

DESCRIPTION

Title of the Invention: LIQUID CLEANING AGENT COMPOSITION
FOR SOIL

Field of the Invention

[0001]

The present invention relates to a liquid cleaning agent composition for soil and a method for cleaning soil.

Background of the Invention

[0002]

In recent years, there have been many cases where we are struck by serious soil contamination on various occasions, which is caused by soil contamination due to the illegal dumping of industrial waste, waste disposal at factories or hazardous substance leakage accidents at final disposal sites, and leakage accidents or long-term leakage of various types of oil at the sites or ruins of petroleum complexes, gas stations, chemical plants or the like.

[0003]

Conventionally, techniques such as incineration after excavation, solidification and immobilization, enclosure, bioremediation, soil washing or the like have been used as remediation methods of such contaminated

soil, but among others, techniques of removing contaminants from soil and cleaning it up are becoming mainstream.

[0004]

Compared to other methods, soil washing has high versatility owing to its ability to even clean up different types of contaminants (oil, heavy metals), applicability also as a pretreatment process for bioremediation or the like and capacity to treat a large amount of contaminated soil, thus including elements that enable the achievement of reduction in cleanup costs overall. Usually, cleaning agents containing surfactants or the like are used in soil washing.

[0005]

JP-A 2005-279423 discloses an in-situ cleanup method of contaminated soil comprising, a step of pouring a mixed liquid of a surfactant such as a nonionic surfactant or the like and a solvent such as a glycol solvent or the like and water into an intrastratal area contaminated with organic contaminants and mixing them with the organic contaminants existing in the stratum to produce a low-viscosity emulsion with the aid of an emulsifying and pulling-apart action, and a step of pouring a foaming agent to promote the mixing and emulsification with the aid of a fine foaming action within the stratum, wherein the emulsion with a lowered viscosity is pumped up to the ground and collected.

Summary of the Invention

[0006]

However, surfactants or solvents specifically used in the method of JP-A 2005-279423 posed problems such as hazards associated with flammability and unsatisfactory cleaning performance. Further, it is desirable for liquid cleaning agent compositions for use in soil washing to have excellent composition stability such as a uniform appearance or the like (hereinafter also referred to as one-liquid stability) and an appropriate viscosity for easy handling.

[0007]

The present invention provides a liquid cleaning agent composition for soil having an excellent cleaning effect on soil contamination, low flammability, excellent one-liquid stability (appearance) and a low viscosity, and a method for cleaning soil with the same.

[0008]

The present invention relates to a liquid cleaning agent composition for soil containing, (A) a nonionic surfactant [hereinafter referred to as component (A)], (B) one or more compounds selected from ethylene glycol monobutyl ether, ethylene glycol monoisobutyl ether, diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether and triethylene glycol monobutyl ether [hereinafter referred to as component (B)] and (C) water

[hereinafter referred to as component (C)], wherein the content of water (C) is 15 mass% or more and 80 mass% or less.

[0009]

Further, the present invention relates to a method for cleaning soil, wherein contaminated soil is cleaned with the liquid cleaning agent composition for soil of the present invention.

[0010]

According to the present invention, provided are a liquid cleaning agent composition for soil having an excellent cleaning effect on soil contamination, low flammability, excellent one-liquid stability (appearance) and a low viscosity, and a method for cleaning soil with the same.

Embodiments of the Invention

[0011]

The mechanism by which the present invention exhibits its effects is unclear, but is considered to be as follows.

Component (B) is a compound having a so-called glycol backbone, and generally has the property of having higher melting point and viscosity compared to alcohols for its low molecular weight. Owing to this, a liquid cleaning agent composition for soil formulated with component (B) together with a surfactant, for example, a

nonionic surfactant of component (A) has a higher flash point compared to formulations formulated with alcohol solvents, or has an undetectable flash point depending on the formulation amount of water of component (C), and thus is easy to handle.

It is further inferred that, as component (B) having one butyl group or isobutyl group is more soluble in oil, a contaminant, emulsification of oil or its removal from soil due to component (A) is promoted, resulting in improved cleanability. Compounds having a group other than a butyl group, for example, a propyl group, an ethyl group or a methyl group with a smaller number of carbons are less soluble in oil, a contaminant, and less contribute to cleanability. Further, it is considered that compounds having two butyl groups or compounds having an alkyl group with a larger number of carbons such as a hexyl group or the like are well soluble in oil, a contaminant, but their excessive hydrophobicity causes whitishness, separation, separation into layers or the like during formulation of cleaning agents for soil. In other words, in a composition in which component (B) is combined with components (A) and (C), component (B) not only merely serves as a solvent, but also brings about, in addition to one-liquid stability and an appropriate viscosity, the unexpected effect of improving cleaning power in soil washing.

[0012]

Component (A) is a nonionic surfactant. Component (A) is a component favorably used from the viewpoint of improvement in cleanability. Examples of the nonionic surfactant include polyoxyalkylene alkyl or alkenyl ethers, sorbitan fatty acid esters, polyoxyethylene sorbitan fatty acid esters, polyoxyethylene sorbitol fatty acid esters, fatty acid monoglycerides, polyethylene glycol fatty acid esters or the like. A single use or a combined use of two or more of them is possible.

[0013]

Component (A) is preferably a polyoxyalkylene alkyl or alkenyl ether from the viewpoint of improvement in cleanability.

Component (A) is preferably a polyoxyethylene alkyl or alkenyl ether in which the alkyl group or alkenyl group has 10 or more and 18 or less carbons and the average number of added moles of the ethylene oxide is 3 or more and 10 or less [hereinafter referred to as component (A1)] from the viewpoint of improvement in cleanability.

The alkyl group or alkenyl group in component (A1) may be a straight chain or a branched chain, but it is preferably a branched chain from the viewpoint of one-liquid stability.

The alkyl group or alkenyl group in component (A1) has preferably 16 or less and more preferably 14 or less

carbons. The alkyl group or alkenyl group in component (A) preferably has 10 or 12 carbons from the viewpoint of improvement in cleanability.

The average number of added moles of the ethylene oxide in component (A1) is preferably 3 or more from the viewpoint of emulsifying permeated petroleum compounds to improve cleanability, and preferably 10 or less from the viewpoint of permeating through petroleum compounds to improve cleanability.

