The document is a patent application for a method of dispersing oil located on the surface of water, which includes providing solid particles that include a matrix component and an effective amount of a dispersant component, and contacting the solid particles with the oil on the body of water in an amount sufficient to disperse at least a portion of the oil. This is a dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and a solid matrix component.
OIL SPILL DISPERSANTS AND DISPERSION METHODS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application 60/571,751, filed May 17, 2004.

BACKGROUND

Field of Inventions

[0002] Embodiments of the present inventions relate to dispersion of oil spills. At least one embodiment involves dispersing oil located on the surface of a body of water by a method that includes providing solid particles that include a matrix component and an effective amount of a dispersant component; and contacting the solid particles with the oil on the body of water in an amount sufficient to disperse at least a portion of the oil.

Description of Related Art

[0003] The accidental release of oil or other hydrocarbons in the marine environment poses a significant threat to offshore, near-shore and coastal areas. In many cases, immediate action is needed to limit the extent of environmental impact. One approach has been to use liquid chemical treating agents, e.g., chemical dispersants. Such dispersants are typically sprayed over the surface of an oil spill with the goal of forming very small oil droplets and thus dispersing the oil into the water column. Liquid chemical dispersants, however, have limitations that reduce their effectiveness for many situations. Such liquid dispersants tend to lose their effectiveness as the viscosity of the oil increases. Certain oils have higher viscosities than others, e.g., Bunker C. Even low viscosity crude oils tend to weather over time into a more viscous liquid. Some crude oils form emulsions with water that often have higher viscosity than the crude oil itself. Further, oil spilled in an arctic climate tends to immediately increase in viscosity upon contact with cold water. The high viscosity of the oil in these scenarios tends to reduce the effectiveness of liquid
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dispersants by limiting the ability of the dispersant to interact with it. Such liquid
dispersants may tend to flow off the surface of the viscous oil and pass into the water
column rather than mixing into the oil. Once the liquid dispersant enters the water,
column, it is no longer available for contacting the oil.

[0004] Shortcomings have also been encountered when liquid dispersants “herd”
rather than disperse oil. Herding occurs when a material (typically large liquid
dispersant droplets) contacts and penetrates an oil spill (typically a thin oil film
floating on the surface of the water), thus contacting the water surface. Because it has
sufficient “spreading pressure” (greater than the spreading pressure of the crude oil),
the liquid dispersant tends to spread out on the water surface; this tends to “herd” the
oil, e.g., pushing it into one or more particular directions, rather than dispersing the oil
into the water column.

[0005] Another shortcoming of liquid dispersants occurs when the target oil is
missed, possibly because the oil has broken into smaller patches. In that situation, the
liquid dispersant passes directly into the water column and is effectively wasted.

[0006] In one or more specific embodiments below, some or all of the
aforementioned shortcomings are addressed, and in some cases overcome.

SUMMARY

[0007] Each invention claimed herein relates to oil dispersion. In at least one
specific embodiment, a method of dispersing oil located on the surface of a body of
water is provided, comprising (including) providing solid particles that include a
matrix component and an effective amount of a dispersant component; and contacting
the solid particles with the oil on the body of water in an amount sufficient to disperse
at least a portion of the oil.

[0008] One or more other specific embodiments include a method of treating an
oil spill, comprising providing solid particles, wherein each particle includes a matrix
component and an effective amount of a dispersant component; and placing the solid
particles on a vehicle, the solid particles on the vehicle being in an amount sufficient
to disperse oil forming part of an oil spill located on the surface of a body of water when the solid particles are placed in contact with the oil.

[0009] In yet other specific embodiments, a method of dispersing oil located on the surface of a body of water includes placing on an airplane an oil spill treatment agent that includes a plurality of solid particles that each include a matrix component and an effective amount of a dispersant component, wherein the plurality of solid particles has an average particle size of 500 microns or more; flying the airplane over oil located on the surface of a body of water; and dropping the oil spill treatment agent onto the upper surface of the oil spill from the airplane when the airplane is flying at an altitude of 200 feet or more (higher), 500 feet or more, or 750 feet or more, or 1,000 feet or more over the oil spill, wherein the dispersant component is released from the solid particles, resulting in dispersion of some or all of the oil spill. In alternative embodiments of the method, the airplane can be flown at lower altitudes, e.g., 100 feet or more. In yet other alternative embodiments, the method can be flown at higher altitudes, e.g., 1,500 feet or more, or 2,000 feet or more, or 2,500 feet or more, or 3,000 feet or more.

[0010] Also, one or more specific embodiments are directed to a dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and a solid matrix component.

[0011] One or more of the dispersants described above or elsewhere herein includes a solid particle that includes a dispersant component and one or more gas bubbles.

[0012] One or more of the dispersants described above or elsewhere herein includes a solid particle that includes a dispersant component and one or more microballoons.

[0013] One or more of the dispersants described above or elsewhere herein includes a solid particle that includes a dispersant component and a matrix component selected from the group consisting of: a tackifier; a rosin or rosin containing compound; a resin or resin containing compound; a rosin-substituted ester; a
resin-substituted ester; pentaerythritol ester; a rosin substituted pentaerythritol ester; a resin substituted pentaerythritol ester; a fully dimerized rosin; a fully dimerized resin; a rosin maleated with glycerol ester; an ester; a fatty acid; a fatty acid derivative; a fatty acid amide; stearic acid or palmitic acid, or a mixture thereof; an oleamide; and a polymer.

[0014] Other aspects or specific embodiments are described in greater detail below and/or in the claims.

DETAILED DESCRIPTION

Introduction and Definitions

[0015] A detailed description will now be provided. Each of the appended claims defines a separate invention, which for infringement purposes is recognized as including equivalents to the various elements or limitations specified in the claims. Depending on the context, all references below to the “invention” may in some cases refer to certain specific embodiments only. In other cases it will be recognized that references to the “invention” will refer to subject matter recited in one or more, but not necessarily all, of the claims. Each of the inventions will now be described in greater detail below, including specific embodiments, versions and examples, but the inventions are not limited to these embodiments, versions or examples, which are included to enable a person having ordinary skill in the art to make and use the inventions, when the information in this patent is combined with available information and technology. Various terms as used herein are defined below, and those definitions should be adopted when construing the claims that include those terms, except to the extent a different meaning is given within the specification or in express representations to the Patent and Trademark Office (PTO). To the extent a term used in a claim is not defined below, or in representations to the PTO, it should be given the broadest definition persons in the pertinent art have given that term as reflected in printed publications, dictionaries and issued patents.

[0016] The term "oil" means hydrocarbon-based oil, including but not limited to crude oil, such as Arab Medium Crude, Alaska North Slope, or Chayvo Crude and
refined crude oil products including but not limited to Intermediate Fuel Oils. The term “oil” does not include animal or vegetable oil. Different crude oils typically have different characteristics, viscosities, solubilities and compositions, so that their dispersing properties are often different.

[0017] The term “oil spill” means any volume of “oil” that occupies at least a portion of the surface of some “body of water.” The oil spills discussed herein can be oil spills that are located far offshore, at a substantial distance from land, or from an airport, or from an airport that includes a supply of any oil spill treatment agent, preferably one of the oil spill treatment agents described herein. Such “substantial distance” can be over 100 miles; or over 200 miles; or over 500 miles; or over 1,000 miles; or over 1,500 miles; or over 2,000 miles; or over 2,500 miles; or over 3,000 miles. The substantial distance can be a distance that requires an airplane, which can be a jet airplane, to deliver the oil spill treatment agent, e.g., the solid particles described herein, to an oil spill.

