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(71) Applicant: **ECOLAB USA INC.** [US/US]; 1 Ecolab Place, Saint Paul, Minnesota 55102 (US).

(72) Inventor: **KE, Wei**; 1-3 Floor, Building C, 255 Gui Qiao Road, Shanghai 201206 (CN).

(74) Agent: **CCPIT PATENT AND TRADEMARK LAW OFFICE**; 8th Floor, Vantone New World Plaza, 2 Fuchengmenwai Street, Beijing 100037 (CN).

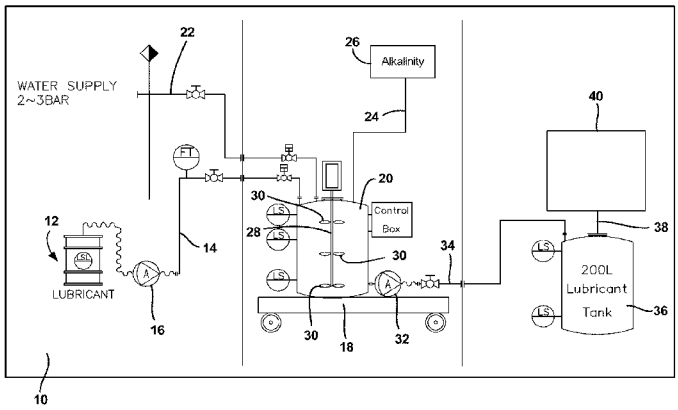
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(54) Title: CONCENTRATED FATTY AMINE SALT CONVEYOR LUBRICANTS

FIG. 1



(57) **Abstract:** A concentrated fatty amine salt conveyor lubricant composition is disclosed along with methods of making and using the composition. The fatty amine salt concentration in the concentrated lubricant composition is more than 25 wt %.

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CONCENTRATED FATTY AMINE SALT CONVEYOR LUBRICANTS

Background Technology

[1] Food and beverage processing plants use conveyor systems to move products throughout the plant. These conveyor systems are lubricated to reduce friction between the food or beverage package and the conveyor moving underneath the package. Food and beverage conveyor lubricants are sometimes categorized as either a wet lubricant or a dry lubricant. Wet lubricants generally refer to a lubricant that is applied at least 50% of the time that the conveyor is operating with packages on it and sometimes applied constantly. Wet lubricants often use copious amounts of lubricant and water to provide lubrication of the interface between the package and the conveyor surface. Dry lubricants are applied infrequently with long stretches of time in between application when run in a very dry mode. When a dry lubricant is used, the conveyor remains relatively "dry" in comparison to the conveyor surface when a traditional wet lubricant is used. Another distinction between a wet lubricant and a dry lubricant is that the coefficient of friction does not significantly increase when a dry lubricant is turned off. This allows the conveyor to continue to operate during long stretches in between lubricant application. In contrast, when a wet lubricant is turned off, the conveyor may be able to continue to operate for a period of time but eventually the coefficient of friction will start to increase above an acceptable level shortly after the lubricant is turned off. Both wet and dry lubricants are sold as concentrates in an effort to reduce the amount of water that is shipped. There is an ongoing need to further concentrate the lubricants and further reduce shipping costs while still ensuring a product that is homogenous and phase stable over a broad temperature range. It is against this background that the present invention is made.

Summary of Invention

[2] In one aspect, the present disclosure relates to a conveyor lubricant composition comprising from about 25wt% to about 60wt% of fatty amine salt, at least about 10wt% of nonionic surfactant, at least about 3wt% acid and less than 15wt% water.

[3] In one aspect, the present disclosure relates to a conveyor lubricant composition comprising the reaction products of a composition comprising from about 20wt% to about 55wt% of a fatty amine, from about 15 to about 35 of an acid, at least about 10wt% of surfactant, and less than 10% water.

Brief Description of the Drawings

[4] Figure 1 shows a diagram of a dilution system.

Detailed Description of Invention

[5] The present disclosure relates to a concentrated fatty amine conveyor lubricant for use in food and beverage plants to lubricate the interface between food and beverage packages and the conveyor surface. The concentrated conveyor lubricant includes one or more fatty amine salts, a surfactant, and a low concentration of water. The concentrated conveyor lubricant is the reaction product of the starting fatty amine and an acid that react to form the fatty amine salt. The starting materials also include the surfactant and a low concentration of water.

[6] As used in this disclosure, the phrase "concentrated lubricant starting composition" refers to the formula of unreacted starting materials including one or more fatty amines and an acid that react to form one or more fatty amine salts.

[7] As used in this disclosure, the phrase "concentrated lubricant composition" refers to the conveyor lubricant with the reacted fatty amine salt. The concentrated lubricant composition is diluted in a food or beverage plant to form the ready-to-use lubricant composition that is applied to the conveyor surface or the package.

[8] The phrase "intermediate lubricant composition" refers to a composition that has been diluted from the concentrated lubricant composition to an intermediate dilution, for example for ease of storing, and is further diluted to form the ready-to-use lubricant composition.

[9] The phrase "ready-to-use lubricant composition" refers to the lubricant composition that is applied to the conveyor equipment, conveyor surface, or the conveyor-contacting surface of the container.