Component (A1) is preferably one having an alkyl group, i.e., a polyoxyethylene alkyl ether from the viewpoint of one-liquid stability.

[0014]

Component (A) preferably has an HLB of 8.0 or more and further 9.0 or more, and 14.0 or less and further 13.0 or less according to Griffin's method from the viewpoint of permeating through petroleum compounds, a contamination in soil, and emulsifying the permeated petroleum compounds to improve cleanability.

[0015]

The content of component (A) in the liquid cleaning agent composition for soil of the present invention may be, for example, 5 mass% or more, further 10 mass% or more and further 20 mass% or more from the viewpoint of distribution costs, and 90 mass% or less, further 85 mass% or less and further 80 mass% or less

from the viewpoint of appearance, viscosity or flash point.

[0016]

Component (B) is one or more compounds selected from ethylene glycol monobutyl ether, ethylene glycol monoisobutyl ether, diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether and triethylene glycol monobutyl ether from the viewpoints of cleanability and one-liquid stability. In the present invention, combining a specific component (B) like these with component (A) and a predetermined amount of component (C) improves the cleaning effect and liquid properties of the liquid cleaning agent composition for soil. As demonstrated by comparative examples later, the effects of the present invention are not obtained with compounds that are not qualified as component (B) even if the compounds have glycol ether structures analogous to that of component (B).

[0017]

Component (B) is preferably one or more compounds selected from diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether and triethylene glycol monobutyl ether, more preferably one or more compounds selected from diethylene glycol monobutyl ether and diethylene glycol monoisobutyl ether, and further preferably diethylene glycol monobutyl ether from the viewpoints of cleanability and one-liquid stability. The

liquid cleaning agent composition for soil of the present invention preferably contains diethylene glycol monobutyl ether as component (B).

[0018]

The content of component (B) in the liquid cleaning agent composition for soil of the present invention may be, for example, 1 mass% or more, further 5 mass% or more and further 7 mass% or more from the viewpoint of one-liquid stability, and 15 mass% or less, further 12 mass% or less and further 10 mass% or less from the viewpoint of improvement in cleanability.

[0019]

Component (C) is water.

The content of component (C) in the liquid cleaning agent composition for soil of the present invention is 15 mass% or more, further 18 mass% or more and further 20 mass% or more from the viewpoint of liquid properties (viscosity) or flash point, and 80 mass% or less, further 75 mass% or less and further 70 mass% or less from the viewpoint of one-liquid stability or distribution costs.

[0020]

The liquid cleaning agent composition for soil of the present invention can contain (D) an anionic surfactant [hereinafter referred to as component (D)] from the viewpoint of improvement in cleanability.

[0021]

Examples of component (D) include anionic surfactants with a molecular weight of 200 or more and 1000 or less.

The molecular weight of component (D) is preferably 200 or more and more preferably 250 or more, and preferably 1000 or less and more preferably 600 or less from the viewpoint of forming a mixed micelle with component (A) to improve cleanability.

[0022]

Examples of component (D) include anionic surfactants with a molecular weight of 200 or more and 1000 or less selected from fatty acid salts, sulfate salts, sulfonic acid salts and phosphate salts from the viewpoint of improvement in cleanability.

[0023]

The fatty acids of the fatty acid salts preferably have 10 or more and 18 or less carbons from the viewpoint of improvement in cleanability. Specific examples of the fatty acid salts include capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid and salts of them, for example, alkali metal salts and organic amine salts of them. The fatty acids may be mixtures of fatty acids.

[0024]

Examples of the sulfate salts include salts of sulfates having an alkyl group or alkenyl group with 10 or more and 20 or less carbons from the viewpoint of

improvement in cleanability. Specific examples of the sulfate salts include sulfate salts having an alkyl group or alkenyl group with 10 or more and 20 or less carbons (AS), polyoxyalkylene alkyl (or alkenyl) ether sulfate salts (AES) (for example, alkyl or alkenyl ether sulfate salts in which the average number of added moles of the alkylene oxide, which has 2 or more and 4 or less carbons, is 0.5 mol or more and 10 mol or less, and which have a straight-chain or branched-chain alkyl group or alkenyl group with 10 or more and 20 or less carbons), polyoxyalkylene alkyl or alkenyl phenyl ether sulfate salts having a straight-chain or branched-chain alkyl group or alkenyl group with 10 or more and 20 or less carbons, and castor oil sulfate salts.

[0025]

Specific examples of the sulfonic acid salts include alkane sulfonic acid salts with 10 or more and 20 or less carbons (SAS), straight-chain or branched-chain alkyl benzene sulfonic acid salts having an alkyl group with 8 or more and 18 or less carbons (LAS or ABS), α -olefin sulfonic acid salts with 10 or more and 20 or less carbons (AOS), di- or monoalkyl sulfosuccinic acid salts (for example, sodium di(2-ethyl hexyl) sulfosuccinate (AOT)), and saturated or unsaturated α -sulfofatty acids with 8 or more and 20 or less carbons or methyl, ethyl or propyl ester salts of them from the viewpoint of improvement in cleanability.

[0026]

Examples of the phosphate salts include salts of phosphates having an alkyl group or alkenyl group with 10 or more and 20 or less carbons from the viewpoint of improvement in cleanability. Specific examples of the phosphate salts include polyoxyalkylene alkyl ether phosphate salts, polyoxyalkylene alkyl phenyl ether phosphate salts and long-chain alkyl phosphate salts. As the phosphoric acid salts, for example, monoester species, diester species or any mixtures of monoester species and diester species (sesquiester species) can be used.

[0027]

Component (D) is preferably an anionic surfactant selected from sulfate salts (AS), polyoxyalkylene alkyl or alkenyl ether sulfate salts (AES) and alkyl benzene sulfonic acid salts (LAS) from the viewpoint of promoting the permeation of component (A) to improve cleanability.

Component (D) is further preferably an anionic surfactant selected from sulfate salts (AS) and polyoxyalkylene alkyl or alkenyl ether sulfate salts (AES) from the viewpoint of forming a mixed micelle with component (A) to improve cleanability.