[0018] The term “body of water” means a large body of water, such as an ocean, sea, gulf, bay, or inlet, and includes any body of water that is connected to an ocean, sea, gulf, bay, or inlet. The term also includes smaller bodies of water, e.g., lakes or rivers, but refers only to bodies of water having a relatively large uninterrupted upper surface area, e.g., at least 1,000 square meters, or even at least 2 square miles. The term does not, for example, include small volumes of water, e.g., water in cups, beakers, or other small containers. In one or more specific embodiments, the term “body of water” refers to a volume of water that, when an oil spill occurs on such body of water, an airplane is a possible vehicle used to deliver the treatment agent, which in embodiments described herein is a collection of solid particles.

[0019] The term “providing” should be given its broadest recognized meaning, and includes, but is not limited to, supplying, making, delivering, combining and forming.

[0020] The term “solid” is defined to encompass any material considered “solid” by an ordinary layperson, including granular material, and also including particulate
material that is porous. The term is to be defined to include any material (e.g., matrix component) or physical object (e.g., particle) that is considered to be neither gas nor liquid nor an emulsion at room temperature (herein considered to be 25 °C). With reference to a “solid particle” that includes a matrix component and a chemical dispersant, the term “solid” may for certain embodiments refer to the matrix component itself, which in certain embodiments herein is a continuous solid phase occupying the outer surface of the particle as well as the inside of the particle, and in other embodiments may refer to the entire particle itself, even though that entire particle may include a chemical dispersant, which in some cases may be liquid at room temperature. Thus, certain materials that are described herein as “solid particles” are porous, and/or include interstices or openings, and/or include microballoons (described in greater detail below) and/or include one or more minor phases or portions that are not themselves solid at room temperature, but rather may be liquid or gaseous (vapor). At least some or all of the pores, or interstices or microballoons (but preferably not all) may be occupied by a chemical dispersant, e.g., the dispersant component, which may be a liquid. In at least one embodiment, discussed below, solid particles formed from a mixture of Pentalyn K (used to form the matrix component) and a liquid dispersant component result in a somewhat heterogenous material, in that a “husk” (or outer shell) rich in Pentalyn K is formed, and an inner core rich in the dispersant component is also formed. It is contemplated that upon cooling some degree of differential shrinkage may occur, so that the inner core shrinks to a smaller diameter than the inner surface of the husk, resulting in a void space between the husk and core. In that situation, although a void space is present, the entire husk/core composite material is regarded herein as “solid,” regardless of whether there is gas or even liquid present. In other embodiments, e.g., where the matrix component is formed from stearic acid, the solid particles are more homogenous, and were not observed as having void spaces.

[0021] The term “solid particle” refers to any object that is “solid” and that would be considered a “particle” by an ordinary layperson. The term “solid particle” also includes any item that would also be referred to as a particulate, grain, dust, powder, pill, pellet, microbead, or granular material. As discussed below, a plurality of any of
the solid particles described below preferably are useful as an oil spill treatment or
dispersion agent that can be delivered via airplane or marine vessel to an oil spill.
The term "microbeads" refers to solid particles having an average diameter less than
500 microns, e.g., 300 microns or less; 200 microns or less; or 100 microns or less.

[0022] The term "matrix component" means the portion of the solid particle that
is not the "dispersant component." (The term "matrix material" refers herein to a
substance before it is formed into a part of the solid particle, after which the matrix
material is considered to become the "matrix component.) Preferably, the "matrix
component" provides structural or mechanical support to the solid particle. However,
it is contemplated that the matrix component can include fillers or inert materials that
do not necessarily themselves provide any or substantial structural or mechanical
support, or that may provide some function other than dispersion. Preferably, the
"matrix component" is any portion of the solid particle that is not liquid or gaseous at
room temperature. As discussed below, a "matrix component" in at least one or more
of the specific embodiments described herein is porous and/or includes interstices
and/or includes microballoons.

[0023] The term "dispersant" means any material regarded as a dispersant by
persons skilled in the art of oil spill dispersion, and includes any material (solid or
liquid) that is capable of causing oil, including particularly a crude oil or a refined oil,
to begin dispersing upon making contact with that oil, or shortly after making such
contact. Preferably, the term "dispersant" herein refers to a solid material that
includes an effective amount of a dispersant component. Unless stated otherwise, any
material that is a herding agent when applied to oil on a body of water is not a
"dispersant." The term "dispersant" includes, but is not limited to, any material that is
classified as a "dispersant" under the NCP Product Schedule published by the United
States Environmental Protection Agency. It is contemplated that many chemicals
exist that are or might be useful in treating oil spills that are not "dispersants." For
example, under the NCP Product Schedule certain materials may qualify as "surface
washing agents," "surface collecting agents" (also referred to as "herding agents"),
"bioremediation agents," or "miscellaneous oil spill control agent," but not as
“dispersants,” to the extent they do not cause oil dispersion. On the other hand, to the extent they do cause oil dispersion, any of such materials would be considered a “dispersant” herein. As used herein, the term “dispersant” also encompasses any material (e.g., a solid particle) that includes both an effective amount of a dispersant component and an effective amount of a matrix component, e.g., where the two components are mixed, blended, or in some manner combined with each other. For example, one of the solid particles discussed herein that includes an effective amount of a “dispersant component” might itself be referred to as a “dispersant” herein even though some portion of the solid particle (e.g., the matrix component) has no dispersion properties. When an oil is located on the surface of a body of water, e.g., as part of an oil spill or slick on an ocean, a preferred dispersant is one that is capable of breaking up the oil on the water’s surface, causing the oil to form droplets and to disperse down into the water column where natural forces can degrade the oil droplets.

[0024] The term “dispersant component” includes any material that qualifies as a “dispersant” (as defined above) and is part of a “solid particle,” but that does not qualify as a “matrix component” (as defined above) except as expressly stated otherwise.

[0025] The term “effective amount” as used herein with reference to solid particles means any amount of solid particles sufficient to result in dispersion of oil on a body of water when that amount of solid particles is applied in any manner to the oil. Preferred amounts of solid particles are described in greater detail below.

[0026] The term “effective amount” as used herein with reference to a dispersant component that occupies at least part of a solid particle means any amount sufficient to result in dispersion of oil on a body of water when an effective amount of solid particles containing such a dispersant component is applied in any manner to the oil. Preferred amounts of dispersant component are described in greater detail below.

[0027] The term “effective amount” as used herein with reference to a matrix component that occupies at least part of a solid particle means any amount sufficient
to support an effective amount of dispersant component. Preferred amounts of matrix component are described in greater detail below.

[0028] The term "particle size" is a term that encompasses any recognized measurement of the size of a single solid particle, e.g., the maximum diameter of an individual solid particle when that term is used in reference to a single solid particle. When used to describe or characterize a plurality of particles, the terms "particle size" and "average particle size" refer to an average particle size for a plurality of solid particles. Unless otherwise indicated, the term particle size or average particle size refers to microns. The term "mesh particle size" or "particle size" (when using "mesh" as a unit) as used herein is based on the recognized "mesh" technique for quantifying sizes for collections of particles. The term "mesh" means the number of apertures per square inch of a screen or sieve, e.g., the square of the number of strands or metal or plastic per linear inch. A preferred average particle size for a collection (e.g., a load) of solid dispersant particles is greater than 500 microns; or 600 microns or more; or 700 microns or more; or 800 microns or more; or 900 microns or more; or 1.0 millimeters or more; or 1.5 millimeters or more; or 2.0 millimeters or more; or 2.5 millimeters or more; or 3.0 millimeters or more; or 3.5 millimeters or more.

