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11 Publication number:

**0 687 720 A2**

12

**EUROPEAN PATENT APPLICATION**21 Application number: **95109017.4**51 Int. Cl.<sup>6</sup>: **C11D 1/00, C11D 1/825**22 Date of filing: **12.06.95**30 Priority: **14.06.94 US 261145**  
**14.06.94 US 261144**43 Date of publication of application:  
**20.12.95 Bulletin 95/51**84 Designated Contracting States:  
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**D-67056 Ludwigshafen (DE)**54 **Composition for machine dishwashing and rinsing comprising a blend of nonionic surfactants**

57 A machine dishwashing composition is provided wherein two specifically defined nonionic surfactants are utilized which in combination have been shown through empirical research to surprisingly yield improved results. One of the nonionic surfactants is an alcohol alkoxylate (as defined) and the other nonionic surfactant is a block copolymer of ethylene oxide and propylene oxide (as defined). The use temperature for efficient cleaning while using the composition extends over a broad range up to at least 140 °F. in the absence of deleterious foaming even in the presence of protein soil (e.g., egg and/or milk soil).

Further, an aqueous rinse-aid composition for kitchen utensils is provided wherein an anionic hydrotrope and a blend of two specifically defined nonionic surfactants are utilized which has been shown through empirical research to surprisingly yield improved results. One of the nonionic surfactants is an alcohol alkoxylate (as defined) and the other nonionic surfactant is a block copolymer of ethylene oxide and propylene oxide (as defined). The composition is suitable for use at a temperature of up to at least 180 °F. in the absence of excessive foaming, spotting and film formation. The components of the composition exhibit good compatibility during storage even if elevated temperatures are experienced thereby maintaining reliable performance upon usage. Rapid high velocity rinsing at a high temperature is made possible in the absence of deleterious foam generation to yield dishes and tableware that can be readily dried without the need for the time consuming hand removal of deleterious spots and/or film.

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Machine dishwashing compositions comprising one or more nonionic surfactants long have been known and are commercially available. For optimum results the detergent composition should be capable of adequate soil removal when used under the varied conditions commonly encountered by the consumer in a typical household machine dishwasher. The operating conditions commonly encountered in household dishwashers used by the public frequently encompass a range of diverse operating temperatures that often are influenced by the temperature of the water currently being supplied by the household hot-water heater for the diverse hot-water requirements of the home. At a time of high demand for hot water within the household, the water temperature may be considerably lower than when there is no competition for the finite supply of hot water. It further is recognized that optimum soil removal commonly is achieved at higher water temperatures. Additionally, it is recognized that certain types of soils, such as protein soil from eggs and/or milk products, in conjunction with the detergent, can enhance the generation of harmful quantities of foam within the dishwasher that serve to impede the removal of soil from dishes by reducing the impact of a stream of water thrown by the spray arm or impeller of the dishwasher.

Representative nonionic surfactants for use in machine dishwashing compositions are disclosed in U.S. Patent Nos. 4,306,987; 4,411,810; and 4,438,014. Additionally, U.S. Patent No. 4,272,394 discloses a surfactant composition comprising a blend of nonionic surfactants.

Aqueous rinse-aid compositions for use in the home or in industrial/institutional applications following the washing of kitchen utensils also long have been known and are commercially available. Such compositions promote rapid draining after the washing is complete and serve to yield easily dryable dishes through the modification of surface tension so that the wash liquid readily flows away. The rinse-aid compositions offer considerable savings in labor to restaurants and institutions where large quantities of dishes and tableware are routinely washed and dried as expeditiously as possible while fully utilizing the finite level of equipment and space that is available. In the past, such rinse-aid compositions commonly have included a surfactant and a hydrotrope (e.g., an anionic hydrotrope) in order to further increase the solubility of the surfactant in water. The hydrotrope commonly adds appreciably to the cost of producing the desired rinse-aid composition particularly when it is present in a large concentration. Rinsing preferably is conducted with vigor in order to increase its effectiveness, and preferably is conducted at elevated temperatures that will better facilitate the removal of remaining traces of the liquid from the surfaces of hot tableware and dishes via volatilization. Also, it is desired that the rinse-aid composition minimize the formation of visually unattractive spots and/or film on the dishes and tableware. However, vigorous rinsing conditions commonly lead to increased foaming which may promote objectionable spotting and film formation. Also, some previously available rinse-aid compositions exhibit stability problems upon storage particularly if heat such as is common in a kitchen environment is encountered prior to use. This can lead to a lack of homogeneity and erratic rinse results when the use of the resulting composition is attempted by kitchen workers without due regard to instability that may have occurred in the rinse-aid composition that is being provided for their use.

Representative nonionic surfactants for rinse-aid compositions are disclosed in U.S. Patent Nos. 4,306,987; 4,411,810 and 4,438,014. Additionally, U.S. Patent No. 4,272,394 discloses a surfactant composition comprising a blend of nonionic surfactants.

Representative previously available rinse-aid compositions are disclosed in U.S. Patent Nos. 3,082,172; 3,563,901; 4,443,270; and 4,678,596. See also, the article by Jay G. Otten and Christine L. Nestor, entitled "Anionic Hydrotropes for Industrial and Institutional Rinse Aids", JAOCS, Vol. 63, No. 8, Pages 1078 to 1081 (August 1986).

It is an object of the present invention to provide an improved aqueous machine dishwashing composition that exhibits good soil removal properties and effective protein soil defoaming over an expanded range of operating temperatures.

It is an object of the present invention to provide an improved aqueous machine dishwashing composition that is suitable for use at a temperature of up to at least 140 °F. in the absence of deleterious foaming even in the presence of protein soil sometimes encountered during the washing of household dishes.

It is an object of the present invention to provide an improved aqueous machine dishwashing composition that in a preferred embodiment is free of an alkyl phosphate ester defoamer.

It is an object of the present invention to provide an improved aqueous rinse-aid composition that is relatively stable upon storage and is suitable for use at a temperature of up to at least 180 °F.

