METHOD OF PROCESSING AND DISPOSING OF HYDROCARBON WASTE

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Abstract: A method of recovering and processing hydrocarbon waste generated by the oil production and refining sector that is currently stored in locations such as large lagoons, pits or on open ground. In particular the hydrocarbon waste is mineral oil waste having a high non-flammable solids content that renders the waste unusable as a fuel. The waste is processed to produce a blend that is suitable for use as a fuel by incineration units such as cement kilns. Wherein the combustion of the blend in the cement kilns consumes all of the components of the blend and does not produce any secondary waste that requires special treatment or disposal. A mobile processing plant (1, 2, 5, 8) is also provided to enable the method to be carried out at an oil waste storage site.
METHOD OF PROCESSING AND DISPOSING OF HYDROCARBON WASTE

Field of the invention

The present invention relates to the recovery, processing and disposal of hydrocarbon waste generated by the oil production and refining sector, in particular the hydrocarbon waste is mineral oil waste that includes oil contaminated sand, weathered waste and drill cuttings.

Background of the Invention

Industry is reliant upon oil and its derivatives for all manner of products, uses etc. As a consequence there are a vast number of oil producing and processing plants around the world. These plants create a large volume of waste and comprise a vast number of storage tanks for crude oil or petroleum products and waste storage facilities such as seepage pits, evaporation ponds and sludge ponds.

Over a long period of time large amounts of waste have accumulated at these various waste storage facilities. The waste comprises residues arising from the various processes employed in the oil production and refining sector, and for which the producers of this waste have no further use.

Although such waste often contains a high proportion of residual hydrocarbons, such waste is not directly suitable for the normal use of the oil company. As a consequence the waste would require a level of treatment before any consideration could be given to its use as a raw material for refining or blending. As at present the economic costs involved in the required treatments is prohibitive.

The sludge ponds, land pits or storage lagoons in which the waste is stored may be lined or unlined, or surrounded by berms. These deposits can be up to several metres thick at least in parts. At their most basic these waste storage sites simply comprise depressions in the land or even piles of waste tipped on the surface. The rudimentary nature of these waste storage sites pose substantial environmental and health and safety hazards.
Changes in regulation, shifts in political and public sentiment and the greater emphasis being placed on environmental issues are forcing the owners of the waste held in these waste storage sites to address the issue of the accumulated waste (often referred to as legacy waste) and find a more permanent solution.

Whereas waste has been largely hidden in the past through remoteness of location, behind fences or other barriers, its presence is becoming ever more apparent and detectable by the development of means of surveillance from above, as for example, by satellite photography. Apart from exceptional circumstances, it is no longer a legally or commercially practical option simply to move the waste to another more convenient or less obtrusive location. Other means of removal need to be employed.

At present there are various technologies available for processing this 'legacy' mineral oil waste. The waste is either processed to recover oil or disposed of by way of injection into wells or other subterranean voids; incineration; land farming; or bioremediation. Suitable processes for oil recovery include centrifuging; thermal desorption; soil washing; and solvent extraction.

However all of these known processes create a secondary, adverse environmental impact, such as fugitive emissions, long term impact on ground water and local blight. Furthermore these processes can also be slow and even then only partially process the waste.

The above processes are very costly for the waste producer to utilize and the potential sale value of any recovered oil makes a negligible contribution to off-setting the extraction and processing costs. Techniques for recovery of this hydrocarbon waste are discussed in more detail in PCT/GB2008/003379.

Despite the above mentioned hazards, oil companies are reluctant to address this legacy waste due to the high economic costs involved in the disposal of the legacy waste for no commercial benefit in return. Therefore, in the absence of new regulations or the enforcement of existing regulations to
coerce the oil companies to address the problem, the only way in which companies can be persuaded into taking remedial action is if there is a commercial benefit, or at least no commercial loss, to be had from recovering and processing their legacy waste.

PCT/GB2008/003379 discloses a process for reclaiming hydrocarbon waste and processing it to produce bitumen, which is a product with some commercial value.

Summary of the Invention

The present invention provides a method of processing mineral oil waste to produce a blend suitable for use as a fuel for cement kilns, wherein a portion of said mineral oil waste has a high content of non-flammable solids content that renders such waste otherwise unusable as a fuel, and wherein said method comprises: a) providing a processing plant at a location; b) auditing the various types of mineral oil waste available at the location to determine the lower heating value and non-flammable solids content of each type of mineral oil waste; c) calculating a blend formulation that will provide a blend with a lower heating value of at least 8 gigajoules per metric ton using a combination of mineral oil waste with the high non-flammable solids content and the other mineral oil waste types available at the location; d) collecting the calculated quantities of the mineral oil waste required to produce the blend; e) using the processing plant to mix the calculated quantities of mineral oil waste to achieve the blend suitable for fueling cement kilns.