[0028]

Component (D) is preferably an anionic surfactant with a molecular weight of 200 or more and 1000 or less selected from alkyl sulfate salts, polyoxyethylene alkyl

ether sulfate salts and alkyl benzene sulfonic acid salts, and more preferably an anionic surfactant with a molecular weight of 200 or more and 1000 or less selected from alkyl sulfate salts and polyoxyethylene alkyl ether sulfate salts from the viewpoint of forming a mixed micelle to promote the permeation of component (A) through petroleum compounds to improve cleanability.

[0029]

The alkyl sulfate salts are preferably alkyl sulfate salts having an alkyl group with 10 or more and 18 or less carbons from the viewpoint of forming a mixed micelle with component (A) to improve cleanability.

The polyoxyethylene alkyl ether sulfate salts are preferably polyoxyethylene alkyl ether sulfate salts in which the alkyl group has 10 or more and 18 or less carbons and the average number of added moles of the ethylene oxide is 0.5 or more and 5.0 or less from the viewpoint of forming a mixed micelle with component (A) to improve cleanability.

The alkyl benzene sulfonic acids are preferably alkyl benzene sulfonic acid salts having an alkyl group with 10 or more and 14 or less carbons from the viewpoint of forming a mixed micelle to promote the permeation of component (A) through petroleum compounds to improve cleanability.

[0030]

Examples of the salt of the anionic surfactant of component (D) include alkali metal salts, alkaline earth metal salts, amine salts, ammonium salts, alkanol amine salts or the like. The salt is preferably a salt selected from alkali metal salts and alkanol amine salts, more preferably a sodium salt or an alkanol amine salt, and further preferably an alkanol amine salt from the viewpoint of forming a mixed micelle depending on the degree of hydration to improve cleanability. The alkanol amine salt is preferably a salt of an alkanol amine having 1 or more and 3 or less alkanol groups with 1 or more and 3 or less carbons.

[0031]

The HLB of component (D) according to Davies' method is preferably 10 or more and further 12 or more from the viewpoint of one-liquid stability due to the formation of a mixed micelle with component (A), and preferably 40 or less and further 35 or less from the viewpoint of improving the ability to clean petroleum compounds that are modified due to the permeation of component (A). Note that, in the present invention, a value calculated based on a compound the salt of which is assumed to be a sodium salt is employed as the HLB of component (D). Further, when component (D) is a multimer-type salt, for example, a compound such as an alkaline earth metal salt of a fatty acid or the like,

the HLB of the sodium salt of the monomer constituting the compound is used as the HLB of the compound.

[0032]

In the present invention, it is preferable that components (A) and (D) each have an alkyl group or an alkenyl group, and the difference between the number of carbons in the alkyl group or alkenyl group of component (A) and that in the alkyl group or alkenyl group of component (D) be within 4, further within 2 and further within 1 from the viewpoint of forming a mixed micelle of components (A) and (D) to improve cleanability. Further, the difference between the number of carbons in the alkyl group or alkenyl group of component (A) and that in the alkyl group or alkenyl group of component (D) may be 0, in other words, the numbers of carbons of the two may be the same.

[0033]

When the liquid cleaning agent composition for soil of the present invention contains component (D), the content of component (D) in the composition may be, for example, 5 mass% or more, further 8 mass% or more and further 10 mass% or more, and 70 mass% or less, further 60 mass% or less and further 50 mass% or less.

[0034]

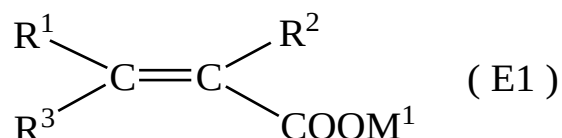
When the liquid cleaning agent composition for soil of the present invention contains component (D), the ratio of the content of component (D) to the total of the

content of component (A) and the content of component (D), $(D)/[(A)+(D)]$, is preferably 3 mass% or more, more preferably 5 mass% or more and further preferably 8 mass% or more from the viewpoint of modifying petroleum compounds to be in a state of being readily removed to improve cleanability, and preferably 35 mass% or less, more preferably 30 mass% or less, further preferably 25 mass% or less, furthermore preferably 20 mass% or less and furthermore preferably 18 mass% or less further from the viewpoint of emulsifying the modified petroleum compounds to improve cleanability.

[0035]

The liquid cleaning agent composition for soil of the present invention can contain (E) a polymer obtained by polymerizing a monomer represented by the following general formula (E1) [hereinafter referred to as monomer (E1)] at a ratio of 30 mol% or more and 100 mol% or less in all monomers or a salt thereof [hereinafter referred to as component (E)] from the viewpoint of dispersing fine-grained soil to improve cleanability:

[0036]



[0037]

wherein R^1 , R^2 and R^3 independently represent a hydrogen atom, a methyl group or $(\text{CH}_2)_m\text{COOM}^2$; $(\text{CH}_2)_m\text{COOM}^2$

may form an anhydride with COOM^1 or another $(\text{CH}_2)_m\text{COOM}^2$, in which case M^1 and M^2 are absent from those groups; M^1 and M^2 independently represent a hydrogen atom, an alkali metal, an alkaline earth metal, an ammonium group, an alkyl ammonium group or a substituted alkyl ammonium group; and m represents a number of 0 or more and 2 or less.

[0038]

It is preferable from the viewpoint of improvement in cleanability that R^1 and R^2 each represent a hydrogen atom, R^3 be $(\text{CH}_2)_m\text{COOM}^2$ and m be 0 in the general formula (E1). In other words, monomer (E1) is preferably maleic acid or a salt thereof or maleic anhydride. Further, M^1 and M^2 in the general formula (E1) preferably independently represent a sodium salt.

[0039]

Component (E) may be a copolymer of monomer (E1) and a monomer copolymerizable with monomer (E1) or a salt thereof from the viewpoint of improvement in cleanability. Component (E) is preferably a copolymer of monomer (E1) and an olefin with 4 or more and 8 or less carbons or a salt thereof, in which case monomer (E1) is preferably maleic acid, and the olefin with 4 or more and 8 or less carbons is preferably diisobutylene. In other words, component (E) is more preferably a copolymer of maleic acid and diisobutylene or a salt thereof.