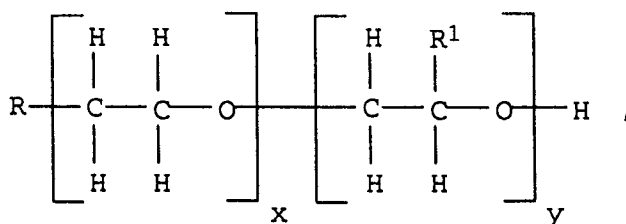
It is an object of the present invention to provide an improved aqueous rinse-aid composition that is suitable for use with vigorous application at a temperature of up to at least 180 °F. in the absence of excessive foaming.

It is an object of the present invention to provide an improved aqueous rinse-aid composition wherein in a preferred embodiment the usage of a high concentration of a hydrotrope is unnecessary.

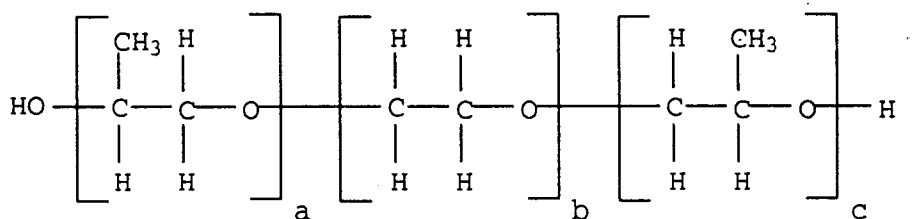
It is an object of the present invention to provide an improved aqueous rinse-aid composition that can be utilized in the absence of excessive spotting and film formation on the tableware and dishes following rinsing.

These and other objects and advantages of the claimed invention will be apparent to those skilled in the art from the following detailed description and appended claims.

It has been found that an improved composition for machine dishwashing and rinsing comprises approximately 1 to 80 percent by weight based upon the total weight of the composition of a blend of nonionic surfactants (i) and (ii), wherein (i) is an alcohol alkoxyate surfactant having a molecular weight of approximately 500 to 2,000 and the structural formula:

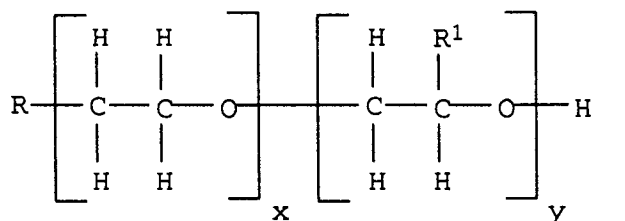


wherein R is an alkyl group of 6 to 18 carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3, and y is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:

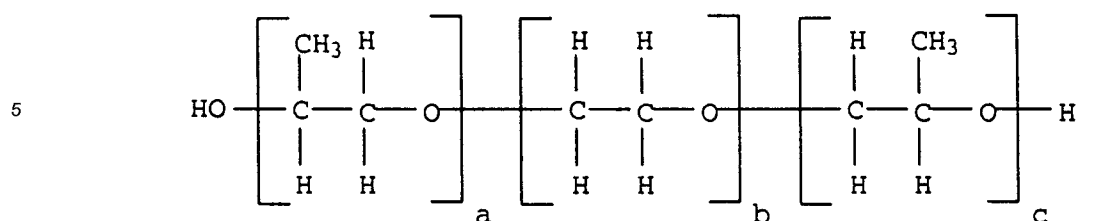


wherein a + c equals at least 20, and b is at least 20.

It has also been found that an improved machine dishwashing composition suitable for use in water at a temperature of up to at least 140 °F. in the absence of excessive foaming even in the presence of protein soil consists essentially approximately 1 to 10 percent by weight based upon the total weight of the composition of a blend of nonionic surfactants (i) and (ii), wherein (i) is an alcohol alkoxyate surfactant having a molecular weight of approximately 300 to 2,000 and the structural formula:



wherein R is an alkyl group of 6 to 18 carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3, and y is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:



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wherein a + c equals at least 20, and b is at least 20; approximately 10 to 90 percent by weight based upon the total weight of the composition of at least one builder detergent; and approximately 0.5 to 50 percent by weight based upon the total weight of the composition of at least one compound containing active chlorine or available oxygen.

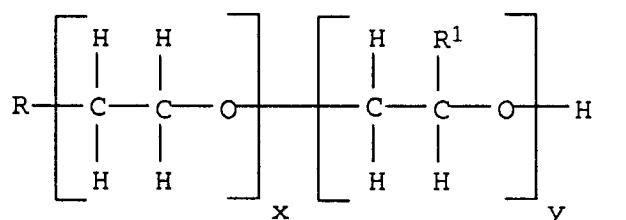
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All weight percentages expressed herein are based upon the total weight of nonaqueous components present in the composition unless otherwise expressed.

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It has also been found that an improved aqueous rinse-aid composition suitable for use at a temperature of up to at least 180°F. in the absence of excessive foaming, spotting and film formation consists essentially of approximately 0.75 to 5 percent by weight of an anionic hydrotrope, and a blend of nonionic surfactants (i) and (ii) in a concentration of approximately 10 to 80 percent by weight, wherein (i) is an alcohol alkoxyate surfactant having a molecular weight of approximately 500 to 2,000 and the structural formula:

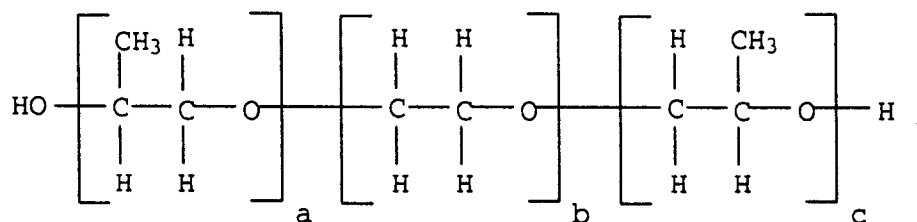
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wherein R is an alkyl group of 6 to 18 carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3, and y is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:

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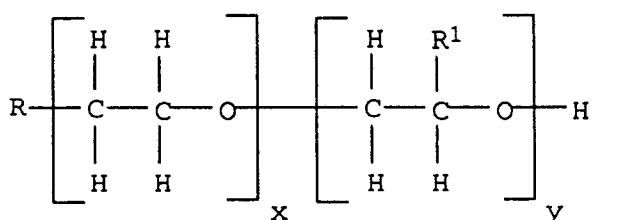


wherein a + c equals at least 20, and b is at least 20.

