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Description**AQUEOUS LUBRICATION AND SURFACE CONDITIONING FOR
FORMED METAL SURFACES**BACKGROUND OF THE INVENTIONField of the Invention

This invention relates to processes and compositions which accomplish at least one, and most preferably all, of the following related objectives when applied to formed metal surfaces, more particularly to the surfaces of cleaned aluminum and/or tin plated cans: (i) reducing the coefficient of static friction of the treated surfaces after drying of such surfaces, without adversely affecting the adhesion of paints or lacquers applied thereto; (ii) promoting the drainage of water from treated surfaces, without causing "water-breaks", i.e., promoting drainage that results in a thin, continuous film of water on the cans, instead of distinct water droplets separated by the relatively dry areas called "water-breaks" between the water droplets; and (iii) lowering the dryoff oven temperature required for drying said surfaces after they have been rinsed with water.

Discussion of Related Art

The following discussion and the description of the invention will be set forth primarily for aluminum cans, as these represent the largest volume area of application of the invention. However, it is to be understood that, with the obviously necessary modifications, both the discussion and the description of the invention apply also to tin plated steel cans and to other types of formed metal surfaces for which any of the above stated intended purposes of the invention is practically interesting.

Aluminum cans are commonly used as containers for a wide variety of products. After their manufacture, the aluminum cans are typically washed with acidic cleaners to remove aluminum fines and other contaminants therefrom. Environmental considerations and the possibility that residues remaining on the cans following acidic cleaning could influence the flavor of beverages packaged in the cans has led to an interest in alkaline or acid cleaning to remove such fines and contaminants. However, such cleaning of aluminum cans generally results in differential rates of metal surface etch on the outside versus on the inside of the cans. For example, optimum conditions

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required to attain an aluminum fine-free surface on the inside of the cans usually leads to can mobility problems on conveyors because of the increased roughness on the outside can surface.

Aluminum cans that lack a low coefficient of static friction (hereinafter often abbreviated as "COF") on the outside surface usually do not move past each other and through the trackwork of a can plant smoothly. Clearing the jams resulting from failures of smooth flow is inconvenient to the persons operating the plant and costly because of lost production. The COF of the internal surface is also important when the cans are processed through most conventional can decorators. The operation of these machines requires cans to slide onto a rotating mandrel which is then used to transfer the can past rotating cylinders which transfer decorative inks to the exterior surface of the cans. A can that does not slide easily on or off the mandrel can not be decorated properly and results in a production fault called a "printer trip". In addition to the misloaded can that directly causes such a printer trip, three to four cans before and after the misloaded one are generally lost as a consequence of the mechanics of the printer and conveyor systems. Jams and printer trips have become increasingly troublesome problems as line speed have increased during recent years to levels of about 1200 to 1500 cans per minute that are now common. Thus, a need has arisen in the can manufacturing industry, particularly with aluminum cans, to modify the COF on the outside and inside surfaces of the cans to improve their mobility.

An important consideration in modifying the surface properties of cans is the concern that such modification may interfere with or adversely affect the ability of the can to be printed when passed to a printing or labeling station. For example, after cleaning the cans, labels may be printed on their outside surface, and lacquers may be sprayed on their inside surface. In such a case, the adhesion of the paints and lacquers is of major concern. It is therefore an object of this invention to improve mobility without adversely affecting adhesion of paints, decorating inks, lacquers, or the like.

In addition, the current trend in the can manufacturing industry is directed toward using thinner gauges of aluminum metal stock. The down-gauging of aluminum can metal stock has caused a production problem in that, after washing, the cans require a lower drying oven temperature in order to pass the column strength pressure

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quality control test. However, lowering the drying oven temperature resulted in the cans not being dry enough when they reached the printing station, and caused label ink smears and a higher rate of can rejects.

One means of lowering the drying oven temperature would be to reduce the amount of water remaining on the surface of the cans after water rinsing. Thus, it is advantageous to promote the drainage of rinse water from the treated can surfaces. However, in doing so, it is generally important to prevent the formation of surfaces with water-breaks as noted above. Such water-breaks give rise to at least a perception, and increase the possibility in reality, of non-uniformity in practically important properties among various areas of the surfaces treated.

Thus, it is desirable to provide a means of improving the mobility of aluminum cans through single filers and printers to increase production, reduce line jammings, minimize down time, reduce can spoilage, improve or at least not adversely affect ink laydown, and enable lowering the drying oven temperature of washed cans.

In the most widely used current commercial practice, at least for large scale operations, aluminum cans are typically subjected to a succession of six cleaning and rinsing operations as described in Table 1 below. (Contact with ambient temperature tap water before any of the stages in Table 1 is sometimes used also; when used, this stage is often called a "vestibule" to the numbered stages.)

Table 1	
STAGE NUMBER	ACTION ON SURFACE DURING STAGE
1	Aqueous Acid Precleaning
2	Aqueous Acid and Surfactant Cleaning
3	Tap Water Rinse
4	Mild Acid Postcleaning, Conversion Coating, or Tap Water Rinse
5	Tap Water Rinse
6	Deionized ("DI") Water Rinse

It is currently possible to produce a can which is satisfactorily mobile and to which subsequently applied inks and/or lacquers have adequate adhesion by using suit-

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able surfactants either in Stage 4 or Stage 6 as noted above. Preferred treatments for use in Stage 6 are described in U. S. Patents 4,944,889 and 4,859,351, and some of them are commercially available from the Parker+Amchem Division of Henkel Corporation (hereinafter often abbreviated as "P+A") under the name ME-40®.

However, many manufacturers have been found to be reluctant to use chemicals such as ME-40® in Stage 6. In some cases, this reluctance is due to the presence of a carbon filter for the DI water (normal Stage 6) system, a filter that can become inadequately effective as a result of adsorption of lubricant and surface conditioner forming additives such as those in ME-40®; in other cases, it is due to a reluctance to make the engineering changes necessary to run ME-40.

For those manufacturers that prefer not to add any lubricant and surface conditioner material to the final stage of rinsing but still wish to achieve the advantages that can be obtained by such additions, alternative treatments for use in Stage 4 as described above have been developed and are described in U. S. Patents 5,030,323 and 5,064,500. Some of these materials are commercially available from P+A under the name FLXODINE® 500.

However, the reduction in coefficient of friction provided by prior art treatments in either Stage 4 or Stage 6 can be substantially reduced, often to an unacceptable level, if the treated cans are subjected to extraordinary heating after completion of the six process stages described above. Such extraordinary heating of the cans in the drying oven occurs whenever a high speed production line is stalled for even a few minutes, an event that is by no means rare in practice. In practical terms, the higher COF measurements correlate with the loss of mobility, thereby defeating the purpose of introducing mobility enhancing surfactants into can washing formulations. Accordingly, it is an object of this invention to provide means of improving the mobility of aluminum cans and/or one of the other objects stated above that are superior to means taught in the prior art, particularly with respect to stability of the beneficial effects to heating well beyond the minimum extent necessary for drying the treated surfaces.

DESCRIPTION OF THE INVENTION

Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions used herein are to be understood as modified in all instances by the term "about" in describing the broadest

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scope of the invention. Practice within the numerical limits given, however, is generally preferred.

Also, unless there is an explicit statement to the contrary, the description below of groups of chemical materials as suitable or preferred for a particular ingredient according to the invention implies that mixtures of two or more of the individual group members are equally as suitable or preferred as the individual members of the group used alone. Furthermore, the specification of chemical materials in ionic form should be understood as implying the presence of some counterions as necessary for electrical neutrality of the total composition. In general, such counterions should first be selected to the extent possible from the ionic materials specified as part of the invention; any remaining counterions needed may generally be selected freely, except for avoiding any counterions that are detrimental to the objects of the invention.