Unlike those processes currently available for dealing with oil waste, the method of the present invention does not separate or concentrate the oil content of the waste. Instead the method of the present invention is specifically designed for blending together various types of mineral oil waste, some of which include non-flammable solids such as sand, and blends them into a predetermined, homogeneous, consistent material that can be utilized and totally destroyed without creating any secondary waste streams (such as for example, dioxins, contaminated water or solids) which require further
special treatment or disposal procedures to avoid adverse environmental impact.

Notwithstanding the fact that the blend produced by the method of the present invention might contain large proportions of inorganic materials, such as sand, the method is such that the blend produced is suitable for use in high temperature incineration systems, such as cement kilns, where the lower heating value (or net calorific value) of the blend makes a useful contribution and where the ash content is either useful or does not constitute a problem as for example in cement kilns or steel works. It will be appreciated that the terms 'lower heating value' and 'net calorific value' are used interchangeably throughout and are considered to have the same meaning.

Preferably the processing plant may be mobile and the location is an individual oil waste storage site. In this way the processing plant is transported to the location of a particular waste storage site so that the various types of waste at the site can be recovered and processed into a blend that is suitable for disposal.

Alternatively the processing plant may be located at a fixed location and the oil waste is collected from one or more waste storage sites. In this way a centrally located processing plant can be used to process waste from one of more waste storage sites located within a distance of the plant that makes transportation of the waste from the storage site to the processing plant possible.

It is therefore envisaged that the methods of the present invention can be carried out at a central processing plant or alternatively on site at a waste storage site.

Preferably the audit may be conducted at a single oil waste storage site and the blend is mixed from the mineral oil waste stored at said oil waste storage site. In this way the various forms of oil waste located at a particular site can be mixed to produce a suitable blend on site, after which the blend can be transported to a second location for use as a fuel in an incinerator such as a cement kiln.
Preferably, the blend has a lower heating value of at least 15 gigajoules per metric ton.

Preferably the waste with the high non-flammable solids content comprises a least one solid mineral material, such as sand or clay, and has an oil content of less than 10%. Preferably the other types of mineral oil waste have an oil content of 10% or more.

Preferably the calculated quantities of mineral oil waste may be mixed using at least one in-line static mixer.

Preferably the method may further comprise at least one pre-processing step, whereby more than one type of mineral oil waste is collected and processed to provide the calculated quantity of waste that is mixed in step e).

Preferably the method may further comprise a step whereby the maximum particle size of the waste in any dimension is reduced to 15mm or below.

Preferably the method may further comprise a step whereby the maximum particle size of the blend in any dimension is reduced to 5mm or below. It is envisaged that the particle size of the blend may be reduced by subjecting the blend to a grinding combined with a percussive process by means of a multiple number of grinding heads. Further preferably the blend may be passed through an in-line grading unit that will reject particles exceeding 5mm in any dimension and recycle them through the grinding process.

Preferably the blend has a pumpable consistency.

Another aspect of the present invention a method of disposing of mineral oil waste having a high content of non-flammable solids content that renders such waste otherwise unusable for use as a fuel, comprising:

a) processing the various types of mineral oil waste to produce a blend having a lower heating value of at least 8 gigajoules per metric ton; b) heating the blend such that volatilization of the non-flammable solids content of the blend takes place.

Preferably the blend may be heated for at least 4 seconds.
It is envisaged that the process of heating the blend can take place in a variety of industrial incinerators, one preferred example of which is a cement kiln.

Preferably the method may further include scrubbing any flue gases produced during the heating of the blend with lime. The process of scrubbing the emissions of the heating process ensures that no adverse secondary waste materials requiring treatment or disposal result from the disposal of the mineral oil waste. It is envisaged that alternative processes for scrubbing the emissions could also be employed. It is envisaged that the blend may preferably be produced using the method of the present invention.

The present invention also provides for a processing plant to produce a blend, suitable for use as a fuel in cement kilns, in accordance with the method of the present invention. In a first embodiment of the processing plant of the present invention said plant is mounted on suitable vehicles, thus enabling the plant to be fully mobile.

Accordingly the present invention provides a mobile oil waste processing plant, preferably for use in accordance with the method of any of the preceding claims, comprising: a main processing unit that is housed within a standard size shipping container that is transportable using conventional vehicles, said main processing unit having at least two oil waste inlets, at least one outlet, and at least one mixing unit to mix the oil waste supplied via the inlets to produce a blend and supply the outlet with the blend; at least one oil waste collecting unit that is housed within a standard size shipping container this is transportable using conventional vehicles, said oil waste collecting unit being connectable to at least one of the main processing unit inlets to supply oil waste for mixing; and a transportation unit that is transportable using conventional vehicles, said transportation unit being connectable to the outlet of the main processing unit to receive the blend.

Preferably the main processing unit mixer units may comprise at least one in-line static mixer.

Preferably the main processing unit may further comprise crushing means to reduce the particle size of the blend before it exits via the outlet.
Preferably said oil waste collecting unit may be selected from a group containing a drum decanter, a drum crusher, a hopper and pumping means. The type of oil waste collecting unit used will be determined by the type of oil waste that is to be introduced into the main processing unit.