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The first nonionic surfactant (i) is an alcohol alkoxyate having a molecular weight of approximately 500 to 2,000 (preferably 1,200 to 1,600) and the structural formula A:

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10 wherein R is an alkyl group of 6 to 18 (preferably 8 to 10) carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3 (e.g., 3 to 12), and y is at least 2 (e.g., 2 to 18).

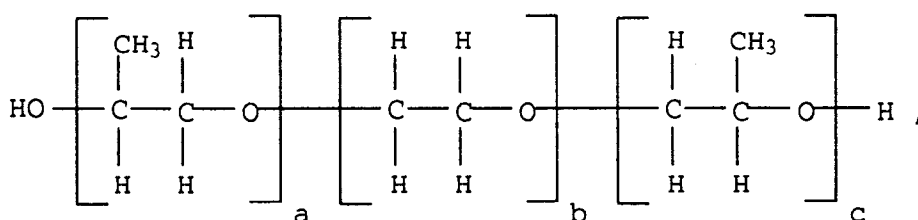
The alkyl groups R of nonionic surfactant (i) can be branched- or straight-chained. Representative examples of preferred alkyl groups include hexyl, octyl, decyl, dodecyl, and mixtures of these.

15 The recurring oxyethylene units in nonionic surfactant (i) designated by x are derived from ethylene oxide and impart hydrophilic moieties to the surfactant. The recurring units y are derived from propylene oxide and/or butylene oxide and impart hydrophobic moieties to the surfactant. In a preferred embodiment R<sup>1</sup> is methyl and the recurring units y are derived exclusively from propylene oxide.

20 The nonionic surfactant (i) can be formed by known techniques wherein a monofunctional initiator (e.g., a monohydric alcohol, such as octyl alcohol and/or decyl alcohol) from which the R portion of the surfactant molecule is derived is first reacted with ethylene oxide and subsequently with propylene oxide and/or butylene oxide. The recurring units x and y commonly are selected so that the weight of the oxyethylene units x constitutes approximately 25 to 45 percent by weight based upon the total weight of nonionic surfactant (i). In a preferred embodiment the recurring units x and y are selected so that the weight of the oxyethylene units x constitutes approximately 30 percent by weight based upon the total weight of nonionic surfactant (i).

25 Nonionic surfactant (i) preferably exhibits a cloud point of no more than approximately 20°C (e.g., approximately 10 to 20°C). Such cloud point conveniently can be determined while observing a 1 weight percent aqueous solution of the surfactant in accordance with conventional procedures.

30 The second nonionic surfactant (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 (preferably 3,000 to 4,000, most preferably approximately 3,200) and the structural formula B:



35 wherein the outermost blocks of the surfactant structure are derived from propylene oxide and are hydrophobic in nature, and the central block is derived from ethylene oxide and is hydrophilic in nature. In the structural formula a + c equals at least 20 (e.g., 20 to 40, and preferably 25 to 36), and b is at least 20 (e.g., 20 to 35, and preferably 22 to 32). In the structural formula a and c individually commonly are at least 10. In a particularly preferred embodiment a and c are substantially equal. Also, in a preferred embodiment the units b derived from ethylene oxide of the nonionic surfactant (ii) are present in a concentration of approximately 30 to 50 (e.g., 40) percent by weight based upon the total weight of nonionic surfactant (ii).

40 The nonionic surfactant (ii) can be formed by conventional techniques, such as that described in U.S. Patent No. 2,674,619. Ethylene oxide can be added to ethylene glycol to provide a hydrophile of the desired molecular weight, and propylene oxide can next be added to obtain hydrophobic blocks at each end of the nonionic surfactant molecule.

45 Nonionic surfactant (ii) preferably exhibits a cloud point of approximately 30 to 50°C. Such cloud point conveniently can be determined while observing a 1 weight percent aqueous solution of the surfactant in accordance with conventional procedures.

50 The machine dishwashing composition of the present invention includes said blend of the two specifically defined nonionic surfactants (i) and (ii) that through empirical research has been found to yield

surprisingly advantageous dishwashing results wherein there is an absence of excessive foaming even at elevated use temperatures as discussed in detail hereafter.

The machine dishwashing composition of the present invention commonly contains a weight concentration of nonionic surfactant (i) to nonionic surfactant (ii) in the blend of nonionic surfactants of approximately 2 to 5:1, preferably approximately 3 to 5:1, and most preferably approximately 4:1. During the marketing and shipment of the surfactants, the surfactant blend conveniently can be provided as a concentrated aqueous solution wherein the nonionic surfactants (i) and (ii) are provided in a combined concentration of approximately 80 percent or more by weight. In a further embodiment the dishwashing composition conveniently can be marketed as a free-flowing granular product that includes nonionic surfactants (i) and (ii). Alternatively, the surfactants can be individually obtained and combined with the other ingredients of the dishwashing composition when added to the machine dishwasher.

The dishwashing composition of the present invention commonly contains the blend of nonionic surfactants (i) and (ii) in a combined concentration of approximately 1 to 10 percent by weight based upon the total weight of nonaqueous components, and preferably surfactants (i) and (ii) are present in a combined concentration of approximately 1 to 6 percent by weight based upon the total weight of nonaqueous components. When a phosphate builder detergent is present in the composition, a combined concentration of nonionic surfactants (i) and (ii) of approximately 1 to 3 percent by weight based upon the total weight of the non-aqueous components commonly is utilized. When no phosphate builder detergent or a phosphate builder detergent is utilized in a low concentration, a combined concentration of nonionic surfactants (i) and (ii) of approximately 3 to 6 percent by weight based upon the total weight of the nonaqueous components commonly is utilized.