[10] Fatty Amines and Fatty Amine Salts

[11] The concentrated lubricant composition includes one or more fatty amine salts. The fatty amine salts are formed through a reaction of one or more fatty amines with an acid. The fatty amine starting material may be a monoamine, diamine, or triamine. The fatty amine may be a primary, secondary, or tertiary amine. The fatty amine preferably has a carbon chain of 3-20, 5-18, or 10-16 carbon atoms. To prepare the fatty amine salt, a fatty amine starting material is combined with an acid starting material to form the corresponding salt.

[12] Preferred fatty amines are those having antimicrobial activity. When used as a wet lubricant, there is a significant amount of water on the conveyor surface and the surrounding equipment and floor. Having an antimicrobial lubricant is desirable to prevent unwanted microorganisms from growing in the wet environment, especially in a food or beverage facility.

It is understood that fatty amines may be selected that do not have antimicrobial properties and in those formulas, an antimicrobial agent may be added if it is desirable for the formula to have antimicrobial properties.

[13] Exemplary fatty amines including N-coco-1,3-propylene diamine, N-oleyl-1,3-propylene diamine, N-tallow-1,3-propylene diamine, tallow dipropylene triamine, N,N-dimethyldodecylamine, and mixtures thereof. The fatty amine salt is preferably an acetate. In some embodiments, the concentrated lubricant composition and concentrated lubricant starting composition are free of alkyl ether amines.

[14] In some embodiments, it is desirable to use a diamine as diamines have been found to have good water solubility in a variety of water sources including hard water with sodium and calcium cations in solution.

[15] When fatty amines are included as starting materials, the concentrated lubricant starting composition includes from about 20 to about 55wt%, from about 25 to about 45wt%, from about 20 to about 40wt%, or from about 40 to about 55wt% of the fatty amine starting material(s). When the fatty amine salt is formed in the concentrated lubricant composition after reaction between the fatty amine and an acid, the fatty amine salt(s) is present in the concentrated lubricant composition in an amount from about 25 to about 60wt%, from about 30 to about 50wt%, from about 25 to about 45wt%, or from about 45 to about 60wt%.

[16] The fatty amine salt concentrations are substantially higher than the concentrations that were previously understood to be possible. While not wanting to be bound by theory, it is believed that using extremely low water concentrations in the concentrate starting materials and lubricant compositions allow for much higher concentrations of fatty amine formulas to be made and remain phase stable over extremely low and high temperatures.

[17] Acid

[18] The fatty amine salt is formed by reacting a fatty amine with an acid. The acid used can be an organic acid and is preferably acetic acid. Acetic acid is particularly beneficial because any residual acetic acid in the concentrated lubricant composition will help solubilize the fatty amine salt. Other organic acids may be used in addition to or instead of acetic acid. Exemplary organic acids include C_1 to C_4 mono-, di-, and tri-carboxylic acids such as acetic acid, hydroxyacetic acid, citric acid, lactic acid, or a combination.

[19] The concentrated lubricant starting composition includes from about 15 to about 35wt%, or from about 20 to about 30wt%, or from about 20 to about 25wt% of the acid. When the fatty amine salt is formed in the concentrated lubricant composition after reaction between the fatty amine and an acid, the acid is present in the concentrated lubricant composition in an

amount from about 3 to about 20wt%, from about 8 to about 15wt%, from about 3 to about 8wt%, or from about 15 to about 20wt%.

[20] In some embodiments, the mole ratio of acid to fatty amine in the concentrated lubricant starting composition is at least 1:1 to permit substantially complete formation of a monoprotonated salt. In some embodiments, the mole ratio of acid to fatty amine in the concentrated lubricant starting composition is at least 2.5:1 to 3:1 to permit substantially complete formulation of the deprotonated salt and provide a sufficient excess of acid to maintain an acidic pH in the concentrated lubricant composition. In some embodiments, the concentrated lubricant composition has a pH from about 3 about 6, or about 3, about 3.5, about 4, about 4.5, about 5, about 5.5, or about 6.

[21] Surfactant

[22] The concentrated lubricant starting composition and concentrated lubricant composition include a surfactant. Without wanting to be bound by theory, it is believed that the surfactant helps keep the fatty amine salt soluble in water when it is diluted. It also enhances the lubricity and gives the concentrated lubricant composition a cleansing effect on the conveyor surface.

[23] Preferred surfactants include nonionic surfactants with a critical micelle concentration (CMC) of 200 ppm or less, 150 ppm or less, or 100 ppm or less. Exemplary nonionic surfactants include fatty alcohol-polyoxyethylene ethers, ethoxylated alkylphenols, ethoxylated aliphatic alcohols, alkyl polyglucoside, carboxylic esters, carboxylic amides, and ethylene oxide/propylene oxide block copolymers. Preferred surfactants have from up to about 25, about 6 to 20, or 8 to 16 carbon atoms. Perferred alcohol ethoxylate surfactants have up to about 25, 4-20, or 6-18 ethylene oxide units. An exemplary commercially available surfactant is Surfonic from Huntsman.

[24] In addition to low CMC nonionic surfactants, other nonionic surfactants may be used. Anionic, cationic, amphoteric, and zwitterionic surfactants may also be used. Care should be taken to select surfactants that do not cause stress cracking or crazing on polyethylene terephthalate (PET) bottles. Certain anionic surfactants such as salts of dodecyl benzene sulfonic acid have been known to contribute to stress cracking or crazing.

