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(21) International Application Number: PCT/US00/12126 (22) International Filing Date: 3 May 2000 (03.05.00) (30) Priority Data: 09/304,196 3 May 1999 (03.05.99) US (63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application US 09/304,196 (CIP) Filed on 3 May 1999 (03.05.99) (71) Applicant (for all designated States except US): SUSTAINABLE TECHNOLOGIES CORPORATION [US/US]; P.O. Box 326, Windfall, IN 46076 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): PIERCE, Anthony, M. [US/US]; 4578 N. 650 East, Windfall, IN 46076 (US). WILLARD, Fred, G. [US/US]; 5389 Lowery Street, Jamestown, IN 46147 (US).		(74) Agents: GANDY, Kenneth, A. et al.; Woodard, Emhardt, Naughton, Moriarty & McNett, Bank One Center/Tower, Suite 3700, 111 Monument Circle, Indianapolis, IN 46204 (US). (81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: ENCAPSULANT COMPOSITIONS AND METHODS FOR TREATING SPILLS OF HYDROPHOBIC AND/OR HYDROPHILIC MATERIALS (57) Abstract <p>Described are preferred encapsulant compositions, devices and methods for treating spills of hydrophobic organic liquids. Preferred compositions include one or a blend of powdered thermoplastic elastomers, along with a flow agent. Additional preferred encapsulant compositions include a powdered thermoplastic elastomer combined with a superabsorbent polymer. Devices for spray application of such encapsulant compositions include a vessel (11) adapted for forcibly spraying a powder, and a powdered encapsulant composition (12) contained in the vessel. Methods for treating spills of hydrophobic organic liquids involve the application of encapsulant compositions as described.</p> <div data-bbox="837 1240 1420 2078" data-label="Image"> </div>		

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5 **ENCAPSULANT COMPOSITIONS AND METHODS FOR
TREATING SPILLS OF HYDROPHOBIC AND/OR
HYDROPHILIC MATERIALS**

REFERENCE TO RELATED APPLICATION

 This application claims the benefit of U.S.
10 application Serial No. 09/304,196 filed May 3, 1999,
which is hereby incorporated by reference in its
entirety.

BACKGROUND OF THE INVENTION

15 The present invention relates generally to the
containment and clean up of hazardous spills. In
particular, the present invention relates to methods
and compositions for encapsulating spills of
20 hydrophobic organic substances, hydrophilic substances,
or mixtures thereof, wherein the compositions comprise
thermoplastic elastomers optionally in admixture with
superabsorbent polymers.

 As further background, the containment of
25 hazardous spills has been the subject of study for
years. In many cases, containment is achieved
utilizing a solid particulate material which is applied
to the spill to absorb and encapsulate the hazardous
material. In large part, the literature discloses

using inorganic materials to absorb hydrophobic organics such as oils and other hydrocarbons. In more recent years, certain compositions including polymers have been suggested for use in treating hydrophobic
5 spills. The following U.S. patents are illustrative of this background to the invention:

<u>PATENT NO.</u>	<u>TITLE</u>	<u>ISSUE DATE</u>
4,383,868	Treatment of Spillages of Hazardous Chemicals	05/17/1983
4,420,573	Method of Treating Water-In-Oil Dispersions	12/13/1983
4,578,119	Method for Clean-Up of Blood Spills	03/25/1986
4,693,755	Method and Composition for Removing Asbestos-Containing Materials	09/15/1987
5,391,300	Method for the Removal of Halogenated Organic Compounds From an Environment	02/21/1995

Despite some teaching in the area, the related art
10 lacks significant teaching in respect of improved compositions and methods which provide better modes of application of encapsulant materials combined with safe and effective handling of materials after the spilled substance has been encapsulated. In addition, there is
15 a need in the art for encapsulant compositions and methods which provide improved absorption capacity for the spilled substance, and more universal application. The present invention addresses these needs.

SUMMARY OF THE INVENTION

It has been discovered that highly effective encapsulant compositions and methods can be provided involving the use of powders of thermoplastic elastomers in combination with flow agents. Such compositions rapidly absorb and encapsulate hydrophobic substances, and despite their initial fine powder form, the compositions result in a solid, unitary mass upon absorption of hydrophobic liquids such as fuels and oils. Accordingly, in one preferred embodiment, the invention provides a free-flowing encapsulant composition for treating a spill of a hydrophobic organic liquid. The inventive composition of this embodiment includes a powdered thermoplastic elastomer having an average particle diameter of less than about 50 microns, and a flow agent in an amount of about 0.1% to about 10% by weight relative to the powdered thermoplastic elastomer. The flow agent is included so as to inhibit adherence among particles of the powdered elastomer. Such composition is effective for encapsulating hydrophobic organic liquids, and forms a unitary solid mass upon such encapsulation. Preferred thermoplastic elastomers include powdered thermoplastic elastomers prepared as block co-polymers of a vinyl

aromatic monomer such as styrene and a rubber-forming monomer.

Another aspect of the invention relates to the discovery that highly effective encapsulant compositions capable of treating a wide range of spills are provided by the inclusion of an admixture of a particulate thermoplastic elastomer with a particulate superabsorbent polymer. Thus, another preferred embodiment of the invention provides an encapsulant composition which comprises an admixture of a particulate thermoplastic elastomer with a particulate superabsorbent polymer. More preferred such compositions also incorporate a flow agent in an amount effective to reduce the tendency of the particles to cake and render the compositions free flowing.

The invention also provides a device for treating a spill of a hydrophobic organic liquid, which includes a pressurized canister equipped to dispense a powder under pressure, and a free flowing powder-form encapsulant composition, for example as disclosed above, contained in the canister. The device is operable to dispense the encapsulant composition in a forced flow so as to evenly broadcast the composition over a spill. In the case of the above-described

compositions containing both a thermoplastic elastomer and a superabsorbent polymer, the spill to be treated can be hydrophobic, hydrophilic (especially aqueous), or a combination of the two.

5 The invention also concerns a method for treating a spill, which includes applying to the spill an encapsulant composition as described herein, allowing the composition to encapsulate the liquid and form a unitary mass, and recovering the unitary mass. Again,
10 in the case of the above-described compositions containing both a thermoplastic elastomer and a superabsorbent polymer, the spill to be treated can be hydrophobic, hydrophilic, or a combination.

One object of the present invention is to provide
15 improved compositions for encapsulating hydrophobic substances, hydrophilic substances, or both.

Another object of the present invention is to provide improved methods for encapsulating hydrophobic substances, hydrophilic substances, or both.

20 Another object of the invention is to provide improved modes of application of encapsulant compositions for hydrophobic substances, including pressurized devices which emit a substantially uniform flow of the encapsulant composition.

Additional objects, features and advantages of the present invention will be apparent from the descriptions herein.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 shows a device for treating a spill of a liquid in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to certain preferred embodiments thereof and
5 specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations, further modifications and applications of the principles of the invention as described herein
10 being contemplated as would normally occur to one skilled in the art to which the invention relates.