Summary of the Invention

In accordance with this invention, it has been found that the coefficient of friction of a surface treated with a lubricant and surface conditioner is less easily damaged by heating when the lubricant and surface conditioner composition includes at least one of the following organic materials: alkoxyated or non-alkoxyated castor oil triglycerides and hydrogenated castor oil derivatives; alkoxyated and non-alkoxyated amine salts of a fatty acid including mono-, di-, tri-, and poly-acids; alkoxyated and non-alkoxyated amino fatty acids; alkoxyated and non-alkoxyated fatty amine N-oxides, alkoxyated and non-alkoxyated quaternary ammonium salts, alkyl esters of 2-substituted alkoxyated fatty alkyloxy acetic acids (briefly denoted hereinafter as "oxa-acid esters") as described more fully in PCT Application US93/01411 filed February 23, 1993, and water-soluble alkoxyated and non-alkoxyated polymers. Furthermore, if the lubricant and surface conditioner is not applied to the surface from the last aqueous composition with which the surface is contacted before the last drying of the surface before automatic conveying, the composition including the organic materials should also include a metallic element selected from the group consisting of zirconium, titanium, cerium, aluminum, iron, tin, vanadium, tantalum, niobium, molybdenum, tungsten, and hafnium in metallic or ionic form, and the film formed on the surface as part of the lubricant and surface conditioner in dried form should include some of this metallic element along with organic material.

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Description of Preferred Embodiments

Preferred alkoxyated, especially ethoxyated, castor oil triglycerides that are commercially available include Trylox® 5900, Trylox® 5902, Trylox® 5904, Trylox® 5906, Trylox® 5907, Trylox® 5909, Trylox® 5918, and preferred hydrogenated castor oil derivatives include commercial materials such as Trylox® 5921 and Trylox® 5922, all available from Henkel Corporation. These materials are particularly useful as additives to final stage rinses, because they provide a dried lubricant and surface conditioner film on the treated surface that resists rise of the COF with heating beyond the minimum necessary to dry the surface.

Another preferred group of organic materials comprise water-soluble alkoxyated, preferably ethoxyated, propoxyated, or mixed ethoxyated and propoxyated materials, most preferably ethoxyated, and non-ethoxyated organic materials selected from amine salts of fatty acids including mono-, di-, tri-, and poly-acids, amino fatty acids, fatty amine N-oxides, and quaternary salts, and water soluble polymers.

Preferred amine salts of fatty acids include ammonium, quaternary ammonium, phosphonium, and alkali metal salts of fatty acids and derivatives thereof containing up to 50 moles of alkylene oxide in either or both the cationic or anionic species. Specific examples include Amphoteric N and Amphoteric 400 iminodipropionate sodium salts, available from Exxon Chemical Co.; Deriphat® 154 disodium N-tallow-beta iminodipropionate and Dcriphat® 160, disodium N-lauryl-beta iminodipropionate, available from Henkel Corp.

Preferred amino acids include alpha and beta amino acids and diacids and salts thereof, including alkyl and alkoxyiminodipropionic acids and their salts and sarcosine derivatives and their salts. Specific examples include Armeen® Z, N-coco-beta-aminobutyric acid, available from Akzo Chemicals Inc.; Amphoteric N, Amphoteric 400, Exxon Chemical Co.; sarcosine (N-methyl glycine); hydroxyethyl glycine; Hamposyl® TL-40 triethanolamine lauroyl sarcosinate, Hamposyl® O oleyl sarcosinate, Hamposyl® AL-30 ammoniumlauroyl sarcosinate, Hamposyl® L lauroyl sarcosinate, and Hamposyl® C cocoyl sarcosinate, all available from W.R. Grace & Co.

Preferred amine N-oxides include amine oxides where at least one alkyl substituent contains at least three carbons and up to 20 carbons. Specific examples include Aromox® C/12 bis-(2-hydroxyethyl)cocoalkylamine oxide, Aromox® T/12



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bis-(2-hydroxyethyl)tallowalkylamine oxide, Aromox® DMC dimethylcocoalkylamine oxide, Aromox® DMHT hydrogenated dimethyltallowalkylamine oxide, Aromox® DM-16 dimethylhexadecylalkylamine oxide, all available from Akzo Chemicals Inc.; and Tomah® AO-14-2 and Tomah® AO-728 available from Exxon Chemical Co.

5 Preferred quaternary salts include quaternary ammonium derivatives of fatty amines containing at least one substituent containing from 12 to 20 carbon atoms and zero to 50 moles of ethylene oxide and/or zero to 15 moles of propylene oxide where the counter ion consists of halide, sulfate, nitrate, carboxylate, alkyl or aryl sulfate, alkyl or aryl sulfonate or derivatives thereof. Specific examples include Arquad® 12-
10 37W dodecyltrimethylammonium chloride, Arquad® 18-50 octadecyltrimethylammonium chloride, Arquad® 210-50 didecyl dimethylammonium chloride, Arquad® 218-100 dioctadecyl dimethylammonium chloride, Arquad® 316(W) trihexadecyl methylammonium chloride, Arquad® B-100 benzyl dimethyl(C₁₂₋₁₈)alkylammonium chloride, Ethoquad® C/12 cocomethyl[POE(2)]ammonium chloride, Ethoquad® C/25 cocomethyl-
15 [POE(15)]ammonium chloride, Ethoquad® C/12 nitrate salt, Ethoquad® T/13 Acetate tris(2-hydroxyethyl)tallowalkyl ammonium acetate, Duoquad® T-50 N,N,N',N',N'-pentamethyl-N-tallow-1,3-diammonium dichloride, Propoquad® 2HT/11 di(hydrogenated tallowalkyl)(2-hydroxy-2-methylethyl)methylammonium chloride, Propoquad® T/12 tallowalkylmethyl-bis-(2-hydroxy-2-methylethyl)ammonium methyl sulfate, all available from Akzo Chemicals Inc.; Monaquat® P-TS stearamidopropyl PG-diammonium
20 chloride phosphate, available from Mona Industries Inc.; Chemquat® 12-33 lauryltrimethylammonium chloride, Chemquat® 16-50 Cetyltrimethylammonium chloride available from Chemax Inc.; and tetraethylammonium pelargonate, laurate, myristate, oleate, stearate or isostearate.

25 Preferred water-soluble polymers include homopolymers and heteropolymers of ethylene oxide, propylene oxide, butylene oxide, acrylic acid and its derivatives, maleic acid and its derivatives, vinyl phenol and its derivatives, and vinyl alcohol. Specific examples include Carbowax® 200, Carbowax® 600, Carbowax® 900, Carbowax® 1450, Carbowax® 3350, Carbowax® 8000, and Compound 20M, all available
30 from Union Carbide Corp.; Pluronic® L61, Pluronic® L81, Pluronic® 31R1, Pluronic® 25R2, Tetronic® 304, Tetronic® 701, Tetronic® 908, Tetronic® 90R4, and Tetronic® 150R1, all available from BASF Wyandotte Corp.; Acusol® 410N sodium



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salt of polyacrylic acid, Acusol® 445 polyacrylic acid, Acusol® 460ND sodium salt of maleic acid/olefin copolymer, and Acusol® 479N sodium salt of acrylic acid/maleic acid copolymer, all available from Rohm & Haas Company; and N-methylglucamine adducts of polyvinylphenol and N-methylethanolamine adducts of polyvinylphenol.

5 Additional improvements can often be achieved, particularly for lubricant and surface condition treatments applied before the final contact of the treated surface with an aqueous composition, by using an inorganic material selected from metallic or ionic zirconium, titanium, cerium, aluminum, iron, vanadium, tantalum, niobium, molybdenum, tungsten, hafnium or tin to produce a film combining one or more of these metals
10 with one or more of the above-described organic materials. A thin film is produced having a coefficient of static friction that is not more than 1.5, preferably not more than 1.2, more preferably not more than 1.0, or still more preferably not more than 0.80, and is less than the coefficient without such film, thereby improving can mobility in high speed conveying without interfering with subsequent lacquering, other
15 painting, printing, or other similar decorating of the containers.

The technique of incorporating such inorganic materials is described, in particular detail with reference to zirconium containing materials, in U.S. Patents 5,030,323 of July 9, 1991 and 5,064,500 of November 12, 1991, the entire disclosures of which, to the extent not inconsistent with any explicit statement herein, are hereby in-
20 corporated herein by reference. The substitution of other metallic materials for those taught explicitly in one of these patents is within the scope of those skilled in the art.