Preferably the transportation units may comprise integral blending equipment and/or heaters that maintain the blend during its transportation from the processing plant to the disposal site for incineration such as a cement works.

Preferably the transportation units may comprise means suitable for discharging the blend directly into the incineration unit at the destination, for example cement works, without further processing. Further preferably the means for discharging may comprise either pumping or tipping of the blend from the transportation unit.

In the second embodiment of the processing plant of the present invention the same components as the mobile processing plant are present but are fixed in a particular location rather than being mobile.

Preferably in the second embodiment the processing plant is capable of receiving various types of waste from various locations so that they might be blended into a final product suitable for incineration at an appropriate location, such as a cement plant, where the net calorific value of the hydrocarbon content of the blend makes it suitable for use as a fuel and where the non-flammable material content is suitable for use as a raw material or does not cause a problem.

Brief Description of the Drawings
The present invention is described with reference to the drawings, wherein:

Figure 1 shows a flow diagram of an application of the method of the present invention;

Figure 2 shows a mobile processing plant for use in accordance with the methods of the present invention;

Figure 3 shows a more detailed view of the main processing unit of Figure 2.
Detailed Description of the Invention

The method of the present invention is considered most applicable to oilfield waste and oil refinery waste, as opposed to mineral oil waste from transfer stations or general industry although these might not necessarily be excluded. The majority of waste that is to be processed using the method will be old and weathered waste that will have been generated mainly by the oil exploration and processing industry before environmental protection became an important issue. This type of waste is commonly referred to as legacy waste. It will be understood that, in general, the stock piles in each oil field location are normally substantial. However newly created hydrocarbon waste from on-going operations, which also requires storage or disposal under controlled conditions, may also be included in the process.

It will be appreciated that, although the characteristics of the oil waste will vary depending upon the waste storage site they come from, and even within a single waste storage site, waste which is collected in any individual location, such as an evaporation pond or stockpile of drill cuttings, will be largely homogeneous or consistent in terms of their physical characteristics, although it is appreciated that there could be variations in the proportion of solids and oil within the totality of any individual waste storage location. Consequently any blending procedure to combine the various forms of oil waste is to a large extent controllable.

In general, the type of oil that is processed in any individual field or refinery tends to be of a specific and predictable type, as defined by API gravity, viscosity and net calorific value and other standard measures of physical characteristics commonly understood in the oil and power generation industries. Therefore the properties of any legacy waste in any location will be largely predictable. This is quite different from the wildly variable waste that can be collected from general industry where materials of very different characteristics are frequently randomly and illicitly mixed (e.g. engine oil and battery acid).
Some typical types of waste which are considered appropriate for processing with the method of the present invention are:

Tank Bottoms - basically the heavy ends of crude oil that have been separated out in storage tanks or are the residues from distillation towers. This waste tends to comprise a higher concentration of waxes and asphaltenes with some water and a small amount of iron scale that has dropped off the inner surfaces of oil tanks;

Oily sludge - largely found in evaporation ponds or as residues in API separators. This may be almost pure crude or depleted crude with some entrained water. In many fields extraction of oil is enhanced by water injection. When the water is disposed of it contains a considerable volume of oil which is unsuitable to be returned to the refinery. In many cases the evaporation ponds may simply be unlined pits in desert locations and the oily water soaks into the sand before the water evaporates. The oily material tends to be heavy with waxes and asphaltenes because the effect of weathering and evaporation has caused most of the more volatile elements to disperse to atmosphere. Significant quantities of this sludge also arise from well-bore cleaning, pipe-line cleaning and shutdown during maintenance. Such oily waste also contains inorganic solids such as sand that might have been blown by the wind, or which form the base and side materials of the repository of the waste so becomes mixed in with the main body of the waste.

Drill Cuttings arising from the use of Oil Based 'mud' - a residue from drilling operations. During drilling operations the drill bit is lubricated with drilling 'mud'. The 'mud' is normally a mixture of diesel or other oil, clay and emulsifiers. The drill cuttings are a mixture of this 'mud' and shale (frequently sandstone) created by the drill bit as it rotates into the rock formation that gets mixed into the mud during drilling operations and which gets returned to the surface for disposal. On retrieval from the hole the drill cuttings are put through a shale shaker which recovers much of the 'mud' with its entrained oil for recycling. The residual non-recyclable cuttings are classified as waste and normally have an oil content of about 18% (w/w).
Apart from the drill cuttings, the solids content of each of the main types of waste will be largely determined by the method and length of time of their storage. In many cases the legacy waste (i.e. long term accumulations) will have been stored in unlined depressions in open ground such as the desert. Some of the non-flammable solids content in the waste will have originated as wind blown sand, but much of it will have been as a result of absorption into the sandy substrate or as the consequence of activities of mechanical handling equipment.

The higher the oil content of a particular waste type the more options there are for its treatment and disposal, as mentioned in the background of the invention. However as the content of non-flammable solid materials, such as sand or day, in the waste increases the oil content tends to decrease. This greatly reduces the options for handling such waste since the volume of secondary waste thus created is greatly increased.