[0040]

Component (E) is a polymer obtained by polymerizing monomer (E1) at a ratio of 30 mol% or more and 100 mol% or less in all monomers or a salt thereof from the viewpoint of improvement in cleanability. When component (E) is a copolymer of monomer (E1) and another monomer, the ratio of monomer (E1) in all monomers may be, for example, 40 mol% or more and further 45 mol% or more, and 80 mol% or less and further 60 mol% or less.

[0041]

When the liquid cleaning agent composition for soil of the present invention contains component (E), the content of component (E) in the composition may be, for example, 0.1 mass% or more, further 0.5 mass% or more and further 1.0 mass% or more, and 10 mass% or less, further 8 mass% or less and further 5 mass% or less.

[0042]

When the liquid cleaning agent composition for soil of the present invention contains component (E), the mass ratio of the content of component (A) to the content of component (E), $(A)/(E)$, is preferably 1 or more, further 1.5 or more, further 2 or more and further 3 or more from the viewpoint of one-liquid stability, and preferably 100 or less, further 20 or less and further 10 or less from the viewpoint of improvement in the ability to clean soil including fine-grained soil.

[0043]

The liquid cleaning agent composition for soil of the present invention can contain (F) one or more compounds selected from isopropyl alcohol and ethanol [hereinafter referred to as component (F)] from the viewpoint of one-liquid stability of formulations including low-HLB nonionic surfactants. When the liquid cleaning agent composition for soil of the present invention contains component (F), the mass ratio of the content of component (B) to the content of component (F), $(B)/(F)$, may be, for example, 4 or more and further 5 or more from the viewpoint of handleability (flash point), and 10 or less and further 8 or less from the viewpoint of one-liquid stability. When the liquid cleaning agent composition for soil of the present invention contains component (F), the content of component (F) in the composition may be, for example, 0.1 mass% or more, further 0.5 mass% or more and further 1 mass% or more, and 4 mass% or less, further 3 mass% or less and further 2 mass% or less.

[0044]

The liquid cleaning agent composition for soil of the present invention can also contain surfactants other than components (A) and (D). The proportion of component (A) or the total of components (A) and (D) in all the surfactants in the liquid cleaning agent composition for soil of the present invention is preferably 90 mass% or

more and more preferably 95 mass% or more, and preferably 100 mass% or less, and may be 100 mass%.

[0045]

The liquid cleaning agent composition for soil of the present invention can contain, as appropriate for its purposes, other optional components within a range that the effects of the present invention are not impaired. The liquid cleaning agent composition for soil of the present invention can contain, for example, gelation inhibitors, thickeners, fragrances, dyes, pigments, disinfectants, antiseptics, pH adjusters and other components.

[0046]

The viscosity of the liquid cleaning agent composition for soil of the present invention at 20°C may be, for example, 10 mPa·s or more, further 15 mPa·s or more and further 20 mPa·s or more, and 500 mPa·s or less, further 300 mPa·s or less and further 150 mPa·s or less. The viscosity is measured with a BM-type viscometer manufactured by TOKYO KEIKI INC. under conditions where the rotor number is No. 2, and the number of revolutions is 60 rpm for one with a viscosity of less than 500 mPa·s, the number of revolutions is 30 rpm for one with a viscosity of 500 mPa·s or more and less than 1000 mPa·s, the number of revolutions is 12 rpm for one with a viscosity of 1000 mPa·s or more and less than 2500 mPa·s

and the number of revolutions is 6 rpm for one with a viscosity of 2500 mPa·s or more.

[0047]

The pH of the liquid cleaning agent composition for soil of the present invention at 20°C may be, for example, 6.0 or more and further 6.5 or more, and 8.0 or less and further 7.5 or less from the viewpoint of leaching of heavy metals or the like, which are assumed to be a combined contamination, from soil.

[0048]

The liquid cleaning agent composition for soil of the present invention may be used for cleaning soil contaminated with petroleum compounds. In other words, the present invention may be a liquid cleaning agent composition for soil used for cleaning oily contaminations such as petroleum compounds in soil. Examples of the petroleum compounds include, for example, petroleum hydrocarbons. The petroleum compounds may be, for example, gasoline, kerosene, light oil, heavy oil, machine oil and others.

[0049]

The liquid cleaning agent composition for soil of the present invention may be for use in cleaning of oily contaminations in fine-grained soil. Here, "fine-grained soil" may be soil with a particle size of 0.075 mm or less. The particle size of soil such as excavated soil or the like is measured by "Test method for particle size

distribution of soils" in JIS A 1204 or the like, a test method directed to soil with a particle size of 0.075 mm or less or the like.

[0050]

The liquid cleaning agent composition for soil of the present invention may be a liquid cleaning agent composition for soil formulated with components (A), (B) and (C), wherein the formulation amount of component (C) is 15 mass% or more and 80 mass% or less. The preferable aspects described above can be appropriately applied to this liquid cleaning agent composition for soil. Further, the content of each component described above can be read as the formulation amount thereof and applied to this liquid cleaning agent composition for soil.

[0051]

The present invention provides a method for producing a liquid cleaning agent composition for soil including, mixing components (A), (B) and (C) and optionally other components, wherein the ratio of the mixing amount of component (C) in the total amount of the mixed components is 10 mass% or more and 80 mass% or less. The matters stated in the liquid cleaning agent composition for soil of the present invention can be appropriately applied to this producing method. For example, the content of each component in the liquid cleaning agent composition for soil of the present

invention can be read as the mixing amount thereof and applied to the producing method.

[0052]

The liquid cleaning agent composition for soil of the present invention may be used as a cleaning liquid in which the content of component (A) is, for example, 0.1 mass% or more and further 0.2 mass% or more, and 5 mass% or less and further 2 mass% or less during use.

[0053]

The present invention includes use of a composition containing components (A), (B) and (C), wherein the content of water (C) is 15 mass% or more and 80 mass% or less, as a liquid cleaning agent composition for soil. The matters stated in the liquid cleaning agent composition for soil of the present invention can be appropriately applied to this use.

[0054]

<Method for cleaning soil>

The present invention relates to a method for cleaning soil, wherein contaminated soil is cleaned with the liquid cleaning agent composition for soil of the present invention.