[25] The concentrated lubricant starting composition and the concentrated lubricant composition include from about 10 to about 50wt%, from about 25 to about 40wt%, from about 10 to about 25wt%, or from about 40 to about 50wt% of surfactant.

[26] Water

[27] The concentrated lubricant starting composition and concentrated lubricant composition both include a limited amount of water. The water in the concentrated lubricant

starting composition is less than 25wt%, less than 20wt%, or less than 15wt%. The water in the concentrated lubricant composition is less than 20wt%, less than 15wt%, or less than 10wt%. In some embodiments, the concentrated lubricant starting composition and concentrated lubricant composition may optionally include other solvents such as alcohols and glycols. In some embodiments, the concentrated lubricant starting composition and concentrated lubricant composition include a blend of water and alcohol or water and glycol in an amount of less than 25wt%, less than 20wt%, less than 15wt%, or less than 10wt%.

[28] Additional Ingredients

[29] The concentrated lubricant starting composition and concentrated lubricant composition may optionally include additional additives including anti-foam additives, viscosity control agents, perfumes, dyes, corrosion protection agents, antimicrobial agents, stress cracking inhibitors, and combinations thereof.

[30] Dilution

[31] The concentrated lubricant composition may be formulated as a solid, liquid, thickened liquid, gel, or thin liquid. When formulated as a solid, the concentrated lubricant composition may be mixed and heated and then allowed to cool and solidify. The viscosity of the concentrated lubricant composition can range from 100 centipoise up to a solid composition, from 100 to 300 centipoise, 300 to 500 centipoise, or 500 to 1000 centipoise, or 1000 centipoise up to a solid composition. When diluted, the ready-to-use lubricant composition typically has a viscosity that is water thin or less than 50 centipoise, less than 30 centipoise, or less than 10 centipoise.

[32] When the concentrate is formulated as a solid, during dilution, the solid may be heated again and allowed to liquefy, and then diluted with water to form an intermediate liquid concentrate that can be stored as a liquid and further diluted for use as a liquid ready-to-use composition or the solid can be diluted to directly form a ready-to-use lubricant composition. When formulated as a liquid, the liquid may be a thickened liquid or gel or a water thin liquid. A liquid concentrated lubricant composition would be diluted to form either an intermediate liquid concentrate that can be stored as a liquid and further diluted for use as a ready-to-use lubricant composition or the liquid concentrated lubricant composition can be diluted to directly form a ready-to-use lubricant composition.

[33] When a concentrate is diluted to form an intermediate lubricant composition, is can be diluted with water at a ratio of concentrate to water of about 1:3 to about 1:20. The intermediate lubricant composition can be further diluted with water at a ratio of intermediate lubricant composition to water of about 1:100 to about 1:1000.

[34] The concentrated lubricant composition is diluted with water to form either an intermediate lubricant composition or the ready-to-use lubricant composition. During dilution, the concentrated lubricant composition is mixed with water. The water may be any water including tap water, deionized water, or softened water. During dilution, it may be beneficial to adjust the pH of the intermediate lubricant composition or ready-to-use lubricant composition to a pH between about 5.5 to about 7 by adding a source of alkalinity to the diluted composition. Exemplary alkalinity sources include alkali metal hydroxides such as sodium hydroxide or potassium hydroxide, sodium carbonate, potassium carbonate, or sodium bicarbonate. In some embodiments, the fatty amine salt concentration in the ready-to-use composition ranges from about 3wt% to about 15wt%, about 5wt% to about 10wt%, or about 10wt% to about 15wt%.

[35] Figure 1 is a diagram of an exemplary dilution system 10. The dilution system 10 includes a container of concentrated lubricant composition 12. The concentrated lubricant composition container 12 may be a tote or drum, and is pumped through line 14 by pump 16 to a skid 18 with a mixing tank 20. In Figure 1, the mixing tank 20 is shown as a 200 liters tank but could be of any desirable size depending on the size of the concentrated lubricant composition container. A water line 22 is also connected to mixing tank 20. The mixing tank 20 may optionally include a line 24 for a source of alkalinity 26. The mixing tank 20 may optionally include a mixing shaft 28 with one or more mixing blades 30. A pump 32 and line 34 lead from the mixing tank 20 to a ready-to-use lubricant composition storage tank 36 where the ready-to-use lubricant composition is stored until it is used on the conveyor. A line 38 leads from tank 36 to the conveyor system 40. In practice, the concentrated lubricant composition is pumped from container 12 through line 14 to the mixing tank 20 where it is mixed with water from line 22 and optionally a source of alkalinity from line 24. Once mixed, the intermediate lubricant composition is pumped from mixing tank 20 through line 34 to the ready-to-use storage tank 36 where it wait to be used on the conveyor system 40.

[36] Application of the Lubricant

[37] A variety of kinds of conveyors and conveyor parts can be coated with the ready-to-use lubricant composition. Parts of the conveyor that support or guide or move the containers are preferably coated with the lubricant composition include belts, chains, gates, chutes, sensors, and ramps having surfaces made of fabrics, metals, plastics, composites, or combinations of these materials.

