



- (51) **International Patent Classification:**  
*C10M 163/00* (2006.01)
- (21) **International Application Number:**  
PCT/US2014/029016
- (22) **International Filing Date:**  
14 March 2014 (14.03.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
61/794,779 15 March 2013 (15.03.2013) US
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- (81) **Designated States** (*unless otherwise indicated, for every  
kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,  
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,  
ZW.

- (84) **Designated States** (*unless otherwise indicated, for every  
kind of regional protection available*): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

**Published:**

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))



WO 2014/144554 A1

(54) **Title:** LUBRICANT ADDITIVES AND COMPOSITIONS

(57) **Abstract:** Embodiments are described herein to provide a functional composition that can be added to the lubricant of the HVAC system to help prevent/reduce the lubricant breakdown. The functional composition can also help prevent/reduce material deposition on, for example, an orifice of an expansion or heat transfer surface(s) or heat transfer surface(s). The functional composition can be added as an additive to a lubricant of a HVAC system to form a lubricant composition. The lubricant composition can be added to a HVAC system to help prevent/reduce the material deposition. In some embodiments, the functional composition can be added to a HVAC system during operation of the HVAC system to help remove/reduce existing material deposition.

## LUBRICANT ADDITIVES AND COMPOSITIONS

### Field

The disclosure herein relates to heating, ventilation, and air-conditioning (“HVAC”) systems, and more particularly to a functional composition that can be added to a lubricant of the HVAC system to help prevent/reduce lubricant breakdown. The functional composition may also help prevent the formation of precipitates and/or remove precipitates that have been deposited on components, such as an expansion device and/or heat exchange surface(s), of the HVAC system.

10

### Background

A HVAC system, such as a chiller, generally includes a compressor, a condenser, an evaporator and an expansion device forming a refrigeration circuit. In a cooling cycle of the HVAC system, the compressor can compress refrigerant vapor, and the compressed refrigerant vapor may be directed into the condenser to condense into liquid refrigerant. The liquid refrigerant can then be expanded by the expansion device and directed into the evaporator. The expansion device may include an orifice, through which the liquid refrigerant can be expanded into a liquid/vapor mixture.

The HVAC system often includes a lubricant to lubricate load bearing surface(s), such as bearings of a compressor. The lubricant may be circulated in the refrigeration circuit along with the refrigerant.

### Summary

Embodiments are described herein to provide a functional composition that can be added to the lubricant of the HVAC system to help prevent/reduce the lubricant breakdown. The functional composition can also prevent precipitate formation and/or prevent/reduce material deposition on, for example, an orifice of an expansion device and/or heat transfer surface(s). In some embodiments, the functional composition can be added as an additive to a lubricant of a

HVAC system to form a lubricant composition. The lubricant composition can be added to a HVAC system in a manufacturing process to help prevent/reduce the material deposition. In some embodiments, the functional composition can be added to a HVAC system during operation of the HVAC system to help remove/reduce existing material deposition.

5 In some embodiments, the functional composition may include a chemical that can interfere with the reaction that can cause lubricant breakdown and formation of the metal-carboxylate at the bearing wear surface(s). In some embodiments, the functional composition may form a coating on, e.g. bearing surface(s), to prevent the deposition of metal carboxylates from forming. In some embodiments, the functional composition may include a chemical that  
10 can reduce the catalytic effects of the metal-carboxylate species. In some embodiments, the functional composition may include a chemical that can change the polarity and/or the acidity of the bulk lubricating oil, which can help remove the deposited lubricant breakdown products. In some embodiments, the functional composition may include a chemical that can coat the expansion device (e.g. an orifice) and/or the heat transfer surface(s) to prevent/reduce material  
15 deposition. In some embodiments, the functional composition may include a chemical that can change the polarity of the lubricating oil, which may help increase the solubility of the metal carboxylates and prevent/reduce material precipitation at the expansion device and/or the heat transfer surface(s).

In some embodiments, the functional composition may include a mixture of an ester of a  
20 hydroxycarboxylic acid; and a base oil lubricant that is at least one selected from a group including an alkylbenzene, an alkylated naphthenic, a polyalkylene glycol, a polyvinylether, a polyalphaolefin, mineral oil, a polyol ester, and a combination thereof. In some embodiments, the base oil lubricant may be different from the lubricant for the compressor.