The principle aim of the method of the present invention is not to extract oil from the waste or indeed to engage in a process of concentrating the waste. Instead the present invention provides a means to combine through a blending process the entirety of various sources of waste in such proportions so as to create a blend of known properties that can be used as a fuel of high net calorific value in compatible industries which use high temperature incineration as part of their process and which can effectively handle a fuel with a high ash content. One such compatible industry is cement manufacturing due to the high temperatures achievable within cement kilns.

A major advantage of the method of the present invention is that provided that the blend produced by the method is incinerated at a temperature to cause clinkerisation of the non-flammable solids content in the blend, and provided that the flue gases are scrubbed with lime, the incineration does not produce any adverse secondary waste materials requiring further treatment or special disposal thereby avoiding the causation of adverse environmental impact arising from the process. Consequently the method allows for a complete disposal of the 'legacy’ waste without the need for treatment or controlled disposal. It is appreciated that all of the oil waste
components used by the method of the present invention b produce the blend are either used up or turned into something commercially valuable during the incineration of the blend.

It has been discovered that by combining the low grade‘ oil waste (i.e. that waste with a high content of non-flammable solids material) with the ‘higher grade’ waste, which has an oil content of above 10%, it is possible b produce a blend of predetermined quality, physical characteristics and net caloric value suitable for use as a fuel in, for example, cement kilns. The blend produced by the method of the present invention has a commercial value that can offset the cost of recovering/processing the waste; which makes the process much more attractive to the industry.

It is envisaged that if the blend produced using the method of the present invention is used as a fuel for cement kilns, it benefits the cement manufacturing operation in two ways. Firstly the oil content fuels the heating of the cement kiln and secondly the non-flammable solid materials, such as sand and day, are used as a raw material in formation of clinker within the cement kiln. In this way every element of the blend is consumed and no secondary waste is created.

Typically the temperature at which clinker takes place is around 1400-1500°C, however it is appreciated that other factors can impact on the temperatures required for clinker to take place and the method of disposal of the present invention is not necessarily limited to a specific temperature range. The temperature of clinkerisation and duration of the incineration process ensures that no harmful waste is generated by the process nor does any harmful waste solid or liquid remain at the end of the process nor is there any waste requiring special disposal. This ensures the commercial attractiveness of the present invention is increased further.

In order for the blend to be suitable for cement kilns the target net calorific value is required to have a minimum net calorific value of 8 gigajoules per metric ton, although a net calorific value of at least 15 gigajoules per metric ton is considered more preferable. It is appreciated that the actual net calorific value of the blend produced by the present method might
advantageously be higher so that lower quality feedstock material can be added to the alternative blend at the site of the cement kiln without impairing the combustion process. However the main aim of the present invention in this regard is to produce blend that can be used directly from the custom built transport tankers that arrive at the cement factory, i.e. without the need for additional on-site blending processing or intermediate storage before the blend can be used.

The majority of the net calorific value of the blend will be provided by the oil content in the mixture. It is appreciated that there is a limit to the amount of non-flammable solids material that can be absorbed into the blend by the oily waste whilst retaining the minimum required net calorific value. Where the non-flammable solid materials may be mainly sand and bentonite clay, which are both compatible with the cement production process, it is anticipated that the maximum content of such solid materials in the blend is 80\% by weight if the minimum net calorific value is to be achieved, although preferably the solids content is 50\% or below. This limit also helps ensure the blend retains a pumpable consistency, which it is envisaged might be similar to that of wet concrete, for example.

Preferably the maximum particle size of oil waste within the blend should be 5mm in three dimensions to avoid any risk of blockage in the injection nozzles by means of which the material is dispensed into the kiln.

It is envisaged that by combining a hydraulically operated, three headed grinder with hammer action all the solids that form part of the oily and pasty blend produced in the sending operation are reduced to the target size on a continuous basis.

As a final quality check all material after the grinder is passed through a grading unit to separate any residual oversized particles for re-circulation through the grinder.

Therefore to achieve an alternative fuel of the correct specification, the procedure will be a blending operation. Thus at any particular location (e.g. a waste storage site), an analysis of each type of waste present on site will be
made against standard criteria. The characteristics tested and typical analytical methods used to measure them include:

- a) identification of inorganic solids (for example by X-Ray Diffraction);
- b) Oil SG (for example by standard calculation);
- c) Oil Viscosity (for example by hydrometer);
- d) Net calorific value (for example by calorimeter);
- e) Oil Content (for example by retort);
- f) Particle size distribution (for example by sieve).

Once the characteristics (e.g. net calorific value) of each type of waste available at a particular location are known, a site-specific formula can be calculated with the aim of producing a blend of the various waste types present that incorporates as much of the lower grade waste as possible whilst at the same time meeting the minimum net calorific value requirements.