[0029] The term "oleophilic" means having an affinity (physical or chemical attraction) to oil that is greater than affinity to water. Preferably, the matrix component of the solid oil spill treatment particle described herein is oleophilic. Also, the solid particles herein are themselves preferably oleophilic, at least when they make initial contact with the oil. For example, a preferred oleophilic solid treatment particle is one that adheres to the oil when it initially contacts that oil. Further, a preferred oleophilic solid particle is one that adheres to the oil even when it is first placed in water next to an oil spill. That is, when placed in the water close to an oil spill, it "sticks" to the surface of the oil spill when the waves or currents cause it to brush up against the oil spill. A solid particle (or a matrix component) that is "oleophilic" may also be "lipophilic," as that term is used in the literature, e.g., U.S. Patent No. 5,348,803, the portions of which that disclose lipophilic materials being hereby incorporated by reference.
[0030] The term “fatty acid” means any carboxylic acid derived from or contained in an animal or vegetable fat or oil, alone or in combination with others, and that term is herein considered to have the definition for that term in the Condensed Chemical Dictionary 507-08 (Hawley, 11th Ed). Specific examples of fatty acids are stearic acid and palmitic acid, alone or in combination.

[0031] The term “density” refers to the mass per unit volume of a material, and is expressed herein in terms of grams per cubic centimeter (g/cc) or grams per milliliter (g/ml), although other ways of quantifying density are also contemplated.

[0032] The term “microballoon” includes any spherical or particulate material that is solid and is capable of existing within and/or forming part of a solid “dispersant particle” as defined below. That is, the microballoons preferably form part of the matrix component. Each microballoon (sphere or particle) is preferably smaller than each solid dispersant particle. Quantitatively speaking, the average diameter of the microballoons that are incorporated into a collection of solid dispersant particles is preferably less than 20%, or less than 10%, or less than 5%, or less than 2%, or even less than 1% of the average diameter of the solid dispersant particles of which they form a part. More preferably, in accordance with preferred embodiments herein, if a single solid dispersant particle is randomly selected from a collection of solid dispersant particles and examined, that solid dispersant particle should include at least 5 microballoons, or at least 10 microballoons, or at least 15 or 20 microballoons. The smaller the microballoons, the more of them can be incorporated into the solid dispersant particle. A preferred type of microballoon is a “glass bubble,” more preferably a Scotchlite™ brand glass bubble manufactured and sold by 3M (Minnesota Mining and Manufacturing Company). Preferably, each microballoon described above and elsewhere herein has a density (or a collection of such microballoons have an average density) of at least 0.05 g/cc, or 0.10 g/cc, or 0.15 g/cc, and no more than 0.40 g/cc, or 0.45 g/cc, or 0.50 g/cc. Preferably, the average particle size of the microballoons that are incorporated into a collection (plurality) of solid dispersant particles is 50 microns or less; or 75 microns or less; or 100 microns or less; or 125 microns or less. In accordance with certain embodiments described
herein, the “matrix component” (defined above) includes one or more microballoons plus another material, e.g., a polymer, which is preferably a material that is oleophilic. Advantageously, in cases where the microballoons collectively have a density lower than the density of the remaining portion of the matrix component, the microballoons lower the density to the desired level.

[0033] The term “solubility” means the general ability, capacity, or tendency of one material to dissolve or blend uniformly with another material, preferably to form a homogenous system, although formation of certain types of emulsions may also be acceptable in certain cases. For example, a preferred type of “solubility” of a material refers to an ability, capacity, or tendency to form a single phase system with another material, e.g., water or oil. As discussed herein, a material (e.g., a solid particle, a dispersant component, or a matrix component) may be considered to have a particular degree of “water solubility” at a given temperature. For example, such material may have a low degree of water solubility (either salt water solubility or fresh water solubility), in that it does not dissolve easily in the water, particularly at low water temperatures that might range from freezing or sub-freezing temperatures (e.g., 0 °C) up to 5 °C, or 10 °C, or 15 °C, or 20 °C, or 25 °C. By the same token, a material may be considered to have a particular degree of “oil solubility” at a given temperature. For example, a material may have a high degree of oil solubility, in that it dissolves readily in oil (or at least a particular type of oil) at a particular temperature (e.g., any of the ranges indicated above). As noted below, certain preferred materials (e.g., certain solid particles) have higher oil solubility than water solubility, meaning that at a given temperature they have a greater tendency to become part of the oil phase rather than the water phase.

Dispersant Component

[0034] As noted above, a solid particle used in treating oil spills preferably includes a dispersant component and a matrix component. In one or more specific embodiments, the dispersant component may include any chemical dispersant that is capable of dispersing oil, when applied alone or in combination with some liquid carrier. The dispersant component is preferably more soluble in the oil to which it is
being applied than in the water surrounding and supporting the oil. It is contemplated that any known and/or appropriate chemical dispersant can be used for the dispersant component. Examples of chemical dispersants useful as a dispersant component are any of the components identified in U.S. Patent No. 3,793,218, or U.S. Patent No. 5,618,468, alone or in combination. The portions of those patents referring to the dispersants, including particularly the chemical formulas of the dispersants, are hereby incorporated by reference, as examples of the “dispersant component” discussed herein.

[0035] The dispersant component may also be a combination, e.g., a blend or mixture, of different chemical dispersants. Some of these chemical dispersants are sold under known trademarks, have established proportions, and may be formulated in a carrier solvent. At least one example of a dispersant component is any of the dispersant chemicals in Corexit® 9500 or Corexit® 9527, sold by Ondeo Nalco Chemical Company. At least one formulation of those products is composed of 9.7 wt% Span® 80 (sorbitan monooleate); 19.4 wt% Tween® 80 (polyoxyethylene sorbitan monooleate); 28.6 wt% Tween® 85 (polyoxyethylene sorbitan trioleate), and 42.3 wt% Aerosol OT (aqueous sodium dioctyl sulfosuccinate). More broadly, an exemplary useful dispersant component may include: (a) sorbitan monooleate (from 5-15 wt%), (b) polyoxyethylene sorbitan monooleate (from 15 to 25 wt%), (c) polyoxyethylene sorbitan trioleate (from 20 to 40 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (from 30 to 50 wt%). More narrowly, a dispersant component may include: (a) sorbitan monooleate (10 wt%), (b) polyoxyethylene sorbitan monooleate (20 wt%), (c) polyoxyethylene sorbitan trioleate (30 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (40 wt%).

Matrix Component

[0036] The matrix component is a non-liquid component of the solid particles that are the “dispersants” discussed herein, and the matrix component is preferably solid (as “solid” is defined above) at temperatures ranging from 30°C (or higher) and below, and in certain embodiments the matrix component is liquid at elevated temperatures, e.g. 50°C and above, or 80°C and above, or 100°C and above, or 120°C
and above. As such, the liquid matrix material can be mixed with the dispersant component at those elevated temperatures, then cooled to form a solid particle formed of a solid matrix component and a dispersant component that may in certain cases remain as a liquid. As noted elsewhere herein, the dispersant particle (except as noted otherwise) includes both a matrix component as well as a dispersant component. At least when it is part of the dispersant particle (e.g., after formation of the particle), the matrix component may have a portion of its internal volume occupied by a gas (vapor), e.g., air or nitrogen, even though certain materials might not have that characteristic until after being manipulated to form the particle. Also, as noted above, the matrix component may include one or more microballoons that are not oil soluble or water soluble, as well as a material that is soluble in oil, e.g. Pentalyn K.