The machine dishwashing composition of the present invention contains approximately 10 to 90 (e.g., 40 to 85) percent by weight of at least one builder detergent that increases the effectiveness of the composition by acting as a softener, sequestering, and/or buffering agent. Commonly one utilizes a combination of builder detergents, such as those commonly employed in the prior art. Representative builder detergents include phosphates, silicates, polyacrylic acid, ethylenediaminetetraacetic acid, zeolites, starch derivatives, etc. Further examples of possible builder detergents for use in the machine dishwashing composition of the present invention include tetrasodium pyrophosphate, sodium tripolyphosphate, sodium carbonate, sodium bicarbonate, mixtures of di- and trisodium orthophosphate, sodium metasilicate, sodium sequisilicate, borax, sodium borate, organic sequestering agents such as ethylenediamine tetraacetates, water-soluble salts of citric acid, tetrasodium ethylene diamine tetraacetate, nitriloacetic acid, etc.

Additionally, the machine dishwashing composition of the present invention contains approximately 0.5 to 50 (e.g., 1 to 5) percent by weight of at least one compound containing active chlorine or available oxygen. Such compound imparts germicidal and bleaching action to the composition. Representative active-chlorine containing compounds include chlorinated trisodium phosphate, trichlorocyanuric acid, sodium trichloroisocyanurate, the sodium salt of dichlorocyanuric acid, the potassium salt of dichlorocyanuric acid, sodium hypochlorite, and 1,3-dichloro-5,5-dimethylhydantoin. The amount of active chlorine or available oxygen provided by each compound will vary as will be apparent to those skilled in the art and the concentration will be selected so as to provide sufficient germicidal bleaching activity. For instance, much higher amounts of active chlorine are provided by a given concentration of a salt of a chlorinated cyanuric acid than by chlorinated trisodium phosphate. Representative compounds for the supply of available oxygen include the conventional peroxygen bleaching compounds, such as sodium perborate, sodium percarbonate, etc.

Other auxiliary components commonly utilized in dishwashing compositions may optionally also be included in the aqueous machine dishwashing composition of the present invention so long as such ingredients do not interfere with the surprising benefits made possible by the blend of nonionic surfactants (i) and (ii) discussed herein. Such optional additional ingredients include fillers (e.g., sodium sulfate), colorants, fragrance-release agents, etc. In a preferred embodiment, a phosphate ester defoamer is absent in the dishwashing composition of the present invention.

The machine dishwasher composition of the present invention commonly is contacted with food-soiled utensils during use when present in an aqueous solution in a concentration of about 0.1 to about 1.5 (e.g., 0.2 to 1) percent by weight at an elevated water temperature.

The dishwashing composition of the present invention provides the user with good cleaning ability for soiled dishes over a broad range of operating conditions up to at least 140 °F. For instance, satisfactory soil removal commonly is achieved at temperatures ranging from 80 °F. up to at least 140 °F. Even if protein-containing soil, such as that derived from eggs and/or milk products is encountered in the dishwasher, excessive foaming does not occur when utilizing the improved machine dishwashing composition of the present invention. Accordingly, excessive quantities of foam surprisingly are not generated even at elevated

temperatures. If such excessive quantities of foam were present, they would inhibit the cleaning of dishes through the at least partial blockage of the action of the surfactant-containing stream of water that is directed by the dishwasher's spray arm or impeller to impact upon the exposed surfaces of the dishes that are intended to be washed. Also, effective foam control is maintained even at lower dishwashing temperatures. Additionally, no potentially harmful phosphate ester defoamers need be utilized in the machine dishwashing composition of the present invention.

The aqueous home or industrial/institutional rinse-aid composition of the present invention constitutes an anionic hydrotrope and said blend of the two specifically defined nonionic surfactants (i) and (ii) that through empirical research has been found to yield surprisingly advantageous rinse results with the absence of excessive foaming, spotting and film formation even at elevated use temperatures as discussed in detail hereafter.

The aqueous rinse-aid composition of the present invention is capable of performing well over a range of rinse temperatures including an elevated temperature of up to at least 180 °F. For instance, under appropriate circumstances rinse temperatures within the range of approximately 90 °F. to approximately 180 °F. can be selected while utilizing the improved rinse-aid composition of the present invention.

The anionic hydrotrope commonly is provided in the aqueous rinse-aid composition of the present invention in a concentration of 0.5 to 5 percent by weight, and preferably in a concentration only 1 to 3 (e.g., 2 to 3) percent by weight. Representative anionic hydrotropes include alkylaryl sulfonates such as sodium xylene sulfonate, sodium dodecyl benzene sulfonate, linear alkyl naphthalene sulfonate, cumene sulfonate, etc.; alkyl sulfates such as sodium-2-ethylhexyl sulfate; dialkyl sulfosuccinates such as sodium dihexyl sulfosuccinate; and phosphate esters. In a particularly preferred embodiment the anionic hydrotrope is sodium dihexyl sulfosuccinate. Such particularly preferred hydrotrope is commercially available as an 80 percent aqueous concentrate from Mona Industries of Patterson, New Jersey under the designation of MONAWET® MM80 hydrotrope.

The aqueous rinse-aid composition of the present invention commonly contains a weight concentration of nonionic surfactant (i) to nonionic surfactant (ii) in the blend of nonionic surfactants of approximately 2 to 5:1, and preferably approximately 4:1. During the marketing and shipment of the surfactants, the surfactant blend conveniently can be provided as a concentrated aqueous solution wherein the nonionic surfactants (i) and (ii) are provided in a combined concentration of approximately 80 percent or more by weight. Alternatively, the hydrotrope and the surfactants can be individually obtained and combined at the time of the preparation of the aqueous rinse-aid composition that is intended for use by the user.

The aqueous rinse-aid composition that is introduced into a dishwasher at the conclusion of the wash cycle commonly contains the blend of nonionic surfactants (i) and (ii) in a combined concentration of approximately 10 to 80 percent by weight, and preferably surfactants (i) and (ii) are present therein in a combined concentration of approximately 15 to 40 (e.g., 10 to 30) percent by weight. In a particularly preferred embodiment surfactants (i) and (ii) are present in a combined concentration of approximately 20 percent by weight.