In a further preferred embodiment of the process of the present invention, in order to provide improved water solubility, especially for the non-ethoxylated organic materials described herein, and to produce a suitable film on the can surface having
25 a coefficient of static friction not more than 1.5 after drying, one employs a mixture of one or more surfactants, preferably alkoxyated and most preferably ethoxylated, along with such non-ethoxylated organic material to contact the cleaned can surface prior to final drying and conveying. Preferred surfactants include ethoxylated and non-ethoxylated sulfated or sulfonated fatty alcohols, such as lauryl and coco alcohols.
30 Suitable are a wide class of anionic, non-ionic, cationic, or amphoteric surfactants. Alkyl polyglycosides such as C₈ - C₁₈ alkyl polyglycosides having average degrees of polymerization between 1.2 and 2.0 are also suitable. Other classes of surfactants suit-



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able in combination are ethoxylated nonyl and octyl phenols containing from 1.5 to 100 moles of ethylene oxide, preferably a nonylphenol condensed with from 6 to 50 moles of ethylene oxide such as Igepal® CO-887 available from Rhone-Poulenc; alkyl/aryl polyethers, for example, Triton® DF-16; and phosphate esters of which Triton® H-66 and Triton® QS-44 are examples, all of the Triton® products being available from Union Carbide Co., and Ethox® 2684 and Ethfac® 136, both available from Ethox Chemicals Inc., are representative examples; polyethoxylated and/or polypropoxylated derivatives of linear and branched alcohols and derivatives thereof, as for example Trycol® 6720 (Henkel Corp.), Surfonic® LF-17 (Texaco) and Antarox® LF-330 (Rhone-Poulenc); sulfonated derivatives of linear or branched aliphatic alcohols, for example, Neodol® 25-3S (Shell Chemical Co.); sulfonated aryl derivatives, for example, Dyasulf® 9268-A, Dyasulf® C-70, Lomar® D (all available from Henkel Corp.) and Dowfax® 2A1 (available from Dow Chemical Co.); and ethylene oxide and propylene oxide copolymers, for example, Pluronic® L-61, Pluronic® 81, Pluronic® 31R1, Tetronic® 701, Tetronic® 90R4 and Tetronic® 150R1, all available from BASF Corp.

Further, the lubricant and surface conditioner in accordance with this invention may comprise a phosphate acid ester or preferably an ethoxylated alkyl alcohol phosphate ester. Such phosphate esters are commercially available under the trade name Gafac® PE 510 from GAF Corporation, Wayne, NJ. and as Ethfac® 136 and Ethfac® 161 from Ethox Chemicals, Inc., Greenville, SC. In general, the organic phosphate esters may comprise alkyl and aryl phosphate esters with and without ethoxylation.

The lubricant and surface conditioner for aluminum cans may be applied to the cans during their wash cycle, during one of their treatment cycles such as cleaning or conversion coating, during one of their water rinse cycles, or during their final water rinse cycle. In addition, the lubricant and surface conditioner may be applied to the cans after their final water rinse cycle, i.e., prior to oven drying, or after oven drying, by fine mist application from water or another volatile non-inflammable solvent solution. It has been found that the lubricant and surface conditioner is capable of depositing on the surface to provide it with the desired characteristics. The lubricant and surface conditioner may be applied by spraying and interacts with the surface through



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chemisorption or physisorption to provide it with the desired dried lubricant and surface conditioner film.

The amount of lubricant and surface conditioner to be applied to the cans should be sufficient to reduce the coefficient of static friction on the outside surface of the cans to a value of about 1.5 or lower, and preferably to a value of about 1 or lower. Generally speaking, such amount should be on the order of from about 3 mg/m² to about 60 mg/m² of lubricant and surface conditioner on the outside surface of the cans.

For a fuller appreciation of the invention, reference should be made to the following examples, which are intended to be merely descriptive, illustrative, and not limiting as to the scope of the invention.

Examples Group I

Uncleaned aluminum cans from an industrial can manufacturer are washed clean in examples Type A with alkaline cleaner available from Parker+Amchem Division, Henkel Corporation, Madison Heights, Michigan, employing the Ridoline® 3060/306 process and in Examples Type B with an acidic cleaner, Ridoline® 125 CO from the same company. Following initial rinsing and before final drying, the cleaned cans are treated with a lubricant and surface conditioner composition comprising one of the following (i) about a 1 % by weight aqueous solution in deionized water of active organic material (I) as specified in Table 2 below; (ii) about 1 % of the active organic (I) in deionized water plus about 2 gm/l (0.2 %) of the inorganic constituent (II) as specified in Table 2; (iii) about 1% active organic (I) in deionized water plus about 0.5 % of surfactant (III) as specified in Table 2; (iv) about 1 % active organic (I), about 0.2% inorganic (II), and about 0.5% surfactant (III) as specified in Table 2.

Among the compositions of the aqueous lubrication and surface conditioning treatment in this group, the ones containing inorganic constituent (II) from Table 2 are applied in Stage 4 as defined above, while those not containing this ingredient are applied immediately before final drying.

In addition, the cans after drying are evaluated for their coefficient of static friction using a custom built slip time tester. This apparatus consisted of three timing stations attached to a motor driven inclinable ramp. Two cans are placed horizontally in each station and a third placed on top of them in the opposite direction. This



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TABLE 2

Ex- am- ple Type	Active Organic (I)		Inorganic (II)	Surfactant (III)	pH
	Trade Name	Chemical Description			
A	Emery 657	Caprylic acid	$Al_2(SO_4)_3$	IGEPAL CO-887	2.2
B	Emery 659	Capric acid	H_2ZrF_6	TRITON X-101	2.2
A	Emery 651	Lauric acid	FeF_3	NEODOL 25-5-3	2.3
B	Emery 655	Myristic acid	$SnCl_4$	TERGITOL TMN-6	2.3
A	Emersol 143	Palmitic acid 91%	$Ce(NO_3)_4$	TRITON DF-16	2.6
B	Emersol 153 NF	Stearic acid 92%	H_2TiF_6	TRYCOL 6720	2.6
A	Emersol 871	Isostearic acid	H_2HfF_6	ANTAROX LF- 330	2.6
B	Emersol 6313 NF	Oleic acid 75%	$(NH_4)_2ZrF_6$	TRITON H-55	2.6
A	Empol 1014	Dimer acid 95%	$Fe_2(SO_4)_3$	TRITON H-66	2.6
B	Emery 1110	Azelaic acid	$Al(NO_3)_3$	TRITON QS-44	2.6
B	Ethox M15	Ethoxylated iso- stearic acid	$TiCl_4$	TRYCOL 6720	3.0
A	Emulphor VN 430	Polyoxyethylat- ed oleic acid	CeI_3	SURFONIC LF- 17	3.0
B	Ethox MO5	Polyoxyethylat- ed oleic acid	FeF_3	LOMAR D	3.0
A	Monamide 150 LW	Lauric alkanol- amide	$FeCl_3$	DOWFAX 2A1	2.0
B	Monamide 150 MW	Myristic alka- nolamide	$FeBr_3$	DYASULF 9268- A	3.0
A	Monamide 150 IS	Isostearic alka- nolamide	H_2ZrF_6	DYASULF C-70	4.0

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Ex- am- ple Type	Active Organic (I)		Inorganic (II)	Surfactant (III)	pH
	Trade Name	Chemical Description			
B	Monamide 718	Stearic alkanol- amide	H ₂ TiF ₆	IGEPAL CO-887	5.0
A	Gafac BH 650	Aliphatic phos- phate ester, acid form	Fe(NO ₃) ₃	POLYTERGENT SLF-18	2.0
B	Ethox PPI6	Aromatic phos- phate ester	(NH ₄) ₂ ZrF ₆	PLURONIC L-61	3.0
A	Gafac BL 750	Aliphatic phos- phate ester, acid form	TaF ₅	TETRONIC 701	6.0
B	Gafac PE510	Aromatic phos- phate ester, acid form	NbF ₅	PLURONIC 31R1	5.0
A	Ethfac 142W	Aliphatic phos- phate ester	H ₂ ZrF ₆	PLURONIC 150R1	4.0
B	Gafac RA 600	Aliphatic phos- phate ester, acid form	(NH ₄) ₂ Mo O ₄	APG 300	6.0
A	Armeen Z	N-Coco-B- aminobutyric acid	H ₂ TiF ₆	TRITON CF-21	6.0
B	Hamposyl L	Lauroyl sarcos- ine	VF ₄	TRITON DF-18	5.0
A	Hamposyl C	Cocoyl sarcos- ine	FeF ₃	TRITON GR-7M	4.0
B	Hamposyl O	Oleoyl sarcos- ine	SnCl ₄	TRITON H-55	3.0
A	Hamposyl S	Stearyl sarcos- ine	Al ₂ (SO ₄) ₃	TRITON X-100	2.0
B	Acusol 410N	Polyacrylic acid, sodium salt,	H ₂ ZrF ₆	TRITON X-120	4.0

