to mild thermal cracking conditions to reduce the wax content and as a result reduce the pour point of both the separated gas oil and vacuum residue. This can also result in the formation of some lighter, more valuable distillate products.

Preferably, the vacuum distillation unit operates at a temperature of between 150 and 375°C e.g. about 345°C and at a pressure of between 0.03 and 0.3 atmospheres e.g. about 0.065 atmospheres.

According to another aspect of the invention there is provided apparatus for the thermal treatment of heavy fuel oil comprising a vacuum distillation unit and a heater arranged to supply heat to the distillation unit, characterised in that the heater has an inlet arranged to receive a gas oil stream from the distillation unit and an outlet arranged to introduce the heated stream into the feedstock inlet stream to the distillation unit and further characterised by fuel burning means arranged to receive directly the bottom product from the distillation unit and to burn the bottom product to generate power.

Preferably the distillation unit includes two or more sections of gas/liquid contact medium and a liquid catch tray beneath each section.

The invention may be carried into practice in various ways and one embodiment will now be described by way of example with reference to the accompanying drawings in which the single figure is a schematic diagram of apparatus for thermally treating heavy fuel oil in accordance with the invention.

Reduced crude feedstock enters the process at 11 at ambient temperature and is heat exchanged in heat exchangers 12, 13 against recirculating heavy gas oil in two recycle streams 14, 15 respectively. The feedstock is then passed via a transfer line 16 to the flash zone 17 of a vacuum column 18 which operates between 0.03 and 0.3 atmospheres pressure and at about 345°C.

In the flash zone 17 heavy gas oil and lighter fractions are flashed out of the feedstock as a vapour and pass up the column 18, whilst the vacuum residue also at about 345°C is removed from the bottom of the column via line 19.

The heavier gas oil fractions are withdrawn as a liquid stream 20 by means of a catch tray 21 located immediately above the flash zone 17 having been condensed by a cooled recirculating gas oil stream 22, in a packing section 23. The heavier fractions are fed to a heater 24 where the temperature is raised to between 450°C and 500°C e.g. about 480°C to induce mild thermal cracking. This tends to crack and hence reduce the wax components in the gas oil. The heated stream is then mixed with the feedstock in line 16 and thus recycled. The heat supplied is preferably sufficient to cause heavy gas oil and any ligher fractions to flash off in the distillation unit 18.

A portion of the withdrawn heavy gas oil 20 is heat exchanged with feedstock as recycle stream 15 in heat exchanger 13, cooled to about 260°C and returned as stream 22 to the column 18 at the top of section 23.

Excess gas oil in this recirculating circuit comprises an overflow line 25 which joins recycle stream 14. This stream comprises recirculating gas oil from a catch tray 26 located beneath a second packing section 27 and is heat exchanged against the feedstock in heat exchanger 12. The stream is then reintroduced to the column 18 above the packing section 27 where gas oil and lighter fractions in the column are condensed.

Excess gas oil and lighter fractions in the recycle stream 14 comprise overflow stream 28 which is passed to a top packing section 29. This stream 28 is cooled against cooling water or air in a heat exchanger 31 to a temperature between 40 and 60°C. The final product is withdrawn in stream 32 from a catch tray 33 beneath the packing section 29 at about 75°C and some of this stream is mixed with stream 28 via line 34 prior to its being cooled.

In the process described, the lightest fractions resulting from mild thermal cracking of the heavier gas oil fraction tend to dissolve into the final withdawn product stream 32 together with any light fractions contained in the feedstock. This also reduces the load on the vacuum inducing equipment.

As an alternative to overflowing excess gas oil from one circuit to the next a portion or all of the excess gas oil in a circuit may be withdrawn as a separate product.

The vacuum in the system may be induced by any suitable means such as vacuum pumps or steam ejectors (not shown) via a top outlet 35.

The vacuum residue in line 19 is removed from the process at the temperature of the flash zone 17 and either passed directly to burners 36 in a power station boilers 37 or to intermediate hot storage (not shown) without heat exchanging against any other stream. The boilers generate steam which is transferred via steam line 38 to electricity generators 39.

Should the intermediate storage or transfer equipment have a temperature restriction then the vacuum residue in line 19 may be heat exchanged and cooled to the practical temperature limit set by the fluid flow properties of the fuel which will be above 150°C.

Claims

1. A method for the thermal treatment of heavy fuel oil which comprises supplying the heavy fuel oil to a vacuum distillation unit (18) operating at a sub-atmospheric pressure, withdrawing a heavy gas oil and any other contained lighter fractions as a top product (32), and withdrawing a vacuum residue as a hot bottom product (19), charac-

terised by withdrawing a gas oil stream (20) from the distillation unit (18), subjecting this stream to mild thermal cracking conditions (24) in which the temperature of the stream is raised whereby a portion of the waxes present are cracked, and introducing the heated stream into the feedstock inlet stream, thereby recycling the stream (16) to the distillation unit, and by supplying the vacuum residue directly to fuel burning means (36) where combustion of the vacuum residue is effected and the heat released is used to generate power.

2. A method as claimed in Claim 1 characterised in that the withdrawn gas oil stream (20) is heated to a temperature of 450 to 500°C.