[38] The ready-to-use lubricant composition can also be applied to a wide variety of containers including beverage containers; food containers; household or commercial cleaning product containers; and containers for oils, antifreeze or other industrial fluids. The containers can be made of a wide variety of materials including glasses; plastics (e.g., polyolefins such as

polyethylene and polypropylene; polystyrenes; polyesters such as PET and polyethylene naphthalate (PEN); polyamides, polycarbonates; and mixtures or copolymers thereof); metals (e.g., aluminum, tin or steel); papers (e.g., untreated, treated, waxed or other coated papers); ceramics; and laminates or composites of two or more of these materials (e.g., laminates of PET, PEN or mixtures thereof with another plastic material). The containers can have a variety of sizes and forms, including cartons (e.g., waxed cartons or TETRAPACK™ boxes), cans, bottles and the like. Although any desired portion of the container can be coated with the lubricant composition, the lubricant composition preferably is applied only to parts of the container that will come into contact with the conveyor or with other containers. Preferably, the lubricant composition is not applied to portions of thermoplastic containers that are prone to stress cracking. In a preferred embodiment of the invention, the lubricant composition is applied to the crystalline foot portion of a blow-molded, footed PET container (or to one or more portions of a conveyor that will contact such foot portion) without applying significant quantities of lubricant composition to the amorphous center base portion of the container. Also, the lubricant composition preferably is not applied to portions of a container that might later be gripped by a user holding the container, or, if so applied, is preferably removed from such portion prior to shipment and sale of the container. For some such applications the lubricant composition preferably is applied to the conveyor rather than to the container, in order to limit the extent to which the container might later become slippery in actual use.

[39] The lubricant composition can be a liquid or semi-solid at the time of application. Preferably, the lubricant composition is a liquid having a viscosity that will permit it to be pumped and readily applied to a conveyor or containers, and that will facilitate rapid film formation whether or not the conveyor is in motion. The lubricant composition can be formulated so that it exhibits shear thinning or other pseudo-plastic behavior, manifested by a higher viscosity (e.g., non-dripping behavior) when at rest, and a much lower viscosity when subjected to shear stresses such as those provided by pumping, spraying or brushing the lubricant composition. This behavior can be brought about by, for example, including appropriate types and amounts of thixotropic fillers (e.g., treated or untreated fumed silicas) or other rheology modifiers in the lubricant composition.

[40] Methods of Application

[41] The lubricant coating can be applied in a constant or intermittent fashion. Preferably, the lubricant coating is applied in constant or near-constant fashion. In some embodiments, the ready-to-use lubricant may be applied intermittently where the ratio of on time to off time is in the range of 1:5 to 5:1, 1:3 to 3:1, 1:2 to 2:1, 1:1 to 1:3, 1:1 to 1:2, or about 1:5, about 1:4.5, about 1:4, about 1:3.5, about 1:3, about 1:2.5, about 1:2, about 1:1, about 1.5:1,

about 2:1, about 2.5:1, about 3:1, about 3.5:1, about 4:1, about 4.5:1, or about 5:1. The application period may be long enough to spread the composition over the conveyor belt (i.e. one revolution of the conveyor belt). During the application period, the actual application may be continuous, i.e. lubricant is applied to the entire conveyor, or intermittent, i.e. lubricant is applied in bands and the containers spread the lubricant around. The lubricant is preferably applied to the conveyor surface at a location that is not populated by packages or containers. For example, it is preferable to apply the lubricant spray upstream of the package or container flow or on the inverted conveyor surface moving underneath and upstream of the container or package.

[42] In some embodiments, the ready-to-use lubricant maintains a coefficient of friction below about 0.2, below about 0.15, or below about 0.12.

[43] In some embodiments, a feedback loop may be used to determine when the coefficient of friction reaches an unacceptably high level. The feedback loop may trigger the ready-to-use lubricant composition to turn on for a period of time and then optionally turn the ready-to-use lubricant composition off when the coefficient of friction returns to an acceptable level. The coefficient of friction preferably remains below about 0.2, below about 0.15, or below about 0.12 throughout the entire operation including any periods where ready-to-use lubricant is not being applied.

[44] The ready-to-use lubricant coating thickness preferably is maintained generally at the interface at least about 0.0001 mm, more preferably about 0.001 to about 2 mm, and most preferably about 0.005 to about 0.5 mm.

[45] Dispensing Equipment

[46] Preferred dispensing equipment for applying the ready-to-use lubricant composition includes spraying apparatus that provide a fine lubricant spray at relatively low flow rates (preferably less than about 7.5 gallons/hour at pressures less than about 60 psi) without requiring applied energy (for example high pressure, compressed air, or sonication) to break up the lubricant flow into small droplets. These are sometimes referred to as non-energized nozzles. It is understood that a nozzle can include any device that dispenses lubricant composition as a stream or a spray including orifice nozzles or check valve nozzles. The spray dispensing system preferably operates at relatively lower pressure (preferably less than about 60 psi) and does not comprise either a high pressure lubricant line or a lubricant venting line. Useful droplet sizes for the lubricant spray are from about 100 to about 5000 microns, preferably about 100 to about 500 microns.