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Ex- am- ple Type	Active Organic (I)		Inorganic (II)	Surfactant (III)	pH
	Trade Name	Chemical Description			
B	Triton GR-5M	Dioctylsulfo-succinate	Al(NO ₃) ₃	TRYCOL 5882	6.0
A	Avanel S 70	Sodium alkyl-ether sulfonate	VOSO ₄	TRYCOL 5887	5.0
B	Igepon TC-42	Sodium N-coconut and N-methyl taurate	VF ₃	TRYCOL 5964	4.0
A	Igepon TK-32	Sodium N-methyl-N-tall oil acid taurate	VF ₃	IGEPAL CO-887	3.0
B	Neodol 25-3A	Sulfonated linear alcohol, ammonium salt	(NH ₄) ₂ WO ₄	IGEPAL CO-630	3.0
A	Aromox C/12	Bis(2-hydroxyethyl) cocamine oxide	(NH ₄) ₂ ZrF ₆	NEODOL 25-3	3.0
B	Aromox DMC	Dimethylcocamine oxide	FeF ₃	NEODOL 25-35	3.0
A	Ethoquad 0/25	Oleyl [POE(15)] ammonium chloride	Fe ₂ (SO ₄) ₃	NEODOL 25-9	2.0
B	Ethoquad C/12	Cocomethyl [POE(2)] ammonium chloride	Al ₂ (SO ₄) ₃	NEODOL 91-25	3.0
A	Ethoquad 18/5	Octadecyl [POE(15)] ammonium chloride	Sn(SO ₄)	TRITON Q5-15	3.0

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Ex- am- ple Type	Active Organic (I)		Inorganic (II)	Surfactant (III)	pH
	Trade Name	Chemical Description			
B	Propoquad T/12	Tallowalkyl- methyl-bis-(2- hydroxy-2- methylethyl) ammonium methyl sulfate	$\text{Ce}_2(\text{SO}_4)_3$	TRITON DF-12	2.0
A	Ethfac 136	Phosphate ester	H_2ZrF_6	IGEPAL CO-887	2.3
B	Ethox 2684	Phosphate ester	H_2ZrF_6	IGEPAL CO-887	2.7
A	Trylox 5922	Ethoxylated hydrogenated castor oil	H_2ZrF_6	IGEPAL CO-887	2.3
B	Trylox 5921	"	H_2TiF_6	IGEPAL CO-887	2.7
A	Trylox 5925	"	H_2ZrF_6	TRITON H-66	2.7

procedure insures that the burr on the cut edge of the cans does not interfere with the motion of the cans. The test begins as the ramp is raised toward the vertical. The elapsed time from the start of the ramps movement to the time when the third can slides is recorded as the "Slip Time." This time is then converted into a (Static) Coefficient of Friction ("COF") according to the equation:

$$\text{COF} = \text{Tangent of } [4.84 + (2.79 \cdot t)]$$

where t is the time Slip Time in seconds. Fifteen slip times were collected, converted to COF's and then averaged to give the COF result discussed here. In some cases the tested cans were subjected to an additional bake out at 210° C for 5 minutes and the COF redetermined; this result is denoted hereinafter as "COF-2".

In all cases in this group of examples, the COF produced on the surface is less than 1.5.

Examples and Comparison Examples Group II

In this group, various candidate materials for forming a lubricant and surface



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conditioner were tested at lower concentrations than in Group I.

II.1 *General Procedures.* Mobility enhancer/rinse aid process solutions were prepared using deionized water with a conductivity less than 5 μ siemens; unless otherwise noted, all other solutions were prepared in tap water. Drawn and wall ironed aluminum cans were obtained from commercial factory production.

Most cans were tested on a pilot scale beltwasher, a single track seven stage conveyor belt type washer (hereinafter denoted "BW") at its highest speed of 6.2 feet per minute ("fpm"). Alternatively, a carousel type can washer (hereinafter "CCW") that processes 14 cans in a sequence of batch steps under microprocessor control was employed. Both types of washer were capable of simulating the sequences, dwell and blow off characteristics of full scale production washers.

Free Acidity and Fluoride Activities of the cleaner baths were determined as described in the P+A Technical Process Bulletin (No. 968) for Ridoline 124C. The cleaned and treated cans were dried in an electric forced air oven as described below.

Can mobility was tested as in Group I.

Foam heights were determined by placing 50 milliliters (hereinafter "mL") of the process solution in a 100 mL stoppered graduated cylinder and shaking vigorously for 10 seconds. The total volume of fluid, liquid plus foam, was determined immediately and after 5 minutes of standing. These "foam heights" will be referred to hereinafter as "IFH" (initial foam height) and "PFH" (persistent foam height) respectively.

The water break characteristics of cans treated with candidate final rinse mobility enhancers ("FRME's") were evaluated by visually rating the amount of waterbreak on each of the four major surfaces of the can: interior dome and sidewall and exterior dome and sidewall. In this rating scheme a value of 2 is assigned to a completely waterbreak free surface, zero to a completely waterbroken surface and intermediate values to waterbreaks in between. Four cans are evaluated in this way and the scores totaled to give a number between 32 and 0, the waterbreak free (WBF) result.

II.2 *Effect of Cleaner Bath Fluoride Activity On COF and Reflectivity.* The CCW and subsequent drying oven were used as follows:

Stage 1

tap water, 54.4° C, 30 sec.

Stage 2

RIDOLINE® 124C, 15 mL Free Acid, 3.4 g total of surfactant, Fluoride Activity 10 to -20 mV in 10 mV increments, 60° C, 60 sec.



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Stage 3	tap water, 30 sec.
Stage 4	deionized water, 90 sec.
Stage 5	optional application of 0.4% M.E.40, 20 sec.
Stage 6	not used
Oven	5 minutes at 210° C

5 The "fluoride activity" noted for Stage 2 above is defined and can conveniently be measured by means of a fluoride sensitive electrode as described in U. S. Patent 3,431,182 and commercially available from Orion Instruments. "Fluoride activity" as
10 this term is used herein was measured relative to a 120E Activity Standard Solution commercially available from the Parker+Amchem ("P+A") Division of Henkel Corporation by a procedure described in detail in P+A Technical Process Bulletin No. 968. The Orion Fluoride Ion Electrode and the reference electrode provided with the Orion instrument are both immersed in the noted Standard Solution and the millivolt meter
15 reading is adjusted to 0 with a Standard Knob on the instrument, after waiting if necessary for any drift in readings. The electrodes are then rinsed with deionized or distilled water, dried, and immersed in the sample to be measured, which should be brought to the same temperature as the noted Standard Solution had when it was used to set the meter reading to 0. The reading of the electrodes immersed in the sample
20 is taken directly from the millivolt (hereinafter often abbreviated "mv" or "mV") meter on the instrument. With this instrument, lower positive mv readings indicate higher fluoride activity, and negative mv readings indicate still higher fluoride activity than any positive readings, with negative readings of high absolute value indicating high fluoride activity.

25 Effectiveness of soil removal was measured by use of the "brightness tester." This device consisted of a power stabilized high intensity lamp and a fiber optic bundle conveying the light to the can surface. The light reflected from the can impinged on a photocell whose current output was amplified and converted to a digital readout by an International Microtronics Inc. Model 350 amplifier; the number displayed was
30 recorded as the brightness of the surface. The instrument is calibrated with a back silvered plane mirror to a measured reflectivity of 440. Once calibrated, the reflectivities of fourteen cans were measured and averaged. With this device it was possible to measure the overall interior reflectivity and exterior dome reflectivity. Results are shown in Figures 1(a) - 1(d).