As disclosed above, the present invention provides compositions, methods, and devices for treating spills of hydrophobic liquids, hydrophilic liquids, or
15 mixtures thereof. The invention utilizes free-flowing encapsulant compositions which incorporate at least one powdered thermoplastic elastomer, and which advantageously form unitary solid masses upon encapsulation of hydrophobic organic liquids. In some
20 embodiments of the invention, the compositions also incorporate at least one superabsorbent polymer effective to absorb aqueous substances, and are effective to treat a wide variety of spills, including spills of hydrophobic substances, hydrophilic

substances, and mixtures thereof. Preferred encapsulant compositions also absorb high ratios of the hydrophobic organic liquids and/or hydrophilic substances on a weight-to-weight basis.

5 Referring now to basic materials utilized in the present invention, many thermoplastic elastomers are known and can be used. Such thermoplastic elastomers are usually free or essentially free from crosslinking, but it is also known that some crosslinking can be
10 introduced while nonetheless substantially retaining the properties of the parent thermoplastic elastomer compound. Such thermoplastic elastomers are typically swellable or soluble in hydrocarbons and, as opposed to thermoset elastomers, allow for substantial movement of
15 polymer chains relative to one another.

Thermoplastic elastomers formed as block copolymers containing rubber (soft) and non-rubber (hard) blocks are utilizable in the present invention. Such block copolymers can have linear structures such as di-
20 block and tri-block structures, as well as branched structures such as radial and star structures. The rubber blocks of the copolymers can be formed using conjugated diene monomers such as butadiene and isoprene or alkylene monomers such as ethylene,

propylene and/or butylene, although other monomers forming soft, rubbery blocks are also suitable and encompassed by the present invention. The non-rubber blocks can be formed by vinyl monomers or other
5 monomers providing relatively hard blocks, including for example vinyl aromatic monomers such as styrene.

In preferred thermoplastic elastomers the weight ratio of rubber monomer(s) to non-rubber monomer(s) will generally be 90:10 to 50:50, and more preferably
10 this weight ratio will be in the range of about 80:20 to 60:40. In addition, preferred thermoplastic elastomers will have number average molecular weights less than about 1 million, more preferably less than about 500,000 and most preferably in the range of about
15 30,000 to 300,000. Thermoplastic elastomers having relatively low polydispersities, for example less than about 5, are also preferred.

It has also been discovered that particle size of the thermoplastic elastomer is highly important to the
20 function of the encapsulant composition, particularly in providing free-flowing compositions which can be spray-applied while nonetheless forming unitary masses for recovery. Thus, thermoplastic elastomer powders, desirably having an average particle diameter less than

about 50 microns, are employed with preference, particularly in cases where the composition is to be sprayed or forcibly broadcast over the spill area. In addition to this feature, it is desired that 80% or
5 more of the thermoplastic elastomer particles have a particle diameter less than 50 microns in such applications. Most preferably, 95% or more of the particles have an particle diameter of less than 50 microns in such applications. Prepared or
10 commercially available powder-form elastomer materials can be screened or otherwise treated if necessary to attain such particle sizes and distributions. Illustratively, KRATON® powdered thermoplastic elastomers available from Shell Chemical Company can be
15 screened as necessary to attain average particle sizes and distributions as noted herein. Additional thermoplastic elastomers that can be used in the various aspects of the invention include BLENDEX® thermoplastic elastomers available from GE.

20 It has also been discovered that advantageous encapsulant compositions can be prepared by blending two or more differing thermoplastic elastomer materials, in order to improve the overall absorption capacity of the composition while retaining its unitary

mass-forming properties. For example, a first elastomer having a relatively lower capacity to absorb hydrophobic liquids but a relatively higher gel-forming capacity, can be blended with a second thermoplastic elastomer having a relatively higher capacity to absorb hydrophobic liquids but a relatively lower gel-forming capacity, to form an overall composition having a high absorption capacity that nonetheless forms a solid, unitary mass upon the encapsulation.

10 In one preferred embodiment, a thermoplastic elastomer having an unsaturated rubber block or blocks is blended with one having a saturated rubber block or blocks. Such differing thermoplastic elastomers can be blended in a ratio of 99:1 to 1:99 by weight. More typically, they will be blended in a range of about 20:80 to about 80:20 by weight. As examples, thermoplastic elastomers having unsaturated rubber blocks formed with butadiene or isoprene are available as KRATON® "D" grade polymers, whereas thermoplastic elastomers having saturated rubber blocks formed with ethylene/propylene are available as KRATON® "G" grade polymers. In a most preferred form of the present invention, a linear block copolymer having styrene blocks and ethylene/propylene rubber blocks is blended

with a branched block copolymer having styrene blocks and butadiene blocks, in a ratio of about 30:70 to about 20:80 by weight. For example, a styrene-ethylene/propylene diblock polymer having a

5 styrene/rubber weight ratio of 28:72 sold as KRATON® G1702 can be blended with a branched styrene-butadiene block copolymer having a styrene/rubber weight ratio of 31:69 available as KRATON® D1184. It will be understood that the present invention is not

10 limited to blending of these latter two types of polymers; rather, the present invention contemplates blending a first thermoplastic elastomer with a second thermoplastic elastomer to provide an increased ability to form a unitary mass and/or to provide an increase in

15 the absorption capacity of the composition as compared to the first thermoplastic elastomer if used alone.

Preferred encapsulant compositions of the invention will also include a flow agent which acts to inhibit adherence among particles of the thermoplastic

20 elastomer, and thereby increase the overall flowability of the composition. This flow agent will typically be incorporated at a level of about 0.1% to about 10% by weight relative to the weight of the thermoplastic elastomer(s) in the composition, more typically about

0.5% to about 5% by weight. Such flow agents can be solids, for example as in the case of silica.

Advantageously, such flow agents can also be fluid lubricants, for instance as in the case of silicone

5 fluid lubricants such as fluid polydimethylsiloxanes.

In particularly beneficial embodiments of the invention, a thermoplastic elastomer as described above is included in admixture with a water-absorbing superabsorbent polymer to form an encapsulant

10 composition effective to absorb both hydrophobic organic and aqueous spills. Such compositions can be unitary patty-forming as discussed above, or may exist as a particulate after encapsulation which can be collected for disposal. In addition, encapsulants in
15 such compositions may be fine powders as discussed herein for spray application, or may be larger particles, e.g. granules.

In this regard, superabsorbent polymers are substantially water-insoluble, but water swellable
20 polymers, which form hydrogels upon contacting aqueous liquids. A variety of superabsorbent polymer types are known and are suitable for use in the present invention. These hydrogel-forming absorbent polymers

will typically have anionic functional groups such as sulfonic acid and/or carboxy groups.

Illustrative superabsorbent polymers suitable for use in the invention include those which are prepared
5 from polymerizable, unsaturated, acid-containing monomers. Such monomers include the olefinically unsaturated acids and anhydrides that contain at least one carbon to carbon olefinic double bond. These monomers can be selected, for example, from
10 olefinically unsaturated carboxylic acids and acid anhydrides, olefinically unsaturated sulfonic acids, and mixtures thereof.