3. A method as claimed in any preceding claim characterised in that one or more streams (14) are withdrawn from the distillation unit and heat-exchanged against the feedstock inlet stream (11) to the distillation unit (18) prior to their being recycled (28) to the distillation unit.

4. Apparatus for the thermal treatment of heavy fuel oil according to Claim 1, 2 or 3 comprising a vacuum distillation unit (18) and a heater (24) arranged to supply heat to the distillation unit, characterised in that the heater (24) has an inlet arranged to receive a gas oil stream (20) from the distillation unit (18) and an outlet arranged to introduce the heated stream into the feedstock inlet stream (11) to the distillation unit and further characterised by fuel burning means arranged to receive directly the bottom product (19) from the distillation unit and to burn the bottom product to generate power.

5. Apparatus as claimed in Claim 4 characterised in that the distillation unit includes two or more sections of gas/liquid contact medium (23, 27, 29) and a liquid catch tray (21, 26, 33) beneath each section.

Revendications

1. Procédé pour le traitement thermique de fuel-oil lourd suivant lequel on fournit le fuel-oil lourd à une unité de distillation sous vide (18) fonctionnant à une pression inférieure à la pression atmosphérique, on soutire un gas-oil lourd et toutes les autres fractions légères éventuelles contenues à titre de produits de tête (32) et on soutire un résidu sous vide à titre de produit de queue chaud (19), caractérisé en ce qu'on soutire un courant de gas-oil (20) de l'unité de distillation (18), on soumet ce courant à des conditions de craquage thermique modérées (24) au cours desquelles la température du courant est accrue de telle sorte qu'une fraction des cires présentes soit craquée, et on introduit le courant chauffé dans le courant admis de matière d'alimentation afin de recycler le courant (16) vers l'unité de distillation, et on fournit le résidu sous vide directement au dispositif de combustion de combustible (36) dans lequel la combustion du résidu sous vide est effectuée et la chaleur produite est utilisée pour engendrer de l'électricité.

2. Procédé suivant la revendication 1, caractérisé en ce qu'on chauffe le courant de gas-oil soutiré (20) à une température de 450 à 500°C.

3. Procédé suivant l'une ou l'autre des revendications précédentes, caractérisé en ce qu'un ou plusieurs courants (14) sont soutirés de l'unité de distillation et subissent un échange thermique avec le courant d'alimentation de matière première (11) parvenant à l'unité de distillation (18) avant d'être recyclés (28) vers l'unité de distillation.

4. Appareil pour le traitement thermique de fuel-oil lourd suivant la revendication 1, 2 ou 3, comprenant une unité de distillation sous vide (18) et un appareil de chauffage (24) propre à fournir de la chaleur à l'unité de distillation, caractérisé en ce que l'appareil de chauffage (24) comporte une entrée destinée à recevoir un courant de gas-oil (20) provenant de l'unité de distillation (18) et une sortie destinée à introduire le courant chauffé dans le courant d'admission de matière d'alimentation (11) parvenant à l'unité de distillation et caractérisé en outre par un dispositif de combustion de combustible destiné à recevoir directement le produit de queue (19) de l'unité de distillation et à brûler ce produit de queue pour produire de l'électricité.

5. Appareil suivant la revendication 4, caractérisé en ce que l'unité de distillation comprend deux ou plus de deux sections à agent de contact de gaz/liquide (23, 27, 29) et un plateau collecteur de liquide (21, 26, 33) en dessous de chaque section.

Patentansprüche

1. Verfahren für die thermische Behandlung von schwerem Brennstofföl, welches das Zuführen des schweren Brennstofföles zu einer Vacuumdestillationseinrichtung (18), welche bei einem subatmosphärischen Druck arbeitet, das Abziehen eines schweren Gasöles und etwaiger anderer enthaltener leichterer Fraktionen als Kopfprodukt (32) und das Abziehen eines Vacuumrückstandes als heißes Bodenprodukt (19) umfaßt, gekennzeichnet durch das Abziehen eines Gasölstromes (20) aus der Destillationseinrichtung (18), Unterwerfen dieses Stromes unter milde thermische Krackbedingungen (24), wobei die Temperatur des Stromes gehoben wird, wodurch ein Tiel der vorhandenen Wachse gekrackt wird, und Einführen des erwärmten Stromes in den Einsatzeinlaßstrom, dadurch Rückführung des Stromes (16) zu der Destillationseinrichtung, und durch Zuführen des Vacuumrückstandes direkt zu Brennstoffverbrennungseinrichtungen (36), wo die Verbrennung des Vacuumrückstandes bewirkt wird und die freigesetzte Wärme zur Erzeugung von Kraft verwendet wird.