[0037] The matrix component (which may include microballoons) preferably has an overall density that is lower than the density of water, e.g., the water forming the body of water to which the dispersant is to be applied, at least when it is part of the dispersant particle. For that reason, the inclusion of microballoons is particularly advantageous, in at least certain embodiments, particularly if the remaining portions of the matrix component do not have a density lower than the density of water. When the body of water is salty (e.g., ocean water), the density of that water will be greater than 1.0 g/ml (e.g., 1.02 g/ml). In that case, the overall density of the matrix component should be such that the density of the entire dispersant particle (including the dispersant component) is less than 1.02 g/ml, or in certain embodiments even less than 1.00 g/ml, so that the dispersant particles do not sink, but rather float on the surface of the body of water. In one or more specific embodiments, the matrix component (or a particle that includes the matrix component) has a density that ranges from a low of 0.85 g/ml, or 0.90 g/ml, or 0.93 g/ml, or 0.95 g/ml, to a high of 0.95 g/ml, to 0.98 g/ml, to 0.99 g/ml, to 1.00 g/ml, to 1.01 g/ml. In at least one specific embodiment, the matrix component or the solid particle or both has a density that falls below 1.02 (g/ml), so that it is at least capable of floating on salt water.

[0038] Preferably, the matrix component is oleophilic as a whole, even though it may include (for at least certain embodiments) microballoons that are not themselves
oleophilic, e.g., glass microballoons. Also, at least a portion of the matrix component (e.g., the part that is not the microballoons) is oil soluble, but not water soluble (or has limited solubility in water). In one or more specific embodiments, the oil solubility of at least that portion of the matrix component is preferably higher than its water solubility. In at least one specific embodiment, that portion of the matrix component is soluble in oil but has limited solubility in water. As noted below, a determination of the relative oil and water solubilities can be made at selected temperatures, e.g., 35 °F or 70 °F, even though actual use conditions may be different from those temperatures.

[0039] In one or more of the embodiments described above or elsewhere herein, the matrix component includes a compound that has a standard glass transition temperature above 30°C and a modified glass transition temperature below 25°C when in contact with oil. A standard glass transition temperature refers to a materials glass transition temperature in a vacuum, in an inert gas, or in air. A modified glass transition temperature refers to a materials glass transition temperature when in contact with an oil. If the matrix component has a lower modified glass transition temperature, it can be determined by observing the time that it takes for a quantity of the matrix compound to dissolve in a quantity of the desired oil or through observation under a microscope. A preferred matrix compound will dissolve very rapidly in the oil when its glass transition temperature is reduced below the temperature of the test compared to the dissolution rate of the matrix compound in a pure component hydrocarbon such as decane. In alternate embodiments the oil used in evaluating the modified glass transition temperature is crude oil. In alternate embodiments the oil used in evaluating the modified glass transition temperature is Arab Medium Crude, Alaska North Slope Crude, or Chayvo Crude. In alternate embodiments the matrix component may have a standard glass transition temperature above 35°C, 40°C or 45°C. In alternate embodiments the matrix component may have a modified glass transition temperature below 35°C, 30°C, 20°C or 15°C.

[0040] Examples of materials useful as matrix components are “rosin materials,” defined broadly herein to mean rosin, derivatives of rosin, rosin-containing
compounds, e.g., compounds substituted with rosin groups. The definition of “rosin” in the Hawley’s Condensed Chemical Dictionary (11th ed) is adopted herein, and incorporated by reference. Other examples of materials useful as matrix components are esters, particularly pentaerythritol esters of rosin, e.g., materials sold under the trademark PENTALYN®, sold by Eastman Chemical Company. More specific examples of PENTALYN® materials are those sold as PENTALYN®X, PENTALYN®C, or PENTALYN®K. Another example of a rosin containing material is a fully dimerized rosin, e.g., DYMEREX®, also available from Eastman Chemical. Yet, another matrix component material is a rosin maleated with glycerol ester, e.g., PENTREX® from Eastman Chemical.

[0041] Other examples of matrix components are “resin materials” defined broadly herein to mean resins, derivatives of resins, resin-containing compounds, e.g., compounds substituted with resin groups. The definition of “resin” in the Hawley’s Condensed Chemical Dictionary (13th ed) is adopted herein, and incorporated by reference.

[0042] Other examples of matrix components are “tackifier materials.” The definition of tackifier in the Hawley’s Condensed Chemical Dictionary (11th ed) is adopted herein, and incorporated by reference.

[0043] Other examples of matrix components are (or include) polymers, e.g., CERAMER® 5005 polymer or PETROLITE® E-2000 polymer, or PETROLITE® E-2020 polymer, each of which is available commercially from Baker Petrolite. Other examples of polymer matrix components are POLYWAX® 3000, an ethane copolymer available from Baker Hughes; and ESCOREZ® 1102 and ESCOREZ® 310, both available from ExxonMobil.

[0044] Yet other examples of matrix components are (or include) fatty acids or derivatives thereof. For example, a matrix component may be either stearic acid or palmitic acid, alone or in combination. Another matrix component is a fatty acid amide such as esteramide (e.g., ATMER SA 1750) or an oleamide (e.g., ATMER SA 1759), both available from Unichema. Still other examples of matrix components
are non-polymer organic materials, such as dimers or trimers of polyolefins. A matrix component may also be an aliphatic hydrocarbon resin, e.g., NEVTAC® 100.

**Dispersant Particles**

[0045] The dispersant particle (also referred to herein as the solid particle) includes both a matrix component and a dispersant component. The relative amounts of each component can be varied. At least one version of the dispersant particle contains 50 wt% matrix component and 50 wt% dispersant component. Another version contains 50 vol% matrix component and 50 vol% dispersant component. In yet another version, the dispersant particle contains more dispersant component than matrix component. But the weight percentage or volume percentage of dispersant component can range from a low of 10, or 15, or 20, or 25 or 30, or 35, or 40, or 45, or 50, or 55, or 60, or 65, or 70, or 75, or 80, or 85, or even 90 percent (weight or volume) to a high of 90, or 85, or 80, or 75, or 70, or 65, or 60, or 55, or 50, or 45, or 40, or 35 percent (weight or volume) with the remainder being the matrix component. Thus, for example, the weight percentages can fall between or within any of the aforementioned low points and high points. In at least one embodiment, the dispersant component ranges from a low of 10 wt% to a high of 90 wt%.

**Methods of Making Dispersant Particles**

[0046] Various methods can be employed for making the solid dispersant particles. It is contemplated that any number of encapsulation methods can be used, and the invention is not limited to any particular method, unless specified otherwise. In at least one encapsulation method, the dispersant component (in liquid form) is encapsulated within a solid shell, where the solid shell is (or becomes) the "matrix component" (after the particle is formed). In at least one encapsulation method, the material that will form all or part the matrix component (herein referred to as "matrix material") is melted, and microballoons are then added to that melted matrix material. The desired amount of dispersant (preferably liquid dispersant) is introduced to the melted matrix material. That matrix/dispersant mixture is then placed onto the center of a spinning disk, and the spinning action causes the mixture to spread out as a thin
sheet on the disk as it moves closer to the edge of the disk. The mixture then flies off the disk in the form of multiple stringers that then break into small droplets. As the droplets fall through the air, they cool and harden before falling onto a surface below the disk, where they are recovered, e.g., collected or gathered in the form of “solid dispersant particles.” This collection surface may be pre-coated with a flow aid such as starch; pre-coated with no flow aid; or pre-coated with microballoons used as a flow aid. At least one encapsulation method that may be followed to form the solid dispersant particles herein is described in U.S. Patent No. 4,675,140, which is incorporated by reference at least to the extent methods of encapsulation and other methods of forming particles are described. Another particle formation method includes formation of a solid particle, using a polymer that preferably has a low melting point and acts as a carrier. In that method, the polymer is melted, and then mixed with the dispersant component (in liquid form). The mixture is then solidified and processed to form solid particles and/or cooled and crushed to form particles in the form of a powder.

