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(54) Title: A METHOD FOR REDUCING THE AMOUNT OF OIL IN AN OIL CONTAINING MIXTURE

(57) Abstract: A method for lowering the amount of oil in an oil containing mixture is described. The mixture is heated and oxygen or a mixture of gases comprising oxygen is injected into said heated oil containing mixture.

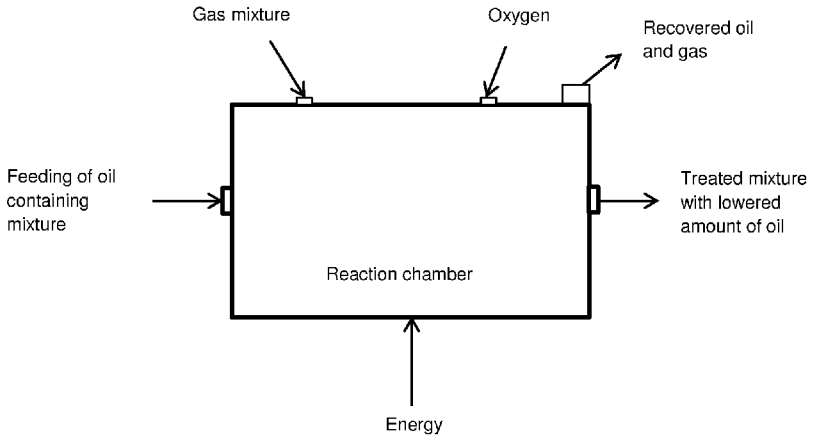


Figure 1

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Title: A method for reducing the amount of oil in an oil containing mixture

Field of invention

The present invention relates to the removal of oil content in a compound comprising a blend of other components. More specifically, the invention relates to a method for removing of oil from a heterogeneous mixture, where a large portion of the mixture is solid components.

Background for the invention

Removal and/or separation of oil components from heterogeneous materials or mixtures is a challenge. Several methods exist, such as indirect and direct drying of the material, which effect removal, separation and recovery of a large fraction of the oil component. Typical materials to be treated are drill cuttings, oily sludge, oily soils, bleaching earth, sludge from oil tanks, oil shale and fish wastes and solid materials contaminated with various hydrocarbon blends such as kerosene, diesel fuel, Fuel oil No. 1, No.2, and No.4, Gasoline, and Petroleum.

However, these conventional drying methods only reduce the level of residual oil in the mixture to about 2500 ppm.

It is thus an object of the present invention to provide a method that reduces the amount of oil in an oil containing mixture. The initial level of oil can be of any amount, for instance as much as about 20% oil in the mixture.

It is a further object of the present invention to completely remove the oil from the oil containing mixture, or to substantially remove all or almost all oil from the mixture. It is preferable to reduce the level of oil to an amount of 0.0001% (weight/weight) (i.e. 1 ppm), or less, i.e. the amount of oil compared to the total amount of mixture, on a

weight basis. The present invention is however not restricted to removal of oil from materials with low amounts of oil, but can as indicated above also be used for all kind off materials, and with all amounts/ratios of oil in the material.

Oil in this context means all types of hydrocarbons, organic matters and oils.

The concept of the present invention is a process that can separate oil from an oil containing mixture by oxidizing a fraction or all oil in such an oil containing mixture. The oil containing mixture can for example be drill cuttings, oily sludge, and other solid, semi-solid, or particulate materials contaminated with oil.

Summary of the invention

The present invention relates to a method for lowering the amount of oil in an oil containing mixture, wherein

i) said mixture is fed to a reaction chamber,

ii) said mixture is preheated before entering the reaction chamber and/or heated in the reaction chamber to a temperature above oxidation stability temperature for said oil,

iii) oxygen or a mixture of gases comprising oxygen is injected into said heated oil containing mixture to oxidize said oil, and lower the amount of oil in said oil containing mixture.

In a preferred embodiment is a portion of the heating energy provided to the reaction chamber comes from the exothermic oxidation of oils in said oil containing mixture.

In a preferred embodiment is said temperature above an auto-ignition temperature of said oil in said oil containing mixture.

In a preferred embodiment is the oil containing mixture preheated and/or heated to a temperature of above 100 °C, more preferable above 150 °C, more preferable above 200 °C and more preferable above 250 °C.

In a preferred embodiment is said temperature about or above 260 °C.

