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## (54) Title: GLYCERIN ETHER ETHOXYLATE SOLFACTANTS

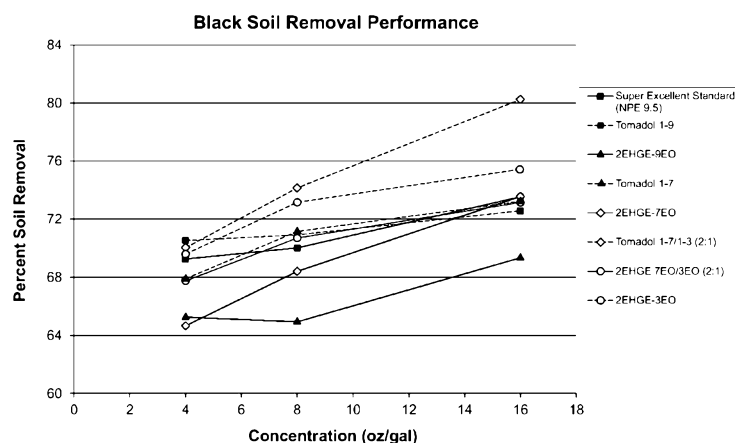


FIG. 1

(57) Abstract: The present invention relates to novel glycerin ether ethoxylate solfactant compounds, compositions employing the same, and methods of using these compounds. Beneficially the compounds have efficacy as both solvents and surfactants with low foam and low viscosity. The compounds of the present invention can be used as antimicrobials and/or sanitizing agents in various formulations. The compounds of the present invention are also suitable for use as solvents and/or hydrotropes.

**TITLE: GLYCERIN ETHER ETHOXYLATE SOLFACTANTS****FIELD OF THE INVENTION**

The present invention relates to novel solfactant compounds having efficacy  
5 as both solvents and surfactants. In particular, the present invention relates to novel  
glycerin ether ethoxylate compounds, compositions employing the same, and  
methods of using these compounds. The compounds of the present invention can be  
used as antimicrobials and/or sanitizing agents in various formulations. The  
compounds of the present invention are also suitable for use as solvents and/or  
10 hydrotropes.

**BACKGROUND OF THE INVENTION**

There are continued needs for novel surfactants having improved surfactant  
characteristics. Desirable improvements to surfactants include characteristics  
15 affecting solubilization, gel formation, foam production and/or cloud points. In  
particular, the ability to employ surfactants having low surface tensions at low use  
levels and/or the ability to control foam characteristics of a surfactant have  
significant industrial importance. Extensive discussions of the fundamental  
properties and practical application of surfactants can be found in Kirk Othmer  
20 Encyclopedia of Chemical Technology, Fourth Edition, Volume 23, pp. 477-541,  
which is herein incorporated by reference in its entirety.

Glycerin ethers represent a new class of emerging solvents, including  
glycerin-derived short-chain aliphatic ether or salts thereof. Various such solvents  
are disclosed for example in U.S. Patent Publication No. 2012/0309849, which is  
25 herein incorporated by reference in its entirety. These solvents can be used  
according to the invention to arrive at the novel solfactant class described herein. In  
particular, the glycerin ethers are particularly well suited for ethoxylation to arrive at  
the novel solfactants of the present invention.

Accordingly, it is an objective of the claimed invention to develop a novel  
30 class of compounds referred to as "solfactants" having improved surfactant and  
solvent characteristics to either replace or use in combination with alcohol  
ethoxylates in various formulations.

A further object of the invention is to develop a novel class of glycerin ether ethoxylate surfactants.

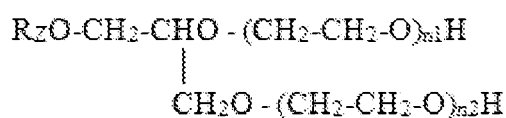
A further object of the invention is to provide methods of making and employing the novel surfactant class of glycerin ether ethoxylate surfactants.

5 Other objects, advantages and features of the present invention will become apparent from the following specification taken in conjunction with the accompanying drawings.

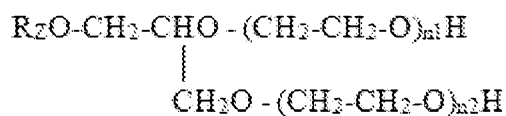
### BRIEF SUMMARY OF THE INVENTION

10 An advantage of the invention is a novel surfactant system. In some aspects, the present invention relates to novel glycerin ether ethoxylate surfactants, and methods for employing the same in various compositions. In some aspects, the present invention provides methods for using the surfactant compounds of the present invention as surfactant and/or solvent systems.

15 In an embodiment, the present invention is directed to a surfactant comprising: A surfactant composition comprising: a compound according to the following formula:



20 In an embodiment, the present invention is directed to a surfactant comprising:  
a compound according to the following formula:



25 wherein  $R_Z$  is a linear or branched alkyl group having 1 to 30 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 20, wherein the molecular weight of the surfactant is from about 200 to about 10,000, wherein the compound is at least partially water soluble, and

wherein the compound does not form a gel when combined with any concentration of water.

In an embodiment, the present invention is directed to a method of employing the solfactant compound comprising: contacting a surface, article and/or substrate in need of cleaning and/or sanitizing with the solfactant or a composition containing the solfactant.

While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a graph of various cleaning compositions containing the glycerin ether ethoxylate solfactants according to the invention, in comparison to a control composition (Super Excellent (with NPE 9.5)) and various equivalent ethoxylated alcohol based compositions on cleaning of black soils.

FIG. 2 shows a graph of various cleaning compositions containing the glycerin ether ethoxylate solfactants according to the invention, in comparison to a control composition (Super Excellent (with NPE 9.5)) and various equivalent ethoxylated alcohol based compositions on cleaning of red food soils.

FIGS. 3A-3C show comparative graphs of gel curves of commercially-available ethoxylated alcohols for which the solfactants according to embodiments of the invention are suitable replacements or substitutes, and which do not form gels with any concentrations of water.

FIGS. 4A-4E show DSC measurements of various glycerin ether ethoxylate solfactants according to embodiments of the invention, demonstrating the low temperature stability.

Various embodiments of the present invention will be described in detail with reference to the drawings, wherein like reference numerals represent like parts throughout the several views. Reference to various embodiments does not limit the

scope of the invention. Figures represented herein are not limitations to the various embodiments according to the invention and are presented for exemplary illustration of the invention.

## 5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to novel glycerin ether ethoxylate surfactants. The compositions have a variety of advantages over conventional alcohol ethoxylate surfactants, including for example, the low foaming profile, low viscosity (*e.g.* no gel curve for the surfactants) and formulation capabilities as both surfactants and  
10 solvents. The compounds of the present invention can be used in combination with various cleaning and/or sanitizing components, beneficially including quaternary ammonium compounds to provide simultaneous cleaning and sanitizing efficacy. The surfactants are preferably incorporated into liquid formulas, and have many uses, including but not limited to antimicrobials, coupling agents, hydrotropes and  
15 sanitizing agents. The embodiments of this invention are not limited to particular methods of making the glycerin ether ethoxylates and/or methods of employing the same, which can vary and are understood by skilled artisans. It is further to be understood that all terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting in any manner or  
20 scope. For example, as used in this specification and the appended claims, the singular forms "a," "an" and "the" can include plural referents unless the content clearly indicates otherwise. Further, all units, prefixes, and symbols may be denoted in its SI accepted form. Numeric ranges recited within the specification are inclusive of the numbers defining the range and include each integer within the  
25 defined range.

So that the present invention may be more readily understood, certain terms are first defined. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which embodiments of the invention pertain. Many methods and materials  
30 similar, modified, or equivalent to those described herein can be used in the practice of the embodiments of the present invention without undue experimentation, the preferred materials and methods are described herein. In describing and claiming

the embodiments of the present invention, the following terminology will be used in accordance with the definitions set out below.

The term "about," as used herein, refers to variation in the numerical quantity that can occur, for example, through typical measuring and liquid handling procedures used for making concentrates or use solutions in the real world; through  
5 inadvertent error in these procedures; through differences in the manufacture, source, or purity of the ingredients used to make the compositions or carry out the methods; and the like. The term "about" also encompasses amounts that differ due to different equilibrium conditions for a composition resulting from a particular  
10 initial mixture. Whether or not modified by the term "about", the claims include equivalents to the quantities.

The term "actives" or "percent actives" or "percent by weight actives" or "actives concentration" are used interchangeably herein and refers to the concentration of those ingredients involved in cleaning expressed as a percentage  
15 minus inert ingredients such as water or salts.

As used herein, "agricultural" or "veterinary" objects or surfaces include animal feeds, animal watering stations and enclosures, animal quarters, animal veterinarian clinics (*e.g.* surgical or treatment areas), animal surgical areas, and the like.

20 As used herein, the phrase "air streams" includes food anti-spoilage air circulation systems. Air streams also include air streams typically encountered in hospital, surgical, infirmity, birthing, mortuary, and clinical diagnosis rooms.

As used herein, the term "alkyl" or "alkyl groups" refers to saturated hydrocarbons having one or more carbon atoms, including straight-chain alkyl  
25 groups (*e.g.*, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, etc.), cyclic alkyl groups (or "cycloalkyl" or "alicyclic" or "carbocyclic" groups) (*e.g.*, cyclopropyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, etc.), branched-chain alkyl groups (*e.g.*, isopropyl, tert-butyl, sec-butyl, isobutyl, etc.), and alkyl-substituted alkyl groups (*e.g.*, alkyl-substituted cycloalkyl groups and cycloalkyl-  
30 substituted alkyl groups).

Unless otherwise specified, the term "alkyl" includes both "unsubstituted alkyls" and "substituted alkyls." As used herein, the term "substituted alkyls" refers

to alkyl groups having substituents replacing one or more hydrogens on one or more carbons of the hydrocarbon backbone. Such substituents may include, for example, alkenyl, alkynyl, halogeno, hydroxyl, alkylcarbonyloxy, arylcarbonyloxy, alkoxycarbonyloxy, aryloxy, aryloxy carbonyloxy, carboxylate, alkylcarbonyl, arylcarbonyl, alkoxycarbonyl, aminocarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkylthiocarbonyl, alkoxyl, phosphate, phosphonato, phosphinato, cyano, amino (including alkyl amino, dialkylamino, arylamino, diarylamino, and alkylaryl amino), acylamino (including alkylcarbonylamino, arylcarbonylamino, carbamoyl and ureido), imino, sulfhydryl, alkylthio, arylthio, thiocarboxylate, sulfates, alkylsulfinyl, sulfonates, sulfamoyl, sulfonamido, nitro, trifluoromethyl, cyano, azido, heterocyclic, alkylaryl, or aromatic (including heteroaromatic) groups.

In some embodiments, substituted alkyls can include a heterocyclic group. As used herein, the term “heterocyclic group” includes closed ring structures analogous to carbocyclic groups in which one or more of the carbon atoms in the ring is an element other than carbon, for example, nitrogen, sulfur or oxygen. Heterocyclic groups may be saturated or unsaturated. Exemplary heterocyclic groups include, but are not limited to, aziridine, ethylene oxide (epoxides, oxiranes), thiirane (episulfides), dioxirane, azetidine, oxetane, thietane, dioxetane, dithietane, dithiete, azolidine, pyrrolidine, pyrroline, oxolane, dihydrofuran, and furan.

An “antiredeposition agent” refers to a compound that helps keep suspended in water instead of redepositing onto the object being cleaned. Antiredeposition agents are useful in the present invention to assist in reducing redepositing of the removed soil onto the surface being cleaned.

As used herein, the term “disinfectant” refers to an agent that kills all vegetative cells including most recognized pathogenic microorganisms, using the procedure described in *A.O.A.C. Use Dilution Methods*, Official Methods of Analysis of the Association of Official Analytical Chemists, paragraph 955.14 and applicable sections, 15th Edition, 1990 (EPA Guideline 91-2). As used herein, the term “high level disinfection” or “high level disinfectant” refers to a compound or composition that kills substantially all organisms, except high levels of bacterial spores, and is effected with a chemical germicide cleared for marketing as a sterilant

by the Food and Drug Administration. As used herein, the term “intermediate-level disinfection” or “intermediate level disinfectant” refers to a compound or composition that kills mycobacteria, most viruses, and bacteria with a chemical germicide registered as a tuberculocide by the Environmental Protection Agency (EPA). As used herein, the term “low-level disinfection” or “low level disinfectant” refers to a compound or composition that kills some viruses and bacteria with a chemical germicide registered as a hospital disinfectant by the EPA.

As used herein, the phrase “food processing surface” refers to a surface of a tool, a machine, equipment, a structure, a building, or the like that is employed as part of a food processing, preparation, or storage activity. Examples of food processing surfaces include surfaces of food processing or preparation equipment (*e.g.*, slicing, canning, or transport equipment, including flumes), of food processing wares (*e.g.*, utensils, dishware, wash ware, and bar glasses), and of floors, walls, or fixtures of structures in which food processing occurs. Food processing surfaces are found and employed in food anti-spoilage air circulation systems, aseptic packaging sanitizing, food refrigeration and cooler cleaners and sanitizers, ware washing sanitizing, blancher cleaning and sanitizing, food packaging materials, cutting board additives, third-sink sanitizing, beverage chillers and warmers, meat chilling or scalding waters, auto dish sanitizers, sanitizing gels, cooling towers, food processing antimicrobial garment sprays, and non-to-low-aqueous food preparation lubricants, oils, and rinse additives.

As used herein, the phrase “food product” includes any food substance that might require treatment with an antimicrobial agent or composition and that is edible with or without further preparation. Food products include meat (*e.g.* red meat and pork), seafood, poultry, produce (*e.g.*, fruits and vegetables), eggs, living eggs, egg products, ready to eat food, wheat, seeds, roots, tubers, leafs, stems, corns, flowers, sprouts, seasonings, or a combination thereof. The term “produce” refers to food products such as fruits and vegetables and plants or plant-derived materials that are typically sold uncooked and, often, unpackaged, and that can sometimes be eaten raw.

As used herein, the term “hard surface” includes showers, sinks, toilets, bathtubs, countertops, windows, mirrors, transportation vehicles, floors, and the like.



These surfaces can be those typified as "hard surfaces" (such as walls, floors, bed-pans, etc.) or fabric surfaces, *e.g.*, knit, woven, and non-woven surfaces.

As used herein, the phrase "health care surface" refers to a surface of an instrument, a device, a cart, a cage, furniture, a structure, a building, or the like that is employed as part of a health care activity. Examples of health care surfaces include surfaces of medical or dental instruments, of medical or dental devices, of electronic apparatus employed for monitoring patient health, and of floors, walls, or fixtures of structures in which health care occurs. Health care surfaces are found in hospital, surgical, infirmity, birthing, mortuary, and clinical diagnosis rooms. These surfaces can be those typified as "hard surfaces" (such as walls, floors, bed-pans, etc.), or fabric surfaces, *e.g.*, knit, woven, and non-woven surfaces (such as surgical garments, draperies, bed linens, bandages, etc.), or patient-care equipment (such as respirators, diagnostic equipment, shunts, body scopes, wheel chairs, beds, etc.), or surgical and diagnostic equipment. Health care surfaces include articles and surfaces employed in animal health care.

As used herein, the term "instrument" refers to the various medical or dental instruments or devices that can benefit from cleaning with a composition according to the present invention. As used herein, the phrases "medical instrument," "dental instrument," "medical device," "dental device," "medical equipment," or "dental equipment" refer to instruments, devices, tools, appliances, apparatus, and equipment used in medicine or dentistry. Such instruments, devices, and equipment can be cold sterilized, soaked or washed and then heat sterilized, or otherwise benefit from cleaning in a composition of the present invention. These various instruments, devices and equipment include, but are not limited to: diagnostic instruments, trays, pans, holders, racks, forceps, scissors, shears, saws (*e.g.* bone saws and their blades), hemostats, knives, chisels, rongeurs, files, nippers, drills, drill bits, rasps, burrs, spreaders, breakers, elevators, clamps, needle holders, carriers, clips, hooks, gouges, curettes, retractors, straightener, punches, extractors, scoops, keratomes, spatulas, expressors, trocars, dilators, cages, glassware, tubing, catheters, cannulas, plugs, stents, scopes (*e.g.*, endoscopes, stethoscopes, and arthoscopes) and related equipment, and the like, or combinations thereof.

The term "microemulsion" as used herein, refers to a thermodynamically stable liquid dispersion of one liquid phase into another that is stabilized by an interfacial film of surfactant. According to the invention, the microemulsion forms an interface with the surfactant between the two immiscible phases of oil and water.

5           As used herein, the phrase "meat product" refers to all forms of animal flesh, including the carcass, muscle, fat, organs, skin, bones and body fluids and like components that form the animal. Animal flesh includes, but is not limited to, the flesh of mammals, birds, fishes, reptiles, amphibians, snails, clams, crustaceans, other edible species such as lobster, crab, etc., or other forms of seafood. The forms  
10 of animal flesh include, for example, the whole or part of animal flesh, alone or in combination with other ingredients. Typical forms include, for example, processed meats such as cured meats, sectioned and formed products, minced products, finely chopped products, ground meat and products including ground meat, whole products, and the like.

15           As used herein, the term "microorganism" refers to any noncellular or unicellular (including colonial) organism. Microorganisms include all prokaryotes. Microorganisms include bacteria (including cyanobacteria), spores, lichens, fungi, protozoa, virinos, viroids, viruses, phages, and some algae. As used herein, the term "microbe" is synonymous with microorganism.

20           As used herein, the phrase "plant" or "plant product" includes any plant substance or plant-derived substance. Plant products include, but are not limited to, seeds, nuts, nut meats, cut flowers, plants or crops grown or stored in a greenhouse, house plants, and the like. Plant products include many animal feeds.

          As used herein the term "poultry" refers to all forms of any bird kept,  
25 harvested, or domesticated for meat or eggs, and including chicken, turkey, ostrich, game hen, squab, guinea fowl, pheasant, quail, duck, goose, emu, or the like and the eggs of these birds. Poultry includes whole, sectioned, processed, cooked or raw poultry, and encompasses all forms of poultry flesh, by-products, and side products. The flesh of poultry includes muscle, fat, organs, skin, bones and body fluids and  
30 like components that form the animal. Forms of animal flesh include, for example, the whole or part of animal flesh, alone or in combination with other ingredients. Typical forms include, for example, processed poultry meat, such as cured poultry

meat, sectioned and formed products, minced products, finely chopped products and whole products.

As used herein, the phrase "poultry debris" refers to any debris, residue, material, dirt, offal, poultry part, poultry waste, poultry viscera, poultry organ, fragments or combinations of such materials, and the like removed from a poultry carcass or portion during processing and that enters a waste stream.

For the purpose of this patent application, successful microbial reduction is achieved when the microbial populations are reduced by at least about 50%, or by significantly more than is achieved by a wash with water. Larger reductions in microbial population provide greater levels of protection.

As used herein, the term "sanitizer" refers to an agent that reduces the number of bacterial contaminants to safe levels as judged by public health requirements. In an embodiment, sanitizers for use in this invention will provide at least a 99.999% reduction (5-log order reduction). These reductions can be evaluated using a procedure set out in *Germicidal and Detergent Sanitizing Action of Disinfectants*, Official Methods of Analysis of the Association of Official Analytical Chemists, paragraph 960.09 and applicable sections, 15th Edition, 1990 (EPA Guideline 91-2). According to this reference a sanitizer should provide a 99.999% reduction (5-log order reduction) within 30 seconds at room temperature, 25±2°C, against several test organisms.

The term "solvent" refers to an organic material or mixture of such materials suitable for cleaning, degreasing or stripping the desired surface, coupling, coalescing or adjusting viscosity.

As used in this invention, the term "sporicide" refers to a physical or chemical agent or process having the ability to cause greater than a 90% reduction (1-log order reduction) in the population of spores of *Bacillus cereus* or *Bacillus subtilis* within 10 seconds at 60° C. In certain embodiments, the sporicidal compositions of the invention provide greater than a 99% reduction (2-log order reduction), greater than a 99.99% reduction (4-log order reduction), or greater than a 99.999% reduction (5-log order reduction) in such population within 10 seconds at 60° C.

Differentiation of antimicrobial "-cidal" or "-static" activity, the definitions which describe the degree of efficacy, and the official laboratory protocols for measuring this efficacy are considerations for understanding the relevance of antimicrobial agents and compositions. Antimicrobial compositions can affect two kinds of microbial cell damage. The first is a lethal, irreversible action resulting in complete microbial cell destruction or incapacitation. The second type of cell damage is reversible, such that if the organism is rendered free of the agent, it can again multiply. The former is termed microbiocidal and the later, microbistatic. A sanitizer and a disinfectant are, by definition, agents which provide antimicrobial or microbiocidal activity. In contrast, a preservative is generally described as an inhibitor or microbistatic composition

The term "substantially similar cleaning performance" refers generally to achievement by a substitute cleaning product or substitute cleaning system of generally the same degree (or at least not a significantly lesser degree) of cleanliness or with generally the same expenditure (or at least not a significantly lesser expenditure) of effort, or both, when using the substitute solfactant(s) according to the invention. This degree of cleanliness may, depending on the particular cleaning product and particular substrate, correspond to a general absence of visible soils, or to some lesser degree of cleanliness.

The term "surfactant" or "surface active agent" refers to an organic chemical that when added to a liquid changes the properties of that liquid at a surface. In comparison, as used herein, the term "solfactant" refers to an organic chemical that when added to a liquid changes the properties of that liquid at a surface, specifically including the adjustment of the viscosity of a composition (*e.g.* handleability or ease of use of the compositions). In particular, solfactant refers to a compound having the beneficial properties of both a surfactant and a solvent.

The terms "vehicle" or "car" as used herein, refer to any transportation conveyance including without limitation, automobiles, trucks, sport utility vehicles, buses, trucks, motorcycles, monorails, diesel locomotives, passenger coaches, small single engine private airplanes, corporate jet aircraft, commercial airline equipment, etc.

As used herein, the term “ware” refers to items such as eating and cooking utensils, dishes, and other hard surfaces such as showers, sinks, toilets, bathtubs, countertops, windows, mirrors, transportation vehicles, and floors. As used herein, the term “warewashing” refers to washing, cleaning, or rinsing ware. Ware also refers to items made of plastic. Types of plastics that can be cleaned with the compositions according to the invention include but are not limited to, those that include polycarbonate polymers (PC), acrylonitrile-butadiene-styrene polymers (ABS), and polysulfone polymers (PS). Another exemplary plastic that can be cleaned using the compounds and compositions of the invention include polyethylene terephthalate (PET).

As used herein, the term “waters” includes food process or transport waters. Food process or transport waters include produce transport waters (*e.g.*, as found in flumes, pipe transports, cutters, slicers, blanchers, retort systems, washers, and the like), belt sprays for food transport lines, boot and hand-wash dip-pans, third-sink rinse waters, and the like. Waters also include domestic and recreational waters such as pools, spas, recreational flumes and water slides, fountains, and the like.

The term “weight percent,” “wt-%,” “percent by weight,” “% by weight,” and variations thereof, as used herein, refer to the concentration of a substance as the weight of that substance divided by the total weight of the composition and multiplied by 100. It is understood that, as used here, “percent,” “%,” and the like are intended to be synonymous with “weight percent,” “wt-%,” etc.

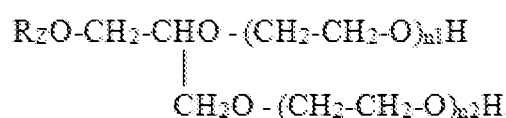
The methods and compositions of the present invention may comprise, consist essentially of, or consist of the components/ingredients and steps set forth for the present invention as well as other ingredients and/or production steps described herein. As used herein, “consisting essentially of” means that the methods and compositions may include additional steps, components or ingredients, but only if the additional steps, components or ingredients do not materially alter the basic and novel characteristics of the claimed methods and compositions.

While an understanding of the mechanism is not necessary to practice the present invention and while the present invention is not limited to any particular mechanism of action, it is contemplated that, in some embodiments, the novel glycerin ether ethoxylate surfactants are produced according to the disclosed

methods for ethoxylation of glycerin ethers, such as using ethylene oxide for the ethoxylation methods. These and other methods are set forth in further detail according to the invention and are not intended to limit the scope of the invention set forth herein.

5            *Compositions – Glycerin Ether Ethoxylate Solfactants*

According to an embodiment of the invention, glycerin ether ethoxylate solfactants according to the following formula are provided:



- 10    wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  may vary between the ethoxylated tails of the solfactant, such that an average degree of ethoxylation (average EO) is
- 15    between 1-25, preferably from 1 to 20, and more preferably from 1 to 9. Varying amounts of the ethylene oxide (EO or  $C_2H_4O$ ) may be included in the glycerin ether ethoxylate solfactants.

The average molecular weight of the glycerin ether ethoxylate solfactants according to the invention is from about 200 to about 10,000, preferably from about

20    200 to about 5,000, more preferably from about 200 to about 3,000.