In view of the fact that, as mentioned above, most of these types of legacy waste are reasonably homogeneous in nature at any particular location, once a site-specific formula has been devised it can be applied for all future production of the fuel at that particular location. This also allows the fuel produced to be QA tested against a known standard for that particular location.

In addition to ensuring that the produced fuel meets the minimum net calorific value requirement, the formula preferably ensures that the fuel has acceptable handling and storage characteristics, whilst optimizing commercial benefits. Thus a balance must be struck between having enough oily waste (i.e. waste with high oil content) to provide the minimum net calorific value without using too much of what is essentially more commercially valuable than the waste with high non-flammable solids content.

Once the site-specific formula has been calculated for a particular site, the process of recovering the various types of oil waste can begin. The methods used to recover the waste can vary from site to site and even for each different type of waste on a particular site. It is envisaged that various
types of equipment and methodologies can suitably be used to recover each of the different types of oil waste that may be present at the site. These recovery mechanisms range from pumped extraction for pumpable materials to the use of land-moving vehicles such as diggers, for waste that is unpumpable in its current state.

For instance at one waste storage site the entire feedstock of waste might be stored in an uniined pit or iagoon that has been formed in the middle of the desert, which is not an uncommon situation for legacy waste from the oil industry. At such sites the waste with the higher oil content would be recovered from the actual body of the iagoon. in contrast, the waste with high non-flammable solids content would be recovered from the sand around the edges of the lagoon, where the oil waste has been absorbed by the sand over time, it will be appreciated that, as the waste with the higher oil content is recovered from the iagoon, more of the waste with the higher non-flammable solids content will become accessible for recovery.

It is also appreciated that the method of the present invention might be used in concert with other oil waste recovery methods that are currently used to process waste that has high oil content, such as the process described in PCT/GB2008/003379.

At some waste storage sites there may be oil waste that is stored in drums; such waste can be recovered by way of a single or multi-drum heated decanter. Alternatively a drum crusher may be used to squeeze the oil waste from the drum.

As mentioned above, the waste with high non-flammable solids content will be collected from stockpiles with standard handling equipment (excavators, mechanical shovels, etc). Where necessary the solids will be passed through a screen and crusher to ensure that particle sizes with a diameter of up to 15mm in three dimensions fall within the constraints of subsequent parts of the process. The crusher unit might be a free-standing standard crusher, or alternatively a mobile unit attached to the excavator or digger.
Typically each type of waste with high non-flammable solids content will be loaded onto transfer equipment, such as conveyor, by handling equipment diggers and the conveyor system will then carry that specific waste at a controlled speed to a hopper or other appropriate storage device. Alternatively the waste material might be deposited directly into the hopper by means of the excavator.

Preferably, in the event that the production unit is a mobile unit located temporarily on or near the site where the oil waste is located, such oil waste will be deposited directly into storage hoppers by the excavator that preferably is fitted with a portable screener/crusher. If the size of the particles in the waste is above the maximum limit the diggers may instead deposit the waste at the screening/crushing apparatus for resizing, after which the waste could feed the conveyor system.

From the hopper, each type of waste with high non-flammable solids content will typically be propelled by a gear or piston pump, which it is envisaged might be operated by air, electricity or hydraulic power, at a controlled rate through pipe work and, if appropriate, through a series of in-line mixers to the main static in-line mixer for blending into a homogeneous stream of waste containing a high proportion of non-flammable solids. Eventually this composite material will be blended with the appropriate oily waste, with a higher oil content.

Although the preferred form of mixing used in the present process provided by in-line static mixers it is appreciated that other mechanisms of mixing might be effectively applied. For example a trommel, concrete mixer, or attrition scrubber might alternatively be used to mix the blend.

In some situations a particular oil waste site may store more than one type of waste with high non-flammable solids content. When this is the case it is appreciated that in order to enable a single site-specific formula to be applied consistently a pre-blending operation might be employed. However it is appreciated that it is possible, although not necessarily desirable, that a different formula might be calculated for each type of waste with high non-flammable solids content present at a particular site.
The pre-blending operation would once again utilise in-line static mixers to mix the various types of the waste with high non-flammable solids content so as to produce a single stream of waste for entry into the main static mixer. Such pre-blending will of course take place according to calculated formula proportions and it may be appropriate to carry out a quality control check to ensure the waste stream produced by the pre-blending operation has characteristics that fall within the desired ranges.

Depending on its consistency, the oily waste (i.e. waste with oil content above 10%) will be pumped (with or without heat assistance) or excavated by conventional handling equipment. It is envisaged that the oily waste could be anything in the range from pure diesel to a semi solid of heavily weathered waxy crude mixed with sand.

Typically the oily waste will be moved by mechanical handling equipment such as excavator, conveyor system or pipe (depending on its viscosity) into a suitable containment such as a hopper. The contents of the containment will then be fed into the main in-line static mixer via pumping by gear or piston pump. The oily waste will then be blended with the waste with high non-flammable solid content to form a fuel in accordance with the site-specific formula.