The matters stated in the liquid cleaning agent composition for soil of the present invention can be appropriately applied to the method for cleaning soil of the present invention.

[0055]

In the method for cleaning soil of the present invention, the contaminated soil can be cleaned with a cleaning liquid obtained by mixing the liquid cleaning agent composition for soil with water. In such a case, the cleaning liquid can be prepared immediately before cleaning the contaminated soil.

[0056]

In the method for cleaning soil of the present invention, for example, the composition of the present invention or the cleaning liquid can be poured into the soil without carrying out excavation to clean the soil. In the present invention, for example, the liquid cleaning agent composition for soil of the present invention or the cleaning liquid can be poured into the contaminated soil at a predetermined position, passed through the contaminated soil, and thereafter collected at a position different from the predetermined position. Accordingly, in the present invention, for example, the composition of the present invention or the cleaning liquid can be poured into soil contaminated with petroleum compounds at a predetermined position without carrying out excavation, passed through the soil to take in the petroleum compounds, and collected at a position different from the predetermined position. In the present invention, contaminants such as petroleum compounds or the like can be separated from the collected composition or cleaning liquid. The collection of the

composition or the cleaning liquid can be performed by water pumping techniques or the like, and specifically, it can be performed by pumping means such as lift pumps or the like. Further, while the method of JP-A 2005-279423 comprises a step of pouring a foaming agent, an excellent cleaning effect can be obtained without pouring a foaming agent in the method for cleaning soil of the present invention. The method for cleaning soil of the present invention may be a cleaning method in which foaming agents, for example, foaming agents including sodium bicarbonate, and further, foaming agents in which sodium bicarbonate and acetic acid are combined, are not used.

[0057]

Further, the method for cleaning soil of the present invention can be directed to, and used for cleaning, for example, excavated soil. Accordingly, the present invention provides a method for cleaning excavated soil, wherein excavated soil contaminated with petroleum compounds is cleaned with the composition of the present invention or the cleaning liquid. In the method for cleaning excavated soil of the present invention, the cleaned excavated soil may be or may not have to be rinsed. The present invention does not require carrying out the rinsing step from the viewpoint of a simplification of the process or the like. The

excavated soil after cleaning can be reused as backfill soil for sites where it was gathered or other sites.

[0058]

The pH of the cleaning liquid used in the present invention may be 6 or more and 8 or less. Further, the content of component (A) in the cleaning liquid used in the present invention may be, for example, 0.1 mass% or more and further 0.2 mass% or more, and 5 mass% or less and further 2 mass% or less. The composition of the present invention used in the method for cleaning soil of the present invention may also have a pH and a content of component (A) falling within the above ranges.

Examples

[0059]

The liquid cleaning agent compositions for soil shown in Tables 1 to 6 were prepared, and the appearances and viscosities thereof were measured by the methods described later and cleaning tests were conducted thereon in the manner described later. The results are shown in Tables 1 to 6. Note that the abbreviations for components used in the tables mean the following. The HLB of component (A) is HLB according to Griffin's method, and the HLB of component (D) is HLB according to Davies' method. Note that the HLB of component (D) was calculated based on a compound the salt of which was assumed to be a sodium salt. Further, note that

compounds not qualified as component (B) are also shown in the columns for component (B) in the tables for convenience.

[0060]

<Component (A)>

C12(EO)6: a polyoxyethylene straight-chain alkyl (with 12 carbons) ether with an average number of added moles of 6, HLB 11.7

C12(EO)8: a polyoxyethylene straight-chain alkyl (with 12 carbons) ether with an average number of added moles of 8, HLB 12.0

C12-13(EO)5: a polyoxyethylene branched-chain alkyl (with 12 to 13 carbons) ether with an average number of added moles of 5, HLB 10.6

C12-13(EO)9: a polyoxyethylene branched-chain alkyl (with 12 to 13 carbons) ether with an average number of added moles of 9, HLB 13.4

C18F1(EO)8: a polyoxyethylene straight-chain alkenyl (with 18 carbons) ether with an average number of added moles of 9, HLB 11.3

The HLB of component (A) is HLB according to Griffin's method.

[0061]

<Component (B)>

DEG-MBE: diethylene glycol monobutyl ether

EG-MBE: ethylene glycol monobutyl ether

TEG-MBE: triethylene glycol monobutyl ether

DEG-MiBE: diethylene glycol monoisobutyl ether

EG-MiBE: ethylene glycol monoisobutyl ether

[0062]

<Comparative component for component (B)>

EG-DBE: ethylene glycol dibutyl ether

DEG-DBE: diethylene glycol dibutyl ether

DEG-MME: diethylene glycol monomethyl ether

DEG-MEE: diethylene glycol monoethyl ether

DEG-MHE: diethylene glycol monohexyl ether

PG-MME: propylene glycol monomethyl ether

[0063]

<Component (D)>

C12OSO₃·TEA: a triethanol amine salt of an alkyl sulfate having a straight-chain alkyl group with 12 carbons, HLB 33

C12OSO₃·Na: a sodium salt of an alkyl sulfate having a straight-chain alkyl group with 12 carbons, HLB 33

C12O(EO)₂SO₃·Na: a sodium salt of a polyoxyethylene alkyl ether sulfate which has a straight-chain alkyl group with 12 carbons and in which the average number of added moles of the ethylene oxide is 2, HLB 33.7

LAS·Na: a sodium salt of an alkyl benzene sulfonic acid having a straight-chain alkyl group with 12 carbons, HLB 2.5

C11COO·Na: a sodium salt of a straight-chain fatty acid with 12 carbons, HLB 13.9

The HLB of component (D) is HLB according to Davies' method. Note that the HLB of component (D) was calculated based on a compound the salt of which was assumed to be a sodium salt.

[0064]

<Component (E)>

DIB-MA-Na: a sodium salt of a copolymer of diisobutylene and maleic acid (diisobutylene/maleic acid=50/50 (molar ratio), weight average molecular weight 25000)

[0065]

<Component (F)>

IPA: isopropyl alcohol

[0066]

(1) Appearance

After the liquid cleaning agent compositions for soil were prepared and then left to stand at 20 to 22°C for 24 hours, the appearances thereof were visually observed to evaluate the states.