The glycerin ether ethoxylates have a hydrophobic head and twin EO hydrophilic tails providing unique properties. The novel surfactants have a twin tail or Gemini-like structure, as a result of the ethoxylation of the hydroxyl groups of the glycerin ether. The twin hydrophilic tails are distinct from conventional twin tail or

25    Gemini surfactants due to the tails being hydrophilic and the single head being hydrophobic. As a result, the glycerin ether ethoxylate solfactants of the present invention are distinct from conventional alcohol ethoxylate surfactants due to the branched structure of the glycerin ether yielding a branched (*i.e.* twin), hydrophilic ethoxylated tails of the novel solfactants.

Beneficially, the glycerin ether ethoxylate solfactants are water soluble. In preferred aspects, the solfactants are 100% soluble, which as one skilled in the art will vary depending up on the degree of ethoxylation (*e.g.* moles of ethoxylation). In comparison to conventional alcohol ethoxylate surfactants, such as an alcohol  
5 ethoxylate with 3 moles of ethoxylation (such as commercially-available as Tomadol® 1-3), which are known to be water insoluble, the equivalent glycerin ether 3 mole ethoxylate solfactant is water soluble. An additional beneficial characteristic of the glycerin ether ethoxylate solfactants is the low melt points of the compositions, resulting in the solfactants being suitable for liquid formulations at  
10 low temperatures.

Additional suitable substitutions to the glycerin ether ethoxylates are set forth below describing variations in ethoxylation and/or propoxylation of the glycerin ethers. In an aspect of the invention, propylene oxide can be added to the glycerin ether ethoxylate of the invention.

15 In addition to the substitution to the glycerin ether ethoxylates using ethoxylation and/or propoxylation, the solfactants may further be modified by "capping" or "end blocking" the terminal ethoxylate group or groups. In an aspect, the propylene oxide group is a preferred cap. In other suitable aspects, the solfactant may have a halogen cap, including for example, fluorine (F), chlorine (Cl), bromine  
20 (Br), and iodine (I). In an aspect, the solfactant has a fluoro-, chloro-, bromo-, or iodo- cap. In other aspects, the cap may include linear, branched and/or aromatic hydrocarbons.

The glycerin ether ethoxylate solfactants according to the invention can have varying degrees of water solubility, which are not intended to limit the scope of the  
25 invention. In some aspects, the glycerin ether ethoxylate solfactants and/or propoxylate solfactants are water insoluble. In other aspects of the invention, the glycerin ether ethoxylates are slightly water soluble and/or substantially water soluble. In yet other aspects of the invention, the glycerin ether ethoxylates are completely water soluble. As one skilled in the art will ascertain, an increase in the  
30 degree of ethoxylation of the glycerin ether ethoxylates will increase the water solubility of the surfactants. Similarly, an increase in the degree of propoxylation will decrease the water solubility of the surfactants.

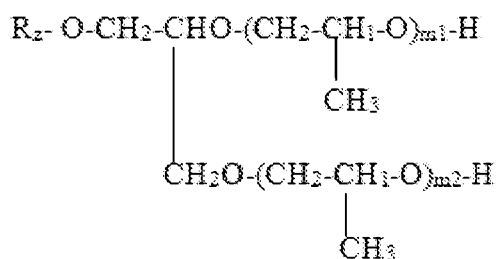
In a further aspect of the invention, the glycerin ether ethoxylates have additional improved properties, including for example, gel formation, foam production, hydrotrope, cleaning, pour and melt points and/or cloud points, in comparison to conventional alcohol ethoxylates, providing beneficial properties for product formulations.

In an aspect of the invention, the glycerin ether ethoxylate branches may disrupt gel formation and/or change the cloud points in comparison to conventional alcohol ethoxylates, providing beneficial properties for product formulations. In an aspect, the glycerin ether ethoxylate surfactants do not form a gel in solution with any concentration of water.

*Compositions – EO-PO / PO-EO / PO Glycerin Ether Surfactants*

According to an additional embodiment of the invention, EO-PO glycerin ethers and/or PO glycerin ethers and/or PO-EO glycerin ethers are provided for use in compositions in need of a surfactant disclosed herein.

PO glycerin ethers according to the following formulas are provided:

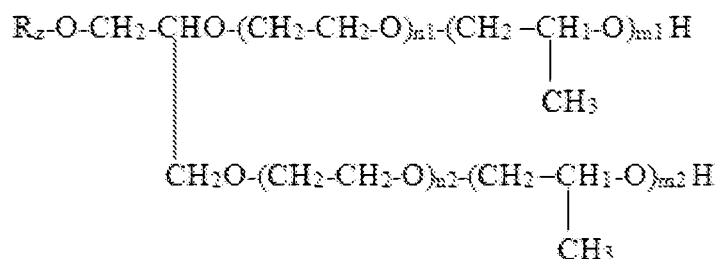


wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $m$  may vary between the propoxylated tails of the surfactant, such that an average degree of propoxylation (average PO) is between 1-25, preferably from 1 to 20, and more preferably from 1 to 9. Varying amounts of the propylene oxide (PO or  $C_3H_6O$ ) may be included in the PO glycerin ethers.

The average molecular weight of the PO glycerin ethers according to the invention may vary between about 200 to about 20,000, preferably from about 200 to about 10,000, more preferably from about 200 to about 5,000.



In an additional aspect of the invention, EO-PO glycerin ethers according to the following formulas are provided:

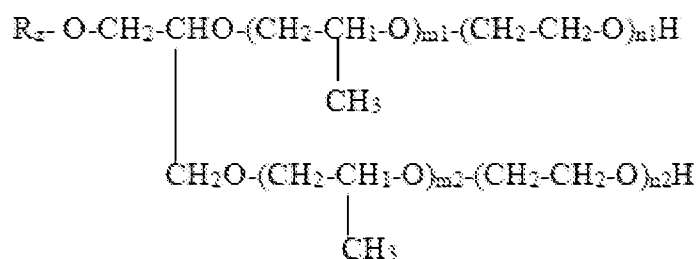


5 wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 20 carbon atoms, more preferably 6 to 18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  and  $m$  may vary between the ethoxylated and  
 10 propoxylated tails of the surfactant, such that an average degree of ethoxylation/propoxylation (average EO-PO) is between 1-30, preferably from 1 to 20, and more preferably from 1 to 9. Varying amounts of the ethylene oxide (EO or  $C_2H_4O$ ) and propylene oxide (PO or  $C_3H_6O$ ) may be included in the EO-PO glycerin ethers.

15 The average molecular weight of the EO-PO glycerin ethers according to the invention may vary between about 200 to about 40,000, preferably from about 200 to about 20,000, more preferably from about 200 to about 10,000.

In an additional aspect of the invention, PO-EO glycerin ethers according to the following formulas are provided:

20



wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 20 carbon atoms, more preferably 6 to

18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  and  $m$  may vary between the ethoxylated and propoxylated tails of the surfactant, such that an average degree of  
5 ethoxylation/propoxylation (average EO-PO) is between 1-30, preferably from 1 to 20, and more preferably from 1 to 9. Varying amounts of the ethylene oxide (EO or  $C_2H_4O$ ) and propylene oxide (PO or  $C_3H_6O$ ) may be included in the PO-EO glycerin ethers.

The average molecular weight of the PO-EO glycerin ethers according to the  
10 invention may vary between about 200 to about 40,000, preferably from about 200 to about 20,000, more preferably from about 200 to about 10,000.

#### *Compatibility*

The compositions of the invention may be suitable for use in a variety of cleaning compositions, including applications of use set forth in the methods of the  
15 invention. In an aspect of the invention, the compositions may be further formulated to include additional surfactants and/or additional functional ingredients (*e.g.* surfactants, solvents, sequestrants, antiredeposition agents, thickening agents, bleaching agents, fillers, defoaming agents, dispersants, dyes, fragrances, preservatives, other adjuvants, hydrotropes, water and the like), such as those  
20 described, for example, in U.S. Patent No. 7,341,983, which is herein incorporated by reference. It should be understood by those of skill in the art and others that the particular materials are given by way of example only, and that a broad variety of other functional materials may be used. For example, many of the functional materials relate to materials used in cleaning applications, but it should be  
25 understood that other embodiments may include functional materials for use in other applications.

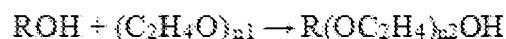
The compositions of the invention may be formulated into a variety of forms, including for example, microemulsions, solutions, solids and the like.

#### *Methods of Making Glycerin Ether Ethoxylates*

30 The methods of making the novel glycerin ether ethoxylates, PO glycerin ethers, PO-EP glycerin ethers and/or EO-PO glycerin ethers of the invention employ well-known ethoxylation and/or propoxylation methods using ethylene oxide (EO or

C<sub>2</sub>H<sub>4</sub>O) and/or (propylene oxide (PO or C<sub>3</sub>H<sub>6</sub>O) to combine with alcohols to create the novel surfactants of the invention.

In an aspect, standard ethoxylation methods are employed as are well known by those of skill in the art. According to certain methods suitable for generating the glycerin ether ethoxylates of the invention, an initiator such as potassium hydroxide (KOH) serves as a catalyst. The potassium hydroxide, ethylene oxide and glycerin ether (or other glycerin ether precursor) are combined in a reactor to produce a cationic alcohol that reacts with the ethylene oxide. The ethoxylation reaction is catalytic and thereafter continues to produce the glycerin ether ethoxylates of the present invention. The general formula for an ethoxylation reaction is shown:



wherein  $n_1$  represents the units of ethylene oxide, and is generally at least 3, preferably at least 5, or greater than 6. The value of  $n$  determines the degree of ethoxylation of the resultant ethoxylate, along with reaction conditions including reaction time.

The ethoxylation reaction generally takes place in a pressurized reactor containing nitrogen. The reactor is generally heated to temperatures, above 120°C, preferably about 150 °C. The rate of the overall reaction is controlled by the pressure of the reactor vessel.

Glycerin ethers are a preferred starting material for the ethoxylation according to the invention due to the two hydroxyl groups on the compound. The two hydroxyl groups allow for greater ethoxylation (in comparison to a glycerin alcohol having a single hydroxyl group). Glycerin ethers suitable for use according to the methods of the invention have the following formula:



In a preferred aspect, the glycerin ethers suitable for use according to the methods of the invention have the following formula:



wherein the C4-C20 alkyl is preferably C4-C14, and more preferably C6-C18. It is preferred to employ longer chain glycerin ethers for the methods of the invention to obtain a sufficient chain length from the resultant product in order to obtain glycerin ether ethoxylates having the qualities of a beneficial surfactant. Without being

5 limited to a particular theory of the invention, short chain glycerin ethers, such as C1-4 alkyl groups do not generate active glycerin ether ethoxylate surfactants.

The methods of making the novel glycerin ether ethoxylates of the invention may also include the step of generating glycerin ethers. Various glycerin ethers are commercially-available.

10 The methods of making the novel glycerin ether ethoxylates of the invention may also include the use of a glycerin ether precursor (instead of glycerin ether). In an aspect of the invention, suitable lengths of glycerin ethers may not be commercially-available. Therefore, an initial step of producing glycerin ethers may be employed. For example, glycerin ethers of varying chain lengths may be

15 produced. Methods for generating glycerin ethers are well-known in the art and disclosed for example in the following references, which are herein incorporated by reference in their entirety: Baumann & Mangold, Long-Chain Glyceryl Ethers, 1964, 29, 3055-3057; Queste et al., Green Chemistry, 2006, 8, 822-830; Gu et al., Green Chemistry, 2008, 10, 164-167; U.S. Patent Application Publications

20 US2005/023868A1 and US2011/0009676A1; and U.S. Patent Nos. 4,298,764, 5,176,850 and 5,420,312

The methods of making the novel glycerin ether ethoxylates of the invention may also include the step of using a glycerin ether precursor, for example glycidyl ethers having the following general structure:

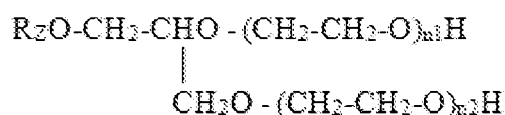


wherein n is 1 to 25, preferably n is 4 to 20, preferably n is 6 to 18, more preferably n is 10 to 12. The glycidyl ethers are commercially available (Sigma Aldrich) or may be synthesized through known methods. Additional description of using glycidyl ethers for ethoxylated surfactants is provided in U.S. Patent Nos. 6,717,019

30 and 5,403,509, which are incorporated herein by reference in their entirety.

Using glycidyl ether is particularly well suited for the methods of the invention due to the limited commercial availability of large chain glycerin ethers. According to an aspect of the invention the glycidyl ether is converted to glycerine ether which is ethoxylated into the glycerin ether ethoxylate. The glycerine ether is preferably prepared from the acid/base catalyzed ring opening of the glycidyl ether. The glycerine ether may also be prepared by catalytical etherification of glycerol.

According to an embodiment of the invention methods employing ethylene oxide for the ethoxylation of the glycerin ethers results in reduced levels of residual (unreacted) alcohols on the substrate glycerin ethers. In a preferred embodiment, the ethoxylation reaction does not leave any unreacted hydroxyl groups on the glycerin ether. Instead, the hydroxyl groups are ethoxylated to generate the glycerin ether ethoxylates according to the following structure:



wherein  $\text{R}_Z$  is  $\text{CH}_3$ , a combination  $\text{CH}_3\text{CH}_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  may vary between the ethoxylated tails of the surfactant, such that an average degree of ethoxylation (average EO) is between 1-25, preferably from 1 to 20. Varying amounts of the ethylene oxide (EO or  $\text{C}_2\text{H}_4\text{O}$ ) may be included in the glycerin ether ethoxylates.

According to an embodiment of the invention, the methods yield from about 90% to about 99.9% glycerin ether ethoxylates, wherein the remainders of products generated are byproducts and/or impurities.

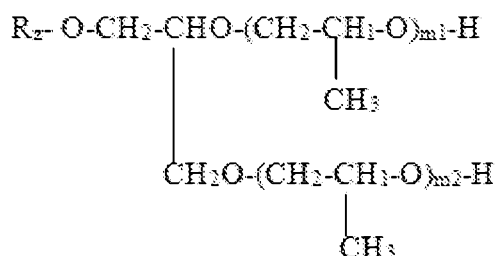
The methods of ethoxylation using ethylene oxide to react with alcohols may also yield additional products. In an exemplary embodiment of the invention, the open ring structure of an ethylene oxide forms a dialcohol. In such an embodiment, the dialcohol can react with the ethoxylate generated according to the methods of the invention. Similarly, according to alternative embodiments, the dialcohol could react with propylene oxide (if PO were employed instead of EO).

According to an embodiment of the invention, a smaller yield of these byproducts are generated according to the methods of the invention, such as from about 0.01% to about 2%, or from about 1% to about 2% may be obtained from the ethoxylation methods of the invention.

5           These and other methods for ethoxylating glycerin ethers and/or other starting substrates are included in the scope of the present invention. However, based upon the disclosure of the invention additional methods may be provided within the scope of the claimed invention.

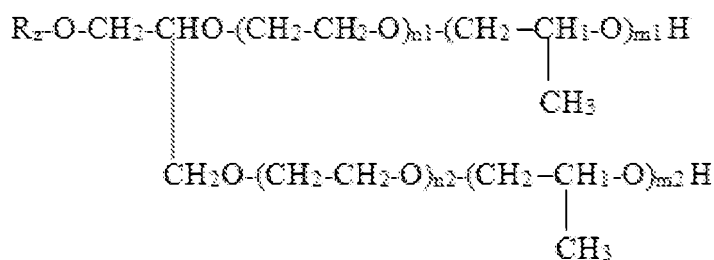
10           In addition to ethoxylation methods according to the invention, methods for making EO-PO glycerin ethers, PO-EO glycerin ethers and PO glycerin ether are also provided. The terms EO, PO, or PO/EO and/or EO/PO as used herein refer to ethylene oxide and propylene oxide, respectively. EO/PO and PO/EO refer to ethylene oxide and propylene oxide block copolymers. Standard methods of ethoxylation and propoxylation can be employed to make the EO and/or PO glycerin  
15 ethers of the present invention, as one of skill in the art will ascertain based upon the disclosure of the invention.

            According to an embodiment of the invention, EO-PO glycerin ethers, PO-EO glycerin ethers and/or PO glycerin ethers may be produced using standard ethoxylation and/or propoxylation methods to produce the PO glycerin ethers, PO-  
20 EO glycerin ethers and/or EO-PO glycerin ethers according to the following formulas:

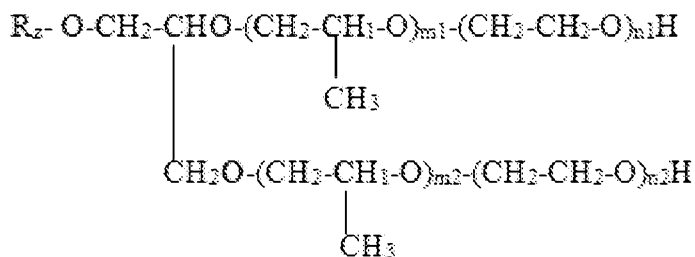


25           wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $m$  may vary between the propoxylated

tails of the surfactant, such that an average degree of propoxylation (average PO) is between 1-25, preferably from 1 to 20.



- 5 wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  and  $m$  may vary between the ethoxylated and
- 10 propoxylated tails of the surfactant, such that an average degree of ethoxylation/propoxylation (average EO-PO) is between 1-30, and preferably between 1 to 20.



- 15 wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 20 carbon atoms, more preferably 6 to 18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15. In an aspect of the invention  $n$  and  $m$  may vary between the ethoxylated and
- 20 propoxylated tails of the surfactant, such that an average degree of ethoxylation/propoxylation (average EO-PO) is between 1-30, preferably from 1 to 20, and more preferably from 1 to 9.

The chemical structures herein are drawn according to the conventional standards known in the art. Thus, where an atom, such as a carbon atom, as drawn appears to have an unsatisfied valency, then that valency is assumed to be satisfied by a hydrogen atom, even though that hydrogen atom is not necessarily explicitly drawn. The structures of some of the compounds of this invention include stereogenic carbon atoms. It is to be understood that isomers arising from such asymmetry (*e.g.*, all enantiomers and diastereomers) are included within the scope of this invention unless indicated otherwise. That is, unless otherwise stipulated, any chiral carbon center may be of either (R)- stereochemistry or (S)-stereochemistry. Such isomers can be obtained in substantially pure form by classical separation techniques and by stereochemically-controlled synthesis. Furthermore, alkenes can include either the E- or Z-geometry, where appropriate. In addition, the compounds of the present invention may exist in unsolvated as well as solvated forms with acceptable solvents such as water, THF, ethanol, and the like. In general, the solvated forms are considered equivalent to the unsolvated forms for the purposes of the present invention.

*Compositions Employing Glycerin Ether Ethoxylate Solfactants*

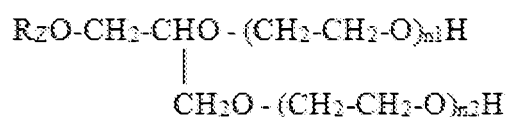
Beneficially, in an aspect of the invention, the solfactants provide a component that may replace and/or reduce the required amount of a solvent in a cleaning composition. Without being limited according to the theory of the invention, the solfactants disclosed herein provide combined efficacy as surfactants and solvents, providing enhanced soil removal properties and desirable a viscosity adjustments of the final compositions employing the solfactants, which vary according to the intended final use of the compositions.

For example, in some aspects of the invention, the solfactant replaces and/or reduces the amount of solvent employed in a cleaning composition. Such solvents may include, for example, isopropyl alcohol. Additional solvents which may be reduced and/or replaced with the solfactants according to the invention, include for example: oxygenated solvents such as lower alkanols, lower alkyl ethers, glycols, aryl glycol ethers, lower alkyl glycol ethers, methanol, ethanol, propanol, isopropanol, butanol, isobutanol, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, mixed ethylene-propylene glycol

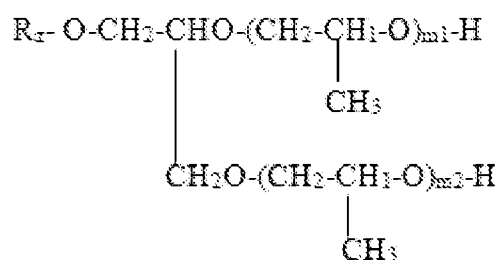


ethers, ethylene glycol phenyl ether, propylene glycol phenyl ether, propylene glycol methyl ether, propylene glycol propyl ether, dipropylene glycol methyl ether, tripropylene glycol methyl ether, ethylene glycol butyl ether, diethylene glycol methyl ether, diethylene glycol butyl ether, ethylene glycol dimethyl ether, ethylene glycol propyl ether, diethylene glycol ethyl ether, triethylene glycol methyl ether, triethylene glycol ethyl ether, triethylene glycol butyl ether and the like.

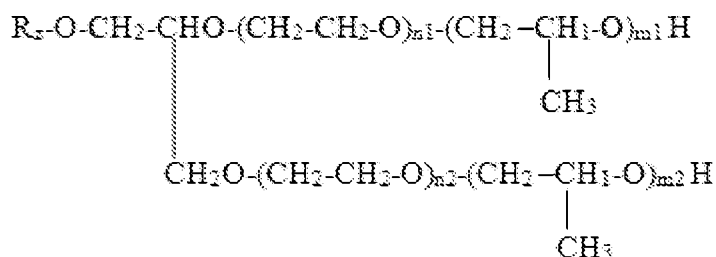
In some aspects, the present invention relates to compositions including a glycerin ether ethoxylate solfactant compound disclosed herein, or mixture thereof, having any of the following formulas:



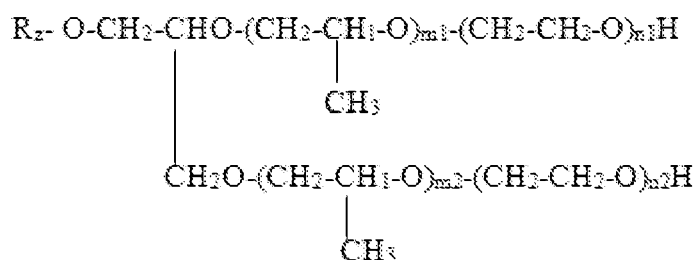
wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $n$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15; or



wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15; or



wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15; or



wherein  $R_Z$  is  $CH_3$ , a combination  $CH_3CH_2$ , or a linear or branched alkyl group having 1 to 30 carbon atoms, preferably 4 to 25 carbon atoms, more preferably 6 to 18 carbon atoms, wherein  $n_1$  and/or  $n_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15, and wherein  $m_1$  and/or  $m_2$  is 1 to 25, preferably 1 to 20, preferably from 1 to 15.

The surfactant compounds of the present invention can be used as antimicrobial and/or sanitizing compositions for a variety of substrates and surfaces, *e.g.*, textiles, hard surfaces. The compositions of the present invention can also be used as disinfectant or antimicrobial compositions. Further, compounds of the present invention can be used as coupling agents in compositions for various applications, *e.g.*, food contact sanitizing, hard surface disinfection, textile disinfection. In some embodiments, compositions containing compounds of the present invention can be multipurpose. That is, the compositions of the present invention can, for example, act as both antimicrobials and sanitizing agents, or as both coupling agents, and antimicrobial agents.

In an aspect, compositions employing the solfactant compounds of the present invention also show at least substantially similar cleaning efficacy as compositions employing equal amounts (moles ethylene oxide) of commercially-available ethoxylated alcohols.

5           In some embodiments, the compositions of the present invention include a glycerin ether ethoxylate solfactant compound or mixture thereof, and at least one additional ingredient. Additional ingredients suitable for use with the compositions of the present invention include, but are not limited to, oxidizing agents, carboxylic acids, surfactants, stabilizing agents (*e.g.*, metal chelators), sanitizing agents,  
10           including quaternary ammonium compounds, enzymes, dyes, odorants including perfumes, and other aesthetic enhancing agents, acidulants, alkalinity sources and mixtures thereof. The disclosed compositions may also contain additional typically non-active (*e.g.* inert) materials, with respect to cleaning and/or sanitizing properties. These ingredients are selected to be compatible with the materials of the  
15           invention and include such materials as fabric softeners, optical brighteners, soil suspension agents, germicides, viscosity modifiers, inorganic carriers, solidifying agents and the like.

          The compounds and compositions of the invention can also be used in conjunction with conventional cleaning and/or sanitizing agents, *e.g.*, alkaline  
20           detergents, such as the exemplary formulas and compositions set forth in the examples, demonstrating the suitable substitution or replacement of alcohol ethoxylates and/or conventional solvents with the glycerin ether ethoxylate solfactant compounds.

          In some embodiments, compositions employing the glycerin ether ethoxylate  
25           solfactant compounds of the present invention can be used as an antimicrobial and/or sanitizing composition for articles cleaned using a clean in place (CIP) technique. Such compositions can include, for example, (wt-%) an oxidizing agent (0.01-10 wt-%), a stabilizing agent (0.01-10 wt-%), an acidulant (0-50 wt-%) and a surfactant or mixture thereof, which may include and/or be substituted with a  
30           glycerin ether ethoxylate solfactant (0.1-50 wt-%).

          In other embodiments, compositions employing the glycerin ether ethoxylate solfactant compounds of the present invention can be used in a laundry detergent.