Non-acid monomers may also be included, usually in minor amounts, in preparing the hydrogel-forming
15 absorbent polymers herein. Such non-acid monomers can include, for example, the water-soluble or water-dispersible esters of the acid-containing monomers, as well as monomers that contain no carboxylic or sulfonic acid groups. Optional non-acid monomers can thus
20 include monomers containing functional groups selected from carboxylic acid or sulfonic acid esters, hydroxyl groups, amide groups, amino groups, nitrile groups and quaternary ammonium salt groups. These non-acid monomers are well-known materials. For additional

information as to such monomers, reference can be made for example to U.S. Pat. Nos. 4,076,663, and 4,062,817.

Olefinically unsaturated carboxylic acid and carboxylic acid anhydride monomers include the acrylic acids typified by acrylic acid itself, methacrylic acid, ethacrylic acid, β -chloroacrylic acid, α -cyanoacrylic acid, β -methylacrylic acid (crotonic acid), sorbic acid, angelic acid, cinnamic acid, p-chlorocinnamic acid, itaconic acid, citraconic acid, mesaconic acid, glutaconic acid, aconitic acid, maleic acid, fumaric acid, tricarboxyethylene, maleic acid anhydride, and the like.

Olefinically unsaturated sulfonic acid monomers include aliphatic or aromatic vinyl sulfonic acids such as vinylsulfonic acid, allyl sulfonic acid, vinyl toluene sulfonic acid and styrene sulfonic acid; acrylic and methacrylic sulfonic acid such as sulfoethyl acrylate, sulfoethyl methacrylate, sulfopropyl acrylate, sulfopropyl methacrylate, 2-hydroxy-3-methacryloxypropyl sulfonic acid and 2-acrylamide-2-methylpropane sulfonic acid.

Preferred hydrogel-forming absorbent polymers for use in the present invention contain carboxy and/or carboxamide groups. These polymers include hydrolyzed

starch-acrylonitrile graft copolymers, partially
neutralized starch-acrylonitrile graft copolymers,
starch-acrylic acid graft copolymers, partially
neutralized starch-acrylic acid graft copolymers,
5 saponified vinyl acetate-acrylic ester copolymers,
hydrolyzed acrylonitrile or acrylamide copolymers,
slightly network crosslinked polymers of any of the
foregoing copolymers, partially neutralized polyacrylic
acid, and slightly network crosslinked polymers of
10 partially neutralized polyacrylic acid. Examples of
these polymer materials are disclosed in U.S. Pat. Nos.
3,661,875, 4,076,663, 4,093,776, 4,666,983, and
4,734,478.

One preferred polymer class for use herein
15 includes partially neutralized polyacrylic acids (e.g.
poly (sodium acrylate/acrylic acid) polymers).

The hydrogel-forming absorbent polymers can be
slightly network crosslinked. Network crosslinking
serves to render the polymer substantially water-
20 insoluble and, in part, determines the absorptive
capacity and extractable polymer content
characteristics of the precursor particles and the
resultant macrostructures.

Compositions of the invention can also include a blend of two (or more) superabsorbent polymers, wherein one of the polymers may have an absorption time significantly greater than the other(s). In this

5 regard, the absorption time for the superabsorbent, as that term is used herein, refers to the period of time required for the superabsorbent polymer to absorb 70% of its total capacity (by weight) for deionized water when immersed in deionized water. As an example, two

10 superabsorbent polymers may be included in the encapsulant composition, wherein a first of the polymers has a first absorption time, and a second of the polymers has a second absorption time at least double (200% of) the first absorption time. Still

15 further, the second absorption time can be at least about 500% that of the first, and the first polymer may have an absorption time of less than about 2 minutes. As examples, the first superabsorbant may have an absorption time of less than about 1 minute, and the

20 second superabsorbent polymer may have an absorption time of greater than about 5 minutes, or even greater than about 10 minutes. Faster acting superabsorbents serve to control the spread of the spill while relatively slower acting superabsorbents assist in

ensuring that a large portion or all of the spill is taken up by the encapsulant composition while forming a solid unitary mass upon final absorption of the spill.

Using two such superabsorbents in combination also
5 allows encapsulant formulations to be tailored for performance in absorbing specific types of spills.

Encapsulant compositions of the invention may include both polyacrylamide and polyacrylic (e.g. poly(C_1 - C_6 alkyl)acrylic acid or esters thereof such as
10 C_1 - C_6 alkyl-poly(C_1 - C_6 alkyl)acrylates) superabsorbent polymers.

Preferred superabsorbent polymers will exhibit the capacity to absorb at least 20 times their own weight in deionized water, more preferably at least about 100
15 times their own weight in deionized water.

Particle size of the superabsorbent polymer is important to the function of the encapsulant composition, particularly in providing free-flowing compositions which can be spray-applied and which form
20 solid, unitary patties after contacting the aqueous spill. Thus, superabsorbent polymer powders, desirably wherein at least 70% of the particles have a particle diameter less than about 500 microns, are employed with preference. It is further preferred that 80% or more

of the superabsorbent polymer particles have a particle diameter less than 500 microns. In this regard, particle size for such powders, as referred to herein, is determined by sieve size analysis. Thus, for
5 example, a hydrogel-forming absorbent polymer particle that is retained on a standard #35 sieve with 500 micron openings is considered to have a particle size greater than 500 microns, and a hydrogel-forming absorbent polymer particle that passes through the #35
10 sieve with 500 micron openings is considered to have a particle size less than 500 microns.

The thermoplastic elastomer(s) and superabsorbent polymer(s) can be incorporated in any suitable weight ratio relative to one another. Generally, each
15 superabsorbent polymer type will comprise at least about 10% by weight of the total weight of the thermoplastic elastomer(s) plus superabsorbent polymer(s) in the composition. More typically the weight ratio of thermoplastic elastomer to
20 superabsorbent polymer will be in the range of about 40:60 about 90:10, and even more preferably about 60:40 to about 80:20.

The encapsulant composition may also include an agent for forming an interpenetrating network between

and among the absorbent particles. Such an agent can include multiple substances. For example, it can include a crosslinkable agent along with a crosslinking agent effective to crosslink the crosslinkable agent.

5 These agents, when in the dry state, do not react significantly with one another. However, upon contacting the spill, these agents are taken up in the spill by dissolution, suspension or otherwise, and react with one another to form the interpenetrating
10 polymer network between the absorbent particles. This network is preferably also a polymer gel (e.g. a hydrogel when the spill is at least partly aqueous), and serves to further bind the absorbent particles to one another and thereby form a more unitary mass that
15 can be removed from the spill site.