In some embodiments, the functional composition may include one or more additional  
25 esters. For example, the functional composition may include an ester of a hydroxycarboxylic acid and an ester of a fatty acid. Any fatty acid may be used including, without limitation, pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid,

hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, oleic acid, 2-ethylhexanoic acid, and a combination thereof. In addition, the ester may have an alkoxylate portion which comprises one or more oxide monomers higher than ethylene oxide. In other embodiments, the functional composition may preferably include more than one ester of a hydroxycarboxylic acid. In other words, each ester may be produced from a different hydroxycarboxylic acid. For exemplary purposes only, in such an embodiment the functional composition may contain a ricinoleic acid ester and a hydroxystearic acid ester.

In some embodiments, the functional composition may include a corrosion inhibitor, such as a corrosion inhibitor for iron or copper containing materials. The corrosion inhibitor can help coat the expansion device and/or heat transfer surfaces to prevent/reduce material depositions. In some embodiments, the functional composition may include: epoxides (e.g. aromatic epoxides, alkyl epoxides, alkenyl epoxides), terpenes, terpenoids, fullerenes, ascorbic acid, terephthalate, nitromethane, unsaturated hydrocarbons or unsaturated halocarbons, phenols, perfluoropolyether, hindered phenols, hydroxylamines, thiols, phosphite and lactones, siloxane, tolytriazoles, benzotriazole, amines, hydrazine, hexamine, phenylenediamine, dimethylethanolamine, zinc dithiophosphates, quaternary and acyclic amines, quaternized alkyl pyridine, amine/phosphate ester salt, cinnamaldehyde, dibutylamine, diethylhydroxylamine, dimethylethanolamine, 3,5 dinitrobenzoic acid, ethylenediamine, hexamethyleneteramine, 1,2 diaminopropane, and a combination thereof.

In some embodiments, the functional composition may include benzotriazole. In some embodiments, a final concentration by weight of the lubricant for benzotriazole may be 0.001% or about 0.001% to 10% or about 10%, more preferably from 0.01% or about 0.01% to 0.1% or about 0.1%.

In some embodiments, a functional composition may include from about 1% to about 60% by weight of the hydroxycarboxylic acid ester, preferably from about 5% to about 40%, more preferably from about 10% to about 20%.

In some embodiments, the functional composition may be added to a lubricant of a HVAC system to about 5 to 10% by weight of the lubricant. In some embodiments, the

functional composition may be added to the lubricant first, then the lubricant may be mixed with the refrigerant in the HVAC system. In some embodiments, the functional composition may be added to a HVAC system that includes a refrigerant and a lubricant. In some embodiments, the functional composition may be added to a HVAC system during operation of the HVAC system.

5 In some embodiments, the functional composition can be directly applied to, for example, bearings, orifice, and/or other parts. The functional composition can be added directly to the parts through, for example, a spray or dip type application during manufacturing or servicing of the HVAC system.

10 Other features and aspects of the fluid management approaches will become apparent by consideration of the following detailed description.

### Detailed Description

15 A vapor-compression HVAC system often includes a compressor, a condenser, an evaporator and an expansion device to form a refrigeration circuit. The compressor may be configured to compress a refrigerant vapor, which is then condensed to liquid refrigerant in the condenser. The expansion device may have an orifice. When the liquid refrigerant passes through the orifice, the liquid refrigerant can be expanded into a liquid/vapor refrigerant mixture and lower the temperature of the liquid/vapor mixture.

20 The HVAC system may include load bearing surface(s), such as bearings of the compressor. A lubricant, such as polyolester (POE) or polyvinyl ether (PVE) lubricant, is often used to lubricate the load bearing surface(s). The lubricant can be added to the HVAC system and circulated along with the refrigerant in the refrigerant cycle. Material wear of the load bearing surface(s) may cause lubricant breakdown, for example, by reacting with the lubricant to form iron carboxylate or other metal-carboxylates. The iron carboxylate or metal-carboxylates  
25 may further break down and react with cations, such as sodium and/or potassium, in the HVAC system, which may form sodium/potassium carboxylate/carbonate or other metal carboxylates/carbonates. The cations may come from, for example, process chemicals, or filter driers or flux of the HVAC system.