[0067]

(2) Viscosity

The viscosities of the liquid cleaning agent compositions for soil were measured at 20°C with a BM-type viscometer manufactured by TOKYO KEIKI INC. Measurements were made under conditions where the rotor number was No. 2, and the number of revolutions was 60 rpm for one with a viscosity of less than 500 mPa·s, the number of revolutions was 30 rpm for one with a viscosity

of 500 mPa·s or more and less than 1000 mPa·s, the number of revolutions was 12 rpm for one with a viscosity of 1000 mPa·s or more and less than 2500 mPa·s and the number of revolutions was 6 rpm for one with a viscosity of 2500 mPa·s or more.

[0068]

(3) Cleaning test

(3-1) Preparation of simulated oil-contaminated soil for evaluation

200 g of silica sand No. 5 (manufactured by MIKAWA KEISEKI K.K.), 200 g of fine powder clay for civil engineering (Sumi clay, Sumitomo Osaka Cement Co., Ltd.) and 3.2 g of light oil were stirred uniformly with a hand mixer to prepare simulated oil-contaminated soil. Note that the content of fine grains with a particle size of 0.075 mm or less in the fine powder clay for civil engineering used here was 90 mass% or more.

[0069]

(3-2) Preparation of cleaning liquid

Each liquid cleaning agent composition for soil was diluted with water such that the active ingredients content was 1.0 mass%, and stirred with a magnetic stirrer for 1 hour to obtain a uniform solution, and the solution was used for a cleaning test. Note that the active ingredients are components (A), (D) and (E).

[0070]

(3-3) Cleaning of simulated oil-contaminated soil

A 30-ml injection syringe (Terumo Syringe) was packed with 20 g of the simulated contaminated soil.

With the outlet side of a tubing pump connected to the needle attaching portion of the syringe packed with the simulated contaminated soil, the cleaning liquid was injected into the syringe from the inlet side of the tubing pump at a constant rate. The flow rate of the cleaning liquid through the tubing pump was adjusted to 6.3 ml per hour to conduct the test, and the injection of the cleaning liquid was completed 8 hours after the start of the injection (the total injection amount was 50 ml).

[0071]

(3-4) Evaluation of cleanability

1. After the injection of the cleaning liquid was completed in (3-3), 10.0 g of the soil was weighed in a 100-ml screw tube, and placed in a thermostatic bath at 40°C without a lid for 15 hours. Coincidentally, about 3 g of the soil after the completion of the injection was precisely weighed, and placed in a thermostatic bath at 105°C for 15 hours to measure the dry clay content of the soil after the completion of the injection.
2. 15 hours later, about 50 g of anhydrous sodium sulfate was added to the screw tube and shaken.
3. Further, 50 ml of dichloromethane was added to the screw tube and stirred with a pencil mixer for 1 minute, and left to stand for 60 minutes.

4. The supernatant liquid after left to stand was transferred to a 100-ml volumetric flask, and 30 ml of dichloromethane was further added thereto and stirred with a pencil mixer for 1 minute, and left to stand for 60 minutes.

5. The supernatant liquid after left to stand in the above 4. was transferred to another 100-ml volumetric flask, and 30 ml of dichloromethane was further added thereto and stirred with a pencil mixer for 1 minute, and left to stand for 60 minutes.

6. The supernatant liquid after left to stand in the above 5. was transferred to another 100-ml volumetric flask and diluted with dichloromethane to 100 ml, and used as a dichloromethane extract liquid.

7. After the dichloromethane extract liquid was filtered through a 0.45- μ m filter, the light oil content was quantified by gas chromatography using 6850A manufactured by Agilent Technologies.

8. The quantification result was converted into the amount included in the dry clay content of the soil after the completion of the injection (which was dried at 105°C) and used as the amount of residual light oil. In the tables, the light oil content (mg) per 1 kg of the soil is shown as TPH (mg/kg). Note that cleaning tests were not conducted on liquid cleaning agent compositions for soil not transparent in appearance because of wide variations in the cleanability results.

[0072]

[Table 1]

Liquid cleaning agent composition for soil														Viscosity (mPa·s)	Appearance	
Composition																
Component (A)			Component (B)		Component (C)		Component (D)		Component (F)		Formulation amount (mass%)	Formulation amount (mass%)	Type			Formulation amount (mass%)
Type	Formulation amount (mass%)		Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)						
Example	1-1	C12(EO)6	75	DEG-MBE	10	15	—	—	—	—	—	—	—	78	Transparent	
	1-2	C12(EO)8	60	DEG-MBE	10	30	—	—	—	—	—	—	—	119	Transparent	
	1-3	C12(EO)8	40	DEG-MBE	10	50	—	—	—	—	—	—	—	335	Transparent	
	1-4	C12(EO)6	54	DEG-MBE	10	28	C12OSO3·TEA	6	Ethanol	2	—	—	53	Transparent		
	1-5	C12(EO)6	36	DEG-MBE	10	50	C12OSO3·TEA	4	—	—	—	—	105	Transparent		
	1-6	C12(EO)6	18	DEG-MBE	10	70	C12OSO3·TEA	2	—	—	—	—	18	Transparent		
	1-7	C12(EO)6	9	DEG-MBE	10	80	C12OSO3·TEA	1	—	—	—	—	10	Transparent		
Comparative example	1-1	C12(EO)6	90	—	—	10	—	—	—	—	—	—	—	88	Transparent	
	1-2	C12(EO)6	85	—	—	15	—	—	—	—	—	—	—	More than 5000	Separated into layers	
	1-3	C12(EO)6	80	—	—	20	—	—	—	—	—	—	—	More than 5000	Whitish gel	
	1-4	C12(EO)8	80	—	—	20	—	—	—	—	—	—	—	More than 5000	Whitish gel	
	1-5	C12(EO)8	60	—	—	40	—	—	—	—	—	—	—	More than 5000	Whitish gel	
	1-6	C12(EO)8	40	—	—	60	—	—	—	—	—	—	—	More than 5000	Transparent gel	

[0073]

[Table 2]