While the present invention is not intended to be bound by any theory, it is believed in the case of aqueous-containing spills that an interpenetrating hydrogel is beneficially dehydrated by the action of
20 the particulate superabsorbent polymer, leading to increased firmness of the interpenetrating gel and convenience in handling the absorbed mass. In addition, such an interpenetrating network can advantageously serve to entrain any other solids that

may have been present in the spill, for example stomach contents in the case of vomit, cells or tissues in the case of other biological fluids such as blood, or organic and/or inorganic particulates in the case of hydrophobic spills.

Preferred crosslinkable agents include polyols such as polyvinyl alcohols, and polysaccharides bearing free hydroxyl groups, such as gums, e.g. guar gum, xanthan gum, and the like. Water soluble silicates, such as water soluble sodium silicates, may also be used. Such crosslinkable agents will typically be included in an amount of about 0.1% to about 20% of the encapsulant composition by weight, more preferably about 0.1% to about 10%.

Preferred crosslinking agents include those agents exhibiting the capacity to crosslink polyols to form an interpenetrating network between the absorbent particles. Most preferably, the encapsulant compositions includes a boron-containing compound such as borate, boric acid, or a mixture thereof, to effect crosslinking of the polyol. Such crosslinking agents will typically be included in an amount of about 0.1% to about 20% of the encapsulant composition by weight, more preferably about 0.1% to about 10%. In addition

to their roles as crosslinkers, boric acid and borax are known disinfectants and antifungals, and borax is a known deodorant compound. These materials may serve beneficially in these capacities as well.

5 In the case of encapsulant compositions described herein containing both hydrophobic-absorbing and aqueous-absorbing encapsulants, water-soluble or suspendable crosslinking agents such as those described herein can be activated upon contacting a spill which
10 is at least partly aqueous, and/or an amount of water can be added to the spill before or after application of the encapsulant composition to activate the water-soluble or suspendable crosslinking system to form the interpenetrating polymer network.

15 Preferred encapsulant compositions of the invention also include a flow agent which acts to inhibit adherence among particles of the thermoplastic elastomer(s) and superabsorbent polymer(s) in the dry state, and thereby increase the overall flowability of
20 the composition. This flow agent will typically be incorporated at a level of about 0.1% to about 10% by weight relative to the weight of the superabsorbent polymer(s) in the composition, more typically about 0.5% to about 5%. Such flow agents can be solids, for

example as in the cases of silica, salts such as alkali or alkaline earth salts of fatty acids (e.g. magnesium or calcium stearate), alkali or alkaline earth carbonates such as magnesium carbonate, modified
5 celluloses such as carboxymethylcellulose; or, suitable fluid lubricants may also be used.

It will also be understood that the composition may include other additives conventional to encapsulant compositions. For example, these may include
10 surfactants, other absorbent particulates, and the like.

In use, the encapsulant compositions of the invention are applied to a liquid spill, whereupon they absorb and encapsulate the liquid and form a unitary
15 solid mass which can then be removed from the spill area. In this regard, the unitary solid mass in accordance with the invention may for instance appear as a continuous mass to the naked eye, or may appear as an agglomerated mass of particles. In any event, it is
20 desired that this solid unitary mass form, as opposed to a fluid mass or individual particles.

Application of the encapsulant composition to the spill may be achieved by any suitable means. For example, the composition can be sprinkled or sprayed

onto the spill. In one more preferred form, the encapsulant composition has flow properties rendering it a sprayable mass so as to evenly distribute the mass upon the spill. Further, upon application to the
5 spill, the encapsulant composition will swell as it absorbs the liquid, whereupon the composition stably incorporates the liquid and will not release the same under normal handling conditions. For example, preferred compositions will retain hydrophobic liquids
10 even upon immersing the encapsulated mass in water.

The time necessary for encapsulation of the spill will of course vary based upon the particular encapsulant composition used and the substance to be encapsulated. Typically, the encapsulation will occur
15 within a span of about 1 to 60 minutes. In that period, the composition forms a unitary, solid mass which can be taken up from the spill site.

As to types of spills which can be treated in accordance with the invention, they may be solid
20 surface spills of hydrophobic and/or aqueous substances, or water-bound spills of hydrophobic substances. In the latter case, there is no need to disperse the spill in the water prior to treatment. Rather, the composition can be applied to the spill

existing atop the water (e.g. for substances having a lower specific gravity than water), and will form a solid mass which can be removed from the surface of the water.

- 5 A wide variety of hydrophobic organic liquids are treatable in accordance with the invention. These include for example hydrocarbons and other relatively non-polar organic substances, including aliphatic and aromatic substances. Most preferred hydrophobic
- 10 liquids are aliphatic hydrocarbons such as occur in many fuels, oils, and similar substances. Thus, hydrophobic liquids which may be treated in accordance with the invention include for example fuels such as gasoline, jet fuel, kerosene, diesel fuel and
- 15 gasoline/alcohol mixtures; oils such as petroleum-based oils such as motor oil, machine oils and crude oils (e.g. light, medium and heavy crude oils), vegetable oils such as soybean oil, canola oil and corn oil; plasticizers such as phthalates, e.g. dioctyl
- 20 phthalate; and a wide variety of hydrophobic aliphatic and aromatic solvents, including for example hydrocarbon solvents. Spills of these and other hydrophobic organic substances may be treated in accordance with the invention.

As to types of hydrophilic spills which can be treated in accordance with the invention, they may be solid surface- or liquid-bound spills. A wide variety of liquids are treatable in accordance with the invention. These include for example aqueous liquids such as biological fluids, for instance vomit, urine, blood, and the like, as well as other chemical hazards such as acidic or caustic spills. Acidic spills can include, for example, spills of aqueous acids, especially strong acids such as hydrochloric, hydrobromic, sulfuric or nitric acid. In the case of such strong acids, it has been found that a unitary solid mass is formed upon applying a powder form superabsorbent encapsulant composition, even where such composition is free from a separate agent for forming an interpenetrating polymer network as described above.

In one aspect of the invention, an apparatus is provided for containing and dispensing encapsulant compositions. With reference now to FIG. 1, the apparatus 10 includes a pressurized canister 11 equipped to dispense a powder under pressure. A free flowing encapsulant composition 12 in accordance with the invention is contained in the vessel. The canister includes, for example, a nozzle 13 and a trigger 14 as

is conventional for such equipment. The pressure within the canister 11 is typically about 50 to about 250 psi, and the canister is pressurized using a suitable gas, for example air or an inert gas such as nitrogen, argon or carbon dioxide. In one feature of the invention, it has been discovered that pressurization with argon gas provides a particularly advantageous device, more readily and uniformly dispensing the powder compositions from the pressure vessel even under relatively lower pressure conditions, for example about 150 psi or lower.

For the purpose of promoting a further understanding of the invention and its advantages, the following specific examples are provided. It will be understood that these examples are illustrative and not limiting of the invention.