Such compositions can include, for example, alkalinity source (0-75 wt-%); chelating agent (0-30 wt-%); anionic surfactant (0-25 wt-%); nonionic surfactant (1-50 wt-%); solvent (1-75 wt-%); oxidizing agent (0-30 wt-%), stabilizing agent (0.1-30 wt-%), and a glycerin ether ethoxylate surfactant (0.1-50 wt-%); adjuvant ingredients (0-30 wt-%).

In other embodiments, compositions employing the glycerin ether ethoxylate surfactant compounds of the present invention can be used as degreasing compositions. Such compositions can include, for example, Alkalinity source (0-20 wt-%); solvent (0.1-30 wt-%); water (0-99 wt-%); surfactant (0-20 wt-%) and a glycerin ether ethoxylate surfactant (0.1-50 wt-%).

In some embodiments, compositions employing the glycerin ether ethoxylate surfactant compounds of the present invention can be used as an antimicrobial and/or sanitizing composition for treatment of hard surfaces, skin, laundry, instruments and/or articles. Such compositions can include, for example, water (1-99 wt-%); Quaternary ammonium surfactant (0-50 wt-%); oxidizer (0-50 wt-%); anionic surfactant (0-40 wt-%); adjuvant ingredients (0-40 wt-%) and a glycerin ether ethoxylate surfactant (0.1-50 wt-%).

In other embodiments, compositions employing the glycerin ether ethoxylate surfactant compounds of the present invention can be used as warewashing, auto dish washing, etc. compositions. Such compositions can include, for example, alkalinity source (0-85 wt-%); chelating agent (40 wt-%); polycarboxylic acid polymers (0-50 wt-%); solvent (0-50 wt-%); enzymes (0-10 wt-%); oxidizer (0-50 wt-%); adjuvant ingredients (0-30 wt-%) and a glycerin ether ethoxylate surfactant (0.1-50 wt-%).

In other embodiments, compositions employing the glycerin ether ethoxylate surfactant compounds of the present invention can be used as hand care compositions. Such compositions can include, for example, water (1-99 wt-%); emollients (0-25 wt-%); surfactant (0.1-40 wt-%); foam stabilizer (0-25 wt-%); antimicrobial agent (0-20 wt-%); pH adjuster (0-15 wt-%); adjuvant ingredients (0-30 wt-%) and a glycerin ether ethoxylate surfactant (0.1-50 wt-%).

In other embodiments, compositions employing the glycerin ether ethoxylate surfactant compounds of the present invention can be used as rinse aid compositions.

Such compositions can include, for example, water (0.1-95 wt-%); nonionic surfactant (0.1-50 wt-%); hydrotrope (0-50 wt-%); organic acid (0-75 wt-%); solvent (0-40 wt-%); solidification agents (0-40 wt-%); adjuvant ingredients (0-50 wt-%) and a glycerin ether ethoxylate solfactant (0.1-50 wt-%).

5           In other embodiments, compositions employing the glycerin ether ethoxylate solfactant compounds of the present invention can be used in paint formulations, glues, lubricants, coolant compositions, fiber glass sizing compositions, water treatment compositions, drilling fluids, gas hydrate inhibitor compositions, corrosion inhibitor compositions, personal care compositions and the like wherein the freezing  
10   and/or melting point properties of the solfactants are desired. Such compositions can include for example in a paint formulation (as a non limiting embodiment): water (1-99 wt-%); solvent (1-90 wt-%); surfactant (0.01-30 wt-%); pigment (0-15 wt-%); biocide (0-10 wt-%); adjuvant ingredients (1-40 wt-%) and a glycerin ether ethoxylate solfactant (0.1-50 wt-%).

15           Various suitable oxidizing agents, carboxylic acids, stabilizing agents, wetting or defoaming agents, chelating agents; solvents and/or carriers, hydrotropes, acidulants, surfactants, additional functional materials, thickening or gelling agents, solidification agents, and/or mixture thereof, can be included within the exemplary formulations set forth herein. These components are described in further detail  
20   within, for example, U.S. Patent Nos. 8,344,026, 8,216,989B2 and 7,341,983B2 and U.S. Patent Publication Nos. 2012/0052134, 2010/0048730, 2013/0035273A1 and 2012/0071438 which are herein incorporated by reference in their entirety.

          In an aspect, the glycerin ether ethoxylates are suitable for formulation with any variety of surfactants, including, but not limited to, nonionic surfactants, anionic  
25   surfactants, cationic surfactants, amphoteric surfactants and/or zwitterionic surfactants.

#### *Nonionic Surfactants*

          Useful nonionic surfactants are generally characterized by the presence of an organic hydrophobic group and an organic hydrophilic group and are typically  
30   produced by the condensation of an organic aliphatic, alkyl aromatic or polyoxyalkylene hydrophobic compound with a hydrophilic alkaline oxide moiety which in common practice is ethylene oxide or a polyhydration product thereof,

polyethylene glycol. Practically any hydrophobic compound having a hydroxyl, carboxyl, amino, or amido group with a reactive hydrogen atom can be condensed with ethylene oxide, or its polyhydration adducts, or its mixtures with alkoxylenes such as propylene oxide to form a nonionic surface-active agent. The length of the hydrophilic polyoxyalkylene moiety which is condensed with any particular hydrophobic compound can be readily adjusted to yield a water dispersible or water soluble compound having the desired degree of balance between hydrophilic and hydrophobic properties. Useful nonionic surfactants include:

1. Block polyoxypropylene-polyoxyethylene polymeric compounds based upon propylene glycol, ethylene glycol, glycerol, trimethylolpropane, and ethylenediamine as the initiator reactive hydrogen compound. Examples of polymeric compounds made from a sequential propoxylation and ethoxylation of initiator are commercially available under the trade names Pluronic<sup>®</sup> and Tetronic<sup>®</sup> manufactured by BASF Corp. Pluronic<sup>®</sup> compounds are difunctional (two reactive hydrogens) compounds formed by condensing ethylene oxide with a hydrophobic base formed by the addition of propylene oxide to the two hydroxyl groups of propylene glycol. This hydrophobic portion of the molecule weighs from about 1,000 to about 4,000. Ethylene oxide is then added to sandwich this hydrophobe between hydrophilic groups, controlled by length to constitute from about 10% by weight to about 80% by weight of the final molecule. Tetronic<sup>®</sup> compounds are tetra-flunctional block copolymers derived from the sequential addition of propylene oxide and ethylene oxide to ethylenediamine. The molecular weight of the propylene oxide hydrotype ranges from about 500 to about 7,000; and, the hydrophile, ethylene oxide, is added to constitute from about 10% by weight to about 80% by weight of the molecule.

2. Condensation products of one mole of alkyl phenol wherein the alkyl chain, of straight chain or branched chain configuration, or of single or dual alkyl constituent, contains from about 8 to about 18 carbon atoms with from about 3 to about 50 moles of ethylene oxide. The alkyl group can, for example, be represented by diisobutylene, di-amyl, polymerized propylene, iso-octyl, nonyl, and di-nonyl. These surfactants can be polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols. Examples of commercial compounds of this chemistry

are available on the market under the trade names Igepal<sup>®</sup> manufactured by Rhone-Poulenc and Triton<sup>®</sup> manufactured by Union Carbide.

3.        Condensation products of one mole of a saturated or unsaturated, straight or branched chain alcohol having from about 6 to about 24 carbon atoms with from about 3 to about 50 moles of ethylene oxide. The alcohol moiety can consist of mixtures of alcohols in the above delineated carbon range or it can consist of an alcohol having a specific number of carbon atoms within this range. Examples of like commercial surfactant are available under the trade names Neodol<sup>™</sup> manufactured by Shell Chemical Co. and Alfonic<sup>™</sup> manufactured by Vista Chemical Co.

4.        Condensation products of one mole of saturated or unsaturated, straight or branched chain carboxylic acid having from about 8 to about 18 carbon atoms with from about 6 to about 50 moles of ethylene oxide. The acid moiety can consist of mixtures of acids in the above defined carbon atoms range or it can consist of an acid having a specific number of carbon atoms within the range. Examples of commercial compounds of this chemistry are available on the market under the trade names Nopalcol<sup>™</sup> manufactured by Henkel Corporation and Lipopeg<sup>™</sup> manufactured by Lipo Chemicals, Inc.

In addition to ethoxylated carboxylic acids, commonly called polyethylene glycol esters, other alkanoic acid esters formed by reaction with glycerides, glycerin, and polyhydric (saccharide or sorbitan/sorbitol) alcohols have application in this invention for specialized embodiments, particularly indirect food additive applications. All of these ester moieties have one or more reactive hydrogen sites on their molecule which can undergo further acylation or ethylene oxide (alkoxide) addition to control the hydrophilicity of these substances. Care must be exercised when adding these fatty ester or acylated carbohydrates to compositions of the present invention containing amylase and/or lipase enzymes because of potential incompatibility.

Examples of nonionic low foaming surfactants include:

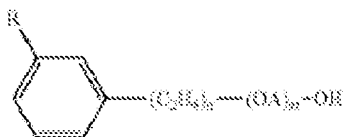
5.        Compounds from (1) which are modified, essentially reversed, by adding ethylene oxide to ethylene glycol to provide a hydrophile of designated molecular weight; and, then adding propylene oxide to obtain hydrophobic blocks

on the outside (ends) of the molecule. The hydrophobic portion of the molecule weighs from about 1,000 to about 3,100 with the central hydrophile including 10% by weight to about 80% by weight of the final molecule. These reverse Pluronics<sup>TM</sup> are manufactured by BASF Corporation under the trade name Pluronic<sup>TM</sup> R surfactants. Likewise, the Tetronic<sup>TM</sup> R surfactants are produced by BASF Corporation by the sequential addition of ethylene oxide and propylene oxide to ethylenediamine. The hydrophobic portion of the molecule weighs from about 2,100 to about 6,700 with the central hydrophile including 10% by weight to 80% by weight of the final molecule.

6. Compounds from groups (1), (2), (3) and (4) which are modified by "capping" or "end blocking" the terminal hydroxy group or groups (of multi-functional moieties) to reduce foaming by reaction with a small hydrophobic molecule such as propylene oxide, butylene oxide, benzyl chloride; and, short chain fatty acids, alcohols or alkyl halides containing from 1 to about 5 carbon atoms; and mixtures thereof. Also included are reactants such as thionyl chloride which convert terminal hydroxy groups to a chloride group. Such modifications to the terminal hydroxy group may lead to all-block, block-heteric, heteric-block or all-heteric nonionics.

Additional examples of effective low foaming nonionics include:

7. The alkylphenoxypolyethoxyalkanols of U.S. Pat. No. 2,903,486 issued Sep. 8, 1959 to Brown et al. and represented by the formula



in which R is an alkyl group of 8 to 9 carbon atoms, A is an alkylene chain of 3 to 4 carbon atoms, n is an integer of 7 to 16, and m is an integer of 1 to 10.

- The polyalkylene glycol condensates of U.S. Pat. No. 3,048,548 issued Aug. 7, 1962 to Martin et al. having alternating hydrophilic oxyethylene chains and hydrophobic oxypropylene chains where the weight of the terminal hydrophobic chains, the weight of the middle hydrophobic unit and the weight of the linking hydrophilic units each represent about one-third of the condensate.



The defoaming nonionic surfactants disclosed in U.S. Pat. No. 3,382,178 issued May 7, 1968 to Lissant et al. having the general formula  $Z[(OR)_nOH]_z$  wherein Z is alkoxylatable material, R is a radical derived from an alkaline oxide which can be ethylene and propylene and n is an integer from, for example, 10 to 2,000 or more and z is an integer determined by the number of reactive oxyalkylatable groups.

The conjugated polyoxyalkylene compounds described in U.S. Pat. No. 2,677,700, issued May 4, 1954 to Jackson et al. corresponding to the formula  $Y(C_3H_6O)_n(C_2H_4O)_mH$  wherein Y is the residue of organic compound having from about 1 to 6 carbon atoms and one reactive hydrogen atom, n has an average value of at least about 6.4, as determined by hydroxyl number and m has a value such that the oxyethylene portion constitutes about 10% to about 90% by weight of the molecule.

The conjugated polyoxyalkylene compounds described in U.S. Pat. No. 2,674,619, issued Apr. 6, 1954 to Lundsted et al. having the formula  $Y[(C_3H_6O)_n(C_2H_4O)_mH]_x$  wherein Y is the residue of an organic compound having from about 2 to 6 carbon atoms and containing x reactive hydrogen atoms in which x has a value of at least about 2, n has a value such that the molecular weight of the polyoxypropylene hydrophobic base is at least about 900 and m has value such that the oxyethylene content of the molecule is from about 10% to about 90% by weight. Compounds falling within the scope of the definition for Y include, for example, propylene glycol, glycerine, pentaerythritol, trimethylolpropane, ethylenediamine and the like. The oxypropylene chains optionally, but advantageously, contain small amounts of ethylene oxide and the oxyethylene chains also optionally, but advantageously, contain small amounts of propylene oxide.

Additional conjugated polyoxyalkylene surface-active agents which are advantageously used in the compositions of this invention correspond to the formula:  $P[(C_3H_6O)_n(C_2H_4O)_mH]_x$  wherein P is the residue of an organic compound having from about 8 to 18 carbon atoms and containing x reactive hydrogen atoms in which x has a value of 1 or 2, n has a value such that the molecular weight of the polyoxyethylene portion is at least about 44 and m has a value such that the oxypropylene content of the molecule is from about 10% to about 90% by weight. In

either case the oxypropylene chains may contain optionally, but advantageously, small amounts of ethylene oxide and the oxyethylene chains may contain also optionally, but advantageously, small amounts of propylene oxide.

8. Polyhydroxy fatty acid amide surfactants suitable for use in the present compositions include those having the structural formula  $R_2CON_{R_1}Z$  in which:  $R_1$  is H,  $C_1$ - $C_4$  hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl, ethoxy, propoxy group, or a mixture thereof;  $R_2$  is a  $C_5$ - $C_{31}$  hydrocarbyl, which can be straight-chain; and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls directly connected to the chain, or an alkoxyated derivative (preferably ethoxylated or propoxylated) thereof. Z can be derived from a reducing sugar in a reductive amination reaction; such as a glycityl moiety.

9. The alkyl ethoxylate condensation products of aliphatic alcohols with from about 0 to about 25 moles of ethylene oxide are suitable for use in the present compositions. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from 6 to 22 carbon atoms.

10. The ethoxylated  $C_6$ - $C_{18}$  fatty alcohols and  $C_6$ - $C_{18}$  mixed ethoxylated and propoxylated fatty alcohols are suitable surfactants for use in the present compositions, particularly those that are water soluble. Suitable ethoxylated fatty alcohols include the  $C_6$ - $C_{18}$  ethoxylated fatty alcohols with a degree of ethoxylation of from 3 to 50.

11. Suitable nonionic alkylpolysaccharide surfactants, particularly for use in the present compositions include those disclosed in U.S. Pat. No. 4,565,647, Llenado, issued Jan. 21, 1986. These surfactants include a hydrophobic group containing from about 6 to about 30 carbon atoms and a polysaccharide, *e.g.*, a polyglycoside, hydrophilic group containing from about 1.3 to about 10 saccharide units. Any reducing saccharide containing 5 or 6 carbon atoms can be used, *e.g.*, glucose, galactose and galactosyl moieties can be substituted for the glucosyl moieties. (Optionally the hydrophobic group is attached at the 2-, 3-, 4-, etc. positions thus giving a glucose or galactose as opposed to a glucoside or galactoside.) The intersaccharide bonds can be, *e.g.*, between the one position of the additional saccharide units and the 2-, 3-, 4-, and/or 6-positions on the preceding saccharide units.

12. Fatty acid amide surfactants suitable for use the present compositions include those having the formula:  $R_6\text{CON}(R_7)_2$  in which  $R_6$  is an alkyl group containing from 7 to 21 carbon atoms and each  $R_7$  is independently hydrogen,  $C_1$ - $C_4$  alkyl,  $C_1$ - $C_4$  hydroxyalkyl, or  $-(C_2H_4O)_xH$ , where  $x$  is in the range of from 1 to 3.

5 13. A useful class of non-ionic surfactants include the class defined as alkoxyated amines or, most particularly, alcohol alkoxyated/aminated/alkoxyated surfactants. These non-ionic surfactants may be at least in part represented by the general formulae:  $R^{20}-(\text{PO})_s\text{N}-(\text{EO})_t\text{H}$ ,  $R^{20}-(\text{PO})_s\text{N}-(\text{EO})_t\text{H}(\text{EO})_u\text{H}$ , and  $R^{20}-\text{N}(\text{EO})_t\text{H}$ ; in which  $R^{20}$  is an alkyl, alkenyl or other aliphatic group, or an alkyl-aryl  
10 group of from 8 to 20, preferably 12 to 14 carbon atoms, EO is oxyethylene, PO is oxypropylene,  $s$  is 1 to 20, preferably 2-5,  $t$  is 1-10, preferably 2-5, and  $u$  is 1-10, preferably 2-5. Other variations on the scope of these compounds may be represented by the alternative formula:  $R^{20}-(\text{PO})_v-\text{N}[(\text{EO})_w\text{H}][(\text{EO})_z\text{H}]$  in which  $R^{20}$  is as defined above,  $v$  is 1 to 20 (*e.g.*, 1, 2, 3, or 4 (preferably 2)), and  $w$  and  $z$   
15 are independently 1-10, preferably 2-5. These compounds are represented commercially by a line of products sold by Huntsman Chemicals as nonionic surfactants. A preferred chemical of this class includes Surfonic™ PEA 25 Amine Alkoxyate. Preferred nonionic surfactants for the compositions of the invention include alcohol alkoxyates, EO/PO block copolymers, alkylphenol alkoxyates, and  
20 the like.

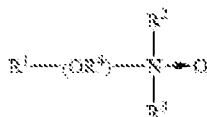
The treatise *Nonionic Surfactants*, edited by Schick, M. J., Vol. 1 of the Surfactant Science Series, Marcel Dekker, Inc., New York, 1983 is an excellent reference on the wide variety of nonionic compounds generally employed in the practice of the present invention. A typical listing of nonionic classes, and species of  
25 these surfactants, is given in U.S. Pat. No. 3,929,678 issued to Laughlin and Heuring on Dec. 30, 1975. Further examples are given in "Surface Active Agents and detergents" (Vol. I and II by Schwartz, Perry and Berch).

#### *Semi-Polar Nonionic Surfactants*

30 The semi-polar type of nonionic surface active agents are another class of nonionic surfactant useful in compositions of the present invention. Generally, semi-polar nonionics are high foamers and foam stabilizers, which can limit their application in CIP systems. However, within compositional embodiments of this

invention designed for high foam cleaning methodology, semi-polar nonionics would have immediate utility. The semi-polar nonionic surfactants include the amine oxides, phosphine oxides, sulfoxides and their alkoxyated derivatives.

14. Amine oxides are tertiary amine oxides corresponding to the general  
5 formula:



wherein the arrow is a conventional representation of a semi-polar bond; and,  $\text{R}^1$ ,  $\text{R}^2$ , and  $\text{R}^3$  may be aliphatic, aromatic, heterocyclic, alicyclic, or combinations thereof. Generally, for amine oxides of detergent interest,  $\text{R}^1$  is an alkyl radical of from about  
10 8 to about 24 carbon atoms;  $\text{R}^2$  and  $\text{R}^3$  are alkyl or hydroxyalkyl of 1-3 carbon atoms or a mixture thereof;  $\text{R}^2$  and  $\text{R}^3$  can be attached to each other, *e.g.* through an oxygen or nitrogen atom, to form a ring structure;  $\text{R}^4$  is an alkaline or a hydroxyalkylene group containing 2 to 3 carbon atoms; and  $n$  ranges from 0 to about 20.

Useful water soluble amine oxide surfactants are selected from the coconut  
15 or tallow alkyl di-(lower alkyl) amine oxides, specific examples of which are dodecyldimethylamine oxide, tridecyldimethylamine oxide, etradecyldimethylamine oxide, pentadecyldimethylamine oxide, hexadecyldimethylamine oxide, heptadecyldimethylamine oxide, octadecyldimethylamine oxide, dodecyldipropylamine oxide, tetradecyldipropylamine oxide,  
20 hexadecyldipropylamine oxide, tetradecyldibutylamine oxide, octadecyldibutylamine oxide, bis(2-hydroxyethyl)dodecylamine oxide, bis(2-hydroxyethyl)-3-dodecoxy-1-hydroxypropylamine oxide, dimethyl-(2-hydroxydodecyl)amine oxide, 3,6,9-trioctadecyldimethylamine oxide and 3-dodecoxy-2-hydroxypropyl-di-(2-hydroxyethyl)amine oxide.

25 Useful semi-polar nonionic surfactants also include the water soluble phosphine oxides having the following structure:



wherein the arrow is a conventional representation of a semi-polar bond; and,  $R^1$  is an alkyl, alkenyl or hydroxyalkyl moiety ranging from 10 to about 24 carbon atoms in chain length; and,  $R^2$  and  $R^3$  are each alkyl moieties separately selected from alkyl or hydroxyalkyl groups containing 1 to 3 carbon atoms.

5           Examples of useful phosphine oxides include dimethyldecylphosphine oxide, dimethyltetradecylphosphine oxide, methylethyltetradecylphosphine oxide, dimethylhexadecylphosphine oxide, diethyl-2-hydroxyoctyldecylphosphine oxide, bis(2-hydroxyethyl)dodecylphosphine oxide, and bis(hydroxymethyl)tetradecylphosphine oxide.

10           Semi-polar nonionic surfactants useful herein also include the water soluble sulfoxide compounds which have the structure:



wherein the arrow is a conventional representation of a semi-polar bond; and,  $R^1$  is an alkyl or hydroxyalkyl moiety of about 8 to about 28 carbon atoms, from 0 to about 5 ether linkages and from 0 to about 2 hydroxyl substituents; and  $R^2$  is an alkyl moiety consisting of alkyl and hydroxyalkyl groups having 1 to 3 carbon atoms.

Useful examples of these sulfoxides include dodecyl methyl sulfoxide; 3-hydroxy tridecyl methyl sulfoxide; 3-methoxy tridecyl methyl sulfoxide; and 3-hydroxy-4-dodecoxybutyl methyl sulfoxide.

Semi-polar nonionic surfactants for the compositions of the invention include dimethyl amine oxides, such as lauryl dimethyl amine oxide, myristyl dimethyl amine oxide, cetyl dimethyl amine oxide, combinations thereof, and the like. Useful water soluble amine oxide surfactants are selected from the octyl, decyl, dodecyl, isododecyl, coconut, or tallow alkyl di-(lower alkyl) amine oxides, specific examples of which are octyldimethylamine oxide, nonyldimethylamine oxide, decyldimethylamine oxide, undecyldimethylamine oxide, dodecyldimethylamine oxide, iso-dodecyldimethyl amine oxide, tridecyldimethylamine oxide, tetradecyldimethylamine oxide, pentadecyldimethylamine oxide,

hexadecyldimethylamine oxide, heptadecyldimethylamine oxide, octadecyldimethylamine oxide, dodecyldipropylamine oxide, tetradecyldipropylamine oxide, hexadecyldipropylamine oxide, tetradecyldibutylamine oxide, octadecyldibutylamine oxide, bis(2-hydroxyethyl)dodecylamine oxide, bis(2-hydroxyethyl)-3-dodecoxy-1-hydroxypropylamine oxide, dimethyl-(2-hydroxydodecyl)amine oxide, 3,6,9-trioctadecyldimethylamine oxide and 3-dodecoxy-2-hydroxypropyl-di-(2-hydroxyethyl)amine oxide.

Suitable nonionic surfactants suitable for use with the compositions of the present invention include alkoxylated surfactants. Suitable alkoxylated surfactants include EO/PO copolymers, capped EO/PO copolymers, alcohol alkoxylates, capped alcohol alkoxylates, mixtures thereof, or the like. Suitable alkoxylated surfactants for use as solvents include EO/PO block copolymers, such as the Pluronic and reverse Pluronic surfactants; alcohol alkoxylates, such as Dehypon LS-54 (R-(EO)<sub>5</sub>(PO)<sub>4</sub>) and Dehypon LS-36 (R-(EO)<sub>3</sub>(PO)<sub>6</sub>); and capped alcohol alkoxylates, such as Plurafac LF221 and Tegoten EC11; mixtures thereof, or the like.

#### *Anionic surfactants*

Also useful in the present invention are surface active substances which are categorized as anionics because the charge on the hydrophobe is negative; or surfactants in which the hydrophobic section of the molecule carries no charge unless the pH is elevated to neutrality or above (*e.g.* carboxylic acids). Carboxylate, sulfonate, sulfate and phosphate are the polar (hydrophilic) solubilizing groups found in anionic surfactants. Of the cations (counter ions) associated with these polar groups, sodium, lithium and potassium impart water solubility; ammonium and substituted ammonium ions provide both water and oil solubility; and, calcium, barium, and magnesium promote oil solubility. As those skilled in the art understand, anionics are excellent deterative surfactants and are therefore favored additions to heavy duty detergent compositions.