	Liquid cleaning agent composition for soil							Appearance	Viscosity (mPa·s)	Cleanability
	Composition									
	Component (A)		Component (B)		Component (C)					
	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Formulation amount (mass%)	Formulation amount (mass%)	Formulation amount (mass%)			
Group I	Example	2-1a	C12-13(EO)5	40	DEG-MBE	10	50	Transparent	51	2355
		2-1b	C12-13(EO)5	40	EG-MBE	10	50	Transparent	33	2449
		2-1c	C12-13(EO)5	40	TEG-MBE	10	50	Transparent	58	2379
		2-1d	C12-13(EO)5	40	DEG-MIBE	10	50	Transparent	43	2370
		2-1e	C12-13(EO)5	40	EG-MIBE	10	50	Transparent	35	2421
		2-1f	C12-13(EO)5	40	DEG-MBE	7	53	Transparent	54	2467
	Comparative example	2-1a	C12-13(EO)5	40	—	—	60	Whitish	272	Not conducted
		2-1b	C12-13(EO)5	40	EG-DBE	10	50	Transparent gel	598	Not conducted
		2-1c	C12-13(EO)5	40	DEG-DBE	10	50	Transparent gel	640	Not conducted
		2-1d	C12-13(EO)5	40	1,4-butanediol	10	50	Separated into layers	84	Not conducted
		2-1e	C12-13(EO)5	40	PG-MME	10	50	Whitish	66	Not conducted
		2-1f	C12-13(EO)5	40	1,3-butanediol	7	53	Separated into layers	100	Not conducted
Group II	Example	C12-13(EO)5	32	DEG-MBE	10	50	Transparent	51	2301	
	Comparative example	C12-13(EO)9	8	—	—	60	Separated into layers	132	Not conducted	
Group III	Example	C12(EO)6	40	DEG-MBE	10	50	Transparent	86	2460	
	Example	C12(EO)6	40	DEG-MBE	8	52	Transparent	86	2480	
	Comparative example	C12(EO)6	40	—	—	60	Separated into layers	237	Not conducted	
	Group IV	Example	C18F1(EO)8	40	DEG-MBE	10	50	Transparent	448	2395
	Comparative example	C18F1(EO)8	40	—	—	60	Whitish	More than 5000	Not conducted	

[0074]

[Table 3]

Liquid cleaning agent composition for soil												
Composition												
		Component (A)		Component (B)		Component (C)		Component (D)		Component (F)		Cleanability
		Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	
Group V	Example	1-5	C12(EO)6	36	DEG-MBE	10	50	C12OSO3·TEA	4	—	—	1851
	Comparative example	1-9	C12(EO)6	36	—	—	60	C12OSO3·TEA	4	—	—	Not conducted
Group VI	Example	3-2a	C12(EO)6	36	DEG-MBE	10	50	C12OSO3·Na	4	—	—	1689
		3-2b	C12(EO)6	36	DEG-MBE	8	52	C12OSO3·Na	4	—	—	1692
		3-2c	C12(EO)6	36	TEG-MBE	8	52	C12OSO3·Na	4	—	—	1688
	Comparative example	3-2a	C12(EO)6	36	—	—	60	C12OSO3·Na	4	—	—	1841~2176 ^{*1}
Group VII	Example	3-3a	C12(EO)6	36	DEG-MBE	10	50	C12O(EO)2SO3·Na	4	—	—	2043
	Comparative example	3-3a	C12(EO)6	36	—	—	60	C12O(EO)2SO3·Na	4	—	—	Not conducted
Group VIII	Example	3-4a	C12(EO)6	36	DEG-MBE	10	50	LAS·Na	4	—	—	2192
	Comparative example	3-4a	C12(EO)6	36	—	—	60	LAS·Na	4	—	—	Not conducted
Group IX	Example	3-5a	C12(EO)6	36	DEG-MBE	10	50	C11COO·Na	4	—	—	2251
	Comparative example	3-5a	C12(EO)6	36	—	—	60	C11COO·Na	4	—	—	Not conducted
Group X	Example	3-6a	C12(EO)5	36	DEG-MBE	10	48	C12OSO3·TEA	4	IPA	2	1558
	Comparative example	3-6a	C12(EO)5	36	—	—	60	C12OSO3·TEA	4	—	—	Not conducted
	3-6b	C12(EO)5	36	—	—	—	60	C12OSO3·TEA	4	IPA	2	Not conducted

[0075]

*1 In comparative example 3-2a, cleanability evaluations were performed three times, and the maximum value and the minimum value thereof are shown. In comparative example 3-2a, the error between the maximum value and the minimum value was about 15% (when calculated as minimum value/maximum value) to about 18% (when calculated as maximum value/minimum value). Note that, if cleanability evaluations were performed in examples multiple times, for example, three times, the errors would be smaller than those in comparative examples. For example, when cleanability evaluations were performed in example 3-2a twice more under the same conditions (cleanability evaluations were performed a total of three times together with the evaluation shown in the table), the TPH values were 1690 mg/kg and 1676 mg/kg. When the error was calculated in the same manner as in comparative example 3-2a with these values as the maximum value and the minimum value, the error was about 0.8% whether the denominator was the maximum value or the minimum value, which was very small compared to that of comparative example 3-2a. Note that the first measurement value of example 3-2a shown in the table is 1689 mg/kg, which falls within the range between the above maximum and minimum values of this example.

[0076]

[Table 4]

Liquid cleaning agent composition for soil												Cleanability
Composition												
Component (A)		Component (B)		Component (C)		Component (D)		Appearance	Viscosity (mPa·s)	TPH (mg/kg)		
Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)	Type	Formulation amount (mass%)					
Group XI	4-1a	C12(EO)6	18	DEG-MBE	1	79	C12OSO3-TEA	2	Transparent	274	2028	
	Example	4-1b	C12(EO)6	18	DEG-MBE	2	78	C12OSO3-TEA	2	Transparent	251	
		4-1c	C12(EO)6	18	DEG-MBE	3	77	C12OSO3-TEA	2	Transparent	226	
	Comparative example	1-10	C12(EO)6	18	-	-	80	C12OSO3-TEA	2	Separated into layers	Not conducted	
	Group XII	Example	4-2a	C12(EO)5	36	DEG-MBE	15	45	C12OSO3-TEA	4	Transparent	1551
Comparative example		3-6a	C12(EO)5	36	-	-	60	C12OSO3-TEA	4	Whitish- separated	Not conducted	