The sodium/potassium carboxylate/carbonate or other metal carboxylates/carbonates may be circulated along with the refrigerant and the lubricant in the refrigerant cycle. When the refrigerant passing through, for example, the orifice, because of the temperature change, the sodium/potassium carboxylate/carbonate or other metal carboxylates/carbonates may become insoluble precipitates and deposit at the orifice, causing orifice restriction. The precipitates deposited at the orifice may also attract and bind to other system debris, such as very fine material such as for example dust from the filter drier, flux, bearing wear particles, copper oxide and the like, of the HVAC system to deposit at the orifice, further restricting the orifice. As the orifice restricts, some of the refrigerant may flood back to the compressor causing the compressor to operate hotter, which in turn can generate more system debris and/or cations. The orifice restriction may cause detrimental effect on the performance of the HVAC system.

Embodiments are described herein to provide a functional composition that can be added to the lubricant of the HVAC system to help prevent/reduce the lubricant breakdown. The functional composition may include one or more of the following compounds: a compound that can interfere with the reaction that can cause lubricant breakdown and/or formation of the iron carboxylate or other metal-carboxylates on the load bearing surface(s); a compound that can coat the load bearing surface(s) of the HVAC system so as to prevent/reduce the formation of the iron carboxylate or other metal-carboxylates; a compound that can reduce the catalytic effect of the metal-carboxylate species; a compound that can change the polarity and/or acidity of the lubricant so as to remove the deposited lubricant breakdown products; a compound that can coat the expansion device (e.g. the orifice) and/or heat transfer surface(s) of the HVAC system so as to prevent deposition of the lubricant breakdown products; and/or a compound that can change the polarity of the lubricant so as to increase the solubility of the iron carboxylate or other metal-carboxylates and prevent deposition of the lubricant breakdown products.

In some embodiments, the functional composition may include a base oil lubricant that is different from the lubricant of the HVAC system. As a non-limiting example, the HVAC system may utilize a first POE and/or PVE lubricant as a lubricant for the compressor of the HVAC system, the functional composition may include a POE, a PVE, a PAG or another similar base oil

lubricant that is different from the first lubricant. In some embodiments, the functional composition may include a phosphonated or sulfonated lubricants or detergents. In some embodiments, the functional composition may include an organic acid with a carbon chain of between C1 to C18. In some embodiments, the functional composition may include a blend of  
5 one or more of the compounds as listed herein.

In some embodiments, a functional composition may include a mixture of an ester of a hydroxycarboxylic acid; and a base oil lubricant selected from a group including an alkylbenzene, an alkylated naphthenic, a polyalkylene glycol, a polyvinylether, a polyalphaolefin, mineral oil, a polyol ester, and a combination thereof. Generally, the  
10 hydroxycarboxylic acid ester is a product of the esterification of a hydroxycarboxylic acid with an alcohol. As defined herein, a hydroxycarboxylic acid is a carboxylic acid containing at least one --COOH group and at least one isolated --OH group. Typically, the ester of the hydroxycarboxylic acid contains no more than one ester group. According to a preferred embodiment, the hydroxycarboxylic acid has a linear chain length ranging from 8 to 22 carbon  
15 atoms.

In some embodiments, the hydroxycarboxylic acid may be a monohydroxy fatty acid, which includes one isolated hydroxyl group. Examples of hydroxycarboxylic acids with one hydroxyl group include without limitation, ricinoleic acid (RA), hydroxystearic acid, hydroxylauric acid, hydroxydecanoic acid, hydroxyarachidic acid, hydroxypalmitic acid,  
20 hydroxyerucic acid, hydroxylinoleic acid, hydroxyarachidonic and a combination thereof.

In some embodiments, the hydroxycarboxylic acid can include more than one isolated hydroxyl group (e.g. hydroxyl polycarboxylic acids). In one embodiment, the hydroxycarboxylic acid including more than one carboxylic acid group may be a hydroxy dicarboxylic acid. Other examples of hydroxy polycarboxylic acids include without limitation,  
25 citric acid, malic acid, tartaric acid, and a combination thereof.