As with the waste with high non-flammable solid content, where more than one type of oily waste with high oil content is present at a particular site, a pre-blending operation may be adopted. As mentioned above it may be appropriate to carry out a quality control check to ensure the waste stream produced by the pre-blending operation has characteristics that fall within the desired ranges.

The pre-blending may be applied to produce a single oily waste stream that is easier to handle by mixing oily waste with relatively high oil content with oily waste that has relatively low oil content.

As described above, the pre-blending operation will mix the various types of oily waste to produce a single oily waste stream, which can then be pumped to the main in-line static mixer for blending with the waste with high
non-flammable solid content to produce a blend suitable for use as a fuel for cement kilns.

In order to ensure that the blend can be used across a wide range of applications and industries, such as a fuel for cement kilns, the product may preferably be passed through one or more specially designed grinder heads that can reduce the ultimate particle size of the blend to 5mm or less in three dimensions. In this way the blend can be pumped through a variety of different nozzle sizes to facilitate effective atomization into the incinerator.

The blend produced by the above mixing stages will then be pumped into fully closed tanks mounted on trailers for immediate transportation to the ultimate destination, such as a cement works. Typically the tanks will each have a capacity of 25 to 30 metric tons, and each could be fitted with a circulatory system such as a ribbon blender and/or a static in-line mixer to ensure that on delivery at the cement works the delivered material remains in its homogeneous state and has not settled out.

The tanks may also comprise a heating system that can be used when it is necessary to heat the fuel to keep it mobile for handling (e.g. pumping) purposes.

In order to ensure fast and efficient transfer into the fuel handling system at the site of a cement kiln the tanks must be provided with compatible couplings and/or tipping mechanisms.

It is appreciated that upon arrival at the cement works, the blend will be unloaded directly into to a storage or other unit (as appropriate) with an active hydraulic extraction device or tipping mechanism which will feed a hydraulic high pressure pump to enable the pumping of it to the pre-calciner of the kiln of a cement works or to a specific location at any other appropriate factory. A nozzle device will inject properly the fuel in the pre-calciner of the kiln ensuring good dispersion and better combustion.

In situations where the blend is not pumpable the discharge method may be by way of tipping, in such arrangements it is envisaged that the inner contact surfaces of the truck will be fabricated, coated or lined with an
appropriate material such as plastic to ensure that the discharge is speedy and complete.

Alternatively the blend may be held in storage in the tank until required. With this in mind it is appreciated that a sufficient number of trailers, tanks and drivers will be needed to keep the process in continuous operation.

As it is anticipated that blend production plant will be capable of producing 25 metric tons per hour, the transport fleet would need to be established to be able to handle the actual rate of production required taking into account distances to be travelled and discharge logistics.

It is envisaged that all of the equipment necessary for carrying out the method of the present invention would advantageously be mounted on vehicles so as to be mobile. In this way the mobile equipment can be taken to the waste sites of which there might be several in any one area in order to avoid the need to transport the waste to a central processing site.

A typical arrangement of a mobile processing plant this is envisaged is shown in Figure 2. The main components of the processing plant are all housed within standard shipping containers (i.e. 20 or 40ft in length). The main components of this exemplary processing plant are the main processing unit 1; the hopper/pump unit 2; the drum decanter unit 5; and the blend transport unit 8.

More detail on the interior of the main processing unit 1, which is shown as being housed within a 40ft container, is provided below.

The hopper/pumping unit 2, which is shown as being housed within a 20ft container, comprises several (and in this case three) hoppers 3 into which the oil waste is deposited. It is envisaged that each of the hoppers 3 could be used for a distinct type of oil waste and could be provided with additional pre-processing means, such as a crusher (not shown) downstream of the hopper 3.

The hopper/pumping unit 2 supplies the various forms of oil waste to the main processing unit 1 via input conduits 4. As already mentioned it is envisaged that certain types of oil waste may be subjected to additional
processing, such as crushing, before the waste enters the main processing unit 1 via the input conduits 4.

The drum decanter unit 5, which is also shown as being housed within a 20ft container, extracts oil waste from storage drums 6 and supplies the main processing unit 1 via input conduit 7.

The blend that is produced from the oil waste within the main processing unit 1 is pumped to a transportation unit 8 via outlet conduit 9. It is envisaged that the transportation unit 8 is mounted on a vehicle so that it can be promptly dispatched to a waiting incineration plant, such as a cement factory, and a new transportation unit 8 can be moved into position. This arrangement allows for a continuous process with limited down time.

The main processing unit 1 is provided with a gantry 10 that is extendable from the main processing unit 1 to the transportation unit 8 so as to provide operator access. The gantry 10 carries the output conduit 9 via which the blend is pumped to the transportation unit 8. It is envisaged that the output conduit 9 is provided with an isolation/fill valve (not shown) to enable the flow of blend out of the output conduit 9 to be stopped while the transportation unit 8 is replaced. In addition, the gantry 10 is foldable so that it can be stowed away when the main processing unit 1 is transported from site to site by lorry or train for example.