In a preferred embodiment is a vapour or a mixture of vapours injected to said heated oil containing mixture.

In a preferred embodiment comprises said gas mixture also a gas selected from the group containing CO_2, Nitrogen, Argon and Helium.

In a preferred embodiment is said vapour a steam, i.e. water vapour.

In a preferred embodiment is said oil containing mixture selected from the group consisting of drill cuttings, oily sludge, oily soils, bleaching earth, sludge from oil tanks, oil shale and fish wastes, and solids contaminated with an oil compound or blend of compounds.

In a preferred embodiment is said oil containing mixture selected from the group containing kerosene, diesel fuel, fuel oil no. 1, no.2, and no.4, gasoline and petroleum.

In a preferred embodiment is said method adapted to sparge/flush the mixture and enhance the separation of the oil from the oil containing mixture by increasing the amount of inert gasses relative to oxygen injected into the reaction chamber.

In a preferred embodiment does the method both sparge/flushes and oxidizes the oil in the oil containing mixture.

In a preferred embodiment is the level of oxidation controlled by regulating;

i) the temperature of the heated or preheated oil containing mixture, or
ii) the temperature of the injected oxygen or mixture of gases, or
iii) the pressure and flow-rate of the injected oxygen or mixture of gases,
iv) the addition of non-oxidative gases, or
v) the addition of steam.

In a preferred embodiment is the oil separated and/or recovered from the oil containing mixture.

In a preferred embodiment is a portion of the oil containing mixture heated before entering the reaction chamber.

In a preferred embodiment is the oil containing mixture partially pre-heated before entering the reaction chamber.

In a preferred embodiment is the method used on a mixture containing less than 5000 ppm, more preferable 4000 ppm, more preferable 3000 ppm, and most preferable 2500 ppm oil, and lowers the amount of oil after treatment to less than about 500 ppm, more preferable less than about 400 ppm, more preferable less than about 300 ppm, or more preferable less than about 200 ppm, and more preferable less than about 150 ppm oil.

Drawing

The invention will be further described below, with reference to the drawing.

Figure 1

Figure 1 is a schematic outline of a reaction chamber which can be used for conducting the method according to the invention. An oil containing mixture is fed to a reaction chamber. The mixture is heated in the chamber, or is fed pre-heated to the chamber. Oxygen is injected into the reaction chamber, optionally in combination with other gases. Cleaned material, i.e. with a reduced amount of oil in the material is removed from the reaction chamber.

In order to achieve the objectives of the invention, oxygen or a mix of gases (for example CO_2, Nitrogen, Argon or Helium) comprising oxygen is added by injecting to

the oil containing material. The material is heated, or preheated to a predetermined temperature. The temperature is sufficient to ensure a partial oxidation of a portion of the oil component in the material.

The partial or complete oxidation of the oil in the material requires oxygen. The oxygen is fed to the chamber wherein the process takes place. Oxygen is added as the sole gas, or as one of the gases of the gas mixture.

The injected oxygen creates a condition for oxidation of the oil component, and this is an exothermic reaction. The exothermic reaction liberates heat which is used to maintain or increase the temperature of the mixture in the chamber. The level of oxidation can be controlled to be up to 100%, i.e. from almost no oxidation to a complete oxidation of the oil component. A partial oxidation can mean that a portion of the oil is fully oxidized, and/or that all the oil is partially oxidized.

In a preferred embodiment is one or more of the gases provided as one or more vapours. The preferred vapour to add to the process is water vapour, i.e. steam.

In a further preferred embodiment are one or more gases other than oxygen added to the mixture. This gas or mixture of gases is selected from the group containing CO_2, Nitrogen, Argon, and Helium.

Figure 1 shows a process chamber containing an inlet for feeding the oil containing material to the process chamber, and an outlet for discharging the cleaned material. The chamber also contains one or more gas and/or vapour entrances, for instance pipe lines equipped with nozzles. The nozzles can be arranged at specific places in the chamber such that it is possible to regulate and control the oxidation and sparging/flushing and gas stripping process that takes place in the chamber. The chamber also contains an outlet for discharge of oil components, i.e. evaporated oil components. This outlet is led to a unit for recovering of the oil component.

The gases other than oxygen have at least four functions in this process, including, but not limited to: i) sparging, ii) temperature control, iii) controlling the oxidation and iv) pressure control.

The temperature, pressure and flow-rate of the injected gas mixture may be adjusted to achieve the desired results.