In some embodiments, the hydroxycarboxylic acid may contain a ring structure which may be aromatic, homocyclic, heterocyclic, etc. Examples of such hydroxy acids include without limitation, salicylic acid, dihydroxybenzoic acid, and a combination thereof. In further

embodiments, the hydroxycarboxylic acid contains halogen groups, additional alkyl substituents, amine groups, and a combination thereof .

In some embodiments, the functional composition includes one or more additional esters. For example, the functional composition may include an ester of a hydroxycarboxylic acid and  
5 an ester of a fatty acid. Any fatty acid may be used including, without limitation, pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, oleic acid, 2-ethylhexanoic acid, and a combination thereof. In addition, the one or more esters may have an  
10 alkoxyate portion which comprises one or more oxide monomers higher than ethylene oxide. In other embodiments, the functional composition may preferably include more than one ester of a hydroxycarboxylic acid. In other words, each ester may be produced from a different hydroxycarboxylic acid. For exemplary purposes only, in such an embodiment the functional composition may contain a ricinoleic acid ester and a hydroxystearic acid ester.

15 According to at least one embodiment, the corresponding alcohols with which the hydroxycarboxylic acid is esterified are linear or long chain alcohols, i.e., monohydric alcohols. Examples of suitable alcohols include without limitation, methanol, ethanol, caproic alcohol, caprylic alcohol, 2-ethylhexyl alcohol, capric alcohol, lauryl alcohol, isotridecyl alcohol, myristyl alcohol, cetyl alcohol, palmitoleyl alcohol, stearyl alcohol, isostearyl alcohol, oleyl  
20 alcohol, elaidyl alcohol, petroselinyl alcohol, linolyl alcohol, linolenyl alcohol, elaeostearyl alcohol, arachidyl alcohol, gadoleyl alcohol, behenyl alcohol, erucyl alcohol, brassidyl alcohol, and a combination thereof.

In some embodiments, polyalkylene glycols may be reacted with the hydroxycarboxylic acid, wherein a polyalkylene glycol may be defined as comprising any of the polymer  
25 initiator/terminating functionalities commonly recognized by those familiar with the art of alkoxylation, and containing a polymer chain including a measurable proportion of at least two oxide monomer types, or containing a polymer chain including a single monomer type higher than ethylene oxide (propylene oxide, butylene oxide and the like). Examples therefore include,

without limitation, all polyalkylene glycols not including ethylene oxide in their entirety, which have at least one hydroxyl functionality and therefore may be esterified, including di-hydroxy and poly-hydroxy functionalized polyalkylene glycols.

In some embodiments, the alcohol may be a polyol such as a diol or triol. Alternatively,  
5 the alcohols may be branched, aliphatic, cyclic, or aromatic in structure.

In some embodiments, a functional composition includes from about 1% to about 60% by weight of the hydroxycarboxylic acid ester(s), preferably from about 5% to about 40%, more preferably from about 10% to about 20%.

According to some preferred embodiments, the carrier fluid/base oil may preferably  
10 include miscible oils such as polyol esters, polyvinylethers or polyalkylene glycols, immiscible oils such as alkylbenzene, polyalphaolefins, alkylated naphthenics and mineral oils, and a combination thereof.

In some embodiments, the functional composition may include a corrosion inhibitor, such as a corrosion inhibitor for iron or copper containing materials. The corrosion inhibitor can help  
15 coat the expansion device and/or heat transfer surfaces to prevent/reduce material depositions. In some embodiments, a final concentration by weight of the lubricant for the corrosion inhibitor may be 0.001% or about 0.001% to 10% or about 10%, more preferably from 0.01% or about 0.01% to 0.1% or about 0.1%. In some embodiments, a final concentration by weight of the lubricant for the corrosive inhibitor may be 0.001% or about 0.001% to 0.05% or about 0.05%.

20 In some embodiments, the functional composition may include: epoxides (e.g. aromatic epoxides, alkyl epoxides, alkenyl epoxides), terpenes, terpenoids, fullerenes, ascorbic acid, terephthalate, nitromethane, unsaturated hydrocarbons or unsaturated halocarbons, phenols, perfluoropolyether, hindered phenols, hydroxylamines, thiols, phosphite and lactones, siloxane, tolytriazoles, benzotriazole, amines, hydrazine, hexamine, phenylenediamine,  
25 dimethylethanolamine, zinc dithiophosphates, quaternary and acyclic amines, quaternized alkyl pyridine, amine/phosphate ester salt, cinnamaldehyde, dibutylamine, diethylhydroxylamine, dimethylethanolamine, 3,5 dinitrobenzoic acid, ethylenediamine, hexamethyleneteramine, 1,2 diaminopropane, and a combination thereof.