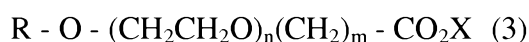
Anionic sulfate surfactants suitable for use in the present compositions include alkyl ether sulfates, alkyl sulfates, the linear and branched primary and secondary alkyl sulfates, alkyl ethoxysulfates, fatty oleyl glycerol sulfates, alkyl phenol ethylene oxide ether sulfates, the C<sub>5</sub>-C<sub>17</sub> acyl-N-(C<sub>1</sub>-C<sub>4</sub> alkyl) and -N-(C<sub>1</sub>-C<sub>2</sub> hydroxyalkyl) glucamine sulfates, and sulfates of alkylpolysaccharides such as

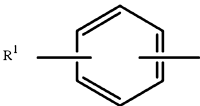
the sulfates of alkylpolyglucoside, and the like. Also included are the alkyl sulfates, alkyl poly(ethyleneoxy) ether sulfates and aromatic poly(ethyleneoxy) sulfates such as the sulfates or condensation products of ethylene oxide and nonyl phenol (usually having 1 to 6 oxyethylene groups per molecule).

5 Anionic sulfonate surfactants suitable for use in the present compositions also include alkyl sulfonates, the linear and branched primary and secondary alkyl sulfonates, and the aromatic sulfonates with or without substituents.

Anionic carboxylate surfactants suitable for use in the present compositions include carboxylic acids (and salts), such as alkanolic acids (and alkanoates), ester  
10 carboxylic acids (*e.g.* alkyl succinates), ether carboxylic acids, and the like. Such carboxylates include alkyl ethoxy carboxylates, alkyl aryl ethoxy carboxylates, alkyl polyethoxy polycarboxylate surfactants and soaps (*e.g.* alkyl carboxyls). Secondary carboxylates useful in the present compositions include those which contain a carboxyl unit connected to a secondary carbon. The secondary carbon can be in a  
15 ring structure, *e.g.* as in *p*-octyl benzoic acid, or as in alkyl-substituted cyclohexyl carboxylates. The secondary carboxylate surfactants typically contain no ether linkages, no ester linkages and no hydroxyl groups. Further, they typically lack nitrogen atoms in the head-group (amphiphilic portion). Suitable secondary soap surfactants typically contain 11-13 total carbon atoms, although more carbons atoms  
20 (*e.g.*, up to 16) can be present. Suitable carboxylates also include acylamino acids (and salts), such as acylglutamates, acyl peptides, sarcosinates (*e.g.* N-acyl sarcosinates), taurates (*e.g.* N-acyl taurates and fatty acid amides of methyl tauride), and the like.

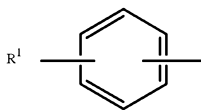
Suitable anionic surfactants include alkyl or alkylaryl ethoxy carboxylates of  
25 the following formula:

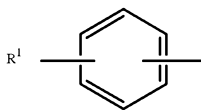


in which R is a C<sub>8</sub> to C<sub>22</sub> alkyl group or , in which R<sup>1</sup> is a C<sub>4</sub>-C<sub>16</sub>

alkyl group; n is an integer of 1-20; m is an integer of 1-3; and X is a counter ion, such as hydrogen, sodium, potassium, lithium, ammonium, or an amine salt such as  
30 monoethanolamine, diethanolamine or triethanolamine. In some embodiments, n is

an integer of 4 to 10 and m is 1. In some embodiments, R is a C<sub>8</sub>-C<sub>16</sub> alkyl group. In some embodiments, R is a C<sub>12</sub>-C<sub>14</sub> alkyl group, n is 4, and m is 1.



In other embodiments, R is  and R¹ is a C<sub>6</sub>-C<sub>12</sub> alkyl group.

In still yet other embodiments, R¹ is a C<sub>9</sub> alkyl group, n is 10 and m is 1.

- 5           Such alkyl and alkylaryl ethoxy carboxylates are commercially available. These ethoxy carboxylates are typically available as the acid forms, which can be readily converted to the anionic or salt form. Commercially available carboxylates include, Neodox 23-4, a C<sub>12-13</sub> alkyl polyethoxy (4) carboxylic acid (Shell Chemical), and Emcol CNP-110, a C<sub>9</sub> alkylaryl polyethoxy (10) carboxylic acid  
10 (Witco Chemical). Carboxylates are also available from Clariant, *e.g.* the product Sandopan<sup>®</sup> DTC, a C<sub>13</sub> alkyl polyethoxy (7) carboxylic acid.

#### *Cationic Surfactants*

- Surface active substances are classified as cationic if the charge on the hydrotrope portion of the molecule is positive. Surfactants in which the hydrotrope  
15 carries no charge unless the pH is lowered close to neutrality or lower, but which are then cationic (*e.g.* alkyl amines), are also included in this group. In theory, cationic surfactants may be synthesized from any combination of elements containing an "onium" structure R<sub>n</sub>X<sup>+</sup>Y<sup>-</sup> and could include compounds other than nitrogen (ammonium) such as phosphorus (phosphonium) and sulfur (sulfonium). In practice,  
20 the cationic surfactant field is dominated by nitrogen containing compounds, probably because synthetic routes to nitrogenous cationics are simple and straightforward and give high yields of product, which can make them less expensive.

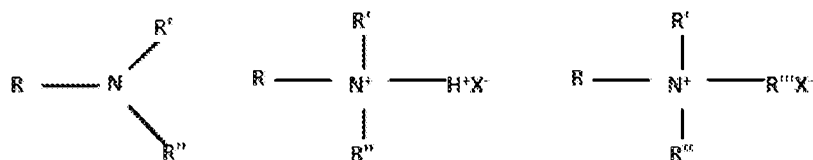
- Cationic surfactants preferably include, more preferably refer to, compounds  
25 containing at least one long carbon chain hydrophobic group and at least one positively charged nitrogen. The long carbon chain group may be attached directly to the nitrogen atom by simple substitution; or more preferably indirectly by a bridging functional group or groups in so-called interrupted alkylamines and amido amines. Such functional groups can make the molecule more hydrophilic and/or  
30 more water dispersible, more easily water solubilized by co-surfactant mixtures, and/or water soluble. For increased water solubility, additional primary, secondary



or tertiary amino groups can be introduced or the amino nitrogen can be quaternized with low molecular weight alkyl groups. Further, the nitrogen can be a part of branched or straight chain moiety of varying degrees of unsaturation or of a saturated or unsaturated heterocyclic ring. In addition, cationic surfactants may contain complex linkages having more than one cationic nitrogen atom.

The surfactant compounds classified as amine oxides, amphoteric and zwitterions are themselves typically cationic in near neutral to acidic pH solutions and can overlap surfactant classifications. Polyoxyethylated cationic surfactants generally behave like nonionic surfactants in alkaline solution and like cationic surfactants in acidic solution.

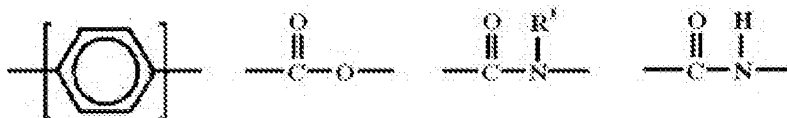
The simplest cationic amines, amine salts and quaternary ammonium compounds can be schematically drawn thus:



in which, R represents a long alkyl chain, R', R'', and R''' may be either long alkyl chains or smaller alkyl or aryl groups or hydrogen and X represents an anion. The amine salts and quaternary ammonium compounds are preferred for practical use in this invention due to their high degree of water solubility.

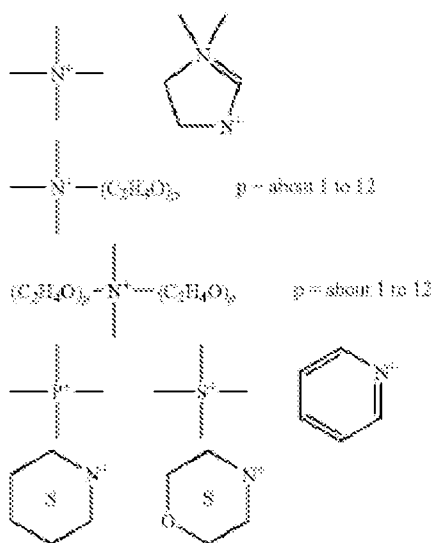
The majority of large volume commercial cationic surfactants can be subdivided into four major classes and additional sub-groups known to those of skill in the art and described in "Surfactant Encyclopedia", *Cosmetics & Toiletries*, Vol. 104 (2) 86-96 (1989). The first class includes alkylamines and their salts. The second class includes alkyl imidazolines. The third class includes ethoxylated amines. The fourth class includes quaternaries, such as alkylbenzyltrimethylammonium salts, alkyl benzene salts, heterocyclic ammonium salts, tetra alkylammonium salts, and the like. Cationic surfactants are known to have a variety of properties that can be beneficial in the present compositions. These desirable properties can include detergency in compositions of or below neutral pH, antimicrobial efficacy, thickening or gelling in cooperation with other agents, and the like.

Cationic surfactants useful in the compositions of the present invention include those having the formula  $R^1_m R^2_x Y_L Z$  wherein each  $R^1$  is an organic group containing a straight or branched alkyl or alkenyl group optionally substituted with up to three phenyl or hydroxy groups and optionally interrupted by up to four of the following structures:



or an isomer or mixture of these structures, and which contains from about 8 to 22 carbon atoms. The  $R^1$  groups can additionally contain up to 12 ethoxy groups.  $m$  is a number from 1 to 3. Preferably, no more than one  $R^1$  group in a molecule has 16 or more carbon atoms when  $m$  is 2 or more than 12 carbon atoms when  $m$  is 3. Each  $R^2$  is an alkyl or hydroxyalkyl group containing from 1 to 4 carbon atoms or a benzyl group with no more than one  $R^2$  in a molecule being benzyl, and  $x$  is a number from 0 to 11, preferably from 0 to 6. The remainder of any carbon atom positions on the  $Y$  group are filled by hydrogens.

$Y$  can be a group including, but not limited to:



or a mixture thereof. Preferably,  $L$  is 1 or 2, with the  $Y$  groups being separated by a moiety selected from  $R^1$  and  $R^2$  analogs (preferably alkylene or alkenylene) having from 1 to about 22 carbon atoms and two free carbon single bonds when  $L$  is 2.  $Z$  is

a water soluble anion, such as a halide, sulfate, methylsulfate, hydroxide, or nitrate anion, particularly preferred being chloride, bromide, iodide, sulfate or methyl sulfate anions, in a number to give electrical neutrality of the cationic component.

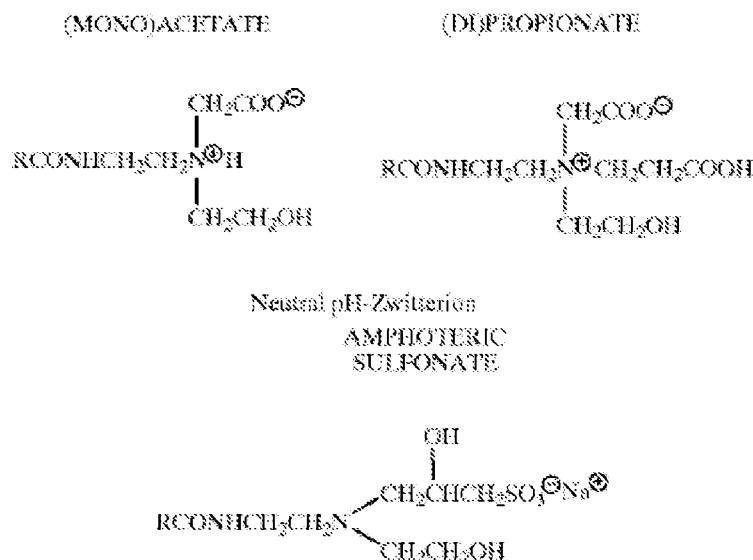
*Amphoteric Surfactants*

5           Amphoteric, or ampholytic, surfactants contain both a basic and an acidic hydrophilic group and an organic hydrophobic group. These ionic entities may be any of anionic or cationic groups described herein for other types of surfactants. A basic nitrogen and an acidic carboxylate group are the typical functional groups employed as the basic and acidic hydrophilic groups. In a few surfactants, sulfonate,  
10   sulfate, phosphonate or phosphate provide the negative charge.

Amphoteric surfactants can be broadly described as derivatives of aliphatic secondary and tertiary amines, in which the aliphatic radical may be straight chain or branched and wherein one of the aliphatic substituents contains from about 8 to 18 carbon atoms and one contains an anionic water solubilizing group, *e.g.*, carboxy,  
15   sulfo, sulfato, phosphato, or phosphono. Amphoteric surfactants are subdivided into two major classes known to those of skill in the art and described in "Surfactant Encyclopedia" Cosmetics & Toiletries, Vol. 104 (2) 69-71 (1989), which is herein incorporated by reference in its entirety. The first class includes acyl/dialkyl ethylenediamine derivatives (*e.g.* 2-alkyl hydroxyethyl imidazoline derivatives) and  
20   their salts. The second class includes N-alkylamino acids and their salts. Some amphoteric surfactants can be envisioned as fitting into both classes.

Amphoteric surfactants can be synthesized by methods known to those of skill in the art. For example, 2-alkyl hydroxyethyl imidazoline is synthesized by condensation and ring closure of a long chain carboxylic acid (or a derivative) with  
25   dialkyl ethylenediamine. Commercial amphoteric surfactants are derivatized by subsequent hydrolysis and ring-opening of the imidazoline ring by alkylation -- for example with chloroacetic acid or ethyl acetate. During alkylation, one or two carboxy-alkyl groups react to form a tertiary amine and an ether linkage with differing alkylating agents yielding different tertiary amines.

30           Long chain imidazole derivatives having application in the present invention generally have the general formula:



wherein R is an acyclic hydrophobic group containing from about 8 to 18 carbon atoms and M is a cation to neutralize the charge of the anion, generally sodium. Commercially prominent imidazoline-derived amphoterics that can be employed in the present compositions include for example: Cocoamphopropionate, 5 Cocoamphocarboxy-propionate, Cocoamphoglycinate, Cocoamphocarboxy-glycinate, Cocoamphopropyl-sulfonate, and Cocoamphocarboxy-propionic acid. Amphocarboxylic acids can be produced from fatty imidazolines in which the dicarboxylic acid functionality of the amphodicarboxylic acid is diacetic acid and/or 10 dipropionic acid.

The carboxymethylated compounds (glycinates) described herein above frequently are called betaines. Betaines are a special class of amphoteric discussed herein below in the section entitled, Zwitterion Surfactants.

Long chain N-alkylamino acids are readily prepared by reaction  $\text{RNH}_2$ , in 15 which  $\text{R}=\text{C}_8\text{-C}_{18}$  straight or branched chain alkyl, fatty amines with halogenated carboxylic acids. Alkylation of the primary amino groups of an amino acid leads to secondary and tertiary amines. Alkyl substituents may have additional amino groups that provide more than one reactive nitrogen center. Most commercial N-alkylamine acids are alkyl derivatives of beta-alanine or beta-N(2-carboxyethyl) 20 alanine. Examples of commercial N-alkylamino acid ampholytes having application in this invention include alkyl beta-amino dipropionates,  $\text{RN}(\text{C}_2\text{H}_4\text{COOM})_2$  and

RNHC<sub>2</sub>H<sub>4</sub>COOM. In an embodiment, R can be an acyclic hydrophobic group containing from about 8 to about 18 carbon atoms, and M is a cation to neutralize the charge of the anion.

Suitable amphoteric surfactants include those derived from coconut products  
5 such as coconut oil or coconut fatty acid. Additional suitable coconut derived surfactants include as part of their structure an ethylenediamine moiety, an alkanolamide moiety, an amino acid moiety, *e.g.*, glycine, or a combination thereof; and an aliphatic substituent of from about 8 to 18 (*e.g.*, 12) carbon atoms. Such a surfactant can also be considered an alkyl amphodicarboxylic acid. These  
10 amphoteric surfactants can include chemical structures represented as: C<sub>12</sub>-alkyl-C(O)-NH-CH<sub>2</sub>-CH<sub>2</sub>-N<sup>+</sup>(CH<sub>2</sub>-CH<sub>2</sub>-CO<sub>2</sub>Na)<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-OH or C<sub>12</sub>-alkyl-C(O)-N(H)-CH<sub>2</sub>-CH<sub>2</sub>-N<sup>+</sup>(CH<sub>2</sub>-CO<sub>2</sub>Na)<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-OH. Disodium cocoampho dipropionate is one suitable amphoteric surfactant and is commercially available under the tradename Miranol™ FBS from Rhodia Inc., Cranbury, N.J. Another suitable  
15 coconut derived amphoteric surfactant with the chemical name disodium cocoampho diacetate is sold under the tradename Mirataine™ JCHA, also from Rhodia Inc., Cranbury, N.J.

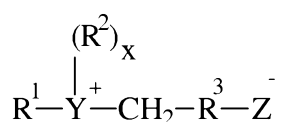
A typical listing of amphoteric classes, and species of these surfactants, is given in U.S. Pat. No. 3,929,678 issued to Laughlin and Heuring on Dec. 30, 1975.  
20 Further examples are given in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch). Each of these references are herein incorporated by reference in their entirety.

#### *Zwitterionic Surfactants*

Zwitterionic surfactants can be thought of as a subset of the amphoteric  
25 surfactants and can include an anionic charge. Zwitterionic surfactants can be broadly described as derivatives of secondary and tertiary amines, derivatives of heterocyclic secondary and tertiary amines, or derivatives of quaternary ammonium, quaternary phosphonium or tertiary sulfonium compounds. Typically, a zwitterionic surfactant includes a positive charged quaternary ammonium or, in some cases, a  
30 sulfonium or phosphonium ion; a negative charged carboxyl group; and an alkyl group. Zwitterionics generally contain cationic and anionic groups which ionize to a nearly equal degree in the isoelectric region of the molecule and which can develop

strong" inner-salt" attraction between positive-negative charge centers. Examples of such zwitterionic synthetic surfactants include derivatives of aliphatic quaternary ammonium, phosphonium, and sulfonium compounds, in which the aliphatic radicals can be straight chain or branched, and wherein one of the aliphatic substituents contains from 8 to 18 carbon atoms and one contains an anionic water solubilizing group, *e.g.*, carboxy, sulfonate, sulfate, phosphate, or phosphonate.

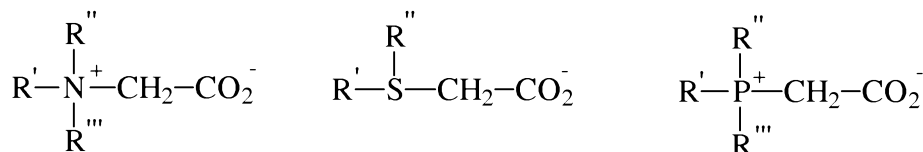
Betaine and sultaine surfactants are exemplary zwitterionic surfactants for use herein. A general formula for these compounds is:



wherein  $R^1$  contains an alkyl, alkenyl, or hydroxyalkyl radical of from 8 to 18 carbon atoms having from 0 to 10 ethylene oxide moieties and from 0 to 1 glyceryl moiety; Y is selected from the group consisting of nitrogen, phosphorus, and sulfur atoms;  $R^2$  is an alkyl or monohydroxy alkyl group containing 1 to 3 carbon atoms; x is 1 when Y is a sulfur atom and 2 when Y is a nitrogen or phosphorus atom,  $R^3$  is an alkylene or hydroxy alkylene or hydroxy alkylene of from 1 to 4 carbon atoms and Z is a radical selected from the group consisting of carboxylate, sulfonate, sulfate, phosphonate, and phosphate groups.

Examples of zwitterionic surfactants having the structures listed above include: 4-[N,N-di(2-hydroxyethyl)-N-octadecylammonio]-butane-1-carboxylate; 5-[S-3-hydroxypropyl-S-hexadecylsulfonio]-3-hydroxypentane-1-sulfate; 3-[P, P-diethyl-P-3,6,9-trioxatetracosanephosphonio]-2-hydroxypropane-1-phosphate; 3-[N,N-dipropyl-N-3-dodecoxy-2-hydroxypropyl-ammonio]-propane-1-phosphonate; 3-(N,N-dimethyl-N-hexadecylammonio)-propane-1-sulfonate; 3-(N,N-dimethyl-N-hexadecylammonio)-2-hydroxy-propane-1-sulfonate; 4-[N,N-di(2(2-hydroxyethyl)-N(2-hydroxydodecyl)ammonio)-butane-1-carboxylate; 3-[S-ethyl-S-(3-dodecoxy-2-hydroxypropyl)sulfonio]-propane-1-phosphate; 3-[P,P-dimethyl-P-dodecylphosphonio]-propane-1-phosphonate; and S[N,N-di(3-hydroxypropyl)-N-hexadecylammonio]-2-hydroxy-pentane-1-sulfate. The alkyl groups contained in said detergent surfactants can be straight or branched and saturated or unsaturated.

The zwitterionic surfactant suitable for use in the present compositions includes a betaine of the general structure:



These surfactant betaines typically do not exhibit strong cationic or anionic characters at pH extremes nor do they show reduced water solubility in their isoelectric range. Unlike "external" quaternary ammonium salts, betaines are compatible with anionics. Examples of suitable betaines include coconut acylamidopropyldimethyl betaine; hexadecyl dimethyl betaine; C<sub>12-14</sub> acylamidopropylbetaine; C<sub>8-14</sub> acylamidohexyldiethyl betaine; 4-C<sub>14-16</sub> acylmethyamidodiethylammonio-1-carboxybutane; C<sub>16-18</sub> acylamidodimethylbetaine; C<sub>12-16</sub> acylamidopentanedithiethylbetaine; and C<sub>12-16</sub> acylmethyamidodimethylbetaine.

Suitable betaines useful in the present invention include those compounds having the formula (R(R<sup>1</sup>)<sub>2</sub> N<sup>+</sup> R<sup>2</sup>SO<sup>3-</sup>), in which R is a C<sub>6</sub>-C<sub>18</sub> hydrocarbyl group, each R<sup>1</sup> is typically independently C<sub>1</sub>-C<sub>3</sub> alkyl, *e.g.* methyl, and R<sup>2</sup> is a C<sub>1</sub>-C<sub>6</sub> hydrocarbyl group, *e.g.* a C<sub>1</sub>-C<sub>3</sub> alkylene or hydroxyalkylene group.

A typical listing of zwitterionic classes, and species of these surfactants, is given in U.S. Pat. No. 3,929,678 issued to Laughlin and Heuring on Dec. 30, 1975. Further examples are given in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch). Each of these references are herein incorporated in their entirety.

#### *Methods of Use*

The glycerin ether ethoxylate surfactants according to the present invention are well suited for use as substitutes and/or replacements for alcohol ethoxylate surfactants (in whole or in part), including for example, in the various compositions disclosed herein. From the disclosure herein, one skilled in the art will ascertain the glycerin ether ethoxylate surfactants can be used in any application, method or use wherein an alcohol ethoxylate is conventionally employed.

The glycerin ether ethoxylate solfactants according to the present invention are well suited for use as substitutes and/or replacements for solvents, solubilizers and/or hydrotropes (in whole in or part) in the various compositions disclosed herein. As one skilled in the art appreciates, "alcohol ethoxylates" include a variety  
5 of branched or linear ethoxylates that may be primary, secondary, or tertiary, and may further be nonionic or anionic. In an aspect of the invention, the compositions provide at least substantially similar cleaning performance, preferably improved cleaning performance, as alcohol ethoxylate surfactants.

Various methods of using the glycerin ether ethoxylate solfactants may be  
10 envisioned, including for example, applications for use in laundry and/or other textile cleaning, all-purpose cleaners and/or detergents, hard surface cleaners, disinfectants, sanitizers, sporicides and the like against a variety of microorganisms, use as rinse aids, lubricants, etc. In a further embodiment, methods of using the glycerin ether ethoxylates may include removing a plurality of soils from various  
15 surfaces, such as industrial surfaces, agricultural or veterinary surfaces, air streams, food processing surfaces, food products, meat products, poultry, health care surfaces, various instruments, plants, plant products, vehicles, ware, and the like.

The scope of the invention is not to be limited in any manner with respect to the methods of using the compositions.

20 Methods of employing the glycerin ether ethoxylate solfactants according to the invention employ varying amounts of actives of the composition, which will vary dependent upon the formulation of the composition, such as for example a concentrate composition as compared to a use solution.

In a further aspect, the methods of employing the glycerin ether ethoxylate  
25 solfactants (and compositions including the same) may include the use of concentrate compositions and use compositions. For example, a concentrate composition can be diluted, for example with water, to form a use composition. In an embodiment, a concentrate composition can be diluted to a use solution before to application to an object. For reasons of economics, the concentrate can be marketed  
30 and an end user can dilute the concentrate with water or an aqueous diluent to a use solution.



The level of active components in the concentrate composition is dependent on the intended dilution factor and the desired activity of the glycerin ether ethoxylate solfactant compound. Generally, a dilution of about 1 fluid ounce to about 10 gallons of water to about 10 fluid ounces to about 1 gallon of water is used for aqueous compositions of the present invention. In some embodiments, higher use dilutions can be employed if elevated use temperature (greater than 25°C) or extended exposure time (greater than 30 seconds) can be employed. In the typical use locus, the concentrate is diluted with a major proportion of water using commonly available tap or service water mixing the materials at a dilution ratio of about 3 to about 40 ounces of concentrate per 100 gallons of water.