According to a preferred embodiment of the method, the temperature is regulated to be less than the boiling temperature plus some safety temperature margins (for example 10%). By increasing the level of O_2 the oxidation of the oil component(s) increases, and thus increases the temperature in the chamber due to the exothermic oxidation reactions.

Thus, by regulating the level of oxidation we can control the process temperature (the chamber pressure effects on the numbers) and also it burns (oxidizes) a part of oil that enhances the cleaning of the solids.

When the temperature in the chamber is high enough we initiate sparging, i.e. the injection of one or more gases for sparging of the residual oil in the solids, for instance with a temperature of at or above 150 °C.

This sparging process may be used independently, and/or in connection with and/or as an integrated part of another process.

The oil transported/flushed by the gasses ("sparged oil") may be recovered and reused.

Definitions

"Oxidation stability temperature" is the lowest temperature at which oil starts to oxidize.

"Hydrocarbon" is defined as a chemical compound that is a mixture of hydrogen and carbon.

"Oil" in the context of the present description and claims means all types of hydrocarbons and organic matters. The term also comprises "oils" which are nonpolar viscous and oxidable compounds.

Experimental results

Example 1

The method according to the invention has been tested in the following experimental design.

The oil containing material used in this experimental test was a cutting material, i.e. a mix of water, emulators, stabilizing chemicals, base oil (no higher than C_{20}), mineral clay and harder gravel of drill cutting.

The composition was as follows:

Water	40%
Solids	44%
Oil	16%

To do the analyses of the composition we use a standard retort, this means that there can be traces of chemical in the water and the oil but it is normally ignorable considering the energy/mass balance.

The material was first dried in a conventional dryer, for instance a friction dryer, and this reduced the level of oil (or hydrocarbons) to about 2500 ppm (parts per million). This material is typically oil containing waste material that has been pre-dried in

conventional drying means. However, all kind of oil containing materials can be used in the method according to the present invention.

The material is heated or preheated to a temperature of about 260 °C, and fed to a chamber, and a temperature of 260 °C or more is maintained in the chamber.

The chamber is filled with about 3000 kg material, which appears to be solid but has a remaining oil content of about 2500 ppm (7500 gram in total).

A gas mixture of 7% oxygen and 93% nitrogen is injected into the chamber at a gas flow of 50-70 l/min, to a total oxygen concentration of 3.2% (i.e. 1200 gram oxygen in total).

The oil containing material was maintained at about 260 °C, supplied with oxygen for about 5 hours, and about 95% of the oil was removed from the solids, i.e. the amount of oil in the mixture was reduced from about 2500 ppm to 141 ppm.

Theoretically, the oil that has been oxidized by oxygen (most likely to CO_2 and H_2O (steam)) amounts to about 400 gram, i.e. more than 6500 gram of the oil has been removed as non-oxidized oil. Without being bound by theory, it is believed that this amount of oil has been removed due to oxidation and/or sparging or flushing of the mixture.

The oxidation of the oil component is an exothermic process which thus generates energy and heats the mixture, i.e. maintains and/or increases the temperature of the mixture.

In addition to the supply of oxygen, we have in separate experiment tested the addition of other gases. Such gases are believed to have a sparging effect on the residual oil component in the chamber.

We have also tested the effect of providing a gas barrier in the reaction chamber. Such a gas barrier can be provided by the addition of an inert gas, such as N_2.

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Claims

1. A method for lowering the amount of oil in an oil containing mixture, wherein
i) said mixture is fed to a reaction chamber,
ii) said mixture is preheated before entering the reaction chamber and/or heated in the reaction chamber to a temperature above oxidation stability temperature for said oil,
iii) oxygen or a mixture of gases comprising oxygen is injected into said heated oil containing mixture to oxidize said oil, and lower the amount of oil in said oil containing mixture.

2. A method according claim 1, wherein a portion of the heating energy provided to the reaction chamber comes from the exothermic oxidation of oils in said oil containing mixture.

3. A method according to claim 1, wherein said temperature is above an auto-ignition temperature of said oil in said oil containing mixture.

4. A method according to any of the preceding claims, wherein the oil containing mixture is preheated and/or heated to a temperature of above 100 °C, more preferable above 150 °C, more preferable above 200 °C and more preferable above 250 °C.

5. A method according to claim 4, wherein said temperature is about or above 260 °C.

6. A method according to claim 1, wherein a vapour or a mixture of vapours is injected to said heated oil containing mixture.