In some embodiments, the functional composition may include benzotriazole. In some embodiments, a final concentration by weight of the lubricant for benzotriazole may be 0.001% or about 0.001% to 10% or about 10%, more preferably from 0.01% or about 0.01% to 0.1% or about 0.1%. In some embodiments, a final concentration by weight of the lubricant for  
5 benzotriazole may be 0.001% or about 0.001% to 0.05% or about 0.05%.

In some embodiments, the functional composition may be added to a lubricant of a HVAC system to about 5 to 10% by weight of the lubricant. In some embodiments, the functional composition may be added to the lubricant first, then the lubricant may be mixed with the refrigerant in the HVAC system. In some embodiments, the functional composition may be  
10 added to a HVAC system that includes a refrigerant and a lubricant, when, for example, maintaining or repairing the HVAC system.

In some embodiments, the functional composition can be used in a HVAC system that uses HFC (hydrofluorocarbons). By way of illustration and not limitation, examples of such refrigerants for use with the functional compositions described herein include R134a, R125, R32,  
15 R23, R143a, R116, R152a, and a combination thereof. In some embodiments, the functional composition may be used with other refrigerant such as isobutene, CO<sub>2</sub>, HCFC (hydrochlorofluorocarbons), and a combination thereof.

In some embodiments, the functional composition can be directly applied to, for example, bearings, orifice, and/or other parts. The functional composition can be added directly to the  
20 parts through, for example, a spray or dip type application during manufacturing or servicing of the HVAC system.

#### Example I

In a HVAC system, functional composition A according to one embodiment was added to  
25 a lubricant/refrigerant mixture of the HVAC system to about 5-10% by weight of the lubricant of the HVAC system. In a field test, an orifice of an expansion device of the HVAC system has a similar size after about 1000 hours of continuous operation. This result indicates that there is little (or no) material deposition to cause orifice restriction after about 1000 hours of operation.

In a comparative field test, the functional composition A was not added into the HVAC system. The size of the orifice reduced to about 70% of the original size after about 200 hours of continuous operation. This result indicates that material deposition caused orifice restriction in the comparative field test. The functional composition A appears to be able to reduce material  
5 deposition on the orifice.

#### Example II

In the HVAC system that had about 200 hours of continuous operation (the comparative field test unit of example I), functional composition B according to another embodiment was  
10 added into the HVAC system. In the HVAC system with about 200 hours of continuous operation, the orifice size was reduced to about 70% of the original size. After adding functional composition B, the HVAC system was kept operating. After about 200 hours of operation, the size of the orifice was restored to about the same as the original size. This indicates that the functional composition B can help remove/reduce materials already deposited on the orifice.

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#### Example III

In a R410A/POE HVAC system, benzotriazole was added into the HVAC system to about 0.020% by weight of lubricant (POE). A size of an orifice of an expansion device in the HVAC system remained about the same after about 900 hours of HVAC operation. Compared to  
20 the functional composition A in Example I, the concentration of benzotriazole is relatively low, which helps reduce the cost associated with the usage of the functional composition.

#### Aspects

Any of aspects 1-3 can be combined with any of aspects 4-27. Any of aspects 4-16 can  
25 be combined with any of aspects 17-27. Any of aspects 17-19 can be combined with any of aspects 20-27.

Aspect 1. A functional composition of a lubricant in a HVAC system, comprising one or a combination of:

a compound that interferes with lubricant breakdown;

a compound that interferes with formation of metal carboxylates on a load bearing surface;

5 a compound that coats the load bearing surfaces so as to reduce deposition of metal carboxylates on the loading surface;

a compound that reduces a catalytic effect of the metal-carboxylates;

a compound that changes a polarity and/or acidity of the lubricant so as to remove the deposited lubricant breakdown;

10 a compound that coats an expansion device or heat transfer surface of the HVAC system so as to prevent deposition of the lubricant breakdown; and

a compound that changes the polarity of the lubricant so as to increase a solubility of metal carboxylates.