EXAMPLE 1

An encapsulant composition of the invention was prepared by dry blending a styrene-ethylene/propylene block copolymer (KRATON® G1702) (49.5 weight parts) with a styrene-butadiene block copolymer (KRATON® D1184) (49.5 weight parts) and a fluid silicone lubricant (polydimethylsiloxane, DMF-350 CS,

Advanced Polymer, Inc) (1 weight part). This material was evaluated for absorption of kerosene, gasoline, and 10W-30 motor oil using the following test method. About 50 ml of water were added to a wide-mouthed glass dish. A known mass of test liquid was then added to the surface of the water (test liquids all had lower specific gravity than water). A known mass of the encapsulant composition was then sprinkled onto the surface of the test liquid. Sufficient absorbent was added to absorb all test liquid. Absorbent and test liquid ratios were then calculated, and the formation of a unitary solid mass was assessed. The results of this testing are found in Table 1 below, and demonstrate that in all cases, the encapsulant composition absorbed at least several times its own weight of the test liquid. In addition, in all of these tests, a solid, unitary mass or patty was quickly formed.

TABLE 1**ANALYSIS RESULTS / FORMULATION 1**

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (g)	WEIGHT % ABSORBED
Kerosene	11.8	2.2	536
Gasoline	10.1	1.2	842
10W-30 Motor Oil	11.7	3.3	355

EXAMPLES 2-9

Additional encapsulant compositions were prepared
5 and tested using the general methods described in
Example 1. The formulations are given in Table 2, and
the results in Table 3.

TABLE 2

10

COMPOSITION OF FORMULATIONS 2-9

FORMULATION	INGREDIENT	WEIGHT %
2	Styrene/butadiene copolymer (Kraton D-1184)	99.0
	Polydimethylsiloxane (DMF-350CS)	0.5
	Polyethylene glycol (Carbowax 8000)	0.5
3	Styrene/butadiene copolymer (Kraton D-1184)	97.8
	Polydimethylsiloxane (DMF-350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1
4	Styrene/butadiene copolymer (Kraton D-1184)	95.8
	Polydimethylsiloxane (DMF-350CS)	2.1
	Polyethylene glycol (Carbowax 8000)	2.1

5	Styrene/butadiene copolymer (Kraton D-1184)	28.9
	Styrene/ethylene/propylene copolymer (Kraton G1702)	68.9
	Polydimethylsiloxane (DMF 350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1
6	Styrene/butadiene copolymer (Kraton D-1184)	38.9
	Styrene/ethylene/propylene copolymer (Kraton G1702)	58.9
	Polydimethylsiloxane (DMF-350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1
7	Styrene/butadiene copolymer (Kraton D-1184)	48.9
	Styrene/ethylene/propylene copolymer (Kraton G1702)	48.9
	Polydimethylsiloxane (DMF-350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1
8	Styrene/butadiene copolymer (Kraton D-1184)	58.9
	Styrene/ethylene/propylene copolymer (Kraton G1702)	38.9
	Polydimethylsiloxane (DMF-350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1

9	Styrene/butadiene copolymer (Kraton D-1184)	68.9
	Styrene/ethylene/propyl ene copolymer (Kraton G1702)	28.9
	Polydimethylsiloxane (DMF-350CS)	1.1
	Polyethylene glycol (Carbowax 8000)	1.1

5

TABLE 3**ANALYSIS RESULTS / FORMULATIONS 2-9**

WEIGHT % ABSORBED

10

Formulation 2

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	11.5	5.5	209
Gasoline	9.7	3.5	277
Kerosene	11.6	3.1	374

Formulation 3

15

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	12.1	5.6	216
Gasoline	9.4	3.4	276
Kerosene	11.8	3.0	393

Formulation 4

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	11.6	5.6	207
Gasoline	9.6	3.4	282
Kerosene	11.1	3.1	358

Formulation 5

5

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	13.0	4.7	277
Gasoline	10.4	2.0	520
Kerosene	11.3	2.7	419

Formulation 6

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	12.7	5.1	249
Gasoline	10.3	2.3	448
Kerosene	11.5	2.5	460

10 Formulation 7

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	12.7	5.2	244
Gasoline	10.6	2.4	441
Kerosene	11.5	2.8	411

Formulation 8

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	12.5	5.4	231
Gasoline	10.4	2.4	433
Kerosene	11.5	2.9	397

15

Formulation 9

TEST LIQUID	MASS OF LIQUID (g)	MASS OF SAMPLE (G)	WEIGHT % ABSORBED
10W-30 Motor Oil	12.9	5.7	226
Gasoline	10.6	2.5	424
Kerosene	11.5	2.9	397

5

In all cases a solid, unitary patty was formed. In the case of kerosene and gasoline, the patty was very hard. In the case of motor oil, the patty was a unitary semi-solid mass.

10

EXAMPLES 10-39
DUAL FUNCTIONAL ENCAPSULANT COMPOSITIONS

15

Compositions for encapsulating aqueous and/or hydrophobic substances were prepared by dry blending ingredients. These compositions were evaluated for absorption of tap water and 10W-30 motor oil in accordance with ASTM F-716 (Standard Methods of Testing Sorbent Performance of Absorbents). In summary, known amounts of the absorbent were slowly added to known amounts of the test fluid. The absorbent/fluid combination was thoroughly blended to promote absorption. Sufficient absorbent was added until all test fluid was absorbed resulting in a dry, gel-like solid. The weights of both absorbent and test fluid were analyzed such as to determine an absorption

25

efficiency (A) expressed as a percentage shown as follows:

5 Absorption Efficiency (A) = $[(W - W_a) / W] \times 100$

 W = weight of absorbent and test
 fluid

10 W_a = weight of absorbent

 The percentage relates mathematically the weight of the absorbent required to absorb a certain weight of liquid. The smaller the amount of absorbent required, the higher the efficiency rating. For example, equal amounts of absorbent and test fluid would result in an absorption efficiency of 50%. Likewise, an absorbent that can absorb three times its weight would result in an absorption efficiency equal to 75%.

20 The objective of this study was to demonstrate the effect of composition variation, with respect to changing weight ratios and introducing alternative ingredients, on the performance of the final product. Examples have been given demonstrating the results.

25 Examples 10-17

 In formulations 10-17, compositions were prepared by blending an acrylonitrile-butadiene-styrene terpolymer (ABS) (Blendex 336, GE) with a crosslinked polyacrylamide (JRM H300) and magnesium stearate as a flow agent. The ratio between the ABS and the acrylic

30

ingredients ranged from 100:0 to 0:100 to demonstrate the affect on the oil and water absorption efficiencies. Specific formulations and results are given in Tables 3 - 4 respectively. Test results show

5 that the oil absorption efficiency increases linearly with the increase in weight percentage of the ABS ingredient. Similarly, the water absorption efficiency increases in relation to the increase in weight

percentage of the polyacrylamide ingredient. The water

10 absorption efficiency, however, levels off at and beyond approximately forty (40) weight percentage of the polyacrylamide ingredient.