[47] Preferred nozzles are small capacity spray nozzles which distribute the liquid lubricant as a solid (full) cone, hollow cone, flat fan or sheet-type of spray at pressures less than about 60 psi. Particularly preferred nozzles are flat spray nozzles with tapering edges which are

useful in establishing uniform spray distribution from overlapping spray patterns between adjacent sprays on a multiple nozzle header. Flat spray nozzles useful in the practice of the current invention include elliptical orifice nozzles and deflector nozzles. In the elliptical orifice design, the axis of the spray pattern is a continuation of the axis of the inlet pipe connection. In the deflector design, the deflection surface diverts the spray pattern away from the axis of the inlet pipe connection. Useful flat spray nozzles include FloodJet and VeeJet Small Capacity Wide Spray Angle nozzles (available from Spraying Systems, Wheaton, IL), FF Extra Wide Angle and NF Standard Fan nozzles (available from Bete Fog Nozzle, Inc., Greenfield, MA), and Flat Spray Standard nozzles (available from Allspray, Inc., Carol Stream, IL). A particularly preferred deflector flat spray nozzle is the Low Flow FloodJet 1/8K-SS.25 nozzle available from Spraying Systems, Wheaton IL. Useful cone spray nozzles include UniJet Small Capacity Standard Spray nozzles (available from Spraying Systems, Wheaton, IL), WT Right Angle Hollow Cone nozzles (available from Bete Fog Nozzle, Inc., Greenfield, MA), and Hollow Cone Standard nozzles (available from Allspray, Inc., Carol Stream, IL). A particularly preferred cone spray nozzle is the UniJetTXVS-1 nozzle available from Spraying Systems, Wheaton IL.

[48] Dispensing apparatus for practice of the present invention includes means to provide lubricant compositions to nozzles under low to moderate pressures, less than about 60 psi. One possible means is to pressurize the lubricant source. Preferred dispensing equipment includes means to pressurize the lubricant composition in line by pumping. The requirements for a pump are modest and can be met by a variety of pump designs including diaphragm pumps, peristaltic pumps, and valveless rotating reciprocating piston metering pumps. Particularly preferred pumps start and stop automatically when a discharge valve downstream of the pump is opened and closed. In this way, the pump is not operating during non-application periods. Examples of pumps that start and stop automatically include positive displacement diaphragm pumps with built-in pressure switches that automatically start and stop pumping instantaneously when the discharge valve is opened. An example includes a Flowjet 2100 pump available from Flowjet, a division of IIT Industries, Foothill Ranch, CA. Other examples of pumps that start and stop automatically are positive displacement reciprocating double diaphragm pumps such as the Wilden PI plastic pump available from Wilden Pump & Engineering, LLC,Grand Terrace, CA and pneumatic single diaphragm pumps such as the Yamada NDP-5 pump available from Yamada America, West Chicago IL. Pumps which do not automatically start and stop upon action of a downstream discharge valve may advantageously be used with a controller that actuates both the downstream discharge valve and the pump. Application of the ready-to-use lubricant composition can be carried out using any suitable technique including spraying, streaming, wiping, brushing, drip coating, roll coating, and other methods for application of a

thin film. In some embodiments, the ready-to-use lubricant composition can be applied under pressure. In some embodiments, the ready-to-use lubricant composition is applied without pressure above the line pressure of the line leading to the dispenser. Nozzles useful in the practice of the current invention do not require additional pressure beyond the line pressure and generate a fine lubricant spray at low to moderate pressures between 5 psi and 80 psi, preferably between 20 psi and 60 psi, and have preferably between 30 psi and 50 psi, and deliver between 0.1 gallons/hour and 10 gallons/hour, preferably between 0.25 gallons/hour and 7.5 gallons/hour, between 0.5 and 5.0 gallons/hour, and between about 0.5 and 2.8 gallons/hour.

Examples

[49] The concentrated lubricant composition formulas in Table 1 were used in the examples.

Table 1

Formula 1

Description	Function	Concentration (wt%)
water	solvent	92.4223
Acetic acid	acid	0.04
N-Oleyltrimethylenediamine, diacetate	active lubricating agent/antimicrobial	3.3288
9-Octadecen-1-amine, (9Z)-, acetate	active lubricating agent/antimicrobial	0.5399
poly(oxy-1,2-ethanediyl), .alpha.-isotridecyl-.omega.-hydroxy-	surfactant	3.3
Sodium acetate	buffer	0.369

Formula 2

Description	Function	Concentration (wt%)
water	solvent	10.6528
Acetic acid	acid	13.8242
N-Oleyltrimethylenediamine, diacetate	active lubricating agent/antimicrobial	37.4487
9-Octadecen-1-amine, (9Z)-, acetate	active lubricating agent/antimicrobial	6.0743
poly(oxy-1,2-ethanediyl), alpha.-isotridecyl-.omega.-hydroxy-	surfactant	32

[50] **Example 1 – Stability Testing**

[51] Example 1 evaluated the stability of the concentrated lubricant composition (Formula 2). For this example, 200 grams of the compositions from Table 1 were placed into reagent bottles and closed. The samples were held at 4°C, ambient, and 40°C for three months.

After three months, the containers were visually observed for product separation or precipitation. The results are shown in Table 2.