15 Aspect 2. The functional composition of aspect 1, wherein the lubricant is selected from a group comprising a group comprising polyolester polyvinyl ether, alkylbenzene, polyalphaolefins, alkylated naphthenics, mineral oil, and a combination thereof.

20 Aspect 3. The functional composition of aspects 1-2, wherein the HVAC system includes a HFC refrigerant.

25 Aspect 4. A method of treating a lubricant composition of a HVAC system, comprising:  
adding a functional composition from about 5 to 10% by weight of the lubricant,  
wherein the functional composition includes: a hydroxycarboxylic acid ester; and  
a base oil lubricant selected from a group comprising a group comprising an  
alkylbenzene, an alkylated naphthenic, a polyalkylene glycol, a polyvinylether, a  
polyalphaolefin, mineral oil, a polyol ester, or a combination thereof.

Aspect 5. The method of aspect 4, wherein the hydroxycarboxylic acid ester of the functional composition is a product of the esterification of a hydroxycarboxylic acid with an alcohol.

Aspect 6. The method of aspect 5, wherein the alcohol is selected from a group comprising  
5 methanol, ethanol, caproic alcohol, caprylic alcohol, 2-ethylhexyl alcohol, capric alcohol, lauryl alcohol, isotridecyl alcohol, myristyl alcohol, cetyl alcohol, palmitoleyl alcohol, stearyl alcohol, isostearyl alcohol, oleyl alcohol, elaidyl alcohol, petroselinyl alcohol, linolyl alcohol, linolenyl alcohol, elaeostearyl alcohol, arachidyl alcohol, gadoleyl alcohol, behenyl alcohol, erucyl alcohol, brassidyl alcohol, or a combination thereof.

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Aspect 7. The method of aspects 4-6, wherein the functional composition includes from about 1% to about 60% by weight of the hydroxycarboxylic acid ester.

Aspect 8. The method of aspect 7, wherein the functional composition includes from about 5% to  
15 about 40% by weight of the hydroxycarboxylic acid ester.

Aspect 9. The method of aspects 7-8, wherein the functional composition includes from about 10% to about 20% by weight of the hydroxycarboxylic acid ester.

20 Aspect 10. The method of aspects 4-9, wherein the hydroxycarboxylic acid is selected from a group comprising  
a hydroxy dicarboxylic acid, a hydroxy bicarboxylic acid, a hydroxyl polycarboxylic acid, or a combination thereof.

25 Aspect 11. The method of aspects 4-10, wherein the hydroxycarboxylic acid is selected from a group comprising:  
a hydroxycarboxylic acid ricinoleic acid (RA), hydroxystearic acid, hydroxylauric acid, hydroxydecanoic acid, hydroxyarachidic acid, hydroxypalmitic acid, hydroxyerucic acid,

hydroxylinoleic acid, hydroxyarachidonic, citric acid, malic acid, tartaric acid, and a combination thereof.

5 Aspect 12. The method of aspects 4-11, wherein the hydroxycarboxylic acid includes a ring structure, wherein the ring structure is selected from a group comprising aromatic, homocyclic, heterocyclic or a combination thereof.

10 Aspect 13. The method of aspect 12, wherein the hydroxycarboxylic acid is selected from a group comprising salicylic acid, dihydroxybenzoic acid, or a combination thereof

Aspect 14. The method of aspects 4-13, wherein the hydroxycarboxylic acid ester is formed by a hydroxycarboxylic acid and a fatty acid.

15 Aspect 15. The method of aspect 14, wherein the fatty acid is selected from pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, oleic acid, 2-ethylhexanoic acid, or a combination thereof.

20 Aspect 16. The method of aspects 4-15, further comprising a second hydroxycarboxylic acid ester.

Aspect 17. A method of servicing a HVAC system, comprising:

25 adding a functional composition from about 5 to 10% by weight of a lubricant of the HVAC system, wherein the functional composition includes: an ester of a hydroxycarboxylic acid; and a base oil lubricant selected from a group comprising an alkylbenzene, an alkylated naphthenic, a polyalkylene glycol, a polyvinylether, a polyalphaolefin, mineral oil, a polyol ester, and a combination thereof.

Aspect 18. The method of aspects 4-17, wherein the HVAC system includes a HFC refrigerant.