[0047] An alternative method of manufacture and delivery of the solid dispersant includes a method of preparing the solid dispersant particles on an airplane. The alternative method consists of loading the raw materials for the solid dispersant, i.e., the matrix compound, the dispersant, and the microballoons on an airplane (or other delivery vehicle), melting and mixing the compounds on the airplane, and then forming the solid particles by dispensing the melt through nozzles on the exterior of the airplane. Alternatively, the method could have the matrix compound, dispersant, and microballoons premixed and solidified in a large volume and loaded onto an airplane (or other delivery vehicle), melted, and dispensed through nozzles on the exterior of the airplane. After dispensing through the nozzles, the particles would solidify and fall to the oil spill. This method may have the following characteristics: (1) long-term storage of tiny particles is not needed and (2) the payload may be increased because it would not lose the volume associated with the porosity of solid particles.
Dispersion Effectiveness


Methods of Delivering Solid Particles to Oil Spills

[0049] Various methods can be utilized for delivering the solid particles to an oil spill. When an oil spill is on the surface of a body of water, a preferred method includes loading a quantity of solid particles (which are described elsewhere herein) onto an airplane, in order to fly the airplane over the oil spill and deliver the particles onto the surface of the oil spill. Alternatively, the solid particles can be loaded onto any type of vehicle, such as a small boat or a larger ship. In at least one specific embodiment, the delivery method includes dropping or otherwise dispensing the particles onto the oil spill, from above the oil spill, most preferably from an airplane. In preferred embodiments, the particles are delivered using pneumatic eductors located on the exterior of an airplane and connected to a central reservoir located on the interior, wherein the central reservoir holds the particles. In a preferred embodiment, the delivery system evenly distributes the dispersant over a portion or all of an oil spill as the plane flies over. In other embodiments, the particles are dropped all at once, e.g., by opening a bay door of the airplane. In still other embodiments, the particles are dropped in batches or “slugs” over the oil spill. In at least one embodiment, each of the solid particles has a size and weight such that it can be accurately dropped from a high altitude and still hit the desired location on the oil
spill, even in inclement weather, e.g., rain, high winds, or storms. The particle size of the load of particles is described elsewhere herein. Although propeller driven planes are currently used for areal delivery of dispersants, at least one version of the delivery method includes use of a jet airplane, which is capable of flying at higher speeds than propeller driven planes, and thus is capable of providing a quicker delivery of dispersant particles than provided by propeller driven planes (measured timewise from airplane take-off). Further, the solid dispersant particles described herein can be accurately dropped onto an oil spill from a higher altitude than can liquid dispersants, since the wind does not diffuse or alter the downward trajectory of the solid dispersants to the extent it does the liquid dispersants, primarily due to the fact that larger particle sizes are possible when using solid dispersants. Particles may also be delivered to a marine oil spill using marine vessels (e.g., boats or ships).

[0050] A number of advantages are contemplated in an oil dispersant delivery method that utilizes a jet airplane. For example, as noted above, the jet airplanes are faster than propeller driven planes. Further, jet airplanes can typically hold larger payloads (more dispersant particles) than propeller planes. At least one reason propeller driven planes are currently used to deliver dispersants to oil spills is because the dispersants are liquid, and there is a need for liquid dispersants to be delivered at relatively low altitudes, e.g., 500 feet or less above the water surface. At least one reason for such low altitudes is the need (or desire) to ensure the liquid dispersants find their target after being discharged from the airplane. Furthermore, to function effectively, the liquid dispersants should be delivered as very small droplets, e.g., 500 microns or less in diameter. Such small diameters are beneficial, even necessary, because larger droplets tend to penetrate the oil film and interact with the seawater by either passing into the water column or “herding” the oil. Herding refers to a situation where surfactant molecules spread in a monolayer over the surface of the water and move the oil slick across the surface rather than dispersing the oil into the water column as desired, e.g., by forming droplets. An important benefit of a lighter-than-water solid dispersant is that the dispersant is bound within the matrix which will prevent, or at least inhibit, “herding” by keeping the dispersant encapsulated until it contacts oil. That is, the solid dispersant particles can be manufactured with a
sufficiently large average particle size so that they can experience high falling velocities in the air following discharge from an airplane. The solid particles penetrate the oil slick (due in part to the velocity and force upon striking the oil surface), but their buoyancy causes them to float back to the surface where they can interact with the oil film. Since in a preferred aspect, the solid matrix component is oleophilic, and has higher oil solubility than water solubility, the solid matrix component tends to dissolve in the oil and release the liquid dispersant in the oil. Accordingly, by providing larger particles than the droplets of liquid dispersants, solid dispersants are more amenable to delivery from jet airplanes which are capable of flying at higher speeds and altitudes than propeller planes.

[0051] An example of a delivery method includes placing on an airplane an oil spill treatment agent that includes a plurality of solid particles, each of which includes a matrix component and a dispersant component, as described elsewhere herein. Preferably, the plurality of solid particles has an average particle size of 500 microns or more, although the particle may alternatively have one of the particle size ranges identified above, e.g., 1.0 millimeter or more. Thereafter, the method preferably includes flying the airplane over oil located on the surface of a body of water (e.g., an oil spill); and dropping the oil spill treatment agent onto the upper surface of the oil spill from the airplane. Preferably, the airplane is flying at an altitude that allows for safe yet effective delivery of the dispersant particle to the oil spill, e.g., 500, or 700, or 1,000 feet or more over the oil spill. After the solid dispersant particles contact the oil spill, the dispersant component is released from the solid particles, resulting in dispersion of some or all of the oil spill.

[0052] Independently of the method of delivery, e.g., by airplane, ship or otherwise, at least one of the benefits of the solid dispersant particles themselves is that highly viscous oil can be effectively dispersed using those solid particles. Certain oils are naturally viscous. Other oils tend to become more viscous as they cool down; accordingly, after an oil spill in frigid waters, the spilled oil will tend to increase in viscosity as time passes and the oil becomes colder. Also, as oil ages the lighter ends of the oil tend to evaporate, resulting in the oil becoming heavier and more viscous.
The solid dispersants described herein are better at treating viscous oil than liquid dispersants.

Specific Embodiments of Methods

[0053] Various specific embodiments of methods are described below, at least some of which are also recited in the claims.

[0054] Each invention claimed herein relates to oil dispersion. In at least one specific embodiment, a method of dispersing oil located on the surface of a body of water is provided, comprising (including) providing solid particles that include a matrix component and a dispersant component (preferably in an effective amount); and contacting the solid particles with the oil on the body of water, preferably in an amount sufficient to disperse at least a portion of the oil.

[0055] One or more other specific embodiments include a method of treating an oil spill, comprising providing solid particles, wherein each particle includes a matrix component and a dispersant component (preferably in an effective amount); and placing the solid particles on a vehicle, the solid particles on the vehicle preferably being in an amount sufficient to disperse oil forming part of an oil spill located on the surface of a body of water when the solid particles are placed in contact with the oil.

[0056] In yet other specific embodiments, a method of dispersing oil located on the surface of a body of water includes placing on an airplane an oil spill treatment agent that includes a plurality of solid particles that each include a matrix component and a dispersant component (preferably in an effective amount), wherein the plurality of solid particles has an average particle size of 500 microns or more; flying the airplane over oil located on the surface of a body of water; and dropping the oil spill treatment agent onto the upper surface of the oil spill from the airplane when the airplane is flying at an altitude of 200 feet or more over the oil spill, wherein the dispersant component is released from the solid particles, resulting in dispersion of some or all of the oil spill.
[0057] In one or more of the methods described above or elsewhere herein, the dispersant component includes a mixture of different chemical dispersants.

[0058] In one or more of the methods described above or elsewhere herein, the dispersant component includes (a) sorbitan monooleate, (b) polyoxyethylene sorbitan monooleate, (c) polyoxyethylene sorbitan trioleate and (d) aqueous sodium dioctyl sulfosuccinate.