[0077]

[Table 5]

Liquid cleaning agent composition for soil											Cleanability
Composition											
Component (A)			Component (B)		Component (C)		Component (E)		Appearance	Viscosity (mPa·s)	
Type	Formulation amount (mass%)		Type	Formulation amount (mass%)		Formulation amount (mass%)	Type	Formulation amount (mass%)			
Example	2-1a	C12-13(EO)5	40	DEG-MBE	10		50	-	Transparent	51	2355
	5-1	C12-13(EO)5	38	DEG-MBE	10		50	DIB-MA-Na	2	Transparent	2156
Example	5-2	C12-13(EO)5	36	DEG-MBE	10		50	DIB-MA-Na	4	Transparent	2100
	2-1a	C12-13(EO)5	40	—	—		60	—	Whitish	272	Not conducted
Comparative example	2-1b	C12-13(EO)5	36	—	—		60	DIB-MA-Na	4	Separated into layers	Not conducted

[Table 6]

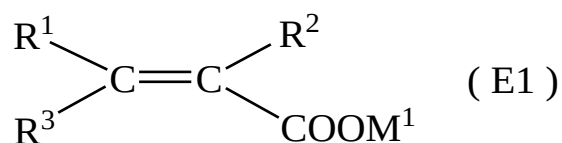
Liquid cleaning agent composition for soil												Cleanability
Composition												
Component (A)			Component (B)		Component (C)		Component (D)		(D)/[(A)+(D)] (mass%)	Appearance	Viscosity (mPa·s)	
Type	Formulation amount (mass%)		Type	Formulation amount (mass%)	Formulation amount (mass%)	Type	Formulation amount (mass%)					
Example	2-3a	C12(EO)6	40	DEG-MBE	10	50	—	—	0	Transparent	86	2460
	6-1	C12(EO)6	38.8	DEG-MBE	10	50	C12OSO3·TEA	1.2	3	Transparent	91	2327
	6-2	C12(EO)6	38	DEG-MBE	10	50	C12OSO3·TEA	2	5	Transparent	98	2051
	1-5	C12(EO)6	36	DEG-MBE	10	50	C12OSO3·TEA	4	10	Transparent	105	1851
	6-3	C12(EO)6	34	DEG-MBE	10	50	C12OSO3·TEA	6	15	Transparent	118	1814
	6-4	C12(EO)6	28	DEG-MBE	10	50	C12OSO3·TEA	12	30	Transparent	145	1847
Comparative example	2-3a	C12(EO)6	40	-	-	60	—	0	Separated into layers	237	Not conducted	

CLAIMS

1. A liquid cleaning agent composition for soil comprising, (A) a nonionic surfactant [hereinafter referred to as component (A)], (B) one or more compounds selected from ethylene glycol monobutyl ether, ethylene glycol monoisobutyl ether, diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether and triethylene glycol monobutyl ether [hereinafter referred to as component (B)] and (C) water, wherein the content of the water (C) is 15 mass% or more and 80 mass% or less.

2. The liquid cleaning agent composition for soil according to claim 1, further comprising (D) an anionic surfactant.

3. The liquid cleaning agent composition for soil according to claim 1 or 2, further comprising (E) a polymer obtained by polymerizing a monomer represented by the following general formula (E1) at a ratio of 30 mol% or more and 100 mol% or less in all monomers or a salt thereof [hereinafter referred to as component (E)],



wherein R^1 , R^2 and R^3 independently represent a hydrogen atom, a methyl group or $(CH_2)_mCOOM^2$; $(CH_2)_mCOOM^2$ may form an anhydride with $COOM^1$ or another $(CH_2)_mCOOM^2$, in which case M^1 and M^2 are absent from those groups; M^1 and M^2 independently represent a hydrogen atom, an alkali metal, an alkaline earth metal, an ammonium group, an alkyl ammonium group or a substituted alkyl ammonium group; and m represents a number of 0 or more and 2 or less.

4. The liquid cleaning agent composition for soil according to claim 3, wherein the component (E) is a copolymer of the monomer represented by the general formula (E1) and an olefin with 4 or more and 8 or less carbons or a salt thereof.

5. The liquid cleaning agent composition for soil according to claim 3 or 4, wherein the component (E) is a copolymer of maleic acid and diisobutylene or a salt thereof.

6. The liquid cleaning agent composition for soil according to any one of claims 1 to 5, further comprising (F) one or more compounds selected from isopropyl alcohol and ethanol, wherein a mass ratio of the content of the component (B) to the content of the component (F), $(B)/(F)$, is 4 or more and 10 or less.

7. The liquid cleaning agent composition for soil according to any one of claims 1 to 6, comprising the component (B) in an amount of 1 mass% or more and 15 mass% or less.

8. The liquid cleaning agent composition for soil according to any one of claims 1 to 7, wherein the component (A) is a polyoxyethylene alkyl or alkenyl ether in which the alkyl group or alkenyl group has 10 or more and 18 or less carbons and the average number of added moles of the ethylene oxide is 3 or more and 10 or less.

9. The liquid cleaning agent composition for soil according to any one of claims 1 to 8, wherein the component (A) is a nonionic surfactant with an HLB of 8.0 or more and 14.0 or less according to Griffin's method.

10. A method for cleaning soil, wherein contaminated soil is cleaned with the liquid cleaning agent composition for soil according to any of claims 1 to 9.

11. The method for cleaning soil according to claim 10, wherein the contaminated soil is cleaned with a cleaning liquid obtained by mixing the liquid cleaning agent composition for soil with water.

12. The method for cleaning soil according to claim 10 or 11, wherein the cleaning liquid is prepared immediately before cleaning the contaminated soil.

13. The method for cleaning soil according to any one of claims 10 to 12, wherein the liquid cleaning agent composition for soil or the cleaning liquid is poured into the contaminated soil at a predetermined position, passed through the contaminated soil, and thereafter collected at a position different from the predetermined position.

14. The method for cleaning soil according to claim 13, wherein the collection of the composition or the cleaning liquid is performed by a pumping means.

15. The method for cleaning soil according to any of claims 10 to 12, wherein the method is used for cleaning excavated soil.