Other auxiliary components commonly utilized in rinse-aid compositions may also be included in the aqueous rinse-aid composition of the present invention in a minor total concentration up to about 10 percent by weight so long as such ingredients do not interfere with the surprising benefits made possible by the hydrotrope and the blend of nonionic surfactants (i) and (ii) as discussed herein. Such optional additional ingredients include isopropanol, ethanol, propylene glycol, hexylene glycol, 1,4-butanediol, urea, chelating agents, polyacrylic acids, colorants, fragrance-release agents, etc. As indicated in the Examples, no auxiliary components need be present in improved rinse-aid composition of the present invention.

The rinse-aid composition of the present invention provides the user with a generally homogeneous and relatively stable composition even when exposed to elevated temperatures and/or vigorous rinse conditions that commonly would lead to deleterious results when utilizing many available rinse-aid compositions of the prior art. Such composition of the present invention surprisingly may be utilized at a temperature of up to at least 180 °F. in the absence of excessive foaming, spotting and film formation. Kitchen utensils accordingly undergo drying in an expeditious manner to produce an attractive and acceptable product that is ready for future use with no or minimal handling by staff members. Good results are achieved even in presence of protein soil from the wash operation, such as that derived from egg and/or milk protein.

#### Examples for machine dishwashing compositions

The following Examples are presented as specific illustrations of the present invention. It should be understood, however, that the invention is not limited to the specific details set forth in the Examples. In the Examples and in the Comparative Examples dishes were washed in a standard Hobart UMP-4 commercial

dishwasher while using various nonionic surfactants (identified hereafter) individually and when blended in accordance with the concept of the present invention. In some instances egg soil or milk soil was added. In each instance, the nonionic surfactant or nonionic surfactant blend was provided in a concentration of 3 percent by weight based upon the total weight of the nonaqueous components of the dishwashing composition that was added to the water which circulated in the dishwasher during the wash cycle. Conventional builder salts in powder form were present in each instance (i.e., 44 percent by weight sodium tripolyphosphate, 20 percent by weight sodium carbonate, 20 percent by weight of sodium metasilicate), and a filler in powder form (i.e., 11.5 percent by weight sodium sulfate). Additionally, 1.5 percent by weight of sodium trichloroisocyanurate was present in each instance as an active chlorine-containing compound.

In each Example and Comparative Example the machine containing typical utensils (e.g., dishes, and flatware) was started and was allowed to fill partially with water, the machine was stopped, 20 grams of the dishwashing composition were added, and the machine was restarted and was allowed to fill completely. In some instances 15 grams of raw egg soil or 12 grams of milk soil also were added. The water temperature was provided at approximately 90 °F. or at approximately 140 °F. After the wash cycle was started, the spray arm rotation rate was measured and is expressed hereafter as a percentage relative to the rotation rate measured in water only. The foaming characteristics of the dishwashing composition were measured in each instance through an observation of the spray-arm rotation rate. Such spray-arm rotation rate was inversely proportional to the quantity of foam generated in the dishwasher. Excess foam interferes with satisfactory dishwashing.

#### Comparative Example 1

An alcohol alkoxylate nonionic surfactant was utilized having a molecular weight of approximately 1,400 that corresponded to structural formula A previously presented for a surfactant of this type wherein R was an alkyl group of 8 to 10 carbon atoms, R<sup>1</sup> was a methyl group, "x" was approximately 10, and "y" was approximately 14. Such surfactant exhibited a cloud point of 19 °C. This composition was evaluated at 90 °F. and 140 °F.

#### Comparative Example 2

Example 1 was repeated with the exception that an alcohol alkoxylate surfactant was utilized having a molecular weight of 600 that corresponded to structural formula A previously presented for a surfactant of this type wherein R was an alkyl group of 10 to 14 carbon atoms, R<sup>1</sup> was an ethyl group, "x" was approximately 5, and "y" was approximately 2. This composition was evaluated at 90 °F. and 140 °F.

#### Comparative Example 3

Example 1 was repeated with the exception that an alcohol alkoxylate surfactant was utilized having a molecular weight of 1,800 that corresponded to structural formula A previously presented for a surfactant of this type wherein R was an alkyl group of 6 to 10 carbon atoms, R<sup>1</sup> was a methyl group, "x" was approximately 12, and "y" was approximately 18. This composition was evaluated at 90 °F. and 140 °F.

#### Comparative Example 4

Example 1 was repeated with the exception that a block copolymer-nonionic surfactant of ethylene oxide and propylene oxide having a molecular weight of approximately 3,000 was utilized that corresponded to structural formula B previously presented for a surfactant of this type wherein a + c was approximately 31, and b was approximately 27. Such surfactant exhibited a cloud point of 40 °C. This composition was evaluated at 90 °F.

#### Comparative Example 5

Example 1 was repeated with the exception that a block copolymer a nonionic surfactant of ethylene oxide and propylene oxide having a molecular weight of approximately 3,200 was utilized that corresponded to structural formula B previously presented for a surfactant of this type wherein a + c was approximately 33, and b was approximately 29. Such surfactant exhibited a cloud point of 40 °C. This composition was evaluated at 90 °F.

Comparative Example 6

5 Example 1 was repeated with the exception that a block copolymer nonionic surfactant of ethylene oxide and propylene oxide having a molecular weight of approximately 3,500 was utilized that corresponded to structural formula B previously presented for a surfactant of this type wherein  $a + c$  was approximately 36, and  $b$  was approximately 32. Such surfactant exhibited a cloud point of 31 °C. This composition was evaluated at 90 °F.

10 Example 7

Example 1 was repeated with the exception that the surfactant was a blend of alcohol alkoxyate surfactant of Example 1 and the block copolymer nonionic surfactant of ethylene oxide and propylene oxide of Example 4. The weight ratio of the nonionic surfactant of Example 1 to that of Example 4 was 4:1.

15 Example 8

Example 1 was repeated with the exception that the surfactant was a blend of alcohol alkoxyate surfactant of Example 1 and the block copolymer nonionic surfactant of ethylene oxide and propylene oxide of Example 5. The weight ratio of the nonionic surfactant of Example 1 to that of Example 5 was 4:1.