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II.3 Screening of Diverse Materials For FRME Activity. The CCW was operated according to the following scheme, in which the extended Stage 3 rinse time simulated a production sequence wherein the normal Stage 3, 4, and 5 applications were used as rinses:

5	Stage 1	sulfuric acid, pH 2.0, 30 sec., 54.4° C
	Stage 2	RIDOLINE® 124C, 15 mL Free Acid, 3.4 g/L total of surfactant, Fluoride Activity -10 mV, 90 sec., 54.4° C
	Stage 3	deionized water, 150 sec. (ca. 17.7 L)
	Stage 4	as noted in Table 3, 30 sec., 29.4° C temperature
10	Stage 5	not used
	Stage 6	not used

For this work Macamine™ SO was predissolved by adding 15 % isopropanol. For the compositions containing Igepal™ 430 or polyvinyl alcohol, 1.6 g/L of Igepal™ CO-887 was added to obtain a homogeneous solution. Nitroguanidine was insoluble and was not investigated further. Results are shown in Table 3. Amine oxides with hydroxyethyl groups bonded to the amine oxide nitrogen, such as Aromox™ C/12 and T/12, and oxa-acid esters such as those identified in the table as OAE 1 - 4, are preferred lubricants and surface conditioners, as are the ethoxylated castor oil derivatives considered in more detail below.

20 **II.4 Ethoxylated Castor Oil FRME's.** The CCW was charged and operated as described in § II.3 with the exceptions that the Stage 3 deionized water rinse was applied for 130 sec and the first oven treatment was performed at 200° C rather than 150° C. The Stage 4 compositions were as shown in Table 4. The experiment using Trylox™ 5921 included 0.2 g/L of Igepal™ CO-887 in an unsuccessful attempt to clarify the solution; a slight cloudiness persisted even in the presence of the cosurfactant.

25 **II.5 The Effect of Ethylene Oxide Content On The Properties of Isostearyl FRME's And Binary Mixtures With Other Surfactants.** The CCW was charged and operated as described in § II.3 with the Stage 4 variations shown in Table 5. The results indicate that only very slight defoaming at best was achievable with these defoamers. However, lower amounts of ethoxylation of the primary ethoxylated isostearic acid lubricant and surface conditioner forming composition result in less foam, with COF values that are fully adequate for most applications. Mixtures of the "defoamers" Pluronic™ 31R1 and Trycol™ LF-1 with Ethox™ MI-9 produce somewhat more foam



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Table 3: CANDIDATE FINAL RINSE MOBILITY ENHANCERS AND COMPARISONS

Candidate or Compar- ison	Chemical Class	Hydrophobe	Hydrophile	Molecular Weight	HLB	COF Mean StD	COF -2 Mean StD	IFH	PFH	WFR
None	-	-	-	-	-	1.168 .108	1.126 .071	-	-	32
None	-	-	-	-	-	1.098 .129	-	-	-	-
None	-	-	-	-	-	1.141 .151	-	-	-	32
None	-	-	-	-	-	1.331 .263	-	-	-	32
None	-	-	-	-	-	1.362 .194	-	-	-	32
None	-	-	-	-	-	1.295 .197	-	-	-	32
None	-	-	-	-	-	1.363 .201	-	59	50	32
Surfynol™ 420	Acetylenic-EO	TMDD	(EO)1.3	-	4	1.404 .276	-	56	51	32
Surfynol™ 440	Acetylenic-EO	TMDD	(EO)3.5	-	8	1.623 .549	-	70	53	31.8
Surfynol™ 465	Acetylenic-EO	TMDD	(EO)10	-	13	1.371 .181	-	56	50	32
Dimethylformamide	Amide	-	-	73.1	-	.457 .020	.645 .127	74	73	32
Monamine™ AD-100	Amide	-	-	-	-	1.184 .172	-	53	51	32
M-Pyrol™	Amine	-	-	-	-	1.645 .476	-	64	50	32
Macamine™ C-10	Amine	-	-	-	-	1.134 .120	-	53	51	32
Triethanolamine	Amine	-	-	-	-	.548 .129	.672 .107	-	-	32
Armox™ T/12	Amine Oxide	C12 (tallow)	N=O/2-hydroxyethyl	366	-	.527 .090	1.005 .190	77	71	32
Aromox™ C/12	Amine Oxide	C12 (coco)	N=O/2-hydroxyethyl	-	-	1.519 .202	-	54	54	32
Aromox™ DM-16	Amine Oxide	C16	-	-	-	1.532 .468	-	70	64	32
Macamine™ CAO	Amine Oxide	Cocamidopropyl	N=O	-	-	1.329 .222	-	51	50	32
Macamine™ CO	Amine Oxide	Cocamine	N=O	-	-	1.180 .116	-	76	73	32
Macamine™ SO	Amine Oxide	Stearamine	N=O	-	-	.802 .179	1.136 .132	69	61	32
Triton™ RW-100	Amine-(EO)10	-	-	-	16	1.099 .096	-	69	66	32
Triton™ RW-50	Amine-(EO)5	-	-	-	13	1.001 .130	1.496 .430	71	62	32
Triton™ RW-75	Amine-(EO)7.5	-	-	-	15	1.214 .438	1.430 .315	52	50	32
TEA Oleate	Amine-Fatty	-	-	-	-	.660 .182	1.463 .299	71	64	32
Armeen™ Z	Amphoteric	C12	RCOOH/NH	-	-	1.146 .201	-	75	66	32
APG® 300	Glycoside	-	-	-	-	1.015 .251	1.211 .183	72	70	32
APG® 325	Glycoside	-	-	-	-	1.211 .157	-	53	51	32
Hostacor™ BF	Borate	-	-	-	-	-	-	-	-	-

.....Table 3 continued on next page.....

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Candidate or Compar- ison	Chemical Class	Hydrophobe	Hydrophile	Molecular Weight	HLB	COF		COF -2		IFH	PFH	WFR
						Mean	Std	Mean	Std			
Hostacor™ BS	Borate	-	-	-	-	1.339	.231	-	-	58	54	32
Henkel™ SF-7112	C-18 EO/PO	C-18/PO(1)	(EO)5	-	-	.315	.040	.343	.032	-	-	32
Henkel™ SF-7111	C16-18 EO	C16-18	(EO)5	-	-	.305	.030	.386	.066	-	-	28
Henkel™ SF-7147	C8-10 EO	C8-10	(EO)5	-	-	.602	.149	.687	.118	-	-	32
Henkel™ SF-7276	C8-18 EO	C8-18	(EO)5	-	-	.282	.017	.483	.071	-	-	16
Acrysol™ LMW-45	Carboxylic Acid	n/a	RCOO(-)	4500	-	1.102	.112	-	-	53	50	32
Aminohexanoic Acid	Carboxylic Acid	C6	RCOOH/NH2	-	-	1.491	.495	-	-	50	50	32
Citric Acid	Carboxylic Acid	-	-	191.1	-	1.334	.110	-	-	55	50	32
Gantrez™ S-95	Carboxylic Acid	-	-	-	-	1.353	.356	-	-	59	52	32
Gluconic acid	Carboxylic Acid	-	COOH/C-OH	-	-	1.551	.316	-	-	50	50	32
Isoascorbic Acid	Carboxylic Acid	-	-	-	-	1.251	.201	-	-	51	50	32
Mirawet™ B	Carboxylic Acid	C4	-	-	-	1.299	.294	-	-	59	52	32
Potassium Biphthalate	Carboxylic Acid	-	-	204.2	-	1.500	.406	-	-	53	50	32
Sodium Glucoheptonate	Carboxylic Acid	-	C-OH/RCOO(-)	249.2	-	1.238	.122	-	-	51	51	32
Sodium Gluconate	Carboxylic Acid	-	C-OH/RCOO(-)	218	-	1.329	.147	-	-	51	50	32
Tartaric Acid	Carboxylic Acid	-	-	-	-	1.501	.322	-	-	52	50	32
Chemquat™ SP-10	Cationic	-	-	-	-	.990	.125	1.538	.162	56	51	32
Tetronic™ 701	EO/PO	(PO)2.04	(EO)13.7	3600	1-7	.972	.244	2.129	.363	64	51	32
Henkel™ SF-7063	EO/PO/Me-ester	C13/CH ₂ -C(=O)OCH ₃	(EO)8.5	-	-	.287	.038	.374	.049	-	-	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.402	.044	.474	.048	70	67	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.492	.076	.558	.146	-	-	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.426	.042	.708	.133	68	67	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.458	.080	.841	.241	67	63	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.455	.087	.841	.274	66	64	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.432	.061	-	-	67	63	32
Ethox™ MI-14	Ester	C18	(EO)14	-	13	.468	.090	-	-	-	-	-
Brij™ 30	Fatty Alcohol	C12	(EO)4	-	-	.890	.161	1.013	.076	-	-	32
Chemal™ 2EH5	Fatty Alcohol	2-ethylhexanol	(EO)2	-	-	1.032	.068	1.075	.103	-	-	32
Chemal™ PA-5P8	Fatty Alcohol	C-10 LA/PO	EO	-	-	.815	.200	.725	.132	57	50	32
Ethal™ 2EH2	Fatty Alcohol	2-ethyl hexanol	(EO)2	-	8.1	1.167	.118	1.149	.146	-	-	32
Ethal™ CSA-10	Fatty Alcohol	C16-18	(EO)12	-	-	.748	.164	.761	.166	high	-	32

.....Table 3 continued on next page.....