In some embodiments, when used in a laundry application, the concentrated compositions can be diluted at a dilution ratio of about 0.1 g/L to about 100 g/L concentrate to diluent, about 0.5 g/L to about 100 g/L concentrate to diluent, about 1.0 g/L to about 4.0 g/L concentrate to diluent, or about 1.0 g/L to about 2.0 g/L concentrate to diluent.

In other embodiments, a use composition can include about 0.01 to about 10 wt-% of a concentrate composition and about 90 to about 99.99 wt-% diluent; or about 0.1 to about 1 wt-% of a concentrate composition and about 99 to about 99.9 wt-% diluent.

In some embodiments, the methods of use employ the glycerin ether ethoxylate solfactant compound in an antimicrobial and/or sanitizing application of use. For example, the invention includes a method for reducing a microbial population and/or a method for sanitizing. These methods can operate on an article, surface, instrument, in a body or stream of water or a gas, or the like, by contacting the article, surface, instrument, body, or stream with a glycerin ether ethoxylate solfactant compound or composition of the invention. Contacting can include any of numerous methods for applying a compound or composition of the invention, such as spraying the compounds or compositions, immersing the article in the compounds or compositions, foam or gel treating the article with the compounds or composition, or a combination thereof.

In some aspects, a composition of the present invention includes an amount of the glycerin ether ethoxylate solfactant compound of the present invention

effective for killing one or more of the food-borne pathogenic bacteria associated with a food product, including, but not limited to, *Salmonella typhimurium*, *Salmonella javiana*, *Campylobacter jejuni*, *Listeria monocytogenes*, and *Escherichia coli* 0157:H7, yeast, and mold. In some embodiments, the compositions of the present invention include an amount of glycerin ether ethoxylate surfactant compound effective for killing one or more of the pathogenic bacteria associated with a health care surfaces and environments including, but not limited to, *Salmonella typhimurium*, *Staphylococcus aureus*, methicillin resistant *Staphylococcus aureus*, *Salmonella choleraesuis*, *Pseudomonas aeruginosa*, *Escherichia coli*, mycobacteria, yeast, and mold. The compounds and compositions of the present invention have activity against a wide variety of microorganisms such as Gram positive (for example, *Listeria monocytogenes* or *Staphylococcus aureus*) and Gram negative (for example, *Escherichia coli* or *Pseudomonas aeruginosa*) bacteria, yeast, molds, bacterial spores, viruses, etc. The compounds and compositions of the present invention, as described above, have activity against a wide variety of human pathogens. The present compounds and compositions can kill a wide variety of microorganisms on a food processing surface, on the surface of a food product, in water used for washing or processing of food product, on a health care surface, or in a health care environment.

20           The compounds of the invention can be used for a variety of domestic or industrial applications, *e.g.*, to reduce microbial or viral populations on a surface or object or in a body or stream of water. The compounds can be applied in a variety of areas including kitchens, bathrooms, factories, hospitals, dental offices and food plants, and can be applied to a variety of hard or soft surfaces having smooth, irregular or porous topography. Suitable hard surfaces include, for example, architectural surfaces (*e.g.*, floors, walls, windows, sinks, tables, counters and signs); eating utensils; hard-surface medical or surgical instruments and devices; and hard-surface packaging. Such hard surfaces can be made from a variety of materials including, for example, ceramic, metal, glass, wood or hard plastic. Suitable soft surfaces include, for example paper; filter media; hospital and surgical linens and garments; soft-surface medical or surgical instruments and devices; and soft-surface packaging. Such soft surfaces can be made from a variety of materials including, for

example, paper, fiber, woven or nonwoven fabric, soft plastics and elastomers. The compounds of the invention can also be applied to soft surfaces such as food and skin (*e.g.*, a hand). The present compounds can be employed as a foaming or nonfoaming environmental sanitizer or disinfectant.

5           The compounds and compositions of the invention can be included in products such as sterilants, sanitizers, disinfectants, preservatives, deodorizers, antiseptics, fungicides, germicides, sporicides, virucides, detergents, bleaches, hard surface cleaners, hand soaps, waterless hand sanitizers, and pre- or post-surgical scrubs.

10           The compounds can also be used in veterinary products such as mammalian skin treatments or in products for sanitizing or disinfecting animal enclosures, pens, watering stations, and veterinary treatment areas such as inspection tables and operation rooms. The present compounds can be employed in an antimicrobial foot bath for livestock or people. The compounds of the present invention can also be  
15 employed as an antimicrobial teat dip.

          In some aspects, the compounds of the present invention can be employed for reducing the population of pathogenic microorganisms, such as pathogens of humans, animals, and the like. The compounds exhibit activity against pathogens including fungi, molds, bacteria, spores, and viruses, for example, *S. aureus*, *E. coli*,  
20 *Streptococci*, *Legionella*, *Pseudomonas aeruginosa*, mycobacteria, tuberculosis, phages, or the like. Such pathogens can cause a variety of diseases and disorders, including mastitis or other mammalian milking diseases, tuberculosis, and the like. The compounds of the present invention can reduce the population of microorganisms on skin or other external or mucosal surfaces of an animal. In  
25 addition, the present compounds can kill pathogenic microorganisms that spread through transfer by water, air, or a surface substrate. The compounds need only be applied to the skin, other external or mucosal surfaces of an animal water, air, or surface.

          The antimicrobial compounds can also be used on foods and plant species to  
30 reduce surface microbial populations; used at manufacturing or processing sites handling such foods and plant species; or used to treat process waters around such sites. For example, the compounds can be used on food transport lines (*e.g.*, as belt

sprays); boot and hand-wash dip-pans; food storage facilities; anti-spoilage air circulation systems; refrigeration and cooler equipment; beverage chillers and warmers, blanchers, cutting boards, third sink areas, and meat chillers or scalding devices. The compounds of the invention can be used to treat produce transport  
5 waters such as those found in flumes, pipe transports, cutters, slicers, blanchers, retort systems, washers, and the like. Particular foodstuffs that can be treated with compounds of the invention include eggs, meats, seeds, leaves, fruits and vegetables. Particular plant surfaces include both harvested and growing leaves, roots, seeds, skins or shells, stems, stalks, tubers, corms, fruit, and the like. The compounds may  
10 also be used to treat animal carcasses to reduce both pathogenic and non-pathogenic microbial levels.

The antimicrobial compounds can also be used to treat waste water and/or other industrial water sources where both its antimicrobial function and its oxidant properties can be utilized. Aside from the microbial issues surrounding waste water,  
15 it is often rich in malodorous compounds of reduced sulfur, nitrogen or phosphorous. In some aspects, the invention includes methods of using the surfactant compositions to prevent biological fouling in various industrial processes and industries, including oil and gas operations, to control microorganism growth, eliminate microbial contamination, limit or prevent biological fouling in liquid  
20 systems, process waters or on the surfaces of equipment that come in contact with such liquid systems. As referred to herein, microbial contamination can occur in various industrial liquid systems including, but not limited to, air-borne contamination, water make-up, process leaks and improperly cleaned equipment. In another aspect, the peroxycarboxylic acid compositions are used to control the  
25 growth of microorganisms in water used in various oil and gas operations. In a further aspect, the compositions are suitable for incorporating into fracturing fluids to control or eliminate microorganisms. For the various industrial processes disclosed herein, "liquid system" refers to flood waters or an environment within at least one artificial artifact, containing a substantial amount of liquid that is capable  
30 of undergoing biological fouling, it includes but is not limited to industrial liquid systems, industrial water systems, liquid process streams, industrial liquid process streams, industrial process water systems, process water applications, process

waters, utility waters, water used in manufacturing, water used in industrial services, aqueous liquid streams, liquid streams containing two or more liquid phases, and any combination thereof.

In some aspects, the compounds and compositions of the present invention are useful in the cleaning or sanitizing of containers, processing facilities, or equipment in the food service or food processing industries. The compounds and compositions have particular value for use on food packaging materials and equipment, and especially for cold or hot aseptic packaging. Examples of process facilities in which the compound of the invention can be employed include a milk line dairy, a continuous brewing system, food processing lines such as pumpable food systems and beverage lines, etc. Food service wares can be disinfected with the compound of the invention. For example, the compounds can also be used on or in ware wash machines, low temperature ware wash machines, dishware, bottle washers, bottle chillers, warmers, third sink washers, cutting areas (*e.g.*, water knives, slicers, cutters and saws) and egg washers. Particular treatable surfaces include packaging such as cartons, bottles, films and resins; dish ware such as glasses, plates, utensils, pots and pans; ware wash and low temperature ware wash machines; exposed food preparation area surfaces such as sinks, counters, tables, floors and walls; processing equipment such as tanks, vats, lines, pumps and hoses (*e.g.*, dairy processing equipment for processing milk, cheese, ice cream and other dairy products); and transportation vehicles. Containers include glass bottles, PVC or polyolefin film sacks, cans, polyester, PEN or PET bottles of various volumes (100 ml to 2 liter, etc.), one gallon milk containers, paper board juice or milk containers, etc.

The compounds and compositions can also be used on or in other industrial equipment and in other industrial process streams such as heaters, cooling towers, boilers, retort waters, rinse waters, aseptic packaging wash waters, and the like. The compounds can be used to treat microbes and odors in recreational waters such as in pools, spas, recreational flumes and water slides, fountains, and the like.

A filter containing the compound can reduce the population of microorganisms in air and liquids. Such a filter can remove water and air-borne pathogens such as *Legionella*.

The present compounds can be employed for reducing the population of microbes, fruit flies, or other insect larva on a drain or other surface.

5 The compounds of the present invention can also be employed by dipping food processing equipment into the use solution, soaking the equipment for a time sufficient to sanitize the equipment, and wiping or draining excess solution off the equipment. The compound may be further employed by spraying or wiping food processing surfaces with the use solution, keeping the surfaces wet for a time sufficient to sanitize the surfaces, and removing excess solution by wiping, draining vertically, vacuuming, etc.

10 The compounds of the present invention may also be used in a method of sanitizing hard surfaces such as institutional type equipment, utensils, dishes, health care equipment or tools, and other hard surfaces.

The antimicrobial compounds can be applied to microbes or to soiled or cleaned surfaces using a variety of methods. These methods can operate on an  
15 object, surface, in a body or stream of water or a gas, or the like, by contacting the object, surface, body, or stream with a compound of the invention. Contacting can include any of numerous methods for applying a compound, such as spraying the compound, immersing the object in the compound, foam or gel treating the object with the compound, or a combination thereof.

20 Other hard surface cleaning applications for the compounds of the present invention include clean-in-place systems (CIP), clean-out-of-place systems (COP), washer-decontaminators, sterilizers, textile laundry machines, ultra and nano-filtration systems and indoor air filters. COP systems can include readily accessible systems including wash tanks, soaking vessels, mop buckets, holding tanks, scrub  
25 sinks, vehicle parts washers, non-continuous batch washers and systems, and the like. CIP systems include the internal components of tanks, lines, pumps and other process equipment used for processing typically liquid product streams such as beverages, milk, juices.

In some aspects, the present invention provides methods for contacting a  
30 food product with the glycerin ether ethoxylate surfactants or compositions containing the surfactants, employing any method or apparatus suitable for applying such a compound or composition. For example, in some embodiments, the food

product is contacted by a compound of the present invention with a spray of the compound, by immersion in the compound, by foam or gel treating with the compound. Contact with a spray, a foam, a gel, or by immersion can be accomplished by a variety of methods known to those of skill in the art for applying antimicrobial agents to food. Contacting the food product can occur in any location in which the food product might be found, such as field, processing site or plant, vehicle, warehouse, store, restaurant, or home. These same methods can also be adapted to apply the compounds of the present invention to other objects.

In other aspects, the solfactant compounds of the present invention can be used in the manufacture of beverage, food, and pharmaceutical materials including fruit juice, dairy products, malt beverages, soybean-based products, yogurts, baby foods, bottled water products, teas, cough medicines, drugs, and soft drinks. The compounds of the present invention can be used to sanitize, disinfect, act as a sporicide for, or sterilize bottles, pumps, lines, tanks and mixing equipment used in the manufacture of such beverages. Further, the solfactant compounds of the present invention can be used in aseptic, cold filling operations in which the interior of the food, beverage, or pharmaceutical container is sanitized or sterilized prior to filling. In such operations, a container can be contacted with a sanitizing solfactant compound composition, typically using a spray, dipping, or filling device to intimately contact the inside of the container with the sulfoperoxydicarboxylic acid compound, for a sufficient period of time to reduce microorganism populations within the container. The container can then be emptied of the amount of sanitizer or sterilant used. After emptying, the container can be rinsed with potable water or sterilized water and again emptied. After rinsing, the container can be filled with the beverage, food, or pharmaceutical. The container can then be sealed, capped or closed and then packed for shipment for ultimate sale. The sealed container can be autoclaved or retorted for added microorganism kill.

In some aspects, the compounds can also be employed in sanitizing articles, *e.g.*, textiles, which have become contaminated. The articles are contacted with the compounds of the invention at use temperatures in the range of about 4°C to 80°C, for a period of time effective to sanitize, disinfect, and/or sterilize the articles. In some embodiments, the compounds of the present invention can be used to bleach

and/or sanitize articles at a temperature of about 30°C to about 50°C or about 40°C. For example, in some embodiments, the compounds of the present invention can be injected into the wash or rinse water of a laundry machine and contacted with contaminated fabric for a time sufficient to sanitize the fabric. In some  
5       embodiments, the contaminated fabric is contacted with the compounds and compositions of the present invention for about 5 to about 30 minutes. Excess solution can then be removed by rinsing or centrifuging the fabric.

          The compounds and compositions of the present invention can be used alone to treat the articles, *e.g.*, textiles, or can be used in conjunction with conventional  
10       detergents suitable for the articles to be treated. The compounds and compositions of the invention can be used with conventional detergents in a variety of ways, for example, the compounds and compositions of the invention can be formulated with a conventional detergent. In other embodiments, the compounds and compositions of the invention can be used to treat the article as a separate additive from a  
15       conventional detergent. When used as a separate additive, the compounds and compositions of the present invention can contact the article to be treated at any time. For example, the compounds and compositions of the invention can contact the article before, after, or substantially simultaneously as the articles are contacted with the selected detergent.

20       A concentrate or use concentration of a compound of the present invention can be applied to or brought into contact with an object by any conventional method or apparatus for applying an antimicrobial or cleaning compound to an object. For example, the object can be wiped with, sprayed with, foamed on, and/or immersed in the compound, or a use solution made from the compound. The compound can be  
25       sprayed, foamed, or wiped onto a surface; the compound can be caused to flow over the surface, or the surface can be dipped into the compound. Contacting can be manual or by machine. Food processing surfaces, food products, food processing or transport waters, and the like can be treated with liquid, foam, gel, aerosol, gas, wax, solid, or powdered stabilized compounds according to the invention, or solutions  
30       containing these compounds.

          In some aspects, the compounds of the present invention can be employed for various non-cleaning compositions, including for example, paint formulations,



glues, lubricants, coolant compositions, fiber glass sizing compositions, water treatment compositions, drilling fluids, gas hydrate inhibitor compositions, corrosion inhibitor compositions, personal care compositions and the like wherein the freezing and/or melting point properties of the solfactants are desired. The solfactant compounds exhibit beneficial properties of having no freezing and/or melting to very low temperatures, including for example to at least about minus 80°C. The compounds of the present invention can maintain liquid formulations at low temperatures without resulting in freezing.

10 All publications and patent applications in this specification are indicative of the level of ordinary skill in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated as incorporated by reference.

15 Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures, embodiments, claims, and examples described herein. Such equivalents are considered to be within the scope of this invention and covered by the claims appended hereto. The contents of all references, patents, and patent applications cited throughout this application are hereby incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated as incorporated by reference.. All publications and patent applications in this specification are indicative of the level of ordinary skill in the art to which this invention pertains. The invention is further illustrated by the following examples, which should not be construed as further limiting.

## EXAMPLES

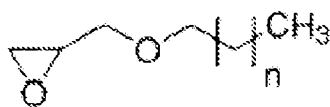
Embodiments of the present invention are further defined in the following non-limiting Examples. It should be understood that these Examples, while indicating certain embodiments of the invention, are given by way of illustration only. From the above discussion and these Examples, one skilled in the art can ascertain the essential characteristics of this invention, and without departing from

the spirit and scope thereof, can make various changes and modifications of the embodiments of the invention to adapt it to various usages and conditions. Thus, various modifications of the embodiments of the invention, in addition to those shown and described herein, will be apparent to those skilled in the art from the foregoing description. Such modifications are also intended to fall within the scope of the appended claims.

### EXAMPLE 1

Initial bench methods for making the glycerin ether ethoxylates of the invention used ethoxylation methods employing ethylene oxide (EO or  $C_2H_4O$ ) to combine with an alcohol (-OH groups suitable for ethoxylation) on a glycerin ether to create the novel surfactant. Initial methods used potassium hydroxide (KOH) as an imitator for the catalytic reaction. Potassium hydroxide, ethylene oxide and a glycerin ether precursor were combined in a heated, pressurized reactor to produce a cationic alcohol capable of reacting with the ethylene oxide.

The glycerin ether precursor employed was glycidyl ether having the following structure:



wherein  $n$  is 1 to 25, preferably  $n$  is 4 to 20, preferably  $n$  is 6 to 18, more preferably  $n$  is 10 to 12. The glycidyl ether was obtained from Sigma Aldrich and employed due to the limited commercial availability of larger chain glycerin ethers. The glycidyl ether (*e.g.* glycerin ether precursor) was converted to the corresponding glycerine ether via an acid catalyzed ring opening of the epoxide. The resulting mixture was then ethoxylated into the glycerin ether ethoxylates according to the invention.

NMR analysis was conducted on the glycerin ether ethoxylates produced according to Example 1. NMR confirms the presence of twin, ethoxylated

hydrophilic tails along with the glycerin ether hydrophobic head of the surfactant as well as dimeric and oligomeric species.

## EXAMPLE 2

5

Various 2-Ethyl Hexanol Glycerin Ether Ethoxylate surfactants were produced using ethoxylation by a KOH Catalyst. The various physical and chemical properties of the exemplary set of novel surfactants are shown in Table 1.

10 TABLE 1

						Cloud Point Data		
Target EO	NMR Moles EO	Wt-% EO	Wt-% Free Alcohol	Wt-% PEG	% 2° Alc. Covered	10% in BDG Soln.	1% in D.I. H <sub>2</sub> O	1% in 10% NaCl
2EHGE (1 EO)	1	17.7	--	--	30.4	59.5°C	--	--
2EHGE (3 EO)	3.03	39.5	3.24	--	59.6	--	50.5°C	33°C
2EHGE (5 EO)	5.07	52.2	0.24	--	76.7	--	--	71.5°C
2EHGE (7 EO)	7	60.2	0.02	--	85.6	--	--	78°C
2EHGE (9 EO)	8.98	66	<0.01	--	92.2	--	--	95°C

As shown in Table 1, the glycerin ether ethoxylates are shown as having increased moles of ethylene oxide (*e.g.* 1, 3, 5, 7, 9) and corresponding decreased percentage of free alcohol as the degree of ethoxylation increases among the surfactants. As shown, as the moles ethylene oxide increase on the surfactants the percentage of the secondary alcohol that is covered by the EO increases to over 90% (at 9 EO surfactant).

Further the cloud point data for the surfactants in various solutions is shown. The cloud point temperatures show the temperature above which a surfactant-rich phase separates from an aqueous solution. There is a clear relationship between the cloud point and the average EO content of the glycerin ether ethoxylate; as the ethylene oxide content of the surfactant increases, the cloud point and water solubility increase. As the carbon number on the molecule increases, a greater

number of moles of ethylene oxide are required to be added to the molecule to retain the same cloud point.

### EXAMPLE 3

5

2-Ethyl hexanol glycerin ether ethoxylate (2EHGE) solfactants according to the invention were analyzed in comparison to commercially-available Tomadol® ethoxylated alcohols in cleaning compositions prepared for testing red and black soils. The evaluated formulas are shown in Table 2. The Tomadol surfactants have the following structures:  $RO(CH_2CH_2O)_nH$ , wherein R is a hydrophobic portion obtained from a linear alcohol, n is the average moles of ethylene oxide per mole of alcohol. In addition, a commercially available cleaning composition Super Excellent Standard (NPE 9.50) (Ecolab Inc.) was also used as a comparison composition. The 2EHGE solfactant compositions were formulated to provide a direct replacement for the ethoxylated alcohol with the glycerin ether ethoxylate, wherein the same moles ethylene oxide were employed in the various formulations shown in FIG. 1.

15

TABLE 2

Component	Tomadol wt-%	2EHGE wt-%
Water	72.1	72.1
Phosphoric acid (75%)	0.4	0.4
Isopropanol (3.5%)	3.5	3.5
Tetrasodium EDTA (40%)	6	6
Ethoxylated alcohol	18	0
2-Ethyl hexanol glycerin ether ethoxylate	0	18

20

Red Soil Removal Test

A black soil including about 50 grams mineral spirits, about 5 grams mineral oil, about 5 grams motor oil, about 2.5 grams black pigment dispersion and about 37.5 grams bandy black clay was prepared.

A plurality of 3" x 3" white vinyl tiles were soiled on the back, grooved side with approximately 0.75 grams of the black test soil using a 3" foam brush. The tiles were allowed to dry at room temperature overnight. The next day, the tiles were placed into a soaking tray containing about 200 grams of the cleaning composition for about 2 minutes. The soil removal test was conducted using a Precision Force Applicator (PFA), available from Precision Analytical Instruments, Inc., using a synthetic sponge. The sponge was pre-dampened with water with the excess water squeezed out and then saturated with about 50 grams of the test compositions.

The tiles were then placed into a PFA (described below) with the grain of the tiles parallel to the direction of sponge travel. The tiles were then scrubbed with about 2 pounds of pressure with the moistened synthetic sponge for 40 cycles, rotating the tiles 90 degrees every 10 cycles for a complete 360 degree rotation of the tiles. The tiles were then rinsed with city water and dried overnight at room temperature. The average percentage reflectance change of the black soil removal was calculated by the following equation:

$$\% \text{ Clean} = \frac{((\text{Reflectance of Cleaned tile}) - (\text{Reflectance of Soiled tile}))}{((\text{Reflectance of New tile}) - (\text{Reflectance of Soiled tile}))}$$

FIG. 1 shows a graph comparing the black soil cleaning efficacy of the various cleaning compositions containing the glycerin ether ethoxylate solfactants versus the equivalent ethoxylated alcohols (*i.e.* Tomadol). A further control composition of Super Excellent (with NPE 9.5) (Ecolab Inc.) was tested. The graphs show that the replacement glycerin ether ethoxylate solfactants provide at least substantially similar cleaning efficacy to the equivalent Tomadol-based cleaning compositions, illustrating the suitability of the solfactants for providing an effective replacement for the commercially-available ethoxylated alcohol surfactants.

#### Red Soil Removal Test

A red soil consisting of lard, oil, protein, and iron (III) oxide (for color) was

prepared. About 30 grams of lard was combined with about 30 grams of corn oil, about 15 grams of whole powdered egg, and about 1.5 grams of  $\text{Fe}_2\text{O}_3$ .

The back, grooved sides of a plurality of 3" x 3" white vinyl tiles were soiled with approximately 0.75 grams of the red soil using a 3" foam brush. The tiles were allowed to dry at room temperature overnight. It is believed that this incubation period allowed the bonds holding the triglycerides and proteins together in the soil to begin to crystallize and interlink. The next day, the tiles were placed into a soaking tray containing about 200 grams of a test composition for about 1 minute.

The soil removal test was conducted using a Precision Force Applicator (PFA), available from Precision Analytical Instruments, Inc., using a synthetic sponge. The PFA is similar to the Gardner Straightline Apparatus except that it is interfaced with a computer to control various parameters, such as, for example speed, number of repetitions, time between cycles, etc. The synthetic sponge was pre-dampened with water with the excess water squeezed out and then saturated with about 50 grams of the test compositions. The tiles were then placed into the PFA with the grain of the tiles parallel to the direction of sponge travel. The tiles were scrubbed with about 2 pounds of pressure with the moistened synthetic sponge for 16 cycles, rotating the tiles 90 degrees every 4 cycles for a complete 360 degree rotation of the tiles. The tiles were then rinsed with city water and dried overnight at room temperature. Hunter Lab  $L^*$  reflectance of the soiled tiles and washed tiles were measured. The soiled tiles  $L^*$  reflectance value is represented by the following equation:

$$\text{soiled } L^* = \frac{1}{3.38 \ln \left( \frac{92.1 - 24.74}{\text{soiled } L^* - 24.74} \right)}$$

where 3.38, 92.1, and 24.74 are constants. The washed tiles  $L^*$  reflectance value is represented by the following equation:

$$\text{washed } L^* = \frac{1}{3.38 \ln \left( \frac{92.1 - 24.74}{\text{washed } L^* - 24.74} \right)}$$

The percent soil removal was then calculated as:

$$\text{percent soil removal} = \left( \frac{\text{soiled } L^{**} - \text{washed } L^{**}}{\text{soiled } L^{**}} \right) * 100$$

5           The compositions were evaluated based on two standards. First, the compositions were evaluated to determine whether an acceptable amount of red soil was removed at low concentrations (*i.e.*, 4 oz./gallon), intermediate concentrations (*i.e.*, 8 oz./gallon) and high concentrations (*i.e.*, 16 oz./gallon). At 18% actives, a composition was considered to perform at an acceptable level if it removed at least  
10   about 71% red soil at low concentrations, at least about 79% red soil at intermediate concentrations and at least about 86% red soil at high concentrations.