20 Example 9

Example 1 was repeated with the exception that the surfactant was a blend of alcohol alkoxyate surfactant of Example 1 and the block copolymer nonionic surfactant of ethylene oxide and propylene oxide of Example 6. The weight ratio of the nonionic surfactant of Example 1 to that of Example 6 was 4:1.

Example 10

30 Example 1 was repeated with the exception that the surfactant was a blend of alcohol alkoxyate surfactant of Example 2 and the block copolymer nonionic surfactant of ethylene oxide and propylene oxide of Example 6. The weight ratio of the nonionic surfactant of Example 2 to that of Example 6 was 4:1.

Example 11

35 Example 1 was repeated with the exception that the surfactant was a blend of alcohol alkoxyate surfactant of Example 3 and the block copolymer nonionic surfactant of ethylene oxide and propylene oxide of Example 6. The weight ratio of the nonionic surfactant of Example 3 to that of Example 6 was 4:1.

The results observed in the foregoing Examples and Comparative Examples are reported in Table 1 hereafter.

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Table 1

| Number                | Temperature ° F. | Spray Arm Efficiency (Percent) |           |          |
|-----------------------|------------------|--------------------------------|-----------|----------|
|                       |                  | No Soil                        | Milk Soil | Egg Soil |
| Comparative Example 1 | 90               | 98                             | 91        | 78       |
|                       | 140              | 99                             | 95        | 79       |
| Comparative Example 2 | 90               | 98                             | 91        | 79       |
|                       | 140              | 100                            | 94        | 78       |
| Comparative Example 3 | 90               | 96                             | 89        | 76       |
|                       | 140              | 98                             | 94        | 79       |
| Comparative Example 4 | 90               | 61                             | 51        | 45       |
| Comparative Example 5 | 90               | 66                             | 46        | 35       |
| Comparative Example 6 | 90               | 70                             | 69        | 54       |
| Example 7             | 90               | 96                             | 90        | 77       |
|                       | 140              | 96                             | 96        | 90       |
| Example 8             | 90               | 97                             | 89        | 79       |
|                       | 140              | 98                             | 96        | 90       |
| Example 9             | 90               | 97                             | 90        | 90       |
|                       | 140              | 100                            | 97        | 92       |
| Example 10            | 90               | 97                             | 95        | 82       |
|                       | 140              | 100                            | 98        | 92       |
| Example 11            | 90               | 94                             | 89        | 87       |
|                       | 140              | 98                             | 99        | 93       |

It will be noted that the nonionic surfactant blends of the present invention surprisingly exhibit improved properties. A spray arm efficiency of at least 70 is required for satisfactory dishwashing efficiency with increasingly higher numbers demonstrating increasing cleaning efficiency. It was found possible to include the surfactants of Comparative Examples 4 to 6 that exhibited extremely low spray arm efficiency values with the surfactants of Comparative Examples 1 to 3, and to surprisingly demonstrate improved efficiency for the surfactant blends particularly when operating at a higher temperature (e.g., 140 ° F.). Also, there was no significant efficiency loss and there was sometimes even an efficiency improvement at a lower operating temperature (e.g., 90 ° F.) An aqueous dishwashing composition is provided that efficiently can operate over a wider range of temperatures with a high level of cleaning and defoaming ability that provides the consumer better results even if somewhat erratic temperatures and/or protein soil are encountered within the dishwasher.

Although the invention has been described with preferred embodiments, it is to be understood that variations and modifications may be resorted to as will be apparent to those skilled in the art. Such variations and modifications are to be considered within the purview and scope of the claims appended hereto.

Examples for rinse-aid compositions

The following Examples are presented as specific illustrations of the present invention. It should be understood, however, that the invention is not limited to the specific details set forth in the Examples.

In the Examples and in the Comparative Examples test glasses initially were washed in a standard Hobart AM-11 commercial dishwasher while using a standard dishwashing composition and standard washing conditions. A composition of the following components was used to wash the dishes:

Table 2

| Component                    | Percent by Weight Prior to Mixing<br>With Water in Dishwasher |
|------------------------------|---|
| Sodium tripolyphosphate      | 34  |
| Sodium carbonate             | 18  |
| Sodium metasilicate          | 25.5  |
| Sodium hydroxide (beads)     | 15  |
| Sodium trichloroisocyanurate | 2.5   |
| Water                        | 5   |

The above-identified components were provided in the commercial dishwasher during the wash cycle in a concentration of approximately 0.23 percent by weight.

In each Example and in comparative Example 13 during the rinse cycle a rinse-aid composition was added and was evaluated at a rinse temperature of 180 °F. for foam height, and for spotting and filming. The rinse water solution was mixed with the subsequent wash cycle as is a common practice of industrial/institutional users. Also, the cloud point for the rinse aid composition was obtained in each instance. The foam height was determined by measuring the foam present inside the machine at the conclusion of the wash and the rinse cycles.

The presence of spotting and filming was determined through careful observation on a scale of 1 (no observable spots and/or film) to 5 (totally unacceptable spotting and filming) by placing dried drinking glasses that had undergone rinsing (as described) upside down in a black-lined box with a bright light source being directed from below into the mouth of each glass. In accordance with this severe test procedure for observing any spotting and filming, a value of 3 or below is considered to be acceptable for all but the most demanding usages. For a typical industrial/institutional usage a value of 3 or less is considered to be very satisfactory. Under ordinary use conditions the appearance of objectionable spotting and/or filming would not be present.

The cloud point for each rinse-aid composition was determined by observing the composition in accordance with standard test procedures.

The results observed are reported in Table 3 that follows the Examples and the Comparative Examples.

#### Comparative Example 12

No rinse-aid composition was utilized and the test glasses were simply rinsed with water provided at approximately 180 °F. at the conclusion of the wash cycle and were allowed to dry thereafter.