7. A method according to claim 1, wherein said gas mixture also comprises a gas selected from the group containing CO_2, Nitrogen, Argon and Helium.

8. A method according to claim 6, wherein said vapour is steam, i.e. water vapour.

9. A method according to claim 1, wherein said oil containing mixture is selected from the group consisting of drill cuttings, oily sludge, oily soils, bleaching earth, sludge from oil tanks, oil shale and fish wastes, and solids contaminated with an oil compound or blend of compounds.

10. A method according to claim 1, wherein said oil containing mixture is selected from the group containing kerosene, diesel fuel, fuel oil no. 1, no.2, and no.4, gasoline and petroleum.

11. A method according to any of the preceding claims, wherein said method is adapted to sparge/flush the mixture and enhance the separation of the oil from the oil containing mixture by increasing the amount of inert gasses relative to oxygen injected into the reaction chamber.

12. A method according to the claim 11, wherein said method both sparge/flushes and oxidizes the oil in the oil containing mixture.

13. A method according to any of the preceding claims, wherein the level of oxidation is controlled by regulating;

i) the temperature of the heated or preheated oil containing mixture, or
ii) the temperature of the injected oxygen or mixture of gases, or
iii) the pressure and flow-rate of the injected oxygen or mixture of gases,
iv) the addition of non-oxidative gases, or
v) the addition of steam.

14. A method according to any of the preceding claims, wherein the oil is separated and/or recovered from the oil containing mixture.

15. A method according to claim 1, wherein a portion of the oil containing mixture is heated before entering the reaction chamber.

16. A method according to claim 1, wherein the oil containing mixture is partially pre-heated before entering the reaction chamber.

17. A method according to any of the preceding claims, wherein the method is used on a mixture containing less than 5000 ppm, more preferable 4000 ppm, more preferable 3000 ppm, and most preferable 2500 ppm oil, and lowers the amount of oil after treatment to less than about 500 ppm, more preferable less than about 400 ppm, more preferable less than about 300 ppm, or more preferable less than about 200 ppm, and more preferable less than about 150 ppm oil.

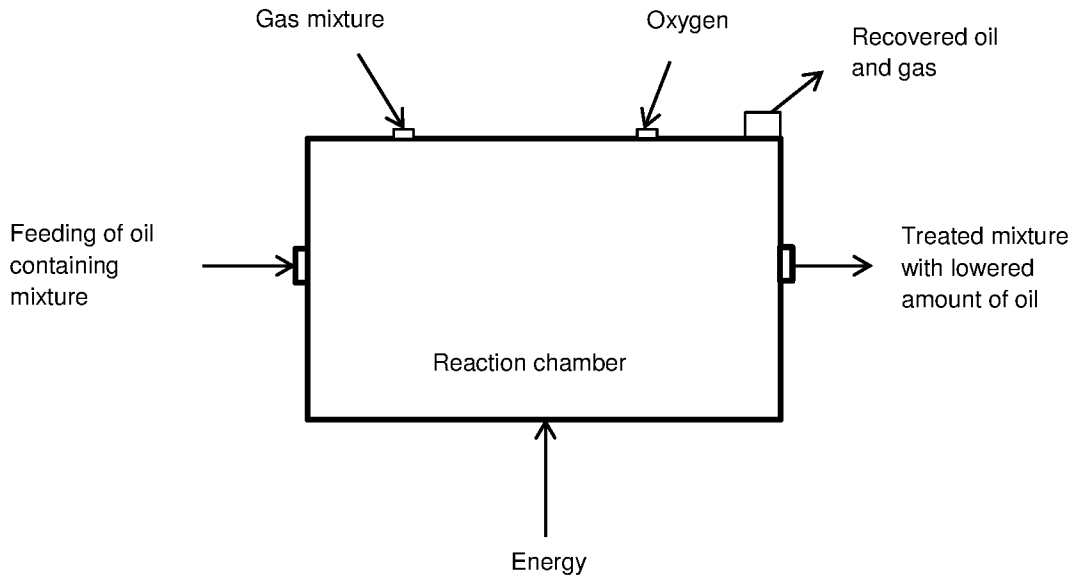

Gas mixture
Oxygen
Recovered oil and gas
Feeding of oil containing mixture
Treated mixture with lowered amount of oil
Reaction chamber
Energy

Figure 1