TABLE 3

15 **Composition of Formulations 10-17**

Formulation	Ingredient	Weight %
10	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	99.5
	Magnesium stearate	0.5
11	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	89.75
	Crosslinked polyacrylamide (JRM H300)	9.75
	Magnesium stearate	0.5
12	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	79.75
	Crosslinked polyacrylamide (JRM H300)	19.75
	Magnesium stearate	0.5

13	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Magnesium stearate	0.5
14	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	39.75
	Crosslinked polyacrylamide (JRM H300)	59.75
	Magnesium stearate	0.5
15	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	19.75
	Crosslinked polyacrylamide (JRM H300)	79.75
	Magnesium stearate	0.5
16	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	9.75
	Crosslinked polyacrylamide (JRM H300)	89.75
	Magnesium stearate	0.5
17	Crosslinked polyacrylamide (JRM H300)	99.5
	Magnesium stearate	0.5

TABLE 4**Analysis Results / Formulations 10-17**

5

Formulation	Water Absorption Efficiency	Oil Absorption Efficiency
10	0.0%	70.0%
11	66.3%	67.7%
12	77.1%	63.9%
13	89.1%	58.8%
14	87.7%	49.2%
15	90.2%	43.9%
16	93.4%	39.1%
17	90.6%	36.6%

EXAMPLES 18-25

10

In formulations 18-25, a styrene-butadiene-styrene (SBS) block copolymer (Kraton D1184) was substituted in place of the ABS ingredient (Blendex 336). Kraton D1184 SBS is a thermoplastic elastomer that is composed of 69% butadiene rubber. The ratio of the SBS and acrylic ranged from 100:0 to 0:100 to evaluate the affect on absorption efficiencies. Specific formulations are given in Table 5 and the results in Table 6. As seen in previous examples, the oil absorption efficiency increases linearly with the increase in weight percentage of the oil absorbing ingredient (SBS). Similarly, the water absorption efficiency increases in relation to the increase in weight percentage of the polyacrylamide ingredient and levels off at and beyond approximately forty (40) weight percentage of the polyacrylamide ingredient.

TABLE 5**Composition of Formulations 18-25**

Formulation	Ingredient	Weight %
18	Styrene-butadiene-styrene block copolymer (Kraton D1184)	99.5
	Magnesium stearate	0.5
19	Styrene-butadiene-styrene block copolymer (Kraton D1184)	89.75
	Crosslinked polyacrylamide (JRM H300)	9.75
	Magnesium stearate	0.5
20	Styrene-butadiene-styrene block copolymer (Kraton D1184)	79.75
	Crosslinked polyacrylamide (JRM H300)	19.75
	Magnesium stearate	0.5

21	Styrene-butadiene-styrene block copolymer (Kraton D1184)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Magnesium stearate	0.5
22	Styrene-butadiene-styrene block copolymer (Kraton D1184)	39.75
	Crosslinked polyacrylamide (JRM H300)	59.75
	Magnesium stearate	0.5
23	Styrene-butadiene-styrene block copolymer (Kraton D1184)	19.75
	Crosslinked polyacrylamide (JRM H300)	79.75
	Magnesium stearate	0.5
24	Styrene-butadiene-styrene block copolymer (Kraton D1184)	9.75
	Crosslinked polyacrylamide (JRM H300)	89.75
	Magnesium stearate	0.5
25	Crosslinked polyacrylamide (JRM H300)	99.5
	Magnesium stearate	0.5

TABLE 6

Analysis Results / Formulations 18-25

5

Formulation	Water Absorption Efficiency	Oil Absorption Efficiency
18	0.0%	61.7%
19	72.8%	60.1%
20	85.0%	61.0%
21	89.0%	55.3%
22	91.5%	52.2%
23	90.2%	44.1%
24	91.3%	41.4%
25	93.8%	39.1%

Examples 26-30

10

In formulations 26-30, the oil absorbing ingredient was varied using different ABS-based thermoplastic elastomers. The ABS ingredient varied by type of

rubber block, % of rubber block, and particle size of rubber phase. All ABS-based ingredients were blended at the same weight percentage with the crosslinked polyacrylamide (JRM H300) and magnesium stearate.

5 Specific formulations are given in Table 7 and the results in Table 8. The following is a description of each ingredient in order of highest to lowest oil absorption efficiency:

- 10 • Blendex 336: 65% styrene-butadiene rubber, large particle size
- Blendex 338: 70% butadiene rubber
- Blendex 360: 50% butadiene rubber
- Blendex 415: 65% styrene-butadiene rubber, small particle size
- 15 • Blendex 131: 35% butadiene rubber

The large particle size styrene-butadiene rubber resulted in a significantly higher absorption efficiency compared to the smaller sized particles.

20 With respect to the butadiene rubber based ABS ingredients, there is a direct relationship between % rubber and oil absorption efficiency.

TABLE 7**Composition of Formulations 26-30**

5

Formulation	Ingredient	Weight %
26	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336 / 65% styrene-butadiene rubber, large-particle size)	49.75
	Crosslinked polyacrylamide (JRM H300)	49.75
	Magnesium stearate	0.5
27	Acrylonitrile-butadiene-styrene terpolymer (Blendex 338 / 70% butadiene rubber)	49.75
	Crosslinked polyacrylamide (JRM H300)	49.75
	Magnesium stearate	0.5
28	Acrylonitrile-butadiene-styrene terpolymer (Blendex 360 / 50% butadiene rubber)	49.75
	Crosslinked polyacrylamide (JRM H300)	49.75
	Magnesium stearate	0.5
29	Acrylonitrile-butadiene-styrene terpolymer (Blendex 415 / 65% styrene-butadiene rubber, small-particle size)	49.75
	Crosslinked polyacrylamide (JRM H300)	49.75
	Magnesium stearate	0.5
30	Acrylonitrile-butadiene-styrene terpolymer (Blendex 131 / 35% butadiene rubber)	49.75
	Crosslinked polyacrylamide (JRM H300)	49.75
	Magnesium stearate	0.5

TABLE 8**Analysis Results / Formulations 26-30**

Formulation	Water Absorption Efficiency	Oil Absorption Efficiency
26	83.6%	58.2%
27	85.8%	54.5%
28	91.0%	53.6%
29	91.0%	50.2%
30	88.8%	44.0%

5

Examples 31-34

Additional formulations were prepared varying the type of water absorbing ingredient (acrylamide-based polymer). All acrylamide-based ingredients were blended at the same weight percentage with the ABS terpolymer (Blendex 336) and magnesium stearate. Specific formulations are given in Table 8 and the results in Table 9. The formulation with the JRM H600 ingredient (crosslinked polyacrylamide / polyacrylate copolymer) had the highest water absorption efficiency followed by the formulation with the JRM H300 ingredient (crosslinked polyacrylamide).

The JRM H600 particle size ranges from 50-800 microns. This distribution may lead to non-preferred blending with the preferred oil absorbing ingredient (Blendex 336 - mean particle size = 180 microns). In comparison, the JRM H300 has a particle size range of 100-500 microns. Even though JRM H300 had slightly lower water absorption efficiency, its use is desirable

due to its more compatible particle size range with the Blendex 336. In return, the increased compatibility will lead to a more evenly distributed composition.