#### Comparative Example 13

A rinse-aid composition was evaluated that contained 20 percent by weight of alcohol alkoxyate nonionic surfactant, 3 percent by weight of sodium dihexyl sulfosuccinate hydrotrope, and 77 percent by weight of water. The alcohol alkoxyate nonionic surfactant had a molecular weight of approximately 1,400 and corresponded to structural formula A (previously presented) for a surfactant of this type wherein R was an alkyl group of 8 to 10 carbon atoms, R<sup>1</sup> was a methyl group, x was approximately 10, and y was approximately 14. Such surfactant exhibited a cloud point of 19 °C. The sodium dihexylsulfosuccinate hydrotrope was obtained from Mona Industries of Patterson, New Jersey as an 80 percent aqueous solution under the designation of MONAWET® MM80 hydrotrope.

#### Example 14

Example 13 was repeated with the exception that a portion of the alcohol alkoxyate nonionic surfactant was replaced by a block copolymer nonionic surfactant of ethylene oxide and propylene oxide having a molecular weight of approximately 2,500 that corresponded to structural formula B (previously presented) for a surfactant of this type wherein a + b was approximately 26, and b was approximately 23. Such surfactant exhibited a cloud point of 46 °C. More specifically, the weight concentration of the alcohol

alkoxylate to the block copolymer in the rinse-aid composition was 4 : 1.

#### Example 15

5 Example 13 was repeated with the exception that a portion of the alcohol alkoxylate nonionic surfactant was replaced by a block copolymer nonionic surfactant of ethylene oxide and propylene oxide having a molecular weight of approximately 3,200 that corresponded to structural formula B previously presented for a surfactant of this type wherein  $a + c$  was approximately 33, and  $b$  was approximately 29. Such surfactant exhibited a cloud point of 40 °C. More specifically, the weight concentration of the alcohol alkoxylate to the  
10 block copolymer in the rinse-aid composition was 4 : 1.

Table 3

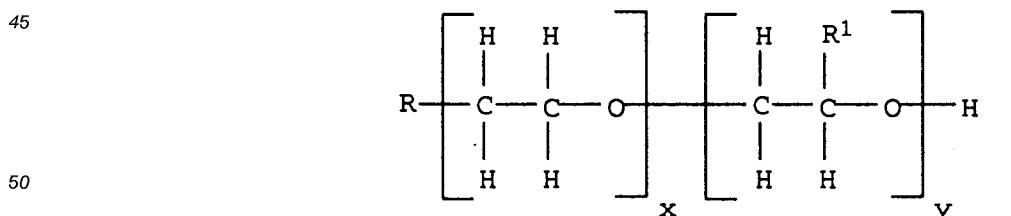
| Number                 | Wash Foam Height (Inches) | Rinse Foam Height (Inches) | Spotting and Filming Value | Cloud Point ( ° F.) |
|------------------------|---------------------------|----------------------------|----------------------------|---------------------|
| Comparative Example 12 | 2.0                       | 1.0                        | 4.5                        | Not applicable      |
| Comparative Example 13 | 1.0                       | 0.5                        | 3.0                        | 117                 |
| 20 Example 14          | 0.5                       | <0.2                       | 2.5                        | 127                 |
| Example 15             | 0.5                       | <0.2                       | 2.5                        | 147                 |

It will be noted that the rinse-aid composition of the present invention surprisingly exhibits improved  
25 properties. The foam generation is insignificant thereby facilitating washing and vigorous rinsing without encountering a foam problem, the spotting and filming value is improved to a highly satisfactory level particularly for a composition that may be used in industrial/institutional applications, and the cloud point is increased thereby making possible a higher use temperature during rinsing. Such higher temperature will expedite rapid draining during the rinse step and will promote more rapid drying. Also, in view of the higher  
30 cloud point the composition of the present invention is more stable even if elevated temperatures are encountered prior to usage.

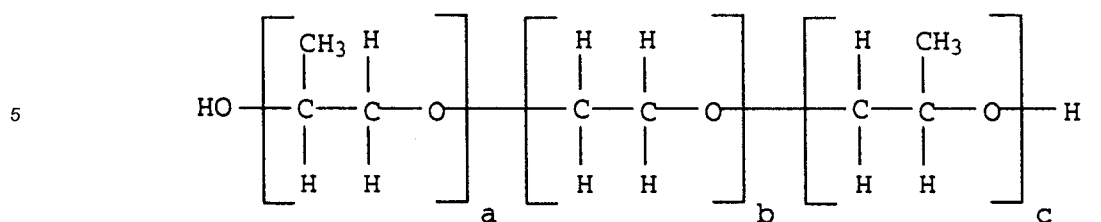
Although the invention has been described with preferred embodiments, it is to be understood that variations and modifications may be resorted to as will be apparent to those skilled in the art. Such variations and modifications are to be considered within the purview and scope of the claims appended  
35 hereto.

#### Claims

1. An improved composition for machine dishwashing and rinsing comprising approximately 1 to 80  
40 percent by weight based upon the total weight of the composition of a blend of nonionic surfactants (i) and (ii), wherein (i) is an alcohol alkoxylate surfactant having a molecular weight of approximately 500 to 2,000 and the structural formula:



wherein R is an alkyl group of 6 to 18 carbon atoms,  $\text{R}^1$  is a methyl group or an ethyl group,  $x$  is at  
55 least 3, and  $y$  is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:



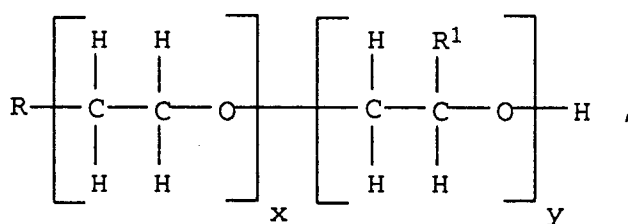
wherein  $a + c$  equals at least 20, and  $b$  is at least 20.