Candidate or Compar- ison	Chemical Class	Hydrophobe	Hydrophile	Molecular Weight	HLB	COF Mean StD	COF-2 Mean StD	IFH	PFH	WFR
Ethal™ CSA-17	Fatty Alcohol	C16-18	(EO)17	-	-	.726	.177 .677	.167	-	32
Ethal™ DA-6	Fatty Alcohol	C10	(EO)6	-	12.4	.931	.201 1.045	.155	-	32
Ethal™ OA-23	Fatty Alcohol	C18	(EO)23	-	15.8	.698	.175 .749	.192	-	32
Ethal™ TDA-6	Fatty Alcohol	C13	(EO)6	-	11.4	.764	.179 .930	.163	-	32
Sandoxylate™ SX-408	Fatty Alcohol	i-C10-12 LA/PO	EO	-	11	.913	.107 .885	.105	-	32
Sandoxylate™ SX-424	Fatty Alcohol	i-C10-12 LA/PO	EO	-	15	.688	.160 .676	.137	-	32
Sandoxylate™ SX-602	Fatty Alcohol	i-C10-12 LA/PO	EO	-	8	.966	.132 1.145	.175	-	32
Triton™ XL-80N	Fatty Alcohol	C8-10 EO/PO/EO	EO	420	-	.801	.187 .776	.156	-	32
Varonic™ MT-42	Fatty Alcohol	C12-18 CH3 cap	EO	-	-	.549	.093 .581	.156	-	32
Varonic™ MT-48	Fatty Alcohol	C12-18 CH3 cap	EO	-	-	.583	.146 .692	.180	-	32
Varonic™ MT-65	Fatty Alcohol	C12-18 CH3 cap	EO	-	-	.814	.171 .862	.122	-	32
Fluorad™ FC-126	Fluorosurfactant	C7F15	R-COONa	-	-	1.335	.233 -	-	65 50	0
Kellig™ 100	Ligno-Sulfonate	-	-	-	-	1.450	.473 -	-	53 50	32
Kellig™ 400	Ligno-Sulfonate	-	-	-	-	2.022	.773 -	-	54 51	32
Igepal™ 660	NP-(EO)10	Nonyl Phenol	(EO)10	660	13.2	1.527	.555 -	-	70 65	32
Igepal™ 710	NP-(EO)10.4	Nonyl Phenol	(EO)10.4	678.5	13.6	1.330	.329 -	-	75 67	32
Igepal™ 720	NP-(EO)12	Nonyl Phenol	(EO)12	748	14.2	1.524	.423 -	-	76 71	32
Igepal™ 430	NP-(EO)4	Nonyl Phenyl	(EO)4	396	8.8	.516	.064 .815	.195	63 60	32
Igepal™ 610	NP-(EO)7.5	Nonyl Phenyl	(EO)7.5	570.9	12.2	.693	.170 1.021	.176	63 60	32
Carbowax™ Methoxy PEG	PEG	O-CH3	(EO)44.7	2000	-	.766	.222 .886	.199	-	32
Carbowax™ Methoxy PEG	PEG	O-CH3	(EO)7.3	350	-	.955	.126 1.047	.113	-	32
Carbowax™ Methoxy PEG	PEG	O-CH3	(EO)112.8	5000	-	.739	.158 .839	.118	-	32
Carbowax™ Methoxy PEG	PEG	O-CH3	(EO)16.3	750	-	.927	.236 .915	.190	-	32
Carbowax™ PEG 20M	PEG	-	(EO)n	17500	-	.663	.149 .934	.155	-	32
Carbowax™ PEG-1450	PEG	-	(EO)32.5	1450	-	.778	.158 .854	.229	-	32
Carbowax™ PEG-200	PEG	-	(EO)4.15	200	-	1.122	.140 1.050	.114	-	32
Carbowax™ PEG-3350	PEG	-	(EO)75.7	3350	-	.747	.105 .921	.149	-	32
Carbowax™ PEG-8000	PEG	-	(EO)181.2	8000	-	.778	.188 .840	.162	-	32
Carbowax™ PEG-900	PEG	-	(EO)19.5	900	-	.819	.199 .865	.212	-	32
Dequest™ 2000	Phosphonate	-	N[CH2-P=O(OH)2]3	299	-	1.506	.203 -	-	52 50	32
Dequest™ 2006	Phosphonate	-	Na3N[CH2-P=O(OH)2]3	409	-	1.327	.095 -	-	51 51	32

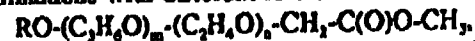
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Candidate or Compar- ison	Chemical Class	Hydrophobe	Hydrophile	Molecular Weight	HLB	COF		COF -2		IFH	PFH	WFR
						Mean	Std	Mean	Std			
Dequest™ 016	Phosphonate	-	[(C-CH ₂ OH)](P=O(Na) ₂) ₂	294	-	1.271	.209	-	-	51	51	32
Dequest™ 2054	Phosphonate	-	HMDA[CH ₂ -P=O(Na) ₂] ₄	721	-	1.095	.225	-	-	51	50	32
Dequest™ 2066	Phosphonate	-	Trien[CH ₂ -P=O(Na) ₂] ₃	683	-	1.176	.150	-	-	51	50	32
Belzak™ AC	Polyhydric	-	R-OH	-	-	1.211	.098	-	-	52	50	32
Cerelease™ 2001	Polyhydric	-	-	-	-	1.318	.095	-	-	51	50	32
Glycerine	Polyhydric	-	-	-	-	1.335	.134	-	-	51	50	32
Hexylene glycol	Polyhydric	2-Me,2,4-C5 diol	(C-OH) ₂	-	-	1.886	.130	-	-	58	50	32
Methocel™ 40-200	Polyhydric	-	-	-	-	.901	.076	1.193	.252	60	54	32
Pentaerythritol	Polyhydric	-	-	-	-	1.133	.088	-	-	54	52	32
Poly(vinyl alcohol)	Polyhydric	-	-	-	-	.479	.067	.982	.420	71	67	32
Sorbitol	Polyhydric	-	C-OH	182	-	1.239	.091	-	-	51	50	32
Tripropylene Glycol	Polyhydric	-	-	-	-	1.266	.125	-	-	60	52	32
Xanthan Gum	Polyhydric	-	-	-	-	1.059	.139	-	-	52	51	32
SOMAT™	Proprietary	-	-	-	-	.714	.161	-	-	-	-	-
Tween™ 20	Sorbitan ester-(EO) ₂₀	C12	EO	-	-	.601	.100	1.146	.498	59	68	32
Dodecylbenzene Sulfonate	Sulfonate	C12-Ph	SO ₃ (-)	-	-	.396	.029	.616	.182	100	82	8.5
Dowfax™ 2A1	Sulfonate	iso-C12-Ph (bis)	[SO ₃ (-)] ₂	576	-	.614	.112	.793	.109	71	68	0
Heptane Sulfonate	Sulfonate	C6	C6-COOH	-	-	1.214	.436	-	-	52	50	32
Nacconol™ 90F	Sulfonate	-	-	-	-	.387	.021	.462	.065	100	95	9

Notes for Table 3

"Std" here and in subsequent tables means "standard deviation from the mean." "WFR" means "waterbreak free rating". The multiple entries for "None" and for Elbox™ MI-14 represent determinations with different lots of cans. The Henkel™ SF products shown have the general chemical formula:



with the straight chain alkyl group R ranging from 8 to 18 carbon atoms in length, "m" being 0 or 1, and "n" ranging from 5 to an average of 8.5.