Aspect 19. The method of aspect 17, wherein the HVAC system includes a HFC refrigerant.

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Aspect 20. A functional composition for a HVAC lubricant, comprising:

from about 0.001% to about 10% by weight of the lubricant, wherein the functional composition includes one or more compounds that are used as corrosion inhibitors for iron or copper containing materials.

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Aspect 21. The functional composition of aspect 20, wherein the one or more compounds that are used as corrosion inhibitors for iron or copper containing materials are from about 0.01% to about 0.1% by the weight of the lubricant.

15 Aspect 22. The functional composition of aspect 20, wherein the one or more compounds that are used as corrosion inhibitors for iron or copper containing materials are from about 0.001% to about 0.05% by the weight of the lubricant.

Aspect 23. The functional composition of aspects 20-22, wherein the functional composition  
20 includes epoxides, terpenes, terpenoids, fullerenes, ascorbic acid, terephthalate, nitromethane, unsaturated hydrocarbons or unsaturated halocarbons, phenols, perfluoropolyether, hindered phenols, hydroxylamines, thiols, phosphite and lactones, siloxane, tolytriazoles, benzotriazole, amines, hydrazine, hexamine, phenylenediamine, dimethylethanolamine, zinc dithiophosphates, quaternary and acyclic amines, quaternized alkyl pyridine, amine/phosphate ester salt,  
25 cinnamaldehyde, dibutylamine, diethylhydroxylamine, dimethylethanolamine, 3,5 dinitrobenzoic acid, ethylenediamine, hexamethyleneteramine, 1,2 diaminopropane, or a combination thereof.

Aspect 24. The functional composition of aspects 23, wherein the benzotriazole is from about

0.001% to about 10% by weight of the lubrication.

Aspect 25. The functional composition of aspects 23-24, wherein the benzotriazole is from about 0.01% to about 0.1% by weight of the lubrication.

- 5 Aspect 26. The functional composition of aspects 23-25, wherein the benzotriazole is from about 0.001% to about 0.05% by weight of the lubrication.

Aspect 27. The functional composition of aspects 23-26, wherein the benzotriazole is about 0.0020% by weight of the lubrication.

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With regard to the foregoing description, it is to be understood that changes may be made in detail, without departing from the scope of the present invention. It is intended that the specification and depicted embodiments are to be considered exemplary only, with a true scope and spirit of the invention being indicated by the broad meaning of the claims.

15

### Claims

What claimed is:

1. A functional composition of a lubricant in a HVAC system, comprising one or a combination of:
  - 5 a compound that interferes with lubricant breakdown,
  - a compound that interferes with formation of metal carboxylates on a load bearing surface;
  - a compound that coats the load bearing surfaces so as to reduce deposition of metal-carboxylates on the loading surface;
  - 10 a compound that reduces a catalytic effect of the metal carboxylates;
  - a compound that changes a polarity and/or acidity of the lubricant so as to remove the deposited lubricant breakdown;
  - a compound that coats an expansion device or heat transfer surface of the HVAC system so as to prevent deposition of the lubricant breakdown; and
  - 15 a compound that changes the polarity of the lubricant so as to increase a solubility of metal carboxylates.
2. The functional composition of claim 1, wherein the lubricant is selected from a group comprising polyolester polyvinyl ether, alkylbenzene, polyalphaolefins, alkylated naphthenics,  
20 mineral oil, and a combination thereof.
3. The functional composition of claim 1, wherein the HVAC system includes a HFC refrigerant.
- 25 4. A method of treating a lubricant composition of a HVAC system, comprising:
  - adding a functional composition from about 5 to 10% by weight of the lubricant,
  - wherein the functional composition includes: a hydroxycarboxylic acid ester; and
  - a base oil lubricant selected from a group comprising an alkylbenzene, an alkylated

naphthenic, a polyalkylene glycol, a polyvinylether, a polyalphaolefin, mineral oil, a polyol ester, or a combination thereof.