[0059] In one or more of the methods described above or elsewhere herein, the dispersant component includes (a) sorbitan monooleate (from 5-15 wt%), (b) polyoxyethylene sorbitan monooleate (from 15 to 25 wt%), (c) polyoxyethylene sorbitan trioleate (from 20 to 40 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (from 30 to 50 wt%).

[0060] In one or more of the methods described above or elsewhere herein, the dispersant component occupies 40 % or more by volume of the solid particle. In other methods, the dispersant component occupies 50 % or more by volume of the solid particle. In other methods, the dispersant component occupies 70 % or more by volume of the solid particle. In still other methods, the dispersant component occupies 90% or more by volume of the solid particle.

[0061] In one or more of the methods described above or elsewhere herein, the matrix component is solid. In others, the matrix component is a porous solid. In others, the matrix component is solid and includes interstices.

[0062] In one or more of the methods described above or elsewhere herein, the matrix component includes microballoons.

[0063] In one or more of the methods described above or elsewhere herein, the matrix component (as a whole) is oleophilic, even though in certain embodiments the microballoons or other portions of the matrix component are not oleophilic.
[0064] In one or more of the methods described above or elsewhere herein, the oil solubility of the matrix component at 35 °F (a relatively low temperature) is higher than the water solubility of the matrix component at that temperature.

[0065] In one or more of the methods described above or elsewhere herein, the oil solubility of the matrix component at 70 °F (a higher temperature) is higher than the water solubility of the matrix component at that temperature.

[0066] In a preferred method, the oil solubility of the matrix component at both 35 °F and at 70 °F remains higher than the water solubility of the matrix component at each of those temperatures, and at temperatures between 35 °F and at 70 °F.

[0067] In one or more of the methods described above or elsewhere herein, the matrix component includes a rosin material.

[0068] In one or more of the methods described above or elsewhere herein, the matrix component includes a resin material.

[0069] In one or more of the methods described above or elsewhere herein, the matrix component includes a tackifier material.

[0070] In one or more of the methods described above or elsewhere herein, the matrix component includes a rosin substituted ester.

[0071] In one or more of the methods described above or elsewhere herein, the matrix component includes a resin substituted ester.

[0072] In one or more of the methods described above or elsewhere herein, the matrix component includes a pentaerythritol ester.

[0073] In one or more of the methods described above or elsewhere herein, the matrix component includes a rosin-substituted pentaerythritol ester.

[0074] In one or more of the methods described above or elsewhere herein, the matrix component includes a resin-substituted pentaerythritol ester.
[0075] In one or more of the methods described above or elsewhere herein, the matrix component includes a fully dimerized rosin.

[0076] In one or more of the methods described above or elsewhere herein, the matrix component includes a fully dimerized resin.

[0077] In one or more of the methods described above or elsewhere herein, the matrix component includes a rosin maleated with glycerol ester.

[0078] In one or more of the methods described above or elsewhere herein, the matrix component includes an ester.

[0079] In one or more of the methods described above or elsewhere herein, the matrix component includes a fatty acid.

[0080] In one or more of the methods described above or elsewhere herein, the matrix component includes a fatty acid derivative.

[0081] In one or more of the methods described above or elsewhere herein, the matrix component includes a fatty acid amide.

[0082] In one or more of the methods described above or elsewhere herein, the matrix component includes stearic acid or palmitic acid, or a mixture thereof.

[0083] In one or more of the methods described above or elsewhere herein, the matrix component includes an oleamide.

[0084] In one or more of the methods described above or elsewhere herein, the matrix component includes a polymer.

[0085] In one or more of the methods described above or elsewhere herein, the matrix component includes a compound that has a standard glass transition temperature above 30°C and a modified glass transition temperature below 25°C when in contact with oil.
[0086] In one or more of the methods described above or elsewhere herein, the matrix component has a density less than 1.00 g/ml.

[0087] In one or more of the methods described above or elsewhere herein, the matrix component has a density less than 1.02 g/ml.

[0088] In one or more of the methods described above or elsewhere herein, the matrix component has a density of from 0.80 to 1.02 g/ml.

Specific Embodiments of Dispersants

[0089] Various specific embodiments of dispersants are described below, at least some of which are also recited in the claims.

[0090] At least one specific embodiment is directed to a dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and a solid matrix component.

[0091] One or more of the dispersants described above or elsewhere herein includes a solid particle that includes a dispersant component and one or more microballoons.

[0092] One or more of the dispersants described above or elsewhere herein includes a solid particle that includes a dispersant component and a matrix component selected from the group consisting of: a tackifier, a resin or resin containing compound; a rosin or rosin containing compound; a rosin-substituted ester; a resin substituted ester; a pentaerythritol ester; a rosin substituted pentaerythritol ester; a resin substituted pentaerythritol ester; a fully dimerized rosin; a rosin maleated with glycerol ester; an ester; a fatty acid; a fatty acid derivative; a fatty acid amide; stearic acid or palmitic acid, or a mixture thereof; an oleamide; and a polymer. In alternative embodiments, the matrix component may be any one of the above-described groups or any combination of the above-described groups. In alternative embodiments, the matrix component may be any one or combination of compounds which fall within the above-described groups.
In one or more of the dispersants described above or elsewhere herein, the matrix component includes one or more gas bubbles.

In one or more of the dispersants described above or elsewhere herein, the matrix component includes one or more microballoons.

In one or more of the dispersants described above or elsewhere herein, the matrix component is oleophilic.

In one or more of the dispersants described above or elsewhere herein, the matrix component includes an oleophilic portion and one or more gas bubbles.

In one or more of the dispersants described above or elsewhere herein, the matrix component includes an oleophilic portion and one or more microballoons.

In one or more of the dispersants described above or elsewhere herein, the oil solubility of at least a portion of the matrix component at a temperature of 35 °F or 70 °F, or both, is higher than the water solubility of that portion of the matrix component at the same temperature.

In one or more of the dispersants described above or elsewhere herein, the dispersant component includes a mixture of different chemical dispersants. For example, in at least one embodiment, the dispersant component includes (a) sorbitan monooleate, (b) polyoxyethylene sorbitan monooleatae, (c) polyoxyethylene sorbitan trioletae and (d) aqueous sodium dioctyl sulfosuccinate. In a more specific embodiment, the dispersant component includes (a) sorbitan monooleate (from 5 to 15 wt%), (b) polyoxyethylene sorbitan monooleatae (from 15 to 25 wt%), (c) polyoxyethylene sorbitan trioletae (from 20 to 40 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (from 30 to 50 wt%).

In one or more of the dispersants described above or elsewhere herein, the dispersant component occupies 40 % or more by volume of the solid particle.
[00101] In one or more of the dispersants described above or elsewhere herein, the matrix component includes any of the following, alone or in combination with one another or another material: a tackifier; a rosin or rosin containing compound; a resin or resin containing compound; a rosin-substituted ester; a resin substituted ester; pentaerythritol ester; a rosin substituted pentaerythritol ester; a resin substituted pentaerythritol ester; a fully dimerized rosin; a fully dimerized resin; a rosin maleated with glycerol ester; an ester; a fatty acid; a fatty acid derivative; a fatty acid amide; stearic acid or palmitic acid, or a mixture thereof; an oleamide; a polymer.

[00102] In one or more of the dispersants described above or elsewhere herein, the matrix component may have a density less than 1.00 g/ml; or a density less than 1.02 g/ml; or a density of from 0.80 to 1.02 g/ml.

EXAMPLES

[00103] The following examples relate to aspects of the methods and/or compositions disclosed above.