FIG. 2 shows a graph comparing the red soil cleaning efficacy of the various cleaning compositions containing the glycerin ether ethoxylate solfactants versus the equivalent ethoxylated alcohols (*i.e.* Tomadol). A further control composition of  
15   Super Excellent (with NPE 9.5) (Ecolab Inc.) was tested. The graphs show that the replacement glycerin ether ethoxylate solfactants provide at least substantially similar cleaning efficacy to the equivalent Tomadol-based cleaning compositions, illustrating the suitability of the solfactants for providing an effective replacement for the commercially-available ethoxylated alcohol surfactants.

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#### EXAMPLE 4

Foam testing was completed for the ethoxylated glycerine ether solfactants in comparison to commercially-available ethoxylated alcohols using a Glewwe foam  
25   meter. A Glewwe foam meter provides a dynamic foam test rather than a static test, which is considered more appropriate for simulation of industrial conditions. The equipment and general procedure for the Glewwe form test is described in U.S. Patent Nos. 3,899,387 and 5,447,648, which are herein incorporated by reference in its entirety. The foam meter itself consists of a thermostated reservoir and a pump to  
30   recirculate the aqueous medium with foaming tendencies. The foam developed by

the action of the aqueous stream impinging on the surface in the reservoir causes foam formation.

The foam heights of the tested compositions were determined using the following method. First 3000 mL of city water (*e.g.* 17 gpg) was filled into the Glewwe cylinder. The pump was turned on, pressure adjusted to 6 psi, and heated water to 140°F. The commercially available surfactant (or the solfactant according to the invention) was added at 50 ppm in the cylinder and the timer was started. Foam height was recorded at 1 minute and 5 minutes. After 5 minutes the pump was stopped and foam stability characteristics were observed. The cylinder was then drained, rinsed, and the methods repeated. The results are shown in Table 3.

TABLE 3

Surfactant	Conc.	Foam Height (in)		OBSERVATIONS
		@ 1 MIN	@ 5 MIN	
Tomadol 1-3	50 ppm	2.5	3.25	Fast to break - remained fairly stable @ 1"
Tomadol 1-5	50 ppm	9.5	9.5	Very stable
Tomadol 1-7	50 ppm	10	12	Very stable
Tomadol 1-9	50 ppm	10	12	Very stable
Solfactant (1 mole EO)	50 ppm	3	3	Unstable - Breaks quickly to 0"
Solfactant (3 mole EO)	50 ppm	3.5	4	Unstable - Breaks quickly to 0"
Solfactant (5 mole EO)	50 ppm	4	4	Unstable - Breaks quickly to 0"
Solfactant (7 mole EO)	50 ppm	5	4.5	Unstable - Breaks quickly to 0"
Solfactant (9 mole EO)	50 ppm	4.5	4.5	Unstable - Breaks quickly to 0"

Results: As shown in Table 3 the glycerin ether ethoxylate solfactants according to the invention beneficially do not create high foam, which providing at least substantially similar cleaning performance. The low foam of the solfactants is illustrated in the "observations" wherein the foam height is "unstable" and quickly breaks down to no foam height. In various applications of use, such as for example, laundry and ware wash applications, low or no foaming cleaning compositions are desired. Beneficially, the ethoxylated glycerine ether solfactants generated



significantly less foam in comparison to the Tomadol 1-X series ethoxylated alcohol surfactants.

#### EXAMPLE 5

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In addition to the low-foaming benefits of the glycerin ether ethoxylate surfactants, the compounds further provide lower viscosity in comparison to ethoxylated alcohol surfactants. The comparative viscosity of textile / laundry cleaning compositions shown in Table 4 was analyzed.

10

TABLE 4

<b>Component</b>	<b>Tomadol Formulation (wt-%)</b>	<b>Solfactant Formulation (wt-%)</b>
Water	59.8340	59.8340
Tomadol 24-7	21.0000	0
Tomadol 24-5	7.0000	0
2 ethylhexyl glycerin ether (7 moles)	0	21.0000
2 ethylhexyl glycerin ether (5 moles)	0	7.0000
Distyryl biphenyl	0.0160	0.0160
Propylene Glycol	12.0000	12.0000
Chloro Methyl Isothiazolin	0.1500	0.1500

Viscosity measurements for the Tomadol formulation and the Solfactant (2 ethylhexyl glycerin ether) formulation were conducted using a Brookfield

15 Viscometer to measure the fluid friction resulting when a layer of fluid is moved in relation to another layer (measured in Poises). The Brookfield Viscometer measures viscosity by measuring the force required to rotate a spindle in a fluid according to known methods (Viscosity – Brookfield, TP-AATM-105A-b, 2006 Edition).

The viscometer was set and read at a constant reading to obtain the speed of the spindle (#3) in centipoises. To obtain the centipoise measurements from the evaluated formulas the propylene glycol (*e.g.* solvent) was removed and water was added back in to total 100 wt-%. The Tomadol Formulation measured at 438 cps, whereas the Solfactant measured at 5 cps. The viscosity of the solfactant was similar to water having minimal measurable viscosity. However, the viscosity of the Tomadol Formulation was unpourable

These results demonstrate the unexpected solvent-type benefits provided by the glycerin ether ethoxylate solfactants, including the 2 ethylhexyl glycerin ether ethoxylate solfactant. The solfactant demonstrates its suitable use for forming more concentrated formulations without having substantial increases in viscosity. This attribute of the solfactant is critical to maintain a highly concentrated formulation that is pourable and/or flowable.

#### EXAMPLE 6

The low foam profiles and low viscosity of the glycerin ether ethoxylate solfactants as shown in Examples 5 and 6 were further compared to gel curves of conventional ethoxylated alcohols (*e.g.* Tomadol surfactants). The glycerin ether ethoxylate solfactant 2 ethylhexyl glycerin ether (having various moles ethylene oxide) was evaluated as shown in Table 5 to determine at what concentrations a gel would form with water.

TABLE 5

<b>Solfactant</b>	<b>Glycerin Ether Ethoxylate % / Water %</b>	<b>Gel Formation</b>
2 ethylhexyl glycerin ether (3 moles)	10% / 90%	None
	20% / 80%	None
	30% / 70%	None
	40% / 60%	None
	50% / 50%	None
	60% / 40%	None

	70% / 30%	None
	80% / 20%	None
	90% / 10%	None
2 ethylhexyl glycerin ether (5 moles)	10% / 90%	None
	20% / 80%	None
	30% / 70%	None
	40% / 60%	None
	50% / 50%	None
	60% / 40%	None
	70% / 30%	None
	80% / 20%	None
	90% / 10%	None
2 ethylhexyl glycerin ether (7 moles)	10% / 90%	None
	20% / 80%	None
	30% / 70%	None
	40% / 60%	None
	50% / 50%	None
	60% / 40%	None
	70% / 30%	None
	80% / 20%	None
	90% / 10%	None
2 ethylhexyl glycerin ether (9 moles)	10% / 90%	None
	20% / 80%	None
	30% / 70%	None
	40% / 60%	None
	50% / 50%	None
	60% / 40%	None
	70% / 30%	None
	80% / 20%	None
	90% / 10%	None

As shown in Table 5, regardless of the ratio of the surfactant and water there is no formation of a gel. This is a significant difference from the commercially-available ethoxylated alcohol surfactants (Tomadol series) that are shown in exemplary FIGS. 3A-3C showing graphs of the gel curves for the surfactants: Tomadol 1-5 (FIG. 3A), Tomadol 23-5 (FIG. 3B), Tomadol 25-9 (FIG. 3C). The gel curves indicate the temperatures over which the surfactants form gels and the corresponding concentration ranges that form gels.

The gel curves shown in FIGS. 3A-3C represent a significant from the glycerin ether ethoxylate surfactants according to the invention, which do not form gels under any of the concentrations with water, as set forth about in Table 5.

#### EXAMPLE 7

The glycerin ether ethoxylate surfactants were evaluated for formulation and efficacy in a wide variety of cleaning compositions and applications, including for example: Dishwashing / Ware wash detergents, Auto dish detergents, Rinse additives, Manual detergents, Hand Soaps, Air Fresheners, Laundry (*e.g.* textile) detergents, Industry Water Treatments, Cosmetics, Disinfectants, Degreasers, Hard surface Cleaners and/or Solubilizers, Sanitizers, Stain Removers, Floor Cleaners, Auto floor scrubbers, CIP detergents, Teat dips, Bowl cleaners (*e.g.* toilet bowl cleaners), etc.

Suitable, non-limiting formulations for the various exemplary glycerin ether ethoxylate surfactant compositions according to the invention are set forth below in Tables 6-8.

TABLE 6 – Degreaser Composition

Component	Surfactant Formula wt-%	Surfactant Formula wt-%
Propylene glycol Phenyl Ether	14.0000	14.0000
Dowanol DPNB	14.0000	14.0000

Monoisopropanolamine	12.0000	12.0000
Tall Oil Fatty Acid	10.0000	10.0000
Benzoic Acid	2.0000	2.0000
Tomadol 1-3	0	4.0000
Neodol 1-9	0	3.0000
2 ethylhexyl glycerin ether (3 moles)	4.0000	0
2 ethylhexyl glycerin ether (9 moles)	3.0000	0
Versene 100	2.0000	2.0000
SXS 40%	3.0000	3.0000
Water	35.4880	35.4880
Red Dye	0.0120	0.0120
Citrus Frag.	0.5000	0.5000
	100	100

The exemplary, non-limiting solfactant degreaser composition shown in Table 6 was formulated with a direct replacement of the conventional ethoxylated alcohol surfactants with the glycerin ether ethoxylate solfactants according to the invention. Beneficially, the solfactant compositions provide at least substantially similar cleaning efficacy while providing low foam, low viscosity compositions that can be concentrated at levels exceeding the conventional ethoxylated alcohol surfactant compositions.

10 TABLE 7 – Hard Surface Cleaning / Solubilizer Composition

<b>Component</b>	<b>Solfactant Formula wt-%</b>	<b>Surfactant Formula wt-%</b>
Water	80.1670	79.6670
MgCl <sub>2</sub>	2.2500	2.2500
LAS	7.4400	7.4400

TEA	1.2400	1.2400
NaOH	1.5000	1.5000
SLES	3.5300	3.5300
Tomadol 1-5	0.4600	0.4600
Ethylan HB4	0	2.5000
2 ethylhexyl glycerin ether (9 moles)	2.0000	0
D-limonene	1.2500	1.2500
Dye	0.0830	0.0830
Kathon	0.0800	0.0800
	100	100

The exemplary, non-limiting solfactant hard surface cleaning / solubilizing composition shown in Table 7 was formulated using the solfactant as a replacement for the conventional solvent material Ethylan HB4. Notably, due to the solvent-based characteristics of the solfactants according to the invention, the glycerin ether ethoxylate solfactants replaced the solvent at a decreased concentration. Without being limited to a particular benefit and/or theory of the invention, the solvent-based characteristics of the glycerin ether ethoxylate solfactants allows for the more efficient formulation and interaction as both a solvent and a hydrotrope. In this exemplary formulation, the solfactant easily brings the water insoluble solvent (*e.g.* D-limonene) into solution using a lower concentration than the conventional solvent Ethylan HB4. Still further, the solfactant compositions provide at least substantially similar cleaning efficacy as the conventional ethoxylated alcohol surfactant compositions.

15

TABLE 8 – Laundry Detergent Composition

<b>Component</b>	<b>Solfactant Formula wt-%</b>	<b>Surfactant Formula wt-%</b>
Water	68.5715	68.5715
EDTA 40%	3.0000	3.0000

Sod. LAS	9.2000	9.2000
Cocamidopropyl Betaine	1.2500	1.2500
Coco DEA	0.0500	0.0500
SXS 40%	6.8000	6.8000
Ethylene Glycol Butyl ether	6.0000	6.0000
Lauryl Dimethylamine Oxide 30%	1.3700	1.3700
Alcohol Ethoxylate C9-11 (6 EO)	0	0.9200
Alcohol Ethoxylate C12-16 (7 EO)	0	0.4600
2 ethylhexyl glycerin ether (5 moles)	0.9200	0
2 ethylhexyl glycerin ether (7 moles)	0.4600	0
D'Limonene	1.2000	1.2000
MEA	1.0000	1.0000
Water	0.1755	0.1755
Dye, Turquoise XB CDG	0.0030	0.0030
	100.0000	100.0000

The exemplary, non-limiting solfactant laundry detergent composition shown in Table 8 was formulated using the solfactant as a replacement for the conventional alcohol ethoxylate surfactants. The solfactant compositions provide at least

5 substantially similar cleaning efficacy as the conventional ethoxylated alcohol surfactant compositions, which is further illustrated in Example.

#### EXAMPLE 8

10 Laundry detergent compositions using 500 ppm sodium hydroxide (*e.g.* caustic) and the indicated conventional Surfonic® surfactant or the glycerin ether ethoxylate solfactant according to the invention were evaluated. A tergotometer test procedure was employed to measure detergency of test compositions according to

the invention. A tergotometer along with 500 mL pots and water bath were employed. First, unwashed swatches from the lot numbers to be used in the test are read on the Konica Minolta Spectrophotometer model CM-3600d to establish the average initial (before washing) L value. A sampling of each swatch type is used.

- 5 The desired wash temperature is programmed into the Tergotometer and its water bath is allowed to heat up to that temperature. 500 mL of the desired water type is added to each Tergotometer pot and allowed to equilibrate to the desired temperature.

The following standard, commercially available (EMPA) soiled swatches  
10 were used for baseline testing in the Examples, as shown in Table 9.

TABLE 9

Sample	Soil	Substrate Fabric
EMPA 101	olive oil / carbon black	Cotton
EMPA 104	olive oil / carbon black	Cotton blend
EMPA 106	mineral oil	Cotton
EMPA 111	Pig blood	Cotton
EMPA 114	Red wine	Cotton
EMPA 116	Blood, milk and ink	Cotton

The test detergent compositions are weighed out and added to the  
15 Tergotometer pots. Various detergent compositions as shown in Tables 10-11 were employed under varying water conditions, including 5 grain water (Table 10) and 17 grain water (Table 11).

The detergent systems were agitated for 10 minutes to mix and dissolve in the water sources. The agitation / mixing speed RPM was adjusted to 200. The  
20 temperature of the detergent compositions dissolved in water was 60°C, unless indicated otherwise in the Figures / Examples set forth below. The swatches are added quickly to their respective pots in a left to right sequence in order to minimize differences in exposure time to the detergent systems. A wash run is completed for at least 10 minutes. At the end of the run, the swatches are removed from the pots  
25 quickly in a left to right sequence using a forceps and are transferred into 500 mL - 1



liter of cool water to rinse. After rinsing with cold tap water, excess water from the swatches was removed by squeezing the swatches. The process was repeated with rinsing and squeezing excess water at least 2 more times. The swatches were air dried on a visa napkin or paper towel on the lab bench.

- 5 The swatches were then read on the HunterLab Color Quest and calculate % soil removal (*i.e.* whiteness) from the difference between the initial (before washing) L value and the final L value (after washing). Percent Soil Removal = (L after – L initial) / (96 – L initial) \* 100 is represented as L\*.

10 TABLE 10A (5 gpg)

	EMP A 116	EMP A 114	EMP A 111							
	Before	After	% removal	Before	After	% removal	Before	After	% removal	
50 ppm Surfonic 24-3	42.99	54.4	27%	77.28	78.94	2%	50.12	74.92	49%	
50 ppm Surfonic 24-5	43.42	55.03	27%	78.14	78.63	1%	49.84	75.96	52%	
50 ppm Surfonic 24-7	43.02	54.58	27%	78.4	78.38	0%	49.4	72.16	46%	
50 ppm Surfonic 24-9	43.3	53.75	24%	78.59	78.4	0%	49.55	75.98	53%	
100 ppm Surfonic 24-3	42.82	53.27	24%	78.11	78.24	0%	49.66	73.51	48%	
100 ppm Surfonic 24-5	43.17	54.38	26%	78.08	79	1%	49.77	72.4	45%	
100 ppm Surfonic 24-7	42.94	56.01	30%	78.22	77.82	-1%	49.72	72.28	45%	
100 ppm Surfonic 24-9	42.99	53.53	25%	78.3	77.17	-1%	49.6	75.81	53%	
50 ppm Ethylhexylglycerine ether 1 mol EO	43.27	54.59	26%	77.98	78.07	0%	49.81	73.99	49%	
50 ppm Ethylhexylglycerine ether 3 mol EO	43.05	57.48	34%	78.13	79.29	1%	49.53	74.29	50%	
50 ppm Ethylhexylglycerine ether 5 mol EO	43.07	56.07	30%	78.1	79.4	2%	49.49	73.19	48%	
50 ppm	43.34	57.63	33%	78.18	79.1	1%	49.63	75.6	52%	

Ethylhexylglycerine ether 7 mol EO					3			3	
50 ppm Ethylhexylglycerine ether 9 mol EO	42.82	56.96	33%	78.32	79.73	2%	49.36	72.87	48%
100 ppm Ethylhexylglycerine ether 1 mol EO	42.96	54.36	27%	78.32	77.63	-1%	49.2	74.9	52%
100 ppm Ethylhexylglycerine ether 3 mol EO	43.26	55.79	29%	78.35	78.15	0%	49.82	73.84	48%
100 ppm Ethylhexylglycerine ether 5 mol EO	42.94	55.03	28%	78.34	78.92	1%	49.53	71.7	45%
100 ppm Ethylhexylglycerine ether 7 mol EO	43.33	51.65	19%	78.36	76.29	-3%	49.43	73.68	49%
100 ppm Ethylhexylglycerine ether 9 mol EO	43.11	53.72	25%	78.43	78.38	0%	49.35	75.96	54%

TABLE 10B (5 gpg)

	EMP A 106 Before	EMP A 104 After	EMP A 101 % removal	Before	After	% removal	Before	After	% removal
50 ppm Surfonic 24-3	59.26	40.02	52.63	40.02	52.63	32%	45	60.82	35%
50 ppm Surfonic 24-5	58.99	40.32	55.54	40.32	55.54	38%	46.01	62.46	36%
50 ppm Surfonic 24-7	59.45	39.99	51.08	39.99	51.08	28%	44.82	61.8	38%
50 ppm Surfonic 24-9	59.27	40.77	55.62	40.77	55.62	36%	46.17	62.3	35%
100 ppm Surfonic 24-3	58.92	40.46	50.72	40.46	50.72	25%	45.77	58.78	28%
100 ppm Surfonic 24-5	59.26	40.26	51.3	40.26	51.3	27%	46.34	58.79	27%
100 ppm Surfonic 24-7	59.12	40.61	49.7	40.61	49.7	22%	46.63	59.33	27%
100 ppm	59.43	40.26	47.41	40.26	47.4	18%	45.7	57.8	27%

Surfonic 24-9					1		1	9	
50 ppm Ethylhexylglycerine ether 1 mol EO	59	40.14	50.77	40.14	50.77	26%	45.57	57.89	27%
50 ppm Ethylhexylglycerine ether 3 mol EO	59.46	40.78	60.8	40.78	60.8	49%	45.29	65.78	45%
50 ppm Ethylhexylglycerine ether 5 mol EO	59.45	40.28	59.51	40.28	59.51	48%	45.47	63.71	40%
50 ppm Ethylhexylglycerine ether 7 mol EO	58.87	40.74	59.88	40.74	59.88	47%	46.62	64.15	38%
50 ppm Ethylhexylglycerine ether 9 mol EO	58.9	40.08	55.18	40.08	55.18	38%	46.08	60.75	32%
100 ppm Ethylhexylglycerine ether 1 mol EO	59.86	40.34	48.73	40.34	48.73	21%	46.37	59.85	29%
100 ppm Ethylhexylglycerine ether 3 mol EO	59.82	40.22	50.39	40.22	50.39	25%	45.53	58.58	29%
100 ppm Ethylhexylglycerine ether 5 mol EO	59.2	40.2	49.62	40.2	49.62	23%	45.58	58.99	29%
100 ppm Ethylhexylglycerine ether 7 mol EO	59.36	39.86	46.8	39.86	46.8	17%	45.12	56.47	25%
100 ppm Ethylhexylglycerine ether 9 mol EO	59.74	40.52	50.14	40.52	50.14	24%	45.49	58.62	29%

TABLE 11A (17 gpg)

	EMP A 116	EMP A 114	EMP A 111						
	Before	After	% removal	Before	After	% removal	Before	After	% removal
50 ppm	43.5	49.8	15%	77.95	76.7	-2%	49.49	61.1	24%

Surfonic 24-3	5	7			2			5	
50 ppm Surfonic 24-5	43.9 1	45.8 4	4%	78.07	79.9 2	2%	49.21	61.4 1	25%
50 ppm Surfonic 24-7	43.4 7	52.0 5	20%	78.08	78.2 1	0%	48.95	63.2 7	29%
50 ppm Surfonic 24-9	43.5 4	52.3 2	20%	78.06	79.4 2	2%	49.36	63.3 3	28%
100 ppm Surfonic 24-3	43.3 4	48.6	12%	78.04	77.3 2	-1%	49.15	61.0 2	24%
100 ppm Surfonic 24-5	43.7 7	54.7 2	25%	77.85	78.5	1%	49.09	69.2 3	41%
100 ppm Surfonic 24-7	43.2 6	53.1 9	23%	78.01	78.6 9	1%	49.09	65.1 7	33%
100 ppm Surfonic 24-9	43.5 4	53.9 7	24%	77.96	79.0 1	1%	49.09	65.3 2	33%
50 ppm Ethylhexylglyce rine ether 1 mol EO	43.2 6	50.6 1	17%	77.98	77.7 7	0%	49.27	65.0 9	32%
50 ppm Ethylhexylglyce rine ether 3 mol EO	43.2 4	49.5 3	15%	77.78	76.5 3	-2%	49.41	63.7 3	29%
50 ppm Ethylhexylglyce rine ether 5 mol EO	43.3 7	50.7 7	17%	77.92	78.3	0%	49.12	64.1	30%
50 ppm Ethylhexylglyce rine ether 7 mol EO	43.2 5	50.0 8	16%	77.85	77.8	0%	49.18	64.8 6	32%
50 ppm Ethylhexylglyce rine ether 9 mol EO	43.6	52.7 8	21%	77.82	78.8 8	1%	49.05	66.2	35%
100 ppm Ethylhexylglyce rine ether 1 mol EO	43.3 6	50.7 8	17%	78.09	77.5 7	-1%	49.25	64.1 8	30%
100 ppm Ethylhexylglyce rine ether 3 mol EO	43.5 5	50.6 9	16%	78.12	77.3 3	-1%	49.18	62.5 3	27%
100 ppm Ethylhexylglyce rine ether 5 mol EO	43.3 1	52.0 9	20%	78.12	78	0%	49.09	69.3 7	41%
100 ppm Ethylhexylglyce rine ether 7 mol	43.5 9	50.8	17%	78.12	78.3 6	0%	49.05	66.2 1	35%

EO									
100 ppm Ethylhexylglyce rine ether 9 mol EO	43.2 7	51.9	20%	78.05	78.6 6	1%	49.17	65.1 2	32%

TABLE 11B (17 gpg)

	EMP A 106 Before	EMP A 104 After	EMP A 101 % remov al	Before	After	% remov al	Before	After	% remov al
50 ppm Surfonic 24-3	57.6 8	65.3 8	13%	40.14	45.2 2	13%	46.2 7	53.9 3	17%
50 ppm Surfonic 24-5	58.1 4	64.2 5	11%	40.4	50.6 5	25%	45.9 6	56.9 2	24%
50 ppm Surfonic 24-7	57.9	67.9 7	17%	39.8	49.4 4	24%	45.8 1	56.9 4	24%
50 ppm Surfonic 24-9	58.4 4	64.4 7	10%	40.27	48.7 7	21%	46.0 5	57.3 5	25%
100 ppm Surfonic 24-3	57.9 2	66.7 3	15%	40.14	47.2 7	18%	45.7 1	54.8 5	20%
100 ppm Surfonic 24-5	58.5 9	65.5	12%	40.18	49.9 2	24%	47	58.7 9	25%
100 ppm Surfonic 24-7	57.6 2	65.9 9	15%	40.05	51.2 1	28%	46.3 3	58.3 8	26%
100 ppm Surfonic 24-9	58.3	67.6 5	16%	40.11	50.7 2	26%	46.1 7	60	30%
50 ppm Ethylhexylglyce rine ether 1 mol EO	59.1 5	62.9 5	6%	40	45.7 7	14%	47.2 7	56.2 6	19%
50 ppm Ethylhexylglyce rine ether 3 mol EO	57.7 8	65.6 1	14%	40.07	46.2 4	15%	46.2	54.1 3	17%
50 ppm Ethylhexylglyce rine ether 5 mol EO	58.4 5	65.8 9	13%	40.23	46.3 4	15%	47.2 6	56.2 3	19%
50 ppm Ethylhexylglyce rine ether 7 mol EO	57.9 2	64.5 2	11%	39.81	45.8 8	15%	46.9	56.1 4	20%
50 ppm Ethylhexylglyce rine ether 9 mol	59.0 9	64.4 7	9%	40.09	47.6 8	19%	47.1	57.2	21%

EO									
100 ppm Ethylhexylglyce rine ether 1 mol EO	59.0 1	63.3 2	7%	40.11	46.2 6	15%	46.8 7	55.2 3	18%
100 ppm Ethylhexylglyce rine ether 3 mol EO	58.6 6	63.6 5	9%	40.09	45.4 2	13%	47	55.7	19%
100 ppm Ethylhexylglyce rine ether 5 mol EO	58.7 5	65.4 6	11%	39.86	47.2 4	19%	46.2 4	55.8 5	21%
100 ppm Ethylhexylglyce rine ether 7 mol EO	59.1 1	64.7 1	9%	40.09	46.8	17%	46.2 6	55.4 6	20%
100 ppm Ethylhexylglyce rine ether 9 mol EO	59.4	65.4	10%	39.82	46.0 4	16%	47.0 9	56.7 3	20%

As shown in Tables 10-11 the solfactant laundry detergent compositions provided at least substantially similar cleaning efficacy as the conventional Surfonic®-based compositions. Beneficially, in addition to the cleaning efficacy, the solfactants further enable increased concentrations of the laundry formulations due to the low viscosity that results from use of the solfactants.