Table 2

Formula 1

Specification	Test method	Initial	3 months later (ambient)	3 months later (4°C)	3 months later (40°C)
ppearance	Visual	Clear yellow liquid	Clear yellow liquid	Clear yellow liquid	Clear yellow liquid
pH	pH of a 100% Soln	5.92	5.91	5.93	5.92
Specific Gravity	Specific Gravity	1.001	1.001	1.002	1.001

Formula 2

Specification	Test method	Initial	3 months later (ambient)	3 months later (4°C)	3 months later (40°C)
Appearance	Visual	Clear amber liquid	Clear amber liquid	Clear amber liquid	Clear amber liquid
pH	pH of a 1% Soln	4.22	4.22	4.25	4.21
Specific Gravity	Specific Gravity	0.992	0.992	0.992	0.992

[52] Table 2 shows that Formula 2, with a higher concentration of lubricant material, remained as stable at low and high temperatures as Formula 1 (with 92.4223% water).

[53] 200 grams of the concentrated lubricant composition Formula 2 from Table 1 were placed into reagent bottles and subjected to freeze/thaw testing. The bottles were held at -18°C for 24 hours, then ambient (18-20°C) for 24 hours to complete one cycle of freeze/thaw testing. After the desired number of cycles were complete, the bottles remained at ambient temperature for an additional two weeks and then were observed for phase separation or precipitation. The results are shown in Table 3.

Table 3 – freeze/thaw testing of Formula 2

Specification	Test method	Initial	1 cycle	2 cycles	3 cycles
Appearance	Visual	Clear amber liquid	Clear amber liquid	Clear amber liquid	Clear amber liquid
pH	pH of a 1% Soln	4.22	4.23	4.26	4.27
Specific Gravity	Specific Gravity	0.992	0.992	0.992	0.992

[54] Table 3 shows that the concentrated lubricant composition of Formula 2 was stable and did not separate or precipitate, even over three freeze/thaw cycles.

[55] **Example 2 – Lubricity Testing**

[56] Example 2 evaluated the lubricity of the ready-to-use lubricant composition on a short conveyor track. For this example, the formulas in Table 1 were diluted and tested along with Lubodrive, a commercially available amine-based lubricant from Ecolab Inc.

[57] For this example, six 500 ml glass beer bottles were placed on a stainless steel conveyor track and linked to a tension meter by a string. The track speed was set to 25 m/min. The lubricant compositions in Table 1 were diluted with water in the following concentrate to water ratios to form ready-to-use lubricant compositions: Formula 1 (1:500), Formula 2 (1:5500), and Lubodrive (1:500). The ready-to-use lubricant compositions were sprayed on the conveyor surface by nozzles (volume 4.8L/hour) using a spray frequency of 20 seconds on, 20 seconds off. The tension was recorded in control system over 60 minutes. The tension measurements were converted to coefficient of friction measurements by the computer system. The median coefficient of friction for each composition is shown in Table 4:

Table 4 – coefficient of friction results

formula	median coefficient of friction
Formula 1 (diluted 1:500)	0.120682
Formula 2 (diluted 1:5500)	0.120342
Lubodrive (diluted 1:500)	0.126665

The results in Table 4 show that the concentrated lubricant composition (Formula 2) achieved comparable lubrication performance to the ready-to-use composition of Formula 1 and Lubodrive.

[58] **Example 3 – Foaming**

[59] Example 3 evaluated the foaming of dilutions of the formulas in Table 1 and Lubodrive. To achieve the desired dilutions, Formula 2 was first diluted with water in concentrate to water ratio of 1:10. That intermediate composition was then further diluted to achieve a 0.20%, 0.40% or 0.60% concentration. Formula 1 and the Lubodrive product were also diluted (but without the intermediate 1:10 dilution) to concentrations of 0.20%, 0.40%, and 0.60%. For this example, 100 ml of test sample was added to a 250 ml graduated cylinder. A stopper was placed in the cylinder and the cylinder was placed into a cylinder rotating device (Lesson Speedmaster™). The cylinders were rotated at 30 rpm for 5 minutes. After that, the foam height of each cylinder was measured. The foam height measurements are reported in Table 5. The results show that the concentrated lubricant composition, when diluted to the ready-to-use lubricant composition, had a better (lower) foam profile than Ecolab's Lubodrive conveyor lubricant.

Table 5 – foam height (in millimeters)

	foam height (mm)		
Concentration	0.20%	0.40%	0.60%
Formula 1	30	55	70
Formula 2 (premixed with water)	30	55	75
Lubodrive	35	60	110

[60] **Example 4 – Antimicrobial Testing**

[61] Example 4 evaluated the antimicrobial efficacy of the formulas in Table 1 against *Saccharomyces cerevisiae* (ATCC 834) and *Psuedomonas aeruginosa* (isolated from a brewery plant). The formulas in Table 1 were tested along with Lubodrive, and Lubodrive EC (an amine-based lubricant, commercially available from Ecolab Inc.). 0.2 grams of Lubodrive, 0.2 grams of Lubodrive EC, and 0.02 grams of Formula 2 were added into 100 ml bacteria suspensions respectively. After 5 minutes, 30 minutes, or 60 minutes, 0.5 ml of sample was transferred to 4.5 ml of a sterile neutralizer (1%Tween 80, 0.5% lecithin) and mixed for 10 minutes. Surviving bacteria or yeast were identified by serial dilution in sterile PBDW. The dilutions were plated on Sabouraud Dextrose Agar as a subculture medium and incubated at 28 ±2℃ for 48-72 hours. After that, the surviving bacteria or yeast were counted on the plates.