The main processing unit 1 is provided with a personnel area 11 that has a small storage area 15 for the operators.

Within the main processing unit 1 are the mixers 12 that mix the various oil waste streams together to form the blend. As has already been described, it is envisaged that such mixers 12 are preferably in-line static mixers, although alternative mixers may also be adopted. The mixers 12 supplied with the various oil waste streams by input conduits 4 and 7, a suitable diameter for which is considered to be 4 inches.

The blend produced by the mixers 12 passes through the main crusher units 13, which ensure that the maximum particle size of the blend is within the desired size range of 5mm or below in all dimensions. It is appreciated
that a filter unit may also be provided to re-circulate the blend back through the crushers (or grinders) until the maximum particle size is reached.

Once the blend has been graded to the required particle size the blend is pumped out of the main processing unit 1 to the waiting transportation unit 8 via the output conduit 9.

In the event that the process of mixing the content of various oil waste streams is required to take place at a centralized fixed location processing plant, trucks will transport untreated waste materials of suitable characteristics and deposit them in storage containments which can be structures built into the ground of impervious concrete, or lined pits or storage tanks above ground. Waste materials will be extracted from these storage containments and blended and otherwise processed in exactly the same manner as for the mobile plant as described above.

This procedure ensures that the process is fully compliant with all environmental regulations and requirements.

Examples of the application of the method of the present invention

By way of further clarification of how the method of the present invention is operated, a typical waste site is schematically represented in the flow diagram of figure 1.

Figure 1 represents a notional waste site having five types of oil waste, which have the following characteristics:

<table>
<thead>
<tr>
<th>Stockpile</th>
<th>Quantity (MT)</th>
<th>Brief Description</th>
<th>LHV (GJ/MT)</th>
<th>% Solids content</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30</td>
<td>High solids stockpile</td>
<td>8</td>
<td>78</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
<td>High solids stockpile with oversized particle size</td>
<td>7</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>High viscosity oil sludge pit</td>
<td>23</td>
<td>48</td>
</tr>
<tr>
<td>D</td>
<td>15</td>
<td>Lower viscosity oil sludge pit</td>
<td>39</td>
<td>10</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>Drummed oil storage</td>
<td>45</td>
<td>5</td>
</tr>
</tbody>
</table>
The first stage of the method of the present invention is to audit each of the five types of oil waste at the waste site to determine the quantity of each waste type present and also certain characteristics of the waste, which is this example are the lower heating value (or net calorific value) and % content by weight of non-flammable solids of each waste type. The values presented in the above table are considered to be a typical representation of waste types present at the waste sites on which the present method is to be employed.

Once the amount of each waste type present and the necessary characteristics thereof are know, a blend formulation can be calculated that produces a fuel with a LHV (or net calorific value) of at least 8 GJ per MT, and preferably at least 15 GJ per MT. Using the above notional values, and for demonstration purposes only, the following blend formulation could be applied:

\[
3A + 4B + C + 1.5D + 0.5E = \text{blended fuel}
\]

Blending the waste types according to the above formula would give 10 metric tons of blended fuel:

\[
3(8GJ) + 4(7GJ) + 23GJ + 1.5(39GJ) + 0.5(45GJ) = \text{LHV of 156GJ}
\]

An LHV of 156GJ for 10 metric tons of blended fuel equates to 15.6GJ per lVIT, which satisfies the preferred minimum lower heating value required by the method of the present invention. Further, the fuel blended according to the above formula also has a non-flammable solids content of 62.0% by weight, which also satisfies the preferred maximum for fuels blended by the present invention.

Once the blend formulation has been calculated the various waste types are mixed together in accordance with said formulation. As already discussed above some types of waste may be subjected to pre-processing before they are mixed together with other types of waste. For example, because stockpile B consists a high solids content waste with particles that
are too large to be compatible with the burning in a cement kiln, the waste of stockpile B is subjected to a crusher before it goes on to be mixed with the high solids content waste of stockpile A.

The various waste types are mixed using an in-line mixer, with the blended product then moving on to be blended with the other blended products formed from waste. This process continues until the final blend exits the final in-ûne mixer and passed into a waiting transportation tanker.

The transportation tanker, which may have means for heating and agitating the blend during transport to prevent the blend separating, then transports the blend to the cement works. At the cement works the blend is deposited into the pre-calciner of the cement work, from which the blend goes on to be burned as a fuel in the cement kûn.

It will be appreciated that the above example is provided for explanation purposes only and is not intended to be imitating on the scope of the present invention.