#### EXAMPLE 9

The glycerin ether ethoxylate solfactants were also formulated into sanitizing compositions employing quaternary ammonium cations, such as shown in the concentrate formula of Table 12.

TABLE 12

Component	Solfactant Formula wt-%
Water	41.75
Bardac 205M (Quat sanitizer)	10.25

2 ethylhexyl glycerine ether (3 moles EO)	48
	100

As the solfactants are shown to provide beneficial cleaning on both red and black soils (see Example 4), the further formulation into sanitizing compositions with quaternary ammonium cations provides the additional benefit of allowing simultaneous cleaning and sanitizing in a single composition. Without being limited to a particular theory and/or mechanism of action of the present invention, the solfactant-based quat composition does not form micelles with the quaternary ammonium cations, as occurs with ethoxylated alcohols (*e.g.* Tomadol) and various other surfactant classes. In addition, the various formulations according to the invention, including for example CIP cleaning and/or sanitizing compositions, illustrate further benefits of the solfactants according to the invention; namely the highly concentrated use of the glycerin ether ethoxylates without forming gels and/or becoming too viscous. Instead, the compositions provide flowable and/or pourable compositions which can be further concentrated.

#### EXAMPLE 10

The water solubility of the glycerin ether ethoxylate solfactants were compared to conventional alcohol ethoxylate surfactants having equivalent degrees of ethoxylation (*e.g.* moles ethoxylation), as shown in Table 13.

TABLE 13

Moles of ethoxylation	Surfactant / Solfactant	% Soluble
Zero	2 Ethylhexano	Insoluble
Zero	2 Ethylhexyl glycerin ether	Insoluble
1 mole	2 Ethylhexyl 1 mole	Insoluble
1 mole	2 Ethylhexyl glycerine	Insoluble

	ether 1 mole	
3 moles	2 Ethylhexyl 3 mole	Insoluble
3 moles	2 Ethylhexyl glycerine ether 3 mole	100%
5 moles	2 Ethylhexyl 5 mole	Partially soluble
5 moles	2 Ethylhexyl glycerine ether 5 mole	100%

### EXAMPLE 11

Differential Scanning Calorimetry (DSC) was run on the various 2-Ethyl  
 5 Hexanol Glycerin Ether Ethoxylate solfactants set forth in Table 1. The DSC  
 evaluated additional properties of the exemplary set of novel solfactants, namely the  
 freezing point of the molecules.

The DSC utilized can be measured down to minus 80°C for determining a  
 freeze or melt points of a liquid. As shown in FIGS. 4A-4E, all evaluated glycerin  
 10 ether ethoxylates remained liquids without freezing down to the measured minus  
 80°C, including 2-Ethyl Hexanol Glycerin Ether Ethoxylate (1 mole) (FIG. 4A), 2-  
 Ethyl Hexanol Glycerin Ether Ethoxylate (3 moles) (FIG. 4B), 2-Ethyl Hexanol  
 Glycerin Ether Ethoxylate (5 moles) (FIG. 4C), 2-Ethyl Hexanol Glycerin Ether  
 Ethoxylate (7 moles) (FIG. 4D), and 2-Ethyl Hexanol Glycerin Ether Ethoxylate (9  
 15 moles) (FIG. 4E). This is distinct from conventional alcohol ethoxylates (having  
 equivalent degrees of ethoxylation) which have very high melt points. For example,  
 many conventional alcohol ethoxylate surfactants have melt points at room  
 temperature or higher, resulting in the compositions being solids at room  
 temperature. In addition, as one skilled in the art ascertains, the more ethyl oxide  
 20 you add to a standard alcohol ethoxylate, the higher the melt point. This is distinct  
 from the solfactants according to the invention, including the 2-Ethyl Hexanol  
 Glycerin Ether Ethoxylate solfactants set forth in Table 1. For example, Tomadol



24-9 is a solid at room temperature, whereas the equivalent 2EHGE 9 mole is a liquid at room temperature.

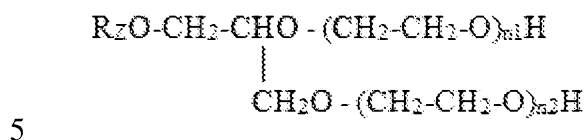
This data demonstrates a further beneficial characteristic of the surfactants according to the invention, namely their stability in low temperature formulations.

- 5 Unlike conventional ethoxylated alcohol surfactants, the glycerin ether ethoxylate surfactants according to the invention may be included in a broad range of formulations and applications of use under low temperatures.

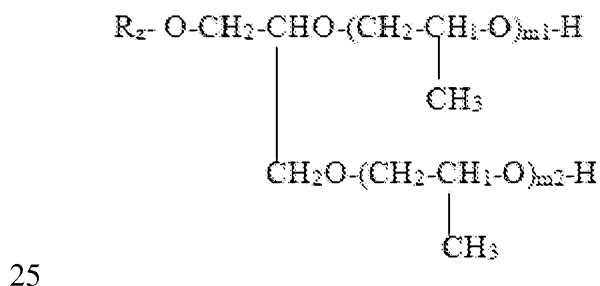
- 10 The above specification provides a description of the manufacture and use of the disclosed compositions and methods. The inventions being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the inventions and all such modifications are intended to be included within the scope of the following claims.

What is claimed is:

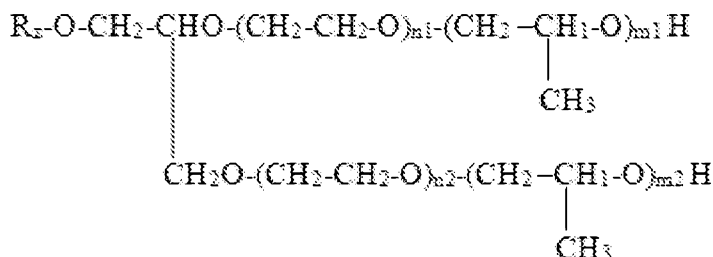
1. A surfactant composition comprising:  
a compound according to the following formula:



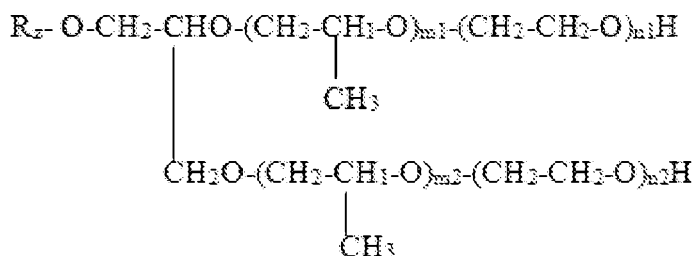
2. The composition of claim 1, wherein  $R_Z$  is a branched or linear alkyl group having 1 to 25 carbon atoms.
- 10 3. The composition of claim 1, wherein  $R_Z$  is a branched or linear alkyl group having 1 to 25 carbon atoms and does not form a gel when combined with any concentration of water.
4. The composition of claim 1, wherein  $n_1$  and/or  $n_2$  is 1 to 25, and wherein the  
15 degree of ethoxylation may vary between the two ethoxylated tails of the surfactant composition.
5. The composition of claim 4, wherein  $n_1$  and/or  $n_2$  is 1 to 10 and wherein the  
20 surfactant has a molecular weight from about 200 to about 10,000 and is a substitute for alcohol ethoxylates.
6. The composition of claim 1, wherein the compound has one of the following formulas:



wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms, and  $m_1$  and/or  $m_2$  is from 1 to 25; or



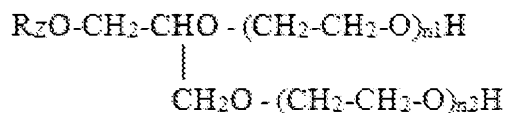
wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms,  $n_1$  and/or  $n_2$  is from 1 to 25, and  $m_1$  and/or  $m_2$  is from 1 to 25; or



wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms,  $n_1$  and/or  $n_2$  is from 1 to 25, and  $m_1$  and/or  $m_2$  is from 1 to 25.

10

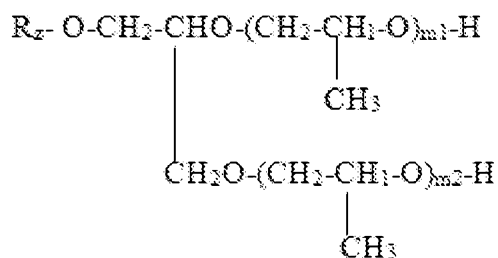
7. A surfactant composition comprising:  
a compound according to the following formula:



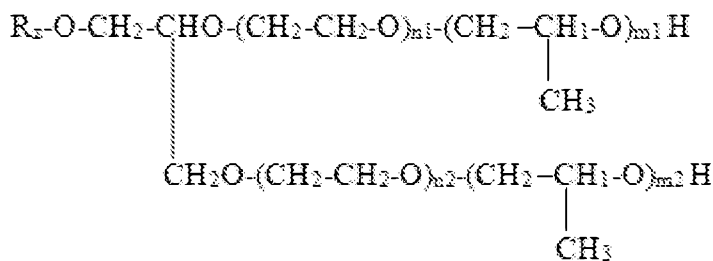
15 wherein:  $R_Z$  is a branched or linear alkyl group having 1 to 25 carbon atoms;  
 $n_1$  and/or  $n_2$  is 1 to 20;  
the molecular weight of the surfactant is from about 200 to about 10,000; and  
the compound is at least partially water soluble.

20

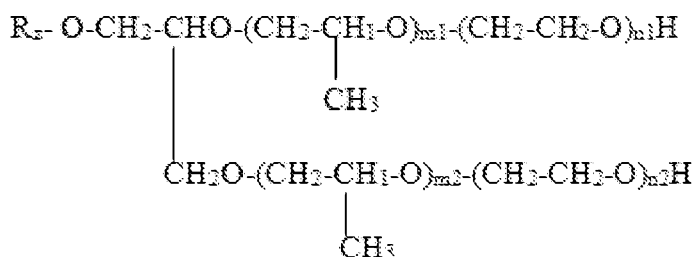
8. The composition of claim 7, wherein  $R_Z$  is a branched or linear alkyl group having 1 to 20 carbon atoms.
9. The composition of claim 7, wherein the degree of ethoxylation varies between the two ethoxylated tails of the surfactant composition.
10. The composition of claim 7, wherein  $n_1$  and/or  $n_2$  is 1 to 25.
11. The composition of claim 7, wherein the compound has one of the following formulas:



wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms, and  $m_1$  and/or  $m_2$  is from 1 to 25; or



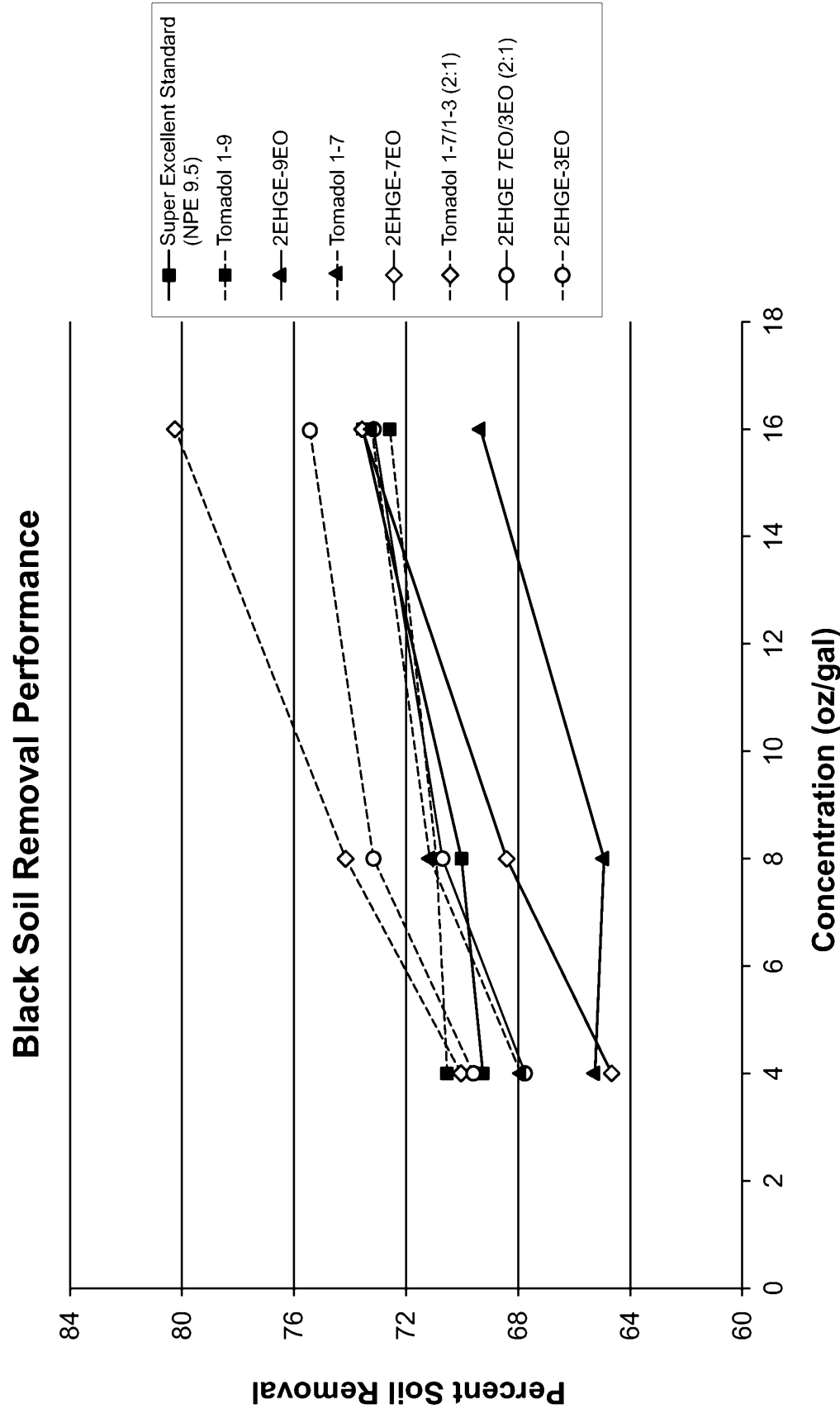
wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms,  $n_1$  and/or  $n_2$  is from 1 to 25, and  $m_1$  and/or  $m_2$  is from 1 to 25; or



wherein  $R_Z$  is a linear or branched alkyl group having 1 to 20 carbon atoms,  $n_1$  and/or  $n_2$  is from 1 to 25, and  $m_1$  and/or  $m_2$  is from 1 to 25.

- 5 12. A method of employing a solfactant comprising:  
contacting a surface, article and/or substrate with the solfactant of claim 7 or a composition containing the solfactant of claim 7.
- 10 13. The method of claim 12, wherein the solfactant is combined with one or more agents selected from the group consisting of surfactant, oxidizing agent, quaternary ammonium compound, stabilizing agent, chelating agent, hydrotrope, solvent, diluent, acidulant, emollient, dye, pigment and combinations thereof.
- 15 14. The method of claim 12, wherein the surface is contacted by a use solution of a composition containing the solfactant with a concentrate diluted to 0.1 g/L to 100 g/L.
- 20 15. The method of claim 12, wherein the solfactant is provided in a use composition, wherein said composition is selected from the group consisting of: a hard surface cleaning composition, a laundry detergent cleaning composition, a ware wash detergent composition, a rinse additive composition, a hand care detergent composition, an air freshening composition, a disinfecting composition, a vehicle cleaning composition, a degreasing composition, a floor cleaning composition, and a CIP detergent composition.
- 25 16. The method of claim 12, wherein a use composition is applied at a temperature of from about 4°C to about 60°C.

17. The method of claim 12, wherein the surface is a floor, countertop, sink or other architectural hard surface.
18. The method of claim 12, wherein the article or surface is ceramic, glass,  
5 metal, wood or hard plastic.
19. The method of claim 12, wherein the substrate is a fabric or textile.
20. The method of claim 12, wherein the composition containing the surfactant is  
10 a form selected from the group comprising: a gel, a liquid, a foam, an aerosol, a gas, a wax, a solid and a powder.
21. The method of claim 12, wherein the composition containing the surfactant is  
15 an antimicrobial, sterilant, sanitizer, disinfectants, preservative, deodorizer, antiseptic, fungicide, germicide, sporicide, virucide, detergent, bleach, hard surface cleaner, hand soap, waterless hand sanitizer, pre- or post-surgical scrub, veterinary product, food and/or processing treatment product, plant and/or processing treatment product, water treatment, industrial process treatment, textile detergent, paint, glue, lubricant, coolant, fiber glass sizing composition, drilling fluid, gas hydrate  
20 inhibitor, corrosion inhibitor, personal care composition or the like.