[62] The results are shown in Tables 6 and 7 below. The results demonstrate that the ready-to-use lubricant composition from Formula 2 has comparable antimicrobial activity against *S. cerevisiae* and *P. aeruginosa* as the commercially available lubricant products Lubodrive (Ecolab) and Lubodrive EC (Ecolab).

Table 6 – *Saccharomyces cerevisiae*

Formula	Initial Count (CFU/mL)	5 min		30 min		60 min	
		Survivors (CFU/mL)	Log Reduction	Survivors (CFU/mL)	Log Reduction	Survivors (CFU/mL)	Log Reduction
Lubodrive	3.8×10^5	< 10	> 4.58	< 10	> 4.58	< 10	> 4.58
Lubodrive EC		< 10	> 4.58	< 10	> 4.58	< 10	> 4.58
Formula 2		1×10	4.58	< 10	> 4.58	< 10	> 4.58

Table 7 – *Psuedomonas aeruginosa*

Formula	Initial Count (CFU/mL)	5 min		30 min		60 min	
		Survivors (CFU/mL)	Log Reduction	Survivors (CFU/mL)	Log Reduction	Survivors (CFU/mL)	Log Reduction
Lubodrive	7.3×10^6	3.49×10^6	0.32	2.44×10^6	0.48	1.67×10^6	0.64
Lubodrive EC		2.84×10^6	0.41	1.36×10^6	0.73	1.07×10^6	0.83
Formula 2		3.8×10^6	0.28	2.03×10^6	0.56	1.46×10^6	0.7

[63] **Example 5 – Water Hardness Tolerance**

[64] Example 5 evaluated the water hardness tolerance of the ready-to-use lubricant composition. For this test, a 0.02% solution of Formula 2 from Table 1 was tested in four solutions with varying hardness levels of 100 ppm, 200 ppm, 300 ppm, and 400 ppm. The dilution water was prepared and tested to confirm the water hardness level by titration. 100 ml of a 0.2% lubricant solution was prepared and mixed with a stir bar until homogenous. The 100 ml was divided into three samples. One was sealed with a lid and the other two were allowed to remain open to the atmosphere. All samples were stored in a 40°C oven for 7 days, after which they were observed for any precipitation on the bottom of the sample container. A successful test will not show any precipitation in either the open or closed containers after 7 days in the 40°C oven. Formula 2 did not have any precipitation at any of the hard water levels (100 ppm, 200 ppm, 300 ppm, or 400 ppm).

[65] The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

What is claimed is

1. A conveyor lubricant concentrate composition comprising:
   a. from about 25wt% to about 60wt% of fatty amine acetate;
   b. at least about 3wt% acid;
   c. at least about 10wt% of a nonionic surfactant; and
   d. less than 15wt% water.

2. The composition of claim 1, wherein the acid is a C_1 to C_4 mono-, di-, or tri-carboxylic acid.

3. The composition of claim 1 or 2, wherein the acid is at least one acid comprising acetic acid, hydroxyacetic acid, citric acid, lactic acid, or combinations thereof.

4. The composition of any one of claims 1-3, wherein the acid is acetic acid.

5. The composition of any one of claims 1-4, wherein the nonionic surfactant has a critical micelle concentration of 200 or less.

6. The composition of any one of claims 1-5, wherein the nonionic surfactant is selected from the group consisting of fatty alcohol-polyoxyethylene ethers, ethoxylated alkylphenols, ethoxylated aliphatic alcohols, alkyl polyglucoside, carboxylic esters, carboxylic amides, ethylene oxide/propylene oxide block copolymers, and mixtures thereof.

7. The composition of any one of claims 1-6, wherein the fatty amine acetate is selected from the group consisting of N-coco-1,3-propylene diamine acetate, N-oleyl-1,3-propylene diamine acetate, N-tallow-1,3-propylene diamine acetate, tallow dipropylene triamine acetate, N,N-dimethyldodecylamine acetate, and mixtures thereof.

8. A conveyor lubricant concentrate composition comprising the reaction products of a composition comprising:
   a. from about 20wt% to about 55wt% of a fatty amine;
   b. from about 15to about 35of an acid;
   c. at least about 10wt% of nonionic surfactant; and

d. less than 10% water.

9. The composition of claim 8, wherein the acid is a C_1 to C_4 mono-, di-, or tri-carboxylic acid.

10. The composition of claim 8 or 9, wherein the acid is at least one acid comprising acetic acid, hydroxyacetic acid, citric acid, lactic acid, or combinations thereof.