TABLE 9

5

Composition of Formulations 31-34

Formulation	Ingredient	Weight %
31	Crosslinked polyacrylamide (JRM H300)	49.75
	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	49.75
	Magnesium stearate	0.5
32	Crosslinked polyacrylamide / polyacrylate (JRM H600)	49.75
	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	49.75
	Magnesium stearate	0.5
33	Anionic polyacrylamide - powder (Aquastore HPP)	49.75
	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	49.75
	Magnesium stearate	0.5
34	Anionic polyacrylamide - granular (Aquastore HPG)	49.75
	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	49.75
	Magnesium stearate	0.5

TABLE 10

10

Analysis Results / Formulations 31-34

Formulation	Water Absorption Efficiency	Oil Absorption Efficiency
31	89.0%	57.7%
32	94.1%	63.8%
33	79.8%	54.5%
34	61.6%	61.6%

Examples 35-39

In formulations 35-39 (Table 11), the preferred invention composition (59.75% Blendex 336/ 39.75% JRM H300) was blended with various common organic and inorganic materials which are flow agent candidates, which in return were evaluated for their anti-caking characteristics at 0.5% loading. These specific materials are typically used as lubricants or fillers in the polymer industry. The purpose of the anti-caking agent is to inhibit adherence among the absorbent particles and thereby increase the overall flow characteristics of the composition.

For the evaluation, settling action for each formulation was promoted followed by flow ability evaluation both within a specific container and onto a floor surface. All anti-caking agents used with the exception of starch resulted in products that were adequately free-flowing (Table 12). In the particular tests conducted, the formulation containing the starch ingredient tended to clump within the container resulting in less desirable pouring characteristics.

Table 11**Composition of Formulations 35-39**

Formulation	Ingredient	Weight %
35	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Magnesium stearate	0.5
36	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Magnesium carbonate	0.5
37	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Carboxymethylcellulose	0.5
38	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Calcium stearate	0.5
39	Acrylonitrile-butadiene-styrene terpolymer (Blendex 336)	59.75
	Crosslinked polyacrylamide (JRM H300)	39.75
	Starch	0.5

5

Table 12**Analysis Results / Formulations 35-39**

Formulation	Flow Ability
42	adequate
43	adequate
44	adequate
45	adequate
46	Some caking

10

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as
5 illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

10 All publications cited herein are indicative of the level of skill in the art and are hereby incorporated by reference as if each had been individually incorporated by reference and fully set forth.

15

WHAT IS CLAIMED IS:

1. A free-flowing encapsulant composition for treating a spill of a hydrophobic organic liquid,
5 comprising:
powdered thermoplastic elastomer having an average particle diameter of less than 50 microns;
a flow agent in an amount of about 0.1% to about 10% by weight relative to said powdered elastomer, said
10 amount effective to inhibit adherence among particles of said powdered elastomer;
said composition effective to encapsulate a hydrophobic organic liquid; and
said composition forming a unitary solid mass upon
15 encapsulating the hydrophobic organic liquid.

2. The encapsulant composition of claim 1,
wherein said powdered thermoplastic elastomer includes a powdered styrene-butadiene block copolymer.
20

3. The encapsulant composition of claim 1,
wherein said powdered elastomer includes a powdered styrene-ethylene-propylene block copolymer.

4. The encapsulant composition of claim 1, wherein said powdered elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered styrene-ethylene-propylene block copolymer.

5

5. The encapsulant composition of claim 1, wherein said flow agent includes a silicon-containing substance.

10

6. The encapsulant composition of claim 5, wherein said flow agent includes at least one member selected from the group consisting of silica and polysiloxanes.

15

7. The encapsulant composition of claim 6, wherein said flow agent includes polydimethylsiloxane.

20

8. The encapsulant composition of claim 7, wherein said powdered elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered styrene-ethylene-propylene block copolymer.

9. The encapsulant composition of claim 8, which comprises:

about 0.5% to about 5% by weight
polydimethylsiloxane;

about 20% to about 50% powdered styrene-butadiene
block copolymer; and

5 about 20% to about 50% powdered styrene-ethylene-
propylene block copolymer.

10. A device for treating a spill of a
hydrophobic organic liquid, comprising:

10 a pressurized vessel equipped to dispense a powder
under pressure;

a free-flowing encapsulant composition contained
in said vessel, said composition comprising:

powdered thermoplastic elastomer having an average
15 particle diameter of less than 50 microns;

a flow agent in an amount of about 0.1% to
about 10% by weight relative to said powdered
thermoplastic elastomer, said amount effective to
prevent adherence among particles of said powdered
20 thermoplastic elastomer;

said composition effective to encapsulate the
hydrophobic organic liquid; and

said composition forming a unitary mass upon
encapsulating the hydrophobic organic liquid.

11. The device of claim 10, wherein said powdered elastomer includes a powdered styrene-butadiene block copolymer.

5

12. The device of claim 10, wherein said powdered elastomer includes a powdered styrene-ethylene-propylene block copolymer.

10

13. The device of claim 10, wherein said powdered elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered styrene-ethylene-propylene block copolymer.

15

14. The device of claim 10, wherein said vessel is pressurized with gas including argon.

15. The device of claim 10, wherein said flow agent includes a fluid lubricant.

20

16. The device of claim 15, wherein said fluid lubricant is a silicone lubricant.

17. The device of claim 16, wherein said silicone lubricant includes a fluid polydimethylsiloxane.

18. The device of claim 17, wherein said powdered
5 elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered styrene-ethylene-propylene block copolymer.

19. The device of claim 13, wherein said vessel
10 is pressurized with gas including argon.

20. The device of claim 19, wherein said encapsulant composition comprises:

about 0.5% to about 5% by weight fluid lubricant;
15 about 20% to about 50% powdered styrene-butadiene block copolymer; and

about 20% to about 50% powdered styrene-ethylene-propylene block copolymer.

20 21. A method for treating a spill of a hydrophobic organic liquid, comprising:

(a) applying to the spill an encapsulant composition comprising:

powdered thermoplastic elastomer;

a flow agent in an amount of about 0.1% to about 10% by weight relative to said powdered elastomer, said amount effective to prevent adherence among particles of said powdered elastomer;

said composition effective to encapsulate liquid hydrocarbons; and

said composition forming a unitary mass upon encapsulating liquid hydrocarbons;

- (b) allowing said composition to encapsulate said hydrophobic organic liquid and form a unitary mass; and
- (c) recovering said unitary mass.

22. The method of claim 21, wherein said powdered thermoplastic elastomer includes a powdered styrene-butadiene block copolymer.

23. The method of claim 21, wherein said powdered elastomer includes a powdered styrene-ethylene-propylene block copolymer.

24. The method of claim 21, wherein said applying includes dispensing said encapsulant composition in a forced flow from a pressure vessel.

25. The method of claim 24, wherein said powdered thermoplastic elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered
5 styrene-ethylene-propylene block copolymer.

26. The method of claim 25, wherein said flow agent includes a silicon-containing substance.

10 27. The method of claim 26, wherein said flow agent includes at least one member selected from the group consisting of silica and polysiloxanes.