The present invention is primarily directed to the processing and disposal of oil waste from the mineral oil discovery and refining industries (e.g. petroleum industries). However it is envisaged that the methodology of the present invention may be implemented to process and dispose of other forms of oil waste, such as organic oil waste and synthetic oil waste, provided such oil waste had the required net calorific values.
CLAiMS

1. A method of processing mineral oil waste to produce a blend suitable for use as a fuel for cement kilns, wherein a portion of said mineral oil waste has a high content of non-flammable solids content that renders such waste otherwise unusable as a fuel, and wherein said method comprises:
   a) providing a processing plant at a location;
   b) auditing the various types of mineral oil waste available at the location to determine the lower heating value and non-flammable solids content of each type of mineral oil waste;
   c) calculating a blend formulation that will provide a blend with a lower heating value of at least 8 gigajoules per metric ton using a combination of mineral oil waste with the high non-flammable solids content and the other mineral oil waste types available at the location;
   d) collecting the calculated quantities of the mineral oil waste required to produce the blend;
   e) using the processing plant to mix the calculated quantities of mineral oil waste to achieve the blend suitable for fueling cement kilns.

2. The method of claim 1, wherein the processing plant is mobile and the location is an individual oil waste storage site.

3. The method of claim 1, wherein the processing plant is located at a fixed location and the oil waste is collected from one or more waste storage sites.

4. The method of any of claims 1 to 3, wherein the lower heating value of the blend is at least 15 gigajoules per metric ton.

5. The method of any of the preceding claims, wherein the waste with the high non-flammable solids content comprises a least one solid mineral material, such as sand or clay, and has an oil content of less than 10%.
6. The method of any of the preceding claims, wherein the other mineral oil waste has an oil content of 10% or more.

7. The method of any of the preceding claims, wherein the calculated quantities of mineral oil waste are mixed using an in-line static mixer.

8. The method of any of the preceding claims, said method further comprising at least one pre-processing step, whereby more than one type of mineral oil waste is collected and processed to provide the calculated quantity of mineral oil waste that is mixed in step e).

9. The method of any of the preceding claims, method further comprising a step whereby the maximum particle size of the mineral oil waste in any dimension is reduced to 15mm.

10. The method of any of the preceding claims, method further comprising a step whereby the maximum particle size of the blend in any dimension is reduced to 5mm.

11. The method of any of the preceding claims, wherein the blend has a pumpable consistency.

12. The method of any of the preceding claims, wherein the maximum amount of non-flammable solids content in the blend is 80% by weight.

13. The method of claim 12, wherein the maximum amount of non-flammable solids content in the blend is 50% weight.

14. A method of disposing of mineral oil waste having a high content of non-flammable solids content that renders such waste otherwise unusable for use as a fuel, comprising:
a) processing the various types of mineral oil waste to produce a blend having a lower heating value of at least 8 gigajoules per metric ton;

b) heating the blend such that coking of the non-flammable solids content of the blend takes place.

15. The method of claim 14, wherein the blend is heated for at least 4 seconds.

16. The method of claim 14 or 15, wherein the blend is heated within a cement kiln.

17. The method of claim 14, 15 or 16, wherein the method further comprises scrubbing any flue gases produced during the heating of the blend.

18. The method of any of claims 14 to 17, wherein the blend is produced using a method according to any of claims 1 to 13.

19. A mobile oil waste processing plant suitable for use in accordance with the method of any of the preceding claims, said plant comprising:

   a main processing unit that is housed within a standard size shipping container that is transportable using conventional vehicles, said main processing unit having at least two oil waste inlets, at least one outlet, and at least one mixing unit to mix the oil waste supplied via the inlets to produce a blend and supply the outlet with the blend;

   at least one oil waste collecting unit that is housed within a standard size shipping container this is transportable using conventional vehicles, said oil waste collecting unit being connectable to at least one of the main processing unit inlets to supply oil waste for mixing; and

   a transportation unit that is transportable using conventional vehicles, said transportation unit being connectable to the outlet of the main processing unit to receive the blend.
20. The oil waste processing plant according to claim 19, wherein the mixer units in the main processing unit comprise at least one in-line static mixer.

21. The oil waste processing plant according to claim 19 or 20, wherein the main processing unit further comprises crushing means to reduce the particie size of the blend before it exits via the outlet.

22. The oil waste processing plant according to claim 19, 20 or 21, wherein the at least one oil waste collecting unit is selected from a group consisting of a drum decanter, a drum crusher, a hopper and pumping means.

23. The oil waste processing plant according to any of claims 19 to 22, wherein the transportation unit comprises integral blending equipment and heaters that maintain the blend during its transportation from the processing plant to an incineration site, such as cement works.

24. The oil waste processing plant according to any of claims 19 to 23, wherein the transportation unit is provided with means for pumping the blend directly into an incinerator, such as a cement kiln, at the incineration site without further processing or blending.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. B09B3/00 B09C1/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
B09B B09C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>WO 2009/047485 A1 (REXOS LTD [GB]; MONBIOT) cited in the application claims 1,14,24</td>
<td>1-24</td>
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Further documents are listed in the continuation of Box C X See patent family annex

Date of the actual completion of the international search 19 January 2011

Date of mailing of the international search report 01/02/2011

Name and mailing address of the ISA/Authorized officer
European Patent Office, P B 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel (+31-70) 340-2040,
Fax (+31-70) 340-3016

Devilers, Erick

Form PCT/ISA/210 (second sheet) (April 2005)
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