- 5 5. The method of claim 4, wherein the hydroxycarboxylic acid ester of the functional composition is a product of the esterification of a hydroxycarboxylic acid with an alcohol.
6. The method of claim 5, wherein the alcohol is selected from a group comprising methanol, ethanol, caproic alcohol, caprylic alcohol, 2-ethylhexyl alcohol, capric alcohol, lauryl alcohol, isotridecyl alcohol, myristyl alcohol, cetyl alcohol, palmitoleyl alcohol, stearyl alcohol,  
10 isostearyl alcohol, oleyl alcohol, elaidyl alcohol, petroselinyl alcohol, linolyl alcohol, linolenyl alcohol, elaeostearyl alcohol, arachidyl alcohol, gadoleyl alcohol, behenyl alcohol, erucyl alcohol, brassidyl alcohol, or a combination thereof.
7. The method of claim 2, wherein the functional composition includes from about 1% to about  
15 60% by weight of the hydroxycarboxylic acid ester.
8. The method of claim 7, wherein the functional composition includes from about 5% to about 40% by weight of the hydroxycarboxylic acid ester.
- 20 9. The method of claim 7, wherein the functional composition includes from about 10% to about 20% by weight of the hydroxycarboxylic acid ester.
10. The method of claim 4, wherein the hydroxycarboxylic acid is selected from a group comprising  
25 a hydroxy dicarboxylic acid, a hydroxy bicarboxylic acid, a hydroxyl polycarboxylic acid or a combination thereof.

11. The method of claim 4, wherein the hydroxycarboxylic acid is selected from a group comprising:

a hydroxycarboxylic acid ricinoleic acid (RA), hydroxystearic acid, hydroxylauric acid, hydroxydecanoic acid, hydroxyarachidic acid, hydroxypalmitic acid, hydroxyerucic acid, 5 hydroxylinoleic acid, hydroxyarachidonic, citric acid, malic acid, tartaric acid, and a combination thereof.

12. The method of claim 4, wherein the hydroxycarboxylic acid includes a ring structure, wherein the ring structure is selected from a group comprising aromatic, homocyclic, heterocyclic 10 or a combination thereof.

13. The method of claim 12, wherein the hydroxycarboxylic acid is selected from a group comprising salicylic acid, dihydroxybenzoic acid, or a combination thereof

15 14. The method of claim 4, wherein the hydroxycarboxylic acid ester is formed by a hydroxycarboxylic acid and a fatty acid.

15. The method of claim 14, wherein the fatty acid is selected from pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic 20 acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, oleic acid, 2-ethylhexanoic acid, or a combination thereof.

16. The method of claim 4, further comprising a second hydroxycarboxylic acid ester. 25

17. A method of servicing a HVAC system, comprising:

adding a functional composition from about 5 to 10% by weight of a lubricant of the HVAC system, wherein the functional composition includes: an ester of a hydroxycarboxylic

acid; and a base oil lubricant selected from a group comprising an alkylbenzene, an alkylated naphthenic, a polyalkylene glycol, a polyvinylether, a polyalphaolefin, mineral oil, a polyol ester, and a combination thereof.

5 18. The method of claim 4, wherein the HVAC system includes a HFC refrigerant.

19. The method of claim 17, wherein the HVAC system includes a HFC refrigerant.

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2014/029016****A. CLASSIFICATION OF SUBJECT MATTER****C10M 163/00(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 163/00; C10M 141/10; C07F 7/08; C09K 5/00; C10M 105/38; C10M 105/42; C11B 3/02; C10L 1/18

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: lubricant, lubricate, hydroxycarboxylic acid, alcohol, deposition, accumulate, precipitation, refrigerant, compressor, HFC, HVAC system

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0161065 A1 (WEI, L. et al.) 28 June 2012 See abstract; claims 1-20; paragraphs [0005], [0018]-[0020], [0022], [0025].	1-19
A	US 2005-0198894 A1 (MIGDAL, C. A. et al.) 15 September 2005 See abstract; claims 1-19.	1-19
A	US 5593957 A (OBARA, N. et al.) 14 January 1997 See abstract; claims 1-13.	1-19
A	US 2008-0020956 A1 (MOSIER, B. et al.) 24 January 2008 See abstract; claims 2 and 58.	1-19
A	US 2012-0004151 A1 (AGUILAR, G. A. et al.) 5 January 2012 See abstract; claims 1-19.	1-19

 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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

25 July 2014 (25.07.2014)

Date of mailing of the international search report

**25 July 2014 (25.07.2014)**

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/US2014/029016**

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