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2. A improved composition according to Claim 1 wherein  $R$  of said nonionic surfactant (i) is an alkyl group of 8 to 10 carbon atoms.
  3. An improved composition according to Claim 1 wherein  $R^1$  of said nonionic surfactant (i) is a methyl group.
  4. An improved composition according to Claim 1 wherein said nonionic surfactant (i) has a molecular weight of approximately 1,200 to 1,600.
  5. An improved composition according to Claim 1 wherein said nonionic surfactant (i) exhibits a cloud point of no more than approximately  $20^\circ\text{C}$ .
  - 25 6. An improved composition according to Claim 1 wherein  $x$  is 3 to 12, and  $y$  is 2 to 18 in said nonionic surfactant (i).
  7. An improved composition according to Claim 1 wherein nonionic surfactant (ii) has a molecular weight of approximately 3,000 to 4,000.
  - 30 8. An improved composition according to Claim 1 wherein said nonionic surfactant (ii) exhibits a cloud point of approximately  $30$  to  $50^\circ\text{C}$ .
  9. An improved composition according to Claim 1 wherein  $a + c$  is approximately 33, and  $b$  is approximately 29 in said nonionic surfactant (ii).
  - 35 10. An improved composition according to Claim 1 wherein  $a$  and  $c$  of said nonionic surfactant (ii) are substantially equal.
  - 40 11. An improved composition according to Claim 1 wherein said units  $b$  derived from ethylene oxide of said nonionic surfactant (ii) are present in a concentration of approximately 30 to 50 percent by weight based upon the total weight of said nonionic surfactant (ii).
  12. An improved composition according to Claim 1 wherein the weight concentration of nonionic surfactant (i) to nonionic surfactant (ii) in said blend of nonionic surfactants ranges from 2 to 5:1.
  - 45 13. An improved machine dishwashing composition suitable for use in water at a temperature of up to at least  $140^\circ\text{F}$ . in the absence of excessive foaming even in the presence of protein soil consisting essentially of approximately 1 to 10 percent by weight based upon the total weight of the composition of a blend of nonionic surfactants (i) and (ii), wherein (i) is an alcohol alkoxyate surfactant having a molecular weight of approximately 500 to 2,000 and the structural formula:

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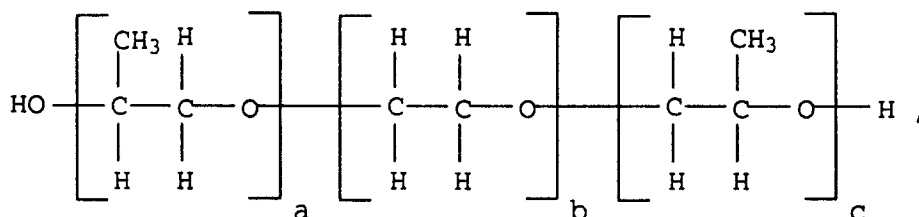
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wherein R is an alkyl group of 6 to 18 carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3, and y is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:

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wherein a + c equals at least 20, and b is at least 20; approximately 10 to 90 percent by weight based upon the total weight of the composition of at least one builder detergent; and approximately 0.5 to 50 percent by weight based upon the total weight of the composition of at least one compound containing active chlorine or available oxygen.

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14. An improved dishwashing composition according to Claim 13 that is free of a phosphate ester defoamer.

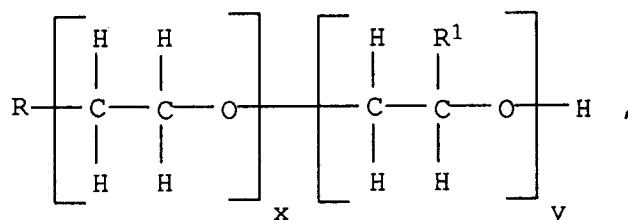
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15. The process of washing food-soiled utensils in a machine dishwasher comprising contacting said utensils with an aqueous solution containing a concentration of about 0.1 to about 1.5 percent by weight of the composition of Claim 13 at a washing temperature within the range of approximately 80° F. to approximately 140° F.

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16. An improved aqueous rinse-aid composition suitable for use at a temperature of up to at least 180° F. in the absence of excessive foaming, spotting and film formation consisting essentially of approximately 0.75 to 5 percent by weight of an anionic hydrotrope, and a blend of nonionic surfactants (i) and (ii) in a concentration of approximately 10 to 80 percent by weight, wherein (i) is an alcohol alkoxyate surfactant having a molecular weight of approximately 500 to 2,000 and the structural formula:

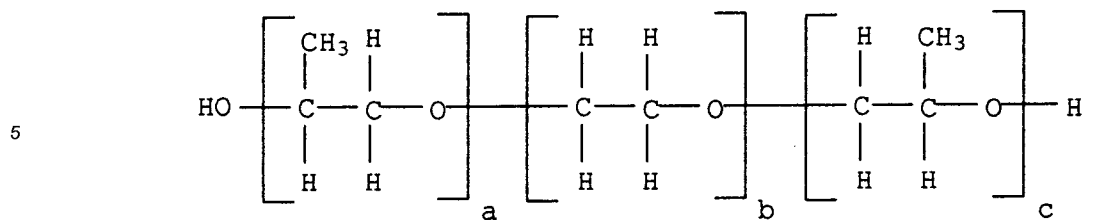
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wherein R is an alkyl group of 6 to 18 carbon atoms, R<sup>1</sup> is a methyl group or an ethyl group, x is at least 3, and y is at least 2, and (ii) is a block copolymer of ethylene oxide and propylene oxide having a molecular weight of approximately 2,000 to 5,000 and the structural formula:



10 wherein a + c equals at least 20, and b is at least 20.

17. An improved rinse-aid composition according to Claim 16 that is suitable for use within the range of approximately 90 °F to approximately 180 °F.

15 18. An improved rinse-aid composition according to Claim 16 wherein said anionic hydrotrope is present in a concentration of approximately 1 to 3 percent by weight.

19. An improved rinse-aid composition according to Claim 16 wherein said anionic hydrotrope is selected from the group consisting of sodium xylene sulfonate, sodium dodecyl benzene sulfonate, linear alkyl naphthalene sulfonate, cumene sulfonate, sodium 2-ethylhexyl sulfate, sodium dihexyl sulfosuccinate, and phosphate esters.

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20. An improved rinse-aid composition according to Claim 16 wherein said blend of nonionic surfactants is present in a concentration of approximately 15 to 40 percent by weight.

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21. The process of rinsing utensils in a machine dishwasher comprising contacting said utensils following washing with the composition of Claim 16 while the temperature of said composition is within the range of approximately 90 °F. to approximately 180 °F.

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