The present invention provides a process for separating oil from sludge wherein the oil is separated under conditions suitable for reuse of the separated oil. The present invention provides a method for separating oil from sludge containing heavy oil, comprising: a reductant addition step of adding a reductant to the sludge; and a separation step of separating oil from the sludge in a way that prevents an oxidant from mixing in the sludge.
ABSTRACT OF THE DISCLOSURE

The present invention provides a process for separating oil from sludge wherein the oil is separated under conditions suitable for reuse of the separated oil. The present invention provides a method for separating oil from sludge containing heavy oil, comprising: a reductant addition step of adding a reductant to the sludge; and a separation step of separating oil from the sludge in a way that prevents an oxidant from mixing in the sludge.
METHOD FOR SEPARATING OIL FROM SLUDGE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for separating oil from oil-containing sludge.

Description of the Related Art

Wastewater including water-soluble cutting oil is discharged from plants for automobiles, machining, metalworking, and the like. This wastewater contains normal hexane (n-hex) extract having a concentration as high as several thousand to several tens of thousands mg/L, and is generally mixed with water in a state where emulsion oil is emulsified. The emulsion oil is always very difficult to separate, making it difficult to completely remove oil from the wastewater including water-soluble cutting oil. On the other hand, there is another problem that discharging wastewater from which oil is incompletely removed has a great impact on the environment. Therefore, for example, the sewage discharge standard for normal hexane extract specifies that 5 mg/L (mineral oil) must not be exceeded.

For this reason, a method for separating oil from wastewater by distilling the wastewater under reduced pressure and then separating, acidizing, and centrifuging the concentrate is described in Japanese Patent Application Laid-Open No. 2001-37467. It seems that a similar method is effective even in separating oil from sludge.

As a method for separating oil from sludge (soil slurry) without using an acid, a method where an alkali such as sodium hydroxide is added to sludge (soil slurry), which is then aerated is described in Japanese Patent Application Laid-Open No. 2002-18420. This method makes it possible to easily separate the oil deposited on soil particles by adding the alkali to the sludge (soil slurry), and to separate the oil with air bubbles.

SUMMARY OF THE INVENTION

However, in the method described in Japanese Patent Application Laid-Open No. 2001-37467, when separated oil is reused, sulfur contained in sulfuric acid and chlorine
contained in hydrochloric acid can corrode pipes and apparatuses, therefore it is difficult to reuse the oil which is separated and recovered from the wastewater. In addition, the method described in Japanese Patent Application Laid-Open No. 2002-18420 is intended to wash soil but does not discuss reuse of separated oil. Moreover, because of the alkali treatment, the oil is changed in quality. Therefore, it is difficult to reuse the oil. As mentioned above, according to above mentioned conventional methods for separating oil from sludge, a corrosive substance is mixed in oil, or the oil itself is changed in quality, therefore it is difficult to reuse the oil.

The present invention has been made in light of these circumstances, and an object thereof is to provide a method for separating oil from sludge under conditions suitable for reuse of separated oil.

In order to achieve the object above, the first aspect of the present invention provides a method for separating oil from sludge, the method separating oil from sludge containing heavy oil, comprising: a reductant addition step of adding a reductant to the sludge; and a separation step of separating oil from the sludge in a way that prevents an oxidant from mixing in the sludge.

According to the first aspect of the present invention, the reductant is used to separate oil, therefore corrosive substances such as sulfur and chlorine are not contained in the oil in contrast to the conventional art. Therefore, it is possible to reuse the separated oil easily.

The second aspect of the present invention provides the method according to the first aspect, wherein the sludge is heated to a temperature between 30°C or more and 100°C or less during or after the reductant addition step.

The second aspect specifies the temperature when or after the reductant is added, and by heating the sludge to the specified temperature the viscosity of the oil decreases and the fluidity of the oil increases. Therefore, the separation of the oil from the sludge is accelerated.

The third aspect of the present invention provides the method according to the first or the second aspect, wherein the heavy oil is any one selected from the group consisting of heavy oil, cutting oil, asphalt, tar, bitumen, and light oil.