**FIG. 1**

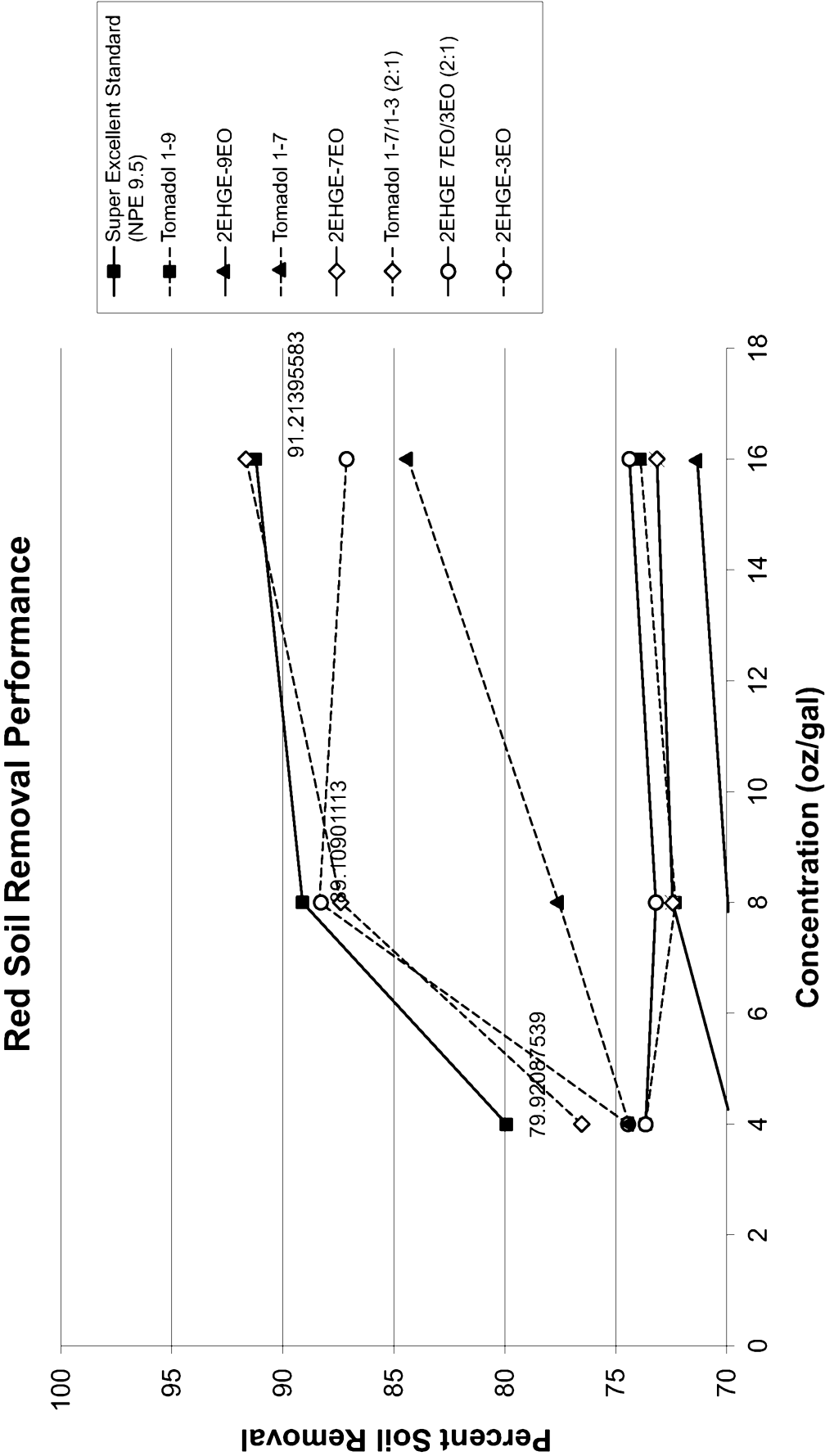


FIG. 2



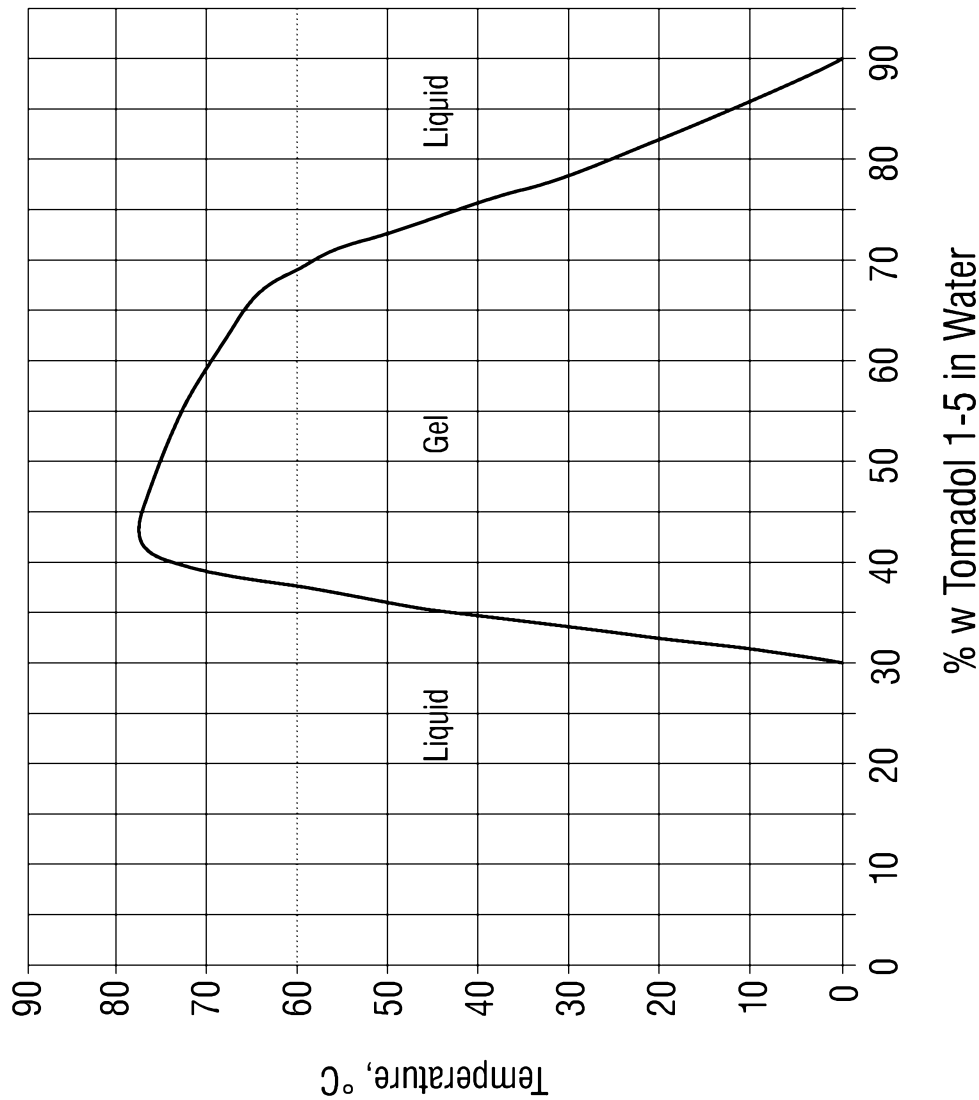


FIG. 3A

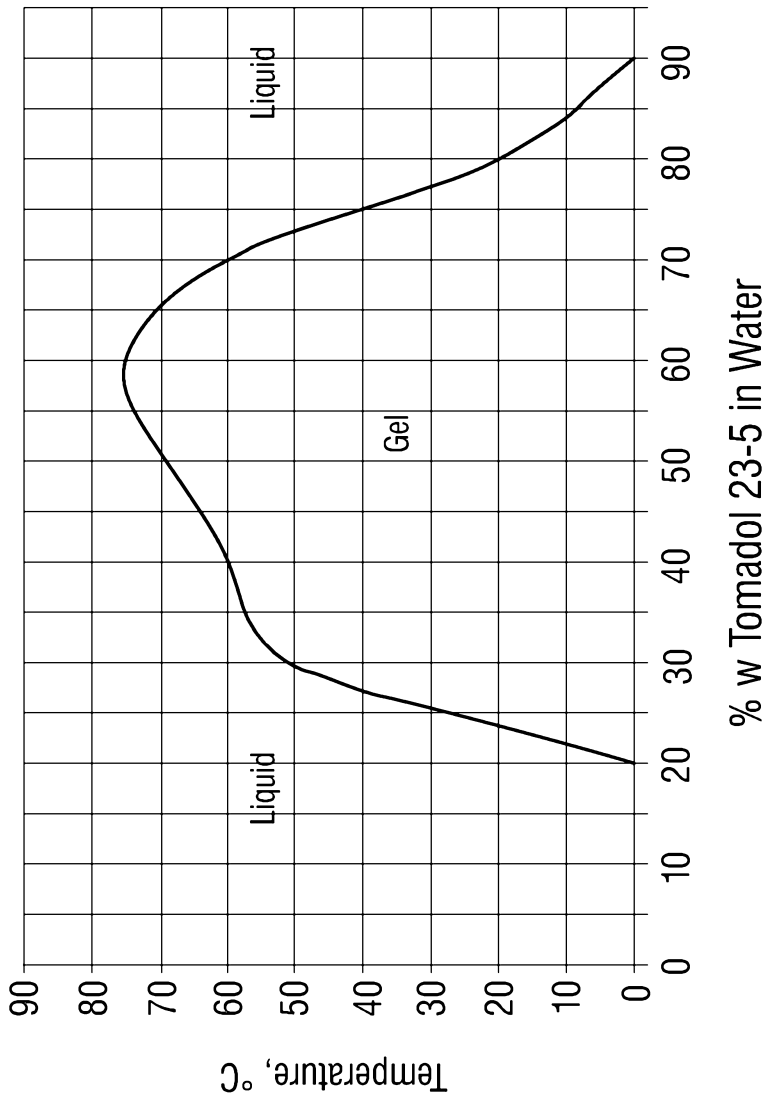


FIG. 3B

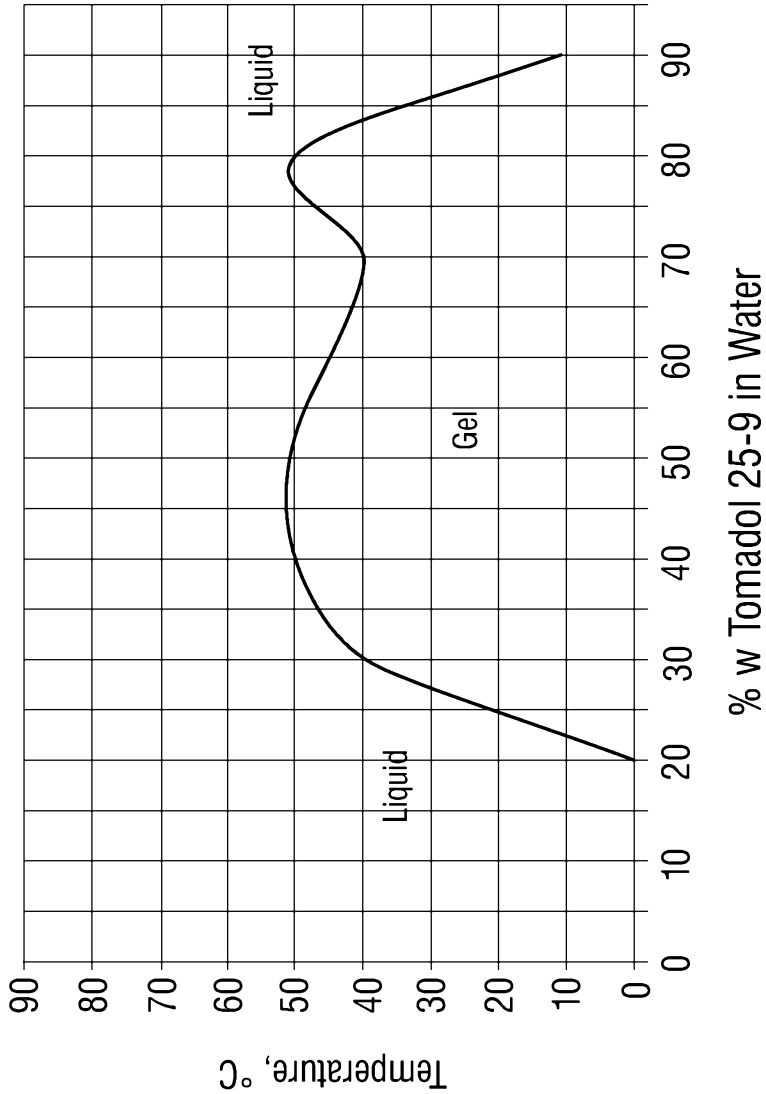


FIG. 3C

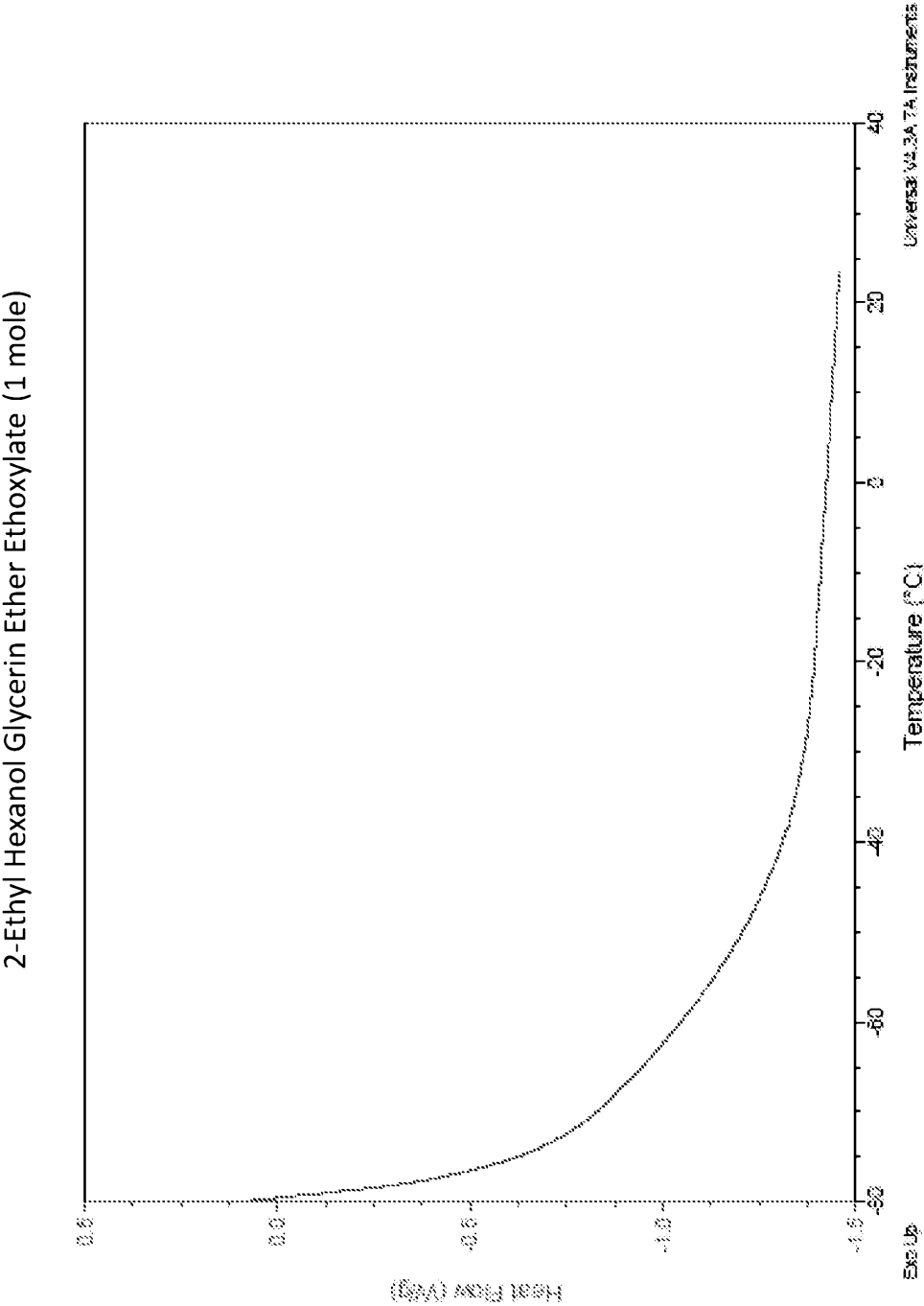


FIG. 4A

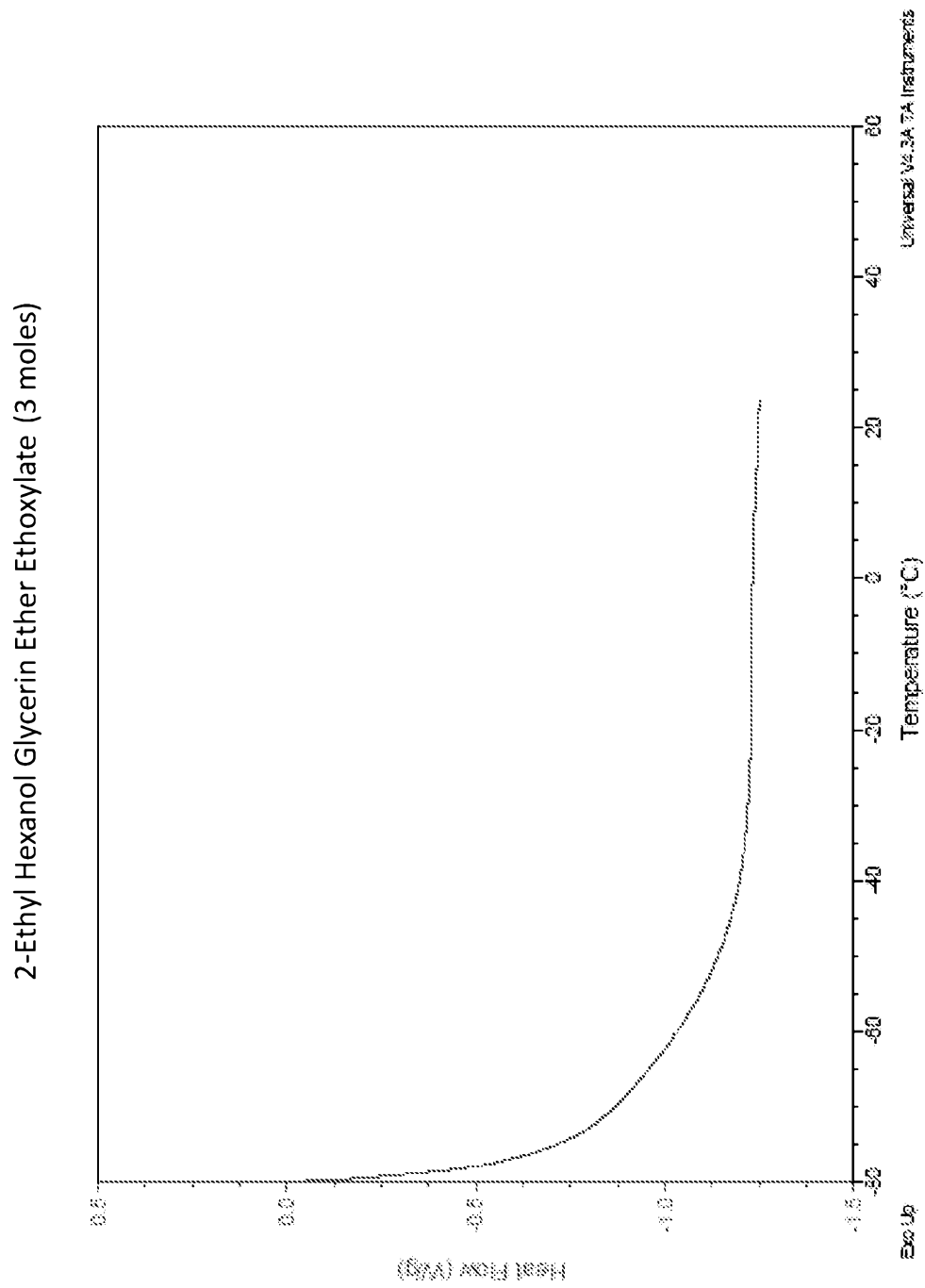


FIG. 4B

2-Ethyl Hexanol Glycerin Ether Ethoxylate (5 moles)

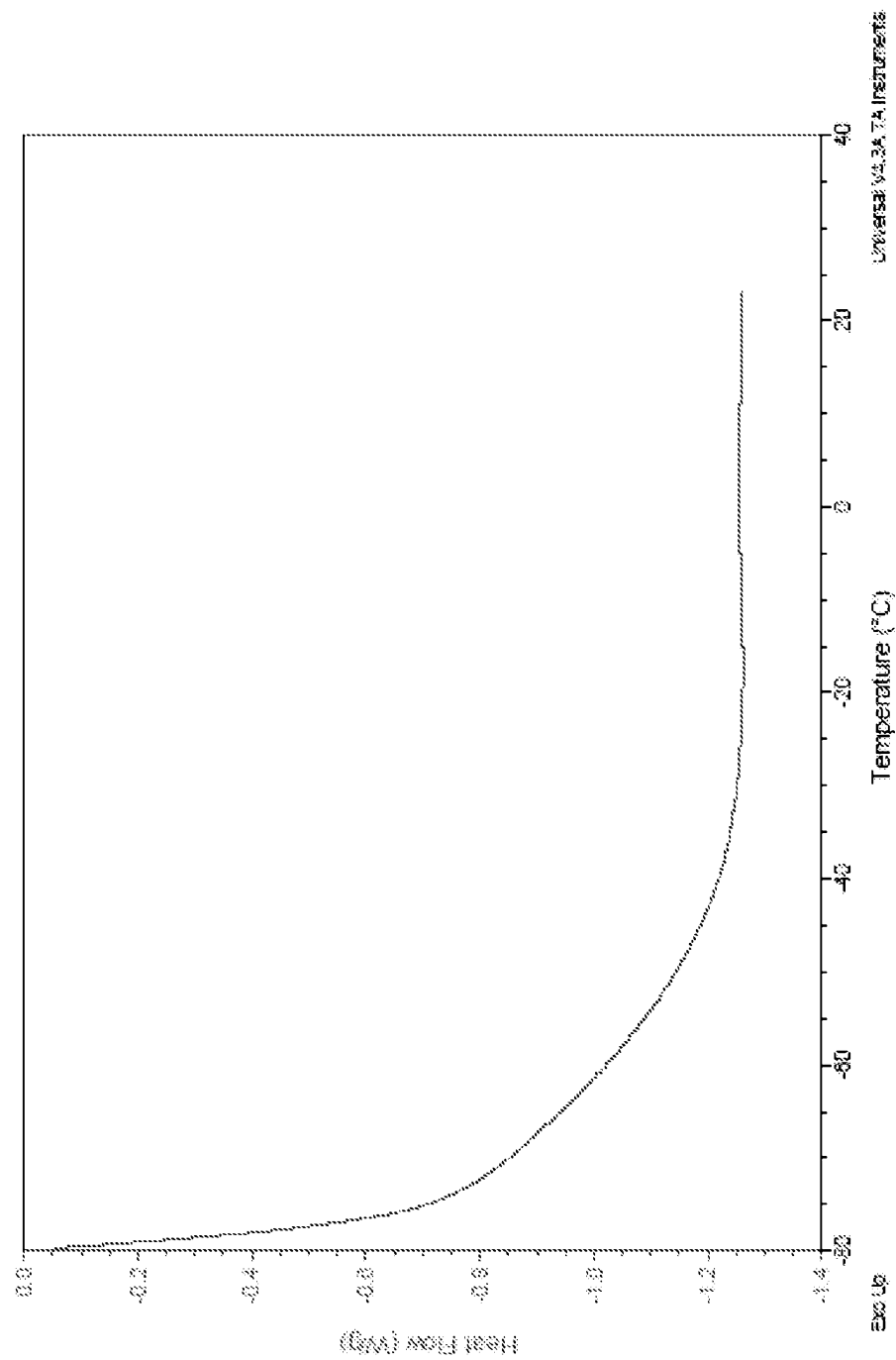


FIG. 4C

2-Ethyl Hexanol Glycerin Ether Ethoxylate (7 moles)

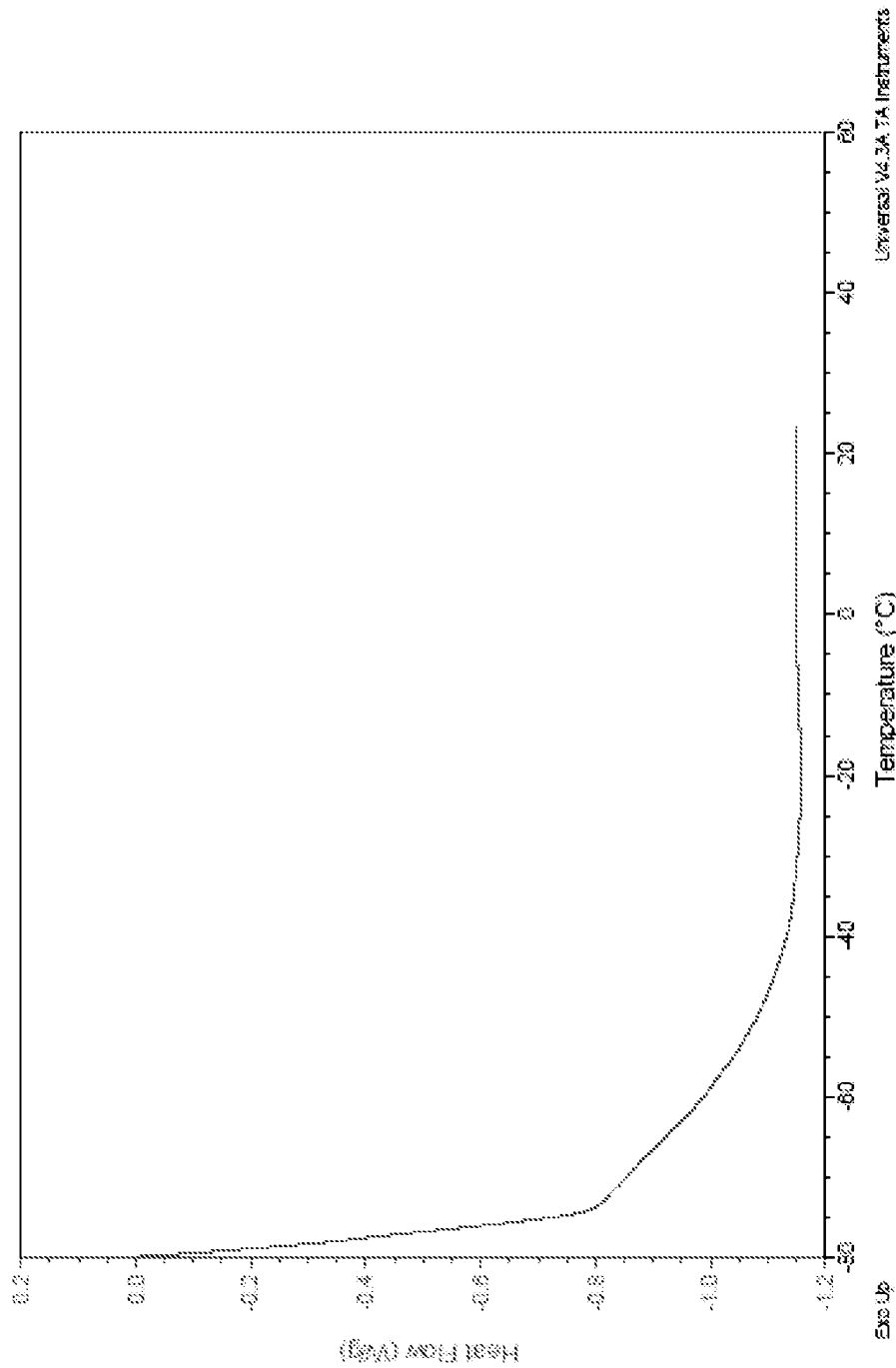


FIG. 4D

2-Ethyl Hexanol Glycerin Ether Ethoxylate (9 moles)

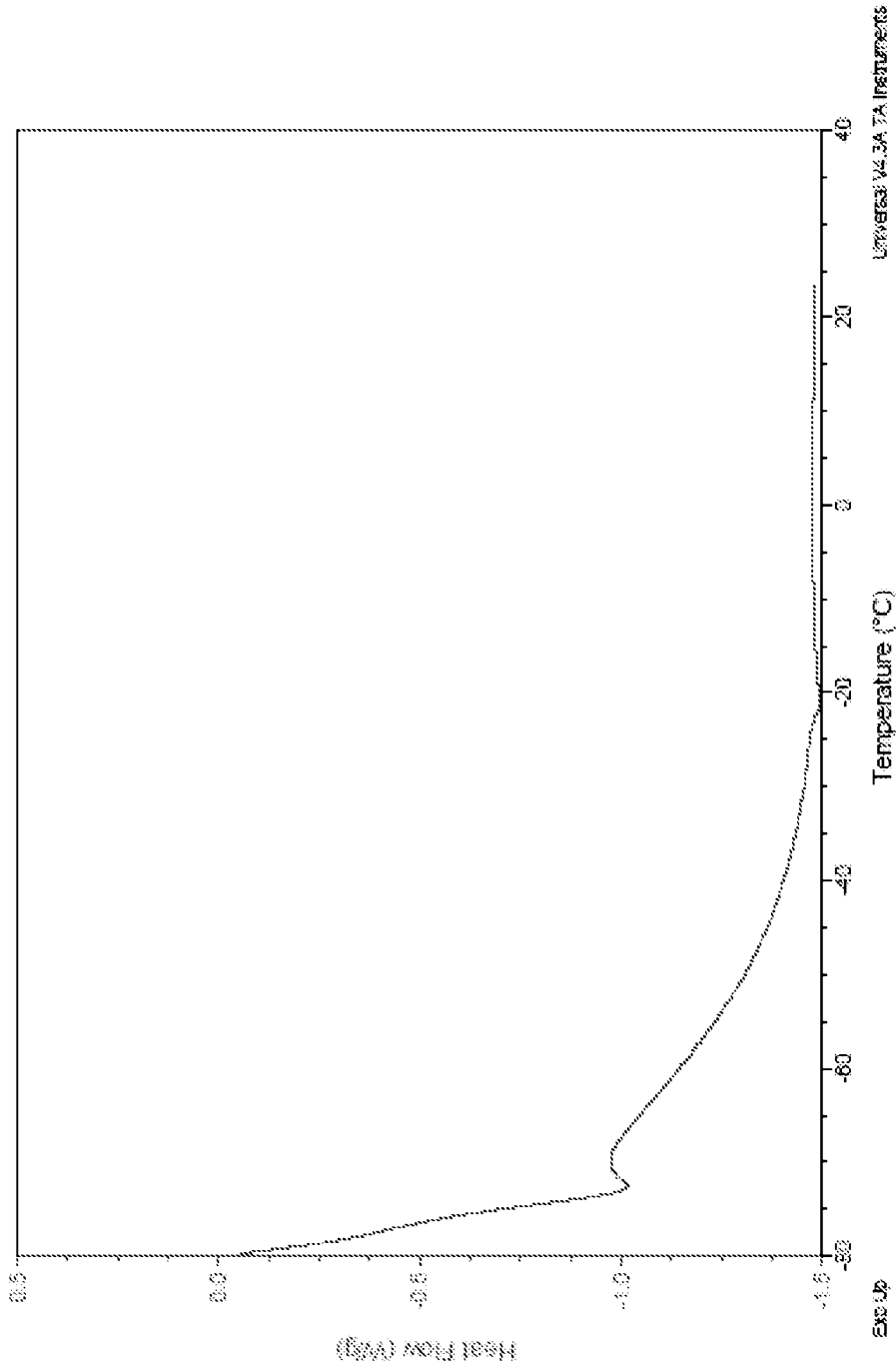


FIG. 4E