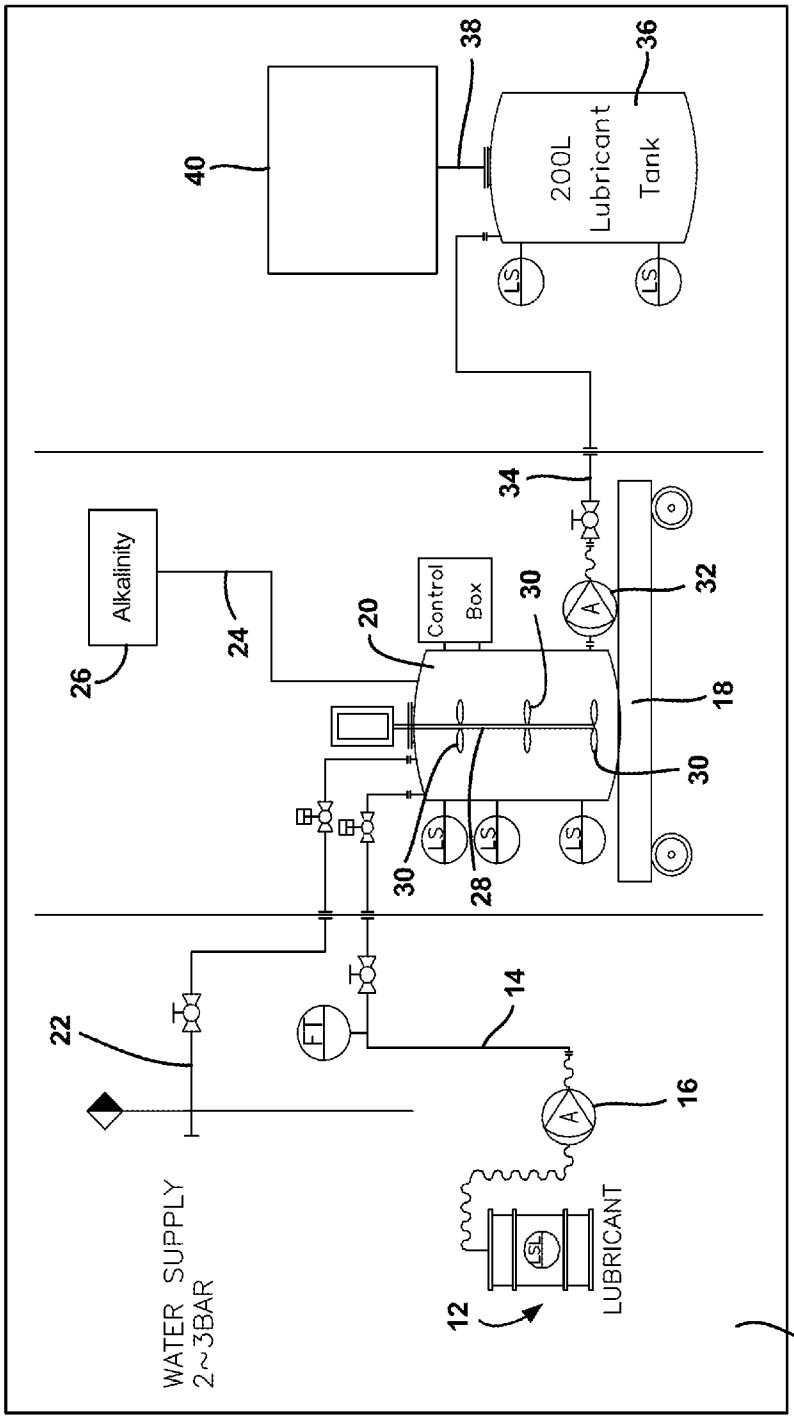
11. The composition of any one of claims 8-10, wherein the acid is acetic acid.

12. The composition of any one of claims 8-11, wherein the nonionic surfactant has a critical micelle concentration of 200 or less.

13. The composition of any one of claims 8-12, wherein the nonionic surfactant is selected from the group consisting of fatty alcohol-polyoxyethylene ethers, ethoxylated alkylphenols, ethoxylated aliphatic alcohols, alkyl polyglucoside, carboxylic esters, carboxylic amides, ethylene oxide/propylene oxide block copolymers, and mixtures thereof.

14. The composition of any one of claims 8-13, wherein the fatty amine acetate is selected from the group consisting of N-coco-1,3-propylene diamine acetate, N-oleyl-1,3-propylene diamine acetate, N-tallow-1,3-propylene diamine acetate, tallow dipropylene triamine acetate, N,N-dimethyldodecylamine acetate, and mixtures thereof.

FIG. 1


WATER SUPPLY
2~3BAR
LUBRICANT
200L
Lubricant
Tank
Alkalinity
Control
Box
LS
LSL
FT
A
10
12
14
16
18
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22
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/075760

A. CLASSIFICATION OF SUBJECT MATTER

C10M 133/02(2006.01)i; C10M 173/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

VEN;CNABS;CNTXT;CNKI;Google Scholar:conveyor,lubricant, fatty amine, acetate, acetic, acid, carboxylic, nonionic, surfactant, water

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5182035 A (ECOLAB INC) 26 January 1993 (1993-01-26) Column 2, lines 11-17, column 4, lines 16-24 and 32-36, column 5, line 63-column 6, line 1	1-14
Y	CN 102803453 A (AKZO NOBEL CHEMICALS INT BV) 28 November 2012 (2012-11-28) Claims 1-6, paragraph [0002]	1-14
A	CN 104194905 A (GUANGDONG HUANKAI MICROBIAL SCI & TECH CO LTD) 10 December 2014 (2014-12-10) Claims 1-7	1-14
A	US 2006046940 A1 (ALMALKI MOHANNAD ET AL.) 02 March 2006 (2006-03-02) Claims 1-27	1-14

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 2019	**20 November 2019**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**REN,Yi**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62084787**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/075760

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