The method for separating oil from sludge according to the present invention can especially separate the heavy oil from sludge effectively.
The fourth aspect of the present invention provides the method according to any one of the first to the third aspect, wherein the reductant addition step is implemented in a stirring tank comprising a pH meter, a thermometer, an oxidation-reduction potentiometer, and a stirrer, and then the separation step is implemented with a centrifuge connected to the stirring tank.

The fifth aspect of the present invention provides the method according to any one of the first to the third aspect, wherein the reductant addition step is implemented in a stirring tank comprising a pH meter, a thermometer, an oxidation-reduction potentiometer, and a stirrer, and then the stirring is stopped and the separation step is implemented by floatation separation in the stirring tank.

The fourth and fifth aspects specify the separation method in the separation step, and allow the separation of oil from water by using the centrifuge or the static separation. According to the present invention, a reductant is used to separate oil from water, therefore mineral acids such as sulfuric acid and hydrochloric acid, which cause corrosion, are not contained in the oil. Therefore, it is unlikely to damage pipes and apparatuses when the oil is reused. In addition, the oil itself is degraded to lower molecular because of reduction, so the oil separated and recovered by the methods according to the present invention can be given a higher use value than that separated and recovered by the conventional methods.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a configuration of an oil separation system for implementing the method for separating oil from sludge according to a first embodiment of the present invention;

Fig. 2 is a schematic view of a configuration of an oil separation system for implementing the method for separating oil from sludge according to a second embodiment of the present invention; and

Fig. 3 is a graph showing a relation between the concentration of hexane extract and a concentration of reductant in case that the reductant is added to bitumen-containing sludge.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
Preferred embodiments of the method for separating oil from sludge according to the present invention will be described below in detail by referring to the attached drawings.

<<First Embodiment>>

Fig. 1 is a schematic view of a configuration of an oil separation system for implementing the method for separating oil from sludge according to a first embodiment of the present invention. As shown in Fig. 1, an oil separation system 10 is a facility which separates oil from heavy oil-containing sludge discharged from machining plants and the like, and comprises a mixing tank 20 and a centrifuge 30.

At first, heavy oil-containing sludge was introduced into the mixing tank 20. The mixing tank 20 includes a reductant addition device that adds a reductant. When the reductant is added into the mixing tank 20 from the reductant addition device, the sludge is anaerobically mixed with the reductant and the heavy oil is hydrogenated by reduction to make the heavy oil degraded to lower molecular.

In addition, the mixing tank 20 has a stirrer 21, and the sludge is stirred by the stirrer 21.

In addition, the mixing tank 20 preferably includes a pH meter 22 and an oxidation-reduction potentiometer 23 to add the reductant so that pH and potential difference in the mixing tank 20 are in predetermined ranges. The range of pH is preferably 5 to 9 and more preferably 6 to 8. Also, the potential difference which is measured with the oxidation-reduction potentiometer 23 is preferably less than or equal to 0 mV and more preferably less than or equal to -300 mV.

Furthermore, the mixing tank 20 preferably includes a thermometer 24 to control the temperature during stirring in the mixing tank 20 during or after the reductant addition step in which the reductant is added. The temperature in the mixing tank 20 is preferably between 30°C or more and less than 100°C and more preferably between 40°C or more and less than 100°C. Chemical reactions depend on temperature, and a higher temperature provides a higher reaction rate. Therefore, oil separation from sludge can be accelerated by heating heavy oil to decrease the viscosity of the oil and increase the fluidity. Meanwhile, a temperature in the mixing tank 20 of 100°C or more is not preferable since water evaporates.
In a method for controlling the temperature in the mixing tank 20, as shown in Fig. 1, a jacket 25 is provided around the mixing tank 20, and vapor or hot water is supplied into the jacket 25, therefore the temperature can be controlled.

The reductant which can be used in the present invention is not particularly limited, and examples thereof include sodium sulfite, ferrous sulfate, urea, ammonia, ascorbic acid, glutathione, and cysteic acid.