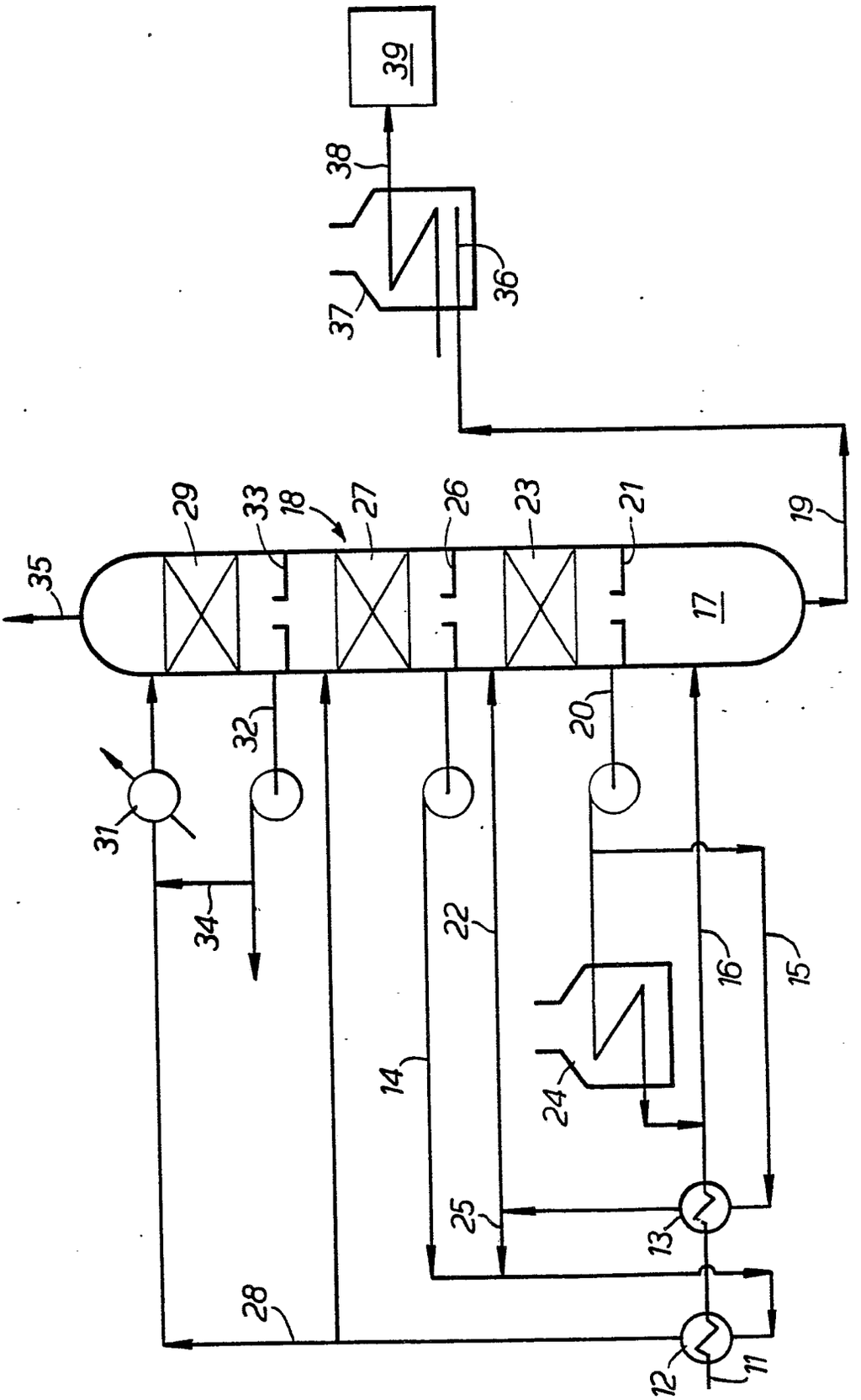
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der abgezogene Gasölstrom (20) auf eine Temperatur von 450 bis 500°C erwärmt wird.

3. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß ein oder mehr Ströme (14) aus der Destillationseinrichtung abgezogen werden und einem Wärme-

austausch gegenüber dem Einsatzeinlaßstrom (11) zu der Destillationseinrichtung (18) unterzogen werden, bevor sie zu der Destillationseinrichtung rückgeführt (28) werden.

4. Vorrichtung für die thermische Behandlung von schwerem Brennstofföl nach Anspruch 1, 2 oder 3, umfassend eine Vacuumdestillationseinrichtung (18) und eine Heizeinrichtung (24), eingerichtet, um Wärme der Destillationseinrichtung zuzuführen, dadurch gekennzeichnet, daß die Heizeinrichtung (24) einen Einlaß aufweist, angeordnet zur Aufnahme eines Gasölstromes (20) aus der Destillationseinrichtung (18), und einen Auslaß aufweist, angeordnet zur Einführung des erwärmten Stromes in den Einsatzeinlaßstrom (11) zu der Destillationseinrichtung, und weiter gekennzeichnet durch eine Brennstoffverbrennungseinrichtung, angeordnet zur direkten Aufnahme des Bodenproduktes (19) aus der Destillationseinrichtung und zur Verbrennung des Bodenproduktes, um Kraft zu erzeugen.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Destillationseinrichtung zwei oder mehr Abschnitte von Gas/Flüssigkeit-Kontaktmedium (23, 27, 29) und einen Flüssigkeit-Sperreinsatz (21, 26, 33) unterhalb eines jeden Abschnittes umfaßt.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