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Table 4
ETHOXYLATED HYDROGENATED CASTOR OIL DERIVATIVES AND
COMPARISONS AS FINAL RINSE MOBILITY ENHANCERS

Product Name	Grams/ 8 Liters	COF		COF-2		IFH	PFH
		Mean	Std	Mean	Std		
None	0	1.231	.149	-	-	-	-
Trylox™ 5922	1.6	.479	.072	.503	.085	69	65
Trylox™ 5922	0.4	.974	.161	1.055	.151	60	56
Trylox™ 5922	0.8	1.007	.117	1.131	.132	70	60
Trylox™ 5921	1.6	.511	.108	.548	.093	74	68
Trylox™ 5921	0.4	1.072	.144	1.034	.201	63	59
Trylox™ 5921	0.8	.883	.154	.958	.152	62	54
Trylox™ 5925	3.2	.914	.140	1.139	.157	67	62
Trylox™ 5925	6.4	1.020	.149	1.231	.122	74	67
Trylox™ 5925	9.6	.965	.180	1.007	.122	73	63
Ethox™ MI-14	1.6	.621	.118	1.059	.144	75	70

than compositions with an equal total amount of Ethox™ MI-9 alone, but also give further reductions in the COF. The interactions are evidently complex and difficult to predict.

II.6 *Final Rinse Mobility Enhancers and Rinse Aids.* The BW was operated as follows:

- Stage 1 sulfuric acid, pH 2.0, 54.4° C
- Stage 2 RIDOLINE 124C, 15 mL Free Acid, 3.4 g/L of total surfactant, Fluoride Activity -10 mV, 60° C
- Stage 3 tap water
- Stage 4 not used
- Stage 5 deionized water
- Stage 6 as noted in Table 6, 0.2 g/L total active additive

The line speed of this washer was controlled by a rheostat with the following approximate relationship between percentage of output and line speed in feet per minute:

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Table 5

EFFECT OF VARIATION OF DEGREE OF ETHOXYLATION IN PRIMARY LUBRICANT
AND SURFACE CONDITIONER (ETHOXYLATED ISOSTEARIC ACID) AND OF
VARIATION OF COSURFACTANT ADDED AS ATTEMPTED DEFOAMER

	COF		Ethoxylated Isostearic Acid		Defoamer		IFH	PFH
	Mean	Std	g/8L	# of EO per Molecule	g/8L	Name		
10	1.139	.170	0	-	0	-	-	-
	1.159	.181	0	-	0	-	-	-
15	1.069	.165	0	-	0	-	-	-
	1.190	.158	0	-	0	-	-	-
	1.154	.198	0	-	0	-	-	-
	1.142	.174	(Average of result with above five can lots)					
20	.587	.170	0	-	1.60	Pluronic™ 31R1	77	50
	.817	.155	0	-	1.60	Triton™ DF-16	79	55
	.659	.175	0	-	1.60	Trycol™ LF-1	50	50
25	.499	.099	1.60	9	0	-	55	55
	.478	.072	1.20	9	.40	Pluronic™ 31R1	61	58
	.479	.093	1.20	9	.40	Triton™ DF-16	63	62
	.423	.027	1.20	9	.40	Trycol™ LF-1	69	67
	.408	.038	.80	9	.80	Pluronic™ 31R1	65	63
	.576	.172	.80	9	.80	Triton™ DF-16	72	69
30	.467	.103	.80	9	.80	Trycol™ LF-1	65	63
	.496	.122	.40	9	1.20	Pluronic™ 31R1	67	64
	.628	.176	.40	9	1.20	Triton™ DF-16	78	76
	.656	.194	.40	9	1.20	Trycol™ LF-1	73	66
35	.457	.074	1.60	10.5	0	-	60	60
	.465	.121	1.20	10.5	.40	Pluronic™ 31R1	60	59
	.531	.108	1.20	10.5	.40	Triton™ DF-16	67	66
	.566	.186	1.20	10.5	.40	Trycol™ LF-1	65	65
	.583	.114	.80	10.5	.80	Pluronic™ 31R1	58	57
40	.564	.142	.80	10.5	.80	Triton™ DF-16	72	72
	.550	.114	.80	10.5	.80	Trycol™ LF-1	69	65
	.539	.111	.40	10.5	1.20	Pluronic™ 31R1	55	53
	.685	.205	.40	10.5	1.20	Triton™ DF-16	75	70
	.644	.133	.40	10.5	1.20	Trycol™ LF-1	77	62
45	.444	.104	1.60	14	0	-	76	75
	.477	.098	1.60	14	0	-	77	75
	.534	.093	1.20	14	.40	Pluronic™ 31R1	74	71
	.456	.121	1.20	14	.40	Triton™ DF-16	80	75
50	.516	.148	1.20	14	.40	Trycol™ LF-1	81	80
	.505	.106	.80	14	.80	Pluronic™ 31R1	82	79
	.532	.128	.80	14	.80	Triton™ DF-16	85	84
	.456	.078	.80	14	.80	Trycol™ LF-1	86	83
	.681	.178	.40	14	1.20	Pluronic™ 31R1	82	79
55	.615	.149	.40	14	1.20	Triton™ DF-16	81	78
	.538	.106	.40	14	1.20	Trycol™ LF-1	80	76

A 1521D This Sheet Has Been Replaced



Setting:	100%	Speed:	6.2 fpm
	70		3.4 "
	40		1.8 "

Three sets of 14 cans each were treated and collected at the end of the washer using
 5 tongs. The cans were stacked on a light gauge aluminum baking pan and weighed
 with the tongs taking care to lose as little water as possible during the manipulations.
 The cans, tongs and tray were then dried at 210° C for ten minutes and reweighed.
 The average of three replicate runs was taken as an estimation of the water retention
 of the finished cans. A fourth set of cans was collected, dried at 210° C for 3 minutes
 10 and tested to determine their COF. For those cases where the COF was less than 1.00
 the COF-2 was determined. Results are shown in Table 6.

Table 6
 VARIATION OF WATER DRAINAGE WITH LINE SPEED AND ADDITIVE
 TO FINAL RINSE

	Lubricant and/or Water Drainage Promoting Additive	Line Speed Setting	Water Retention		COF		COF-2 (Mean)
			Mean	Std	Mean	Std	
20	None	100	31.72	-	-	-	-
	None	100	30.44	-	-	-	-
	None	70	28.40	-	-	-	-
	None	70	28.29	.81	1.446	.071	-
	None	70	27.02	1.00	-	-	-
25	None	40	23.34	-	-	-	-
	Ethox™ MI-14	40	19.11	-	-	-	-
	Neodol™ 91-2.5	70	15.65	.37	1.356	.211	-
	Pluronic™ L-81	70	17.44	.14	1.124	-	-
	Pluronic™ L-61	70	17.71	.09	1.206	-	-
30	Neodol™ 91-6	70	20.83	.27	1.201	.175	-
	Ethox™ MI-14/ Pluronic™ L-81 (1:1)	70	21.02	.53	.728	-	.970
	Ethox™ MI-14/ Pluronic™ L-61 (1:1)	70	21.63	.32	.725	-	.832
35	Ethal™ OA-23	70	21.64	.72	.919	-	1.141
	Ethox™ MI-14	70	21.68	.18	-	-	-
	Ethox™ MI-14	70	21.69	-	-	-	-
	Ethox™ MI-10.5	70	21.93	.38	.550	-	.727
	Neodol™ 91-8	70	22.55	.30	1.009	.204	-
40	Ethox™ MI-14/ Trylox™ S922 (1:1)	70	24.07	1.00	.581	-	.707
	Trylox™ S925	70	24.62	.92	1.090	-	-
	Trylox™ S922	70	25.21	.97	.581	-	.680
	Trylox™ S921	70	25.88	.26	.546	-	.645
45	Ethox™ MI-14	100	26.60	-	-	-	-

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Some surfactants were found that are better at promoting water drainage than the ethoxylated isostearic acids that are very effective in providing lubricant and surface conditioner films. However, the surfactants that are exceptionally good at promoting water drainage are much poorer than ethoxylated isostearic acids in reducing COF. Mixing the two types permits improvement in water drainage, while retaining the ability to achieve COF values that are adequate in many applications.

Examples and Comparison Examples Group III

The combination of ethoxylated castor oil derivatives and fluozirconic acid shown in Table 3 above has been found to have an unexpected additional advantage, which is illustrated further in this group.