28. The method of claim 27 wherein said flow
15 agent includes polydimethylsiloxane.

29. The method of claim 28, wherein said powdered thermoplastic elastomer includes a blend of a powdered styrene-butadiene block copolymer and a powdered
20 styrene-ethylene-propylene block copolymer.

30. The method of claim 29, wherein said encapsulant composition comprises:

about 0.5% to about 5% by weight
polydimethylsiloxane;

about 20% to about 50% powdered styrene-butadiene
block copolymer; and

5 about 20% to about 50% powdered styrene-ethylene-
propylene block copolymer.

31. The method of claim 21, wherein said spill is
a water-born spill.

10

32. The method of claim 31, wherein said
hydrophobic organic liquid includes an aliphatic
hydrocarbon.

15 33. The method of claim 32, wherein said
hydrophobic organic liquid is a fuel, solvent or oil.

34. The method of claim 21, wherein said
encapsulant composition includes a blend of at least
20 two thermoplastic elastomers.

35. The method of claim 34, wherein a first of
said thermoplastic elastomers has saturated rubber

blocks, and a second of said thermoplastic elastomers has unsaturated rubber blocks.

36. An encapsulant composition for treating a
5 spill of a hydrophobic organic liquid, comprising a blend of at least two powdered thermoplastic elastomers, and wherein said composition is effective to encapsulate hydrophobic organic liquids.

10 37. The composition of claim 36 and also comprising a flow agent.

38. The composition of claim 36, wherein the blend includes a first powdered thermoplastic elastomer
15 having unsaturated rubber blocks and a second powdered thermoplastic elastomer having saturated rubber blocks.

39. A method for treating a spill of a hydrophobic organic liquid, comprising applying to the
20 spill a composition of claim 36, allowing the composition to encapsulate the liquid, and recovering the composition containing the liquid.

40. An encapsulant composition comprising a blend
of a particulate thermoplastic elastomer and a
particulate superabsorbent polymer, and wherein said
composition is effective to encapsulate both
5 hydrophobic organic substances and aqueous substances.

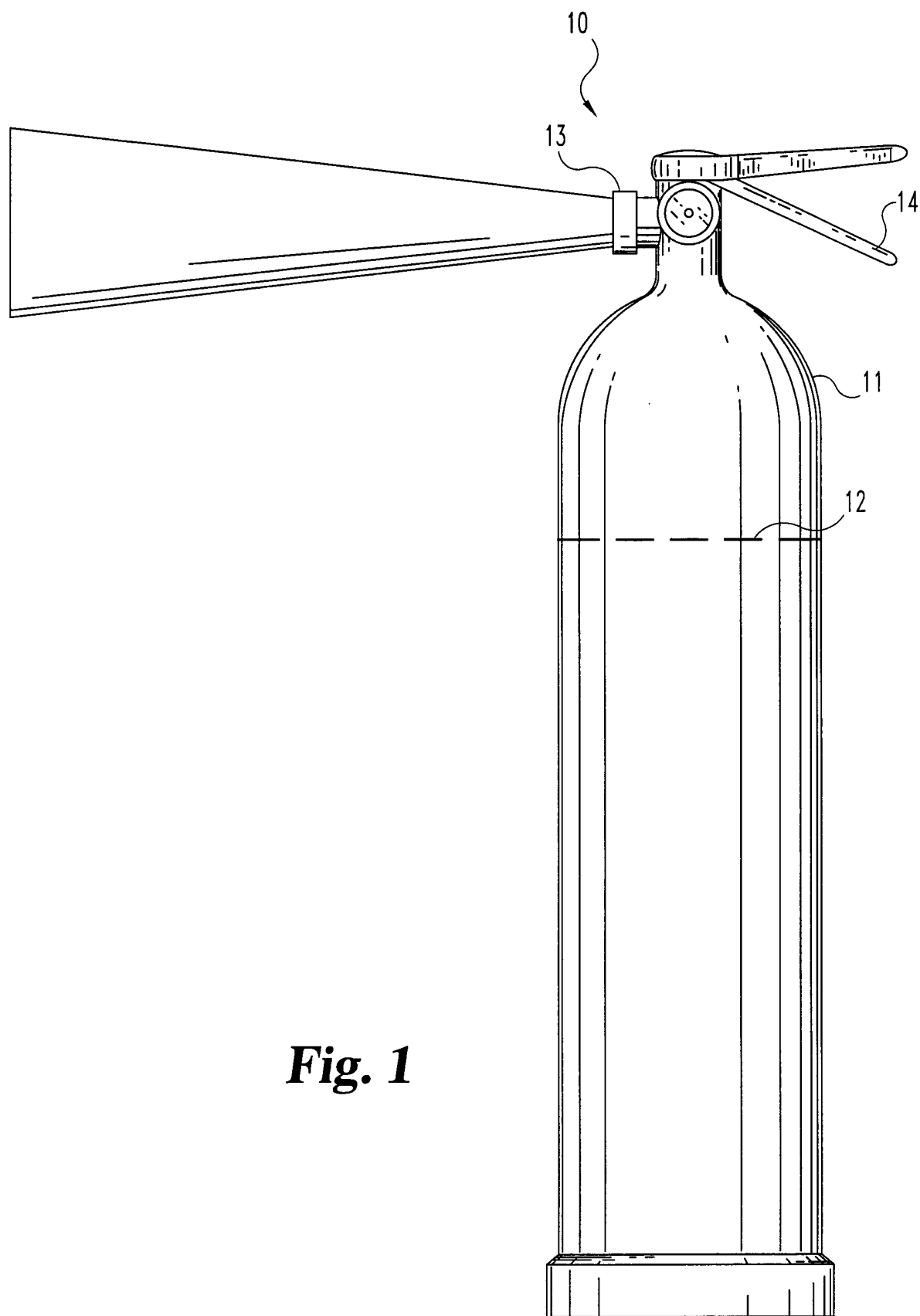
41. The encapsulant composition of claim 40, also
comprising a flow agent.

10 42. The encapsulant composition of claim 41,
wherein said flow agent is a solid.

43. The encapsulant composition of claim 41,
wherein said thermoplastic elastomer comprises a block
15 copolymer.

44. The encapsulant composition of claim 43,
wherein said block copolymer comprises styrene.

20 45. The encapsulant composition of claim 44,
wherein said block copolymer comprises at least one
member selected from the group consisting of butadiene,
acrylonitrile, ethylene, propylene and butylene.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/12126

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B01D 15/00; C02F 1/28

US CL :210/680, 693, 242.4, 502.1, 503, 924; 502/402

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 210/680, 693, 242.4, 502.1, 503, 924; 264/211; 502/402

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,518,183 A (EVANS) 30 June 1970, entire document.	1-45
Y	US 3,607,741 A (SOHNIUS) 21 September 1971, entire document.	1-45
Y	US 3,886,067 A (MIRANDA) 27 May 1975, entire document.	10-20 and 24-30

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

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