[00104] Various materials were tested to determine their suitability as an oleophilic matrix material capable of being easily blended, e.g., miscible, with a particular dispersant material (COREEXIT®) and/or forming a solid dispersant particle composed of a matrix component and a dispersant component. The matrix materials tested were PENTREX 28 (Softening Point (SP) = 128°C), POLYWAX 3000 (Melting Point (MP) = 129°C), CERAMER® 5005 polymer (MP = 121°C), PETROLITE® E-2020 polymer (MP = 116°C), PETROLITE® E-2000 (MP = 126°C), PENTALYN® X (SP = 143°C), PENTALYN K® (SP = 178°C), PENTALYN® C (SP = 126°C), DYMEREK rosin (SP = 145°C), PICOLITE S115 (MP = 115°C), PICOLITE S135 (MP = 135°C), Vinsol Ester Gum (SP = 129°C), stearic acid (MP = 70°C), palmitic acid (MP = 63°C), oleamide (MP = 73°C), stearamide (MP = 100°C), ESCOREZ 1102 (SP = 97-103°C), ESCOREZ 1310LC (SP = 91-97°C), and PERMALYN 6110 (SP = 113°C). The suitability of each matrix material for forming dispersant particles was determined by assessing the interaction of each with a COREEXIT® dispersant product. Subsequently, if those
tests were positive (i.e., the materials were miscible), each matrix material was tested separately for temperature stability (tackiness), and solubility in crude oil (without the presence of the COREEXIT® dispersant).

[00105] To determine the suitability of each matrix component for forming solid particles, the respective matrix component material (e.g., polymer) was melted, and the dispersant component (COREEXIT® 9500 or 9527) was mixed into the melted matrix material to form a mixture, such that the polymer and dispersant each occupied approximately 50% (by weight) of the mixture. The miscibility of each mixture was assessed, and the matrix materials found to be immiscible with the COREEXIT® dispersant were not tested further. (The immiscible matrix compounds were PENTALYN® X, PICOLYTE® S115, PICOLYTE® S135, ESCOREZ® 1102 AND ESCOREZ® 1310LC.) As explained above, the remaining materials were tested for their temperature stability, i.e., ability to exist in a solid state at room temperature. That is, each of those materials was allowed to cool and the tackiness of the resulting solid was assessed. Materials determined to be too tacky at 50% COREEXIT® loading were retested at lower loading levels. The stearic acid and palmitic acid matrix compounds required 40% COREEXIT® loading to avoid undesirable tackiness. Other matrix materials that either became too tacky or did not re-solidify were PENTREX® 28, POLYWAX® 3000, PENTALYN® C, DYMEREX, and PETROLITE® E2000. In each case, the loading of dispersant component was based on the tackiness of the final product, but a loading that approached 50% was desired (and attempted). The stearic acid and palmitic acid particles required a lower loading (40%) to achieve the appropriate (low) tackiness.

[00106] The matrix materials that had acceptable miscibility and low tackiness were then qualitatively tested for oil solubility in Arab Medium Crude, or Chayvo Crude, or both. Small particles of selected matrix materials (alone, i.e., without dispersant compound) were placed into a small quantity of the desired crude oil. After 24 hours, observations were made to determine if the particles had dissolved. Particles made of Ceramer® 5005 were found to readily dissolve in Arab Medium Crude oil, but not in Chayvo Crude oil. Particles made of Pentalyn® K were
found to readily dissolve in Chayvo Crude but slowly dissolve in Arab Medium. Specifically, Pentalyn® K dissolved in Chayvo Crude in a matter of minutes at room temperature; and dissolved in two hours at freezing temperature (0.0 °C). Stearic acid and palmitic acid likewise dissolved in both Arab Medium Crude and Chayvo Crude at room temperature, but such room temperature dissolutions were much slower than that of Pentalyn® K. Stearamide and oleamide did not readily dissolve in Chayvo Crude at room temperature. Permalyn® 6110 particles rapidly dissolved in Chayvo Crude oil samples at both room temperature and freezing; however, microbeads made with a 40% loading of COREXIT® were too tacky and not tested further.

[00107] Based on the results of the tests described above, dispersant particles were formed using each of the following matrix materials: CERAMER® 5005 polymer, PETROLITE® E-2020 polymer, Pentalyn® K, stearic acid, palmitic acid. Dispersant particles using PERMALYN® 6110 were scheduled to be formed.

[00108] Each dispersant particle was tested for dispersion effectiveness using a Paddle Mixer Dispersant Efficiency Test. Two 1000 ml beakers were filled with synthetic seawater (750 ml water per beaker). The tests were performed at room temperature. Oil (2 grams of the desired crude oil) was then poured into each beaker, onto the center of the surface of the water in each beaker. A paddle mixer was inserted into each beaker, and activated to cause the oil to collect around the mixer shaft. Then, 0.1 g of the desired dispersant particles were placed on the surface of the oil to give a weight ratio of 1 part dispersant to 20 parts oil. The paddle mixer was then switched off and the dispersant particles were allowed to soak in the oil for a period of time that depended on the speed of the qualitative solubility tests described above. For example, the Pentalyn® K particles soaked for only a few minutes, but the Ceramer® 5005 particles soaked for 11 days. After the soaking period, the paddle mixers were again activated at 90 rpm for 10 minutes. At ten minutes, a qualitative assessment of the amount of oil dispersed into the water phase was made. Then the paddle mixer speed was increased to 180 rpm for two minutes and another qualitative assessment of the amount of dispersed oil was made.
The results are shown in Table 1, which shows dispersant effectiveness ratings (0 = no dispersion, 10 = 100% dispersion; NT = not tested):

Table 1

<table>
<thead>
<tr>
<th>Matrix Compound</th>
<th>Chayvo</th>
<th>Arab Medium</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramer® 5005</td>
<td>0</td>
<td>10</td>
<td>11 days of solid particles soaked with crude oil</td>
</tr>
<tr>
<td>Petrolite® E-2020</td>
<td>0</td>
<td>10</td>
<td>11 days of solid particles soaked with crude oil</td>
</tr>
<tr>
<td>Pentalyn® K</td>
<td>10</td>
<td>NT</td>
<td>immediate dispersion</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>10</td>
<td>NT</td>
<td>4 hours of solid particles contacted with crude oil</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>0</td>
<td>NT</td>
<td>no soak time</td>
</tr>
</tbody>
</table>
CLAIMS

What is claimed is:

1. A method of dispersing oil located on the surface of a body of water, comprising:
   providing solid particles that include a matrix component and a dispersant component; and
   contacting the solid particles with the oil on the body of water to disperse at least a portion of the oil.

2. A method of treating an oil spill, comprising:
   providing solid particles, wherein each particle includes a matrix component and a dispersant component; and
   placing the solid particles on a vehicle, the solid particles on the vehicle being placed thereon to disperse oil forming part of an oil spill located on the surface of a body of water when the solid particles are placed in contact with the oil.

3. A method of dispersing oil located on the surface of a body of water, comprising:
   placing on an airplane an oil spill treatment agent that includes a plurality of solid particles that each include a matrix component and an effective amount of a dispersant component, wherein the plurality of solid particles has an average particle size of 500 microns or more;
   flying the airplane over oil located on the surface of a body of water; and
   dropping the oil spill treatment agent onto the upper surface of the oil spill from the airplane when the airplane is flying at an altitude of 200 feet or more over the oil spill, wherein the dispersant component is released from the solid particles, resulting in dispersion of some or all of the oil spill.
4. The method of claim 1 wherein the dispersant component includes a mixture of different chemical dispersants.

5. The method of claim 1 wherein the dispersant component includes (a) sorbitan monooleate, (b) polyoxyethylene sorbitan monooleate, (c) polyoxyethylene sorbitan trioleate and (d) aqueous sodium dioctyl sulfosuccinate.

6. The method of claim 1 wherein the dispersant component includes (a) sorbitan monooleate (from 5-15 wt%), (b) polyoxyethylene sorbitan monooleate (from 15 to 25 wt%), (c) polyoxyethylene sorbitan trioleate (from 20 to 40 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (from 30 to 50 wt%).