Some beverages packaged in aluminum cans are pasteurized, and unless the temperature and the composition(s) of the aqueous solution(s) with which cans are contacted during pasteurization are very carefully controlled, staining of the dome of the can often occurs during pasteurization. An FRME combining fluozirconic acid and hydrogenated castor oil derivatives in proper concentrations has been found to provide both protection against dome staining during pasteurization and adequate lowering of the COF for most purposes.

The can washing setup for this group of examples was:

Stage 1	sulfuric acid, pH 2.0, 30 sec., 54.4° C
Stage 2	RIDOLINE® 124C, 15 mL Free Acid, 3.4 g/L total of surfactant, Fluoride Activity -10 mV, 90 sec., 54.4° C
Stage 3	deionized water, 150 sec. (ca. 17.7 L)
Stage 4	as noted in Table 7 and below, 20 sec. spray + 20 sec. dwell, 29.4° C temperature
Stage 5	not used
Stage 6	not used

In addition to the ingredients listed in Table 7, the solutions were all adjusted to pH 4.5 by addition of aqueous ammonia or nitric acid as required.

Dome staining was evaluated by first removing the domes from the treated cans with a can opener. The domes were then placed in a water bath containing 0.2 g/L of borax at 65.6° C for 30 minutes, then rinsed in deionized water and dried in an oven. Staining resistance was evaluated visually by comparison with known satis-



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factory and unsatisfactory standards. Results are shown in Table 7. The last two conditions shown in the Table are highly satisfactory with respect to both COF and dome staining resistance during pasteurization.

Table 7

**EFFECT OF CONCENTRATIONS OF ETHOXYLATED CASTOR OIL
DERIVATIVE AND OF FLUOZIRCONIC ACID ON DOME STAINING
RESISTANCE AND COEFFICIENT OF FRICTION**

	<u>Grams of H₂ZrF₆/Liter</u>	<u>Grams of Trylox™ 5921/Liter</u>	<u>COF</u>	<u>Pasteurization Protection Rating</u>
	0	0	1.16	Fail
	0	0.2	0.57	Fail
	0.14	0.2	0.52	Fail
	0.29	0.2	0.61	Marginal
	0.58	0.2	0.63	Pass
	1.16	0.2	0.70	Pass

Examples and Comparison Examples Group IV

This group illustrates use with tin cans. Three types of materials were tried as lubricant and surface conditioner forming and water drainage promoting agents for tin cans: (i) Ethox™ MI-14; (ii) a combination of 1 part by weight of Pluronic™ 31R1 and 4 parts by weight of Plurafac™ D25; and (iii) Tergitol™ Min-Foam™ 1X. Of these, the Ethox™, Tergitol™, and Plurafac™ products are ethoxylated fatty acids or alcohols, with a poly(propylene oxide) block cap on the end of the poly(ethylene oxide) block in some cases, while the Pluronic™ is a block copolymer of ethylene and propylene oxides, with poly(propylene oxide) block caps on the ends of the polymers. All were used at a concentration of 0.2 g/L of active material with deionized water in a final rinse before drying, after an otherwise conventional tin can washing sequence. Water retention and COF values were measured as generally described above. Results are shown in Table 8.



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Table 8: RESULTS WITH TIN-PLATED STEEL D&I CANS

<u>Additive to Final Rinse</u>	<u>Mean COF Value</u>	<u>Percent Water Retention</u>
None	1.04	100 % (Defined)
Ethox™	0.70	83.6
Pluronic™/Plurafac™	0.81	77.3
Tergitol™	0.82	78.6



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CLAIMS:

1. A process comprising the steps of cleaning a metal can with an aqueous acidic or alkaline cleaning solution, drying the cleaned can, and subsequently conveying the cleaned and dried can via automatic conveying equipment to a location where it is lac-
5 quered or decorated by printing or both, characterized by contacting at least one exterior surface of said metal can, prior to the last drying of said exterior surface before automatic conveying, with a lubricant and surface conditioner forming composition, thereby forming a film on the can surface to provide the surface of the can after dry-
10 ing with a coefficient of static friction that is not more than 1.5, preferably not more than 1.2, more preferably not more than 1.0, still more preferably not more than 0.80, and that is less than would be obtained on a can surface of the same type without such film coating, said lubricant and surface conditioner forming composition being an aqueous solution comprising water-soluble organic material selected from the group consisting of alkoxylated or non-alkoxylated castor oil triglycerides, hydrogenated
15 castor oil derivatives, alkoxylated and non-alkoxylated amine salts of a fatty acid including mono-, di-, tri-, and poly-acids; alkoxylated and non-alkoxylated amino fatty acids, alkoxylated and non-alkoxylated fatty amine N-oxides, alkoxylated and non-alkoxylated quaternary ammonium salts, oxa-acid esters, and water-soluble alkoxylated and non-alkoxylated polymers and mixtures thereof, and also comprising at least one
20 of the elements selected from zirconium, titanium, cerium, aluminum, iron, tin, vanadium, tantalum, niobium, molybdenum, tungsten, and hafnium in metallic or ionic form and the film formed on the can surface contains at least part of said inorganic material in addition to said organic material.
2. A process according to claim 1, wherein said aqueous solution includes at least
25 one material selected from the group consisting of alkoxylated amine salts of a fatty acid including mono-, di-, tri-, and poly-acids; alkoxylated amino fatty acids, alkoxylated fatty amine N-oxides, alkoxylated quaternary ammonium salts, and water-soluble alkoxylated polymers.



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3. A process according to claim 2, wherein said aqueous solution includes at least one material selected from the group consisting of ethoxylated amine salts of a fatty acid including mono-, di-, tri-, and poly-acids; ethoxylated amino fatty acids, ethoxylated fatty amine N-oxides, ethoxylated quaternary ammonium salts, and water-soluble ethoxylated polymers.
4. A process according to claim 1 wherein said aqueous solution includes an amine salt of a fatty acid.
5. A process according to claim 1 wherein said aqueous solution includes an amino fatty acid.
6. A process according to claim 1 wherein said aqueous solution includes a fatty amine N-oxide.
7. A process according to claim 1 wherein said aqueous solution includes a quaternary salt.
8. A process according to claim 1 wherein said aqueous solution includes a water soluble polymer.
9. A process according to claim 1 wherein said aqueous solution includes an alkoxylated or non-alkoxylated castor oil triglyceride or a hydrogenated castor oil derivative.
10. A process according to claim 1 wherein said inorganic material includes zirconium.
11. A process according to claim 1 wherein said inorganic material includes titanium.
12. A process according to claim 1 wherein said aqueous solution also includes a non-ionic, anionic, cationic, or amphoteric surfactant.
13. A process according to claim 12 wherein said surfactant is ethoxylated.
14. A process according to claim 12 wherein said surfactant is an anionic surfactant.



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15. A process according to claim 1 wherein said lubricant and surface conditioner is applied following can cleaning in a cleaning composition with a fluoride ion activity at least as great as the activity indicated by a fluoride sensitive electrode reading of -10 mv.

16. A process according to any one of claims 1 - 15, wherein the can is an aluminum or tin plated steel can.

17. A process according to claim 16, wherein the lubricant and surface conditioner is applied and the treated can is subjected to at least two contacts with aqueous compositions after such application of the lubricant and surface conditioner.

18. A process comprising the steps of cleaning an aluminum can with an aqueous acidic or alkaline cleaning solution, drying the cleaned can, and subsequently conveying the cleaned and dried can via automatic conveying equipment to a location where it is lacquered or decorated by printing or both, characterized by contacting at least one exterior surface of said aluminum can, prior to the last drying of said exterior surface before automatic conveying, with a lubricant and surface conditioner forming composition and drying the can without subsequent rinsing, thereby forming a film on the can surface to provide the surface of the can after drying with a coefficient of static friction that is not more than 1.5, preferably not more than 1.2, more preferably not more than 1.0, still more preferably not more than 0.80, and is less than the COF that would be obtained by an otherwise identical sequence of treatments except that the lubricant and surface conditioner forming composition is substituted with water only, characterized in that the lubricant and surface conditioner forming composition is an aqueous solution comprising at least one of alkoxylated and non-alkoxylated castor oil triglycerides and hydrogenated castor oil derivatives, fatty amine oxides having at least one hydroxyethyl substituent on the amine oxide nitrogen atom, and oxa-acid esters.

19. A process according to claim 18, wherein the lubricant and surface conditioner forming composition comprises ethoxylated, hydrogenated castor oil triglycerides.