The reduced sludge introduced into the centrifuge 30 is continuously subjected to centrifugal force to be efficiently centrifuged into a plurality of phases. Centrifugation can preferably apply high centrifugal force for efficient separation into three phases: water, oil, and sludge (solid), and for example, a disk centrifuge can be used. A disk centrifuge includes a plurality of conic disks stacked at intervals of 1 mm or less inside a main body of the disk centrifuge, and the disks rotate at high speed. In addition, the main body of the disk centrifuge has a supply port through which reduced sludge is introduced. A centrifugal acceleration is given to the reduced sludge introduced, by rotating disks, and the centrifugal acceleration is 39,200 to 147,000 m/s² (4,000 to 15,000 G), preferably 58,800 to 117,600 m/s² (6,000 to 12,000 G). Then, the water, oil, and sludge of acidized water is separated because of the differences in specific gravity between them.

According to the present invention, the reductant is used to make heavy oil degraded to lower molecular, therefore the separation step needs to be implemented so that no oxidant enters sludge. To prevent an oxidant from mixing in the sludge, the mixing tank and the pipes from the mixing tank to the separation step (the centrifuge 30) are preferably sealed.

Separated oil is constantly extracted through an oil recovery opening. Also, sludge is extracted through a sludge recovery opening to recover the sludge. On the other hand, water is constantly extracted through a water recovery opening, and then disposed of, or biological treatment by special bacteria is performed on the water.

Here, the configuration of the centrifuge 30 is not limited to the configuration described above, and for example, the centrifuge may have a configuration that increases the efficiency at which oil is separated from water by through holes formed in the disks or a configuration that only separates oil from water.
Examples of the heavy oil contained in sludge used in the oil separation method of the present invention include fuel oil, cutting oil, asphalt, tar, bitumen, and light oil.

Fig. 2 is a schematic view of a configuration of an oil separation system for implementing the method for separating oil from sludge according to a second embodiment of the present invention.

An oil separation system 110, shown in Fig. 2, is different from the oil separation system according to the first embodiment in that no centrifuge is provided behind a mixing tank 120. As shown in Fig. 2, oil can also be separated from sludge by floatation separation by leaving the sludge to stand in the mixing tank 120, not a centrifuge.

Next, changes in concentration of hexane extract when sodium sulfite or ferrous sulfate is added as a reductant to sludge which contains bitumen derived from oil sand will be described below. Fig. 3 is a graph showing a relation between the concentration of hexane extract and a concentration of reductant in case that the reductant is added to bitumen-containing sludge.

Bitumen is said to be an extra-heavy oil, and cannot be extracted completely with hexane, which can only extract oil having up to about 40 carbon atoms. Therefore, for crude sludge to which reductants are not added, the oil concentration (concentration of hexane extract) is apparently low, as shown in Fig. 3. However, addition of sodium sulfite or ferrous sulfate increases the oil concentration (hexane extract). It seems that the bitumen was degraded to lower molecular by the addition of sodium sulfite or ferrous sulfate, and the lower molecular is extractable with hexane, therefore the oil concentration (hexane extract) increased.

As described above, reductant addition can make oil degraded to lower molecular, make it possible to recover the oil easily.
WHAT IS CLAIMED IS:

1. A method for separating oil from sludge containing heavy oil, comprising:
   a reductant addition step of adding a reductant to the sludge; and
   a separation step of separating oil from the sludge in a way that prevents an
   oxidant from mixing in the sludge.

2. The method according to claim 1,
   wherein the sludge is heated to a temperature between 30°C or more and 100°C
   or less during or after the reductant addition step.

3. The method according to claim 1,
   wherein the heavy oil is any one selected from the group consisting of heavy oil,
   cutting oil, asphalt, tar, bitumen, and light oil.

4. The method according to claim 1,
   wherein the reductant addition step is implemented in a stirring tank comprising
   a pH meter, a thermometer, an oxidation-reduction potentiometer, and a stirrer,
   and then
   the separation step is implemented with a centrifuge connected to the stirring tank.

5. The method according to claim 1,
   wherein the reductant addition step is implemented in a stirring tank comprising
   a pH meter, a thermometer, an oxidation-reduction potentiometer, and a stirrer,
   and then
   the stirring is stopped and the separation step is implemented by floatation separation in
   the stirring tank.