7. The method of claim 1, wherein the dispersant component occupies 40 % or more by volume of the solid particle.

8. The method of claim 1, wherein the dispersant component occupies 50 % or more by volume of the solid particle.

9. The method of claim 1, wherein the dispersant component occupies 70 % or more by volume of the solid particle.

10. The method of claim 1, wherein the dispersant component occupies 90 % or more by volume of the solid particle.

11. The method of claim 1, wherein the matrix component is solid.

12. The method of claim 1, wherein the matrix component is a porous solid.

13. The method of claim 1, wherein the matrix component is solid and includes interstices.
14. The method of claim 1, wherein the matrix component is solids and includes gas bubbles.

15. The method of claim 1, wherein the matrix component includes microballoons.

16. The method of claim 1, wherein the matrix component is oleophilic.

17. The method of claim 1, wherein the oil solubility of the matrix component at 35 °F is higher than the water solubility of the matrix component at that temperature.

18. The method of claim 1, wherein the oil solubility of the matrix component at 70 °F is higher than the water solubility of the matrix component at that temperature.

19. The method of claim 1, wherein the oil solubility of the matrix component at both 35 °F and at 70 °F remains higher than the water solubility of the matrix component at each of those temperatures, and at temperatures between 35 °F and at 70 °F.

20. The method of claim 1 wherein the matrix component includes a tackifier compound.

21. The method of claim 1 wherein the matrix component includes a rosin or rosin containing compound.

22. The method of claim 1 wherein the matrix component includes a resin or resin containing compound.

23. The method of claim 1 wherein the matrix component includes a rosin-substituted ester.
24. The method of claim 1 wherein the matrix component includes a resin-substituted ester.

25. The method of claim 1 wherein the matrix component includes a pentaerythritol ester.

26. The method of claim 1 wherein the matrix component includes a rosin substituted pentaerythritol ester.

27. The method of claim 1 wherein the matrix component includes a resin substituted pentaerythritol ester.

28. The method of claim 1 wherein the matrix component includes a fully dimerized rosin.

29. The method of claim 1 wherein the matrix component includes a fully dimerized resin.

30. The method of claim 1 wherein the matrix component includes a rosin maleated with glycerol ester.

31. The method of claim 1 wherein the matrix component includes an ester.

32. The method of claim 1 where the matrix component includes a fatty acid.

33. The method of claim 1 wherein the matrix component includes a fatty acid derivative.

34. The method of claim 1 wherein the matrix component includes a fatty acid amide.
35. The method of claim 1 wherein the matrix component includes stearic acid or palmitic acid, or a mixture thereof.

36. The method of claim 1 wherein the matrix component includes an oleamide.

37. The method of claim 1 wherein the matrix component includes a polymer.

38. The method of claim 1 wherein the matrix component has a density less than 1.00 g/ml.

39. The method of claim 1 wherein the matrix component has a density less than 1.02 g/ml.

40. The method of claim 1 wherein the matrix component has a density of from 0.80 to 1.02 g/ml.

41. The method of claim 1 wherein said providing solid particles includes:
   providing said dispersant component and said matrix component on a delivery vehicle; and
   forming said solid particles by dispensing the melt within or outside of said delivery vehicle.

42. The method of claim 41 wherein said providing solid particles further includes:
   melting and mixing said dispersant component and said matrix component on said delivery vehicle.

43. The method of claim 41 wherein said forming said solid particles includes:
   forming said solid particles by dispensing the melt through nozzles located on the exterior of delivery vehicle.
44. A dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and a solid matrix component.

45. A dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and one or gas bubbles.

46. A dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and one or more microballoons.

47. A dispersant for treating oil spills, comprising a solid particle that includes a dispersant component and a matrix component selected from the group consisting of: a tackifier; a rosin or rosin containing compound; a resin or resin containing compound; a rosin-substituted ester; a resin-substituted ester; a pentaerythritol ester; a rosin-substituted pentaerythritol ester; a resin-substituted pentaerythritol ester; a fully dimerized rosin; a fully dimerized resin; a rosin maleated with glycerol ester; an ester; a fatty acid; a fatty acid derivative; a fatty acid amide; stearic acid or palmitic acid, or a mixture thereof; an oleamide; and a polymer.

48. The dispersant of claim 44, wherein the matrix component includes one or more gas bubbles.

49. The dispersant of claim 44, wherein the matrix component includes one or more microballoons.

50. The dispersant of claim 44, wherein the matrix component is oleophilic.

51. The dispersant of claim 44, wherein the matrix component includes an oleophilic portion and one or more gas bubbles.

52. The dispersant of claim 44, wherein the matrix component includes an oleophilic portion and one or more microballoons.
53. The dispersant of claim 44, wherein the oil solubility of at least a portion of the matrix component at a temperature of 35 °F or 70 °F, or both, is higher than the water solubility of that portion of the matrix component at the same temperature.

54. The dispersant of claim 44, wherein the dispersant component includes a mixture of different chemical dispersants.

55. The dispersant of claim 44, wherein the dispersant component includes (a) sorbitan monooleate, (b) polyoxyethylene sorbitan monooleate, (c) polyoxyethylene sorbitan trioletae and (d) aqueous sodium dioctyl sulfosuccinate.

56. The dispersant of claim 44, wherein the dispersant component includes (a) sorbitan monooleate (from 5 to 15 wt%), (b) polyoxyethylene sorbitan monooleate (from 15 to 25 wt%), (c) polyoxyethylene sorbitan trioletae (from 20 to 40 wt%) and (d) aqueous sodium dioctyl sulfosuccinate (from 30 to 50 wt%).

57. The dispersant of claim 44, wherein the dispersant component occupies 40 % or more by volume of the solid particle.

58. The dispersant of claim 44, wherein the matrix component includes a tackifier compound.

59. The dispersant of claim 44, wherein the matrix component includes a rosin or rosin containing compound.

60. The dispersant of claim 44, wherein the matrix component includes a resin or resin containing compound.

61. The dispersant of claim 44, wherein the matrix component includes a rosin-substituted ester.
62. The dispersant of claim 44, wherein the matrix component includes a resin-substituted ester.

63. The dispersant of claim 44, wherein the matrix component includes pentaerythritol ester.

64. The dispersant of claim 44, wherein the matrix component includes a rosin-substituted pentaerythritol ester.

65. The dispersant of claim 44, wherein the matrix component includes a resin-substituted pentaerythritol ester.

66. The dispersant of claim 44, wherein the matrix component includes a fully dimerized rosin.

67. The dispersant of claim 44, wherein the matrix component includes a fully dimerized resin.

68. The dispersant of claim 44, wherein the matrix component includes a rosin maleated with glycerol ester.

69. The dispersant of claim 44, wherein the matrix component includes an ester.

70. The dispersant of claim 44, wherein the matrix component includes a fatty acid.

71. The dispersant of claim 44, wherein the matrix component includes a fatty acid derivative.
72. The dispersant of claim 44, wherein the matrix component includes a fatty acid amide.

73. The dispersant of claim 44, wherein the matrix component includes stearic acid or palmitic acid, or a mixture thereof.

74. The dispersant of claim 44, wherein the matrix component includes an oleamide.

75. The dispersant of claim 44, wherein the matrix component includes a polymer.

76. The dispersant of claim 44, wherein the matrix component has a density less than 1.00 g/ml.

77. The dispersant of claim 44, wherein the matrix component has a density less than 1.02 g/ml.

78. The dispersant of claim 44, wherein the matrix component has a density of from 0.80 to 1.02 g/ml.

79. The dispersant of claim 44, wherein the matrix component includes a compound that has a standard glass transition temperature above 30°C and a modified glass transition temperature below 25°C when in contact with oil.