



- (51) **International Patent Classification:**
C10M 141/00 (2006.01) *C10M 125/00* (2006.01)
C10M 171/06 (2006.01)
- (21) **International Application Number:** PCT/FI2012/050131
- (22) **International Filing Date:** 10 February 2012 (10.02.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
20115132 10 February 2011 (10.02.2011) FI
- (71) **Applicant** (for all designated States except US): **AB NAN-OL TECHNOLOGIES OY** [FI/FI]; Annankatu 16 B, FI-00120 Helsinki (FI).
- (72) **Inventors; and**
- (75) **Inventors/Applicants** (for US only): **VON KNORRING, Johan** [FI/FI]; Irisviksstranden 9 A 1, FI-02230 Esbo (FI). **STRAND, Carl-Eirik** [CH/CH]; Sulzbergstrasse 6, CH-8400 Winterthur (CH). **ALBRECHT, Eduard** [DE/DE]; Kronthaler Strasse 53, 65812 Bad Soden Am Taunus (DE). **MAMIKIN, Sergey M.** [RU/RU]; Matrosskaya Tishina 16-19, Moskva, 107076 (RU).
- (74) **Agent:** **PAPULA OY**; Mechelininkatu 1 a, FI-00180 Helsinki (FI).

(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, 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, IS, JP, KE, KG, KM, 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, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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, MD, 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, 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))

(54) **Title:** LUBRICANT ADDITIVE COMPOSITION

(57) **Abstract:** Lubricant additive composition comprising oil soluble metal salts of inorganic and organic acids, further comprising abrasive particles. Use of a lubricant additive composition comprising oil soluble metal salts of inorganic and organic acids abrasive particles for wear protection of friction surfaces.



WO 2012/107649 A1

LUBRICANT ADDITIVE COMPOSITION**FIELD OF THE INVENTION**

The present invention relates to a metal-coating lubricant additive. More specifically, it relates to a composition to be added to lubricants in order to protect friction surfaces and a method for protective film forming on a friction surface.

BACKGROUND OF THE INVENTION

The improvement of wear and friction resistance of moving parts in motors and machines, such as engine pistons, is highly desirable in the modern automotive and transportation industry, as a major part of machine breakdowns are caused by mechanical wear of their moving parts. Typically, friction between moving parts in a system is reduced with different kinds of lubricants separating the moving parts, as lubricant-to-surface friction is much less detrimental than surface-to-surface friction.

Current market trends require cleaner fuels and lube oils. There is an emerging trend to substitute the undesirable components, such as sulphur S and phosphorus P. The driver is certainly the aim for reduced carbon dioxide and harmful exhaust gas emissions. One way to achieve the target is to further reduce the content of harmful components. The aim is to produce lubrication oils with as low content as possible of sulfated ash, phosphorus and sulphur, i.e. low SAPS oils.

A typical lubrication oils consists of base oil (appr. 80%) and an additive package. The additive packages comprise of dispersant packages (e.g. cleanliness agents, i.e. detergents, soot dispersants, anti-oxidants, anti-corrosion agents, anti-wear components) and viscosity modifiers (e.g. SBS, olefin copolymers). The base oils used for manufacturing of

lubrication oils are divided into four categories: API 1, mineral oil base, API 2, modified mineral oil base, API 3, semi-synthetic oil base and API 4, synthetic (PAO) oil base.

5 At present, numerous types of lubricant compositions are known. One well-studied solution for improving the anti-frictional properties of lubricants is adding oil-soluble metal compositions to the base lubricant. United States patent US4431553 discloses a
10 lubricant comprising a mixture of various greases, lubricating oil and from 0.1 to 10% by weight of copper, tin or lead in the form of copper oxyquinolate, tin oxyquinolate lead oxyquinolate or mixtures thereof. However, because of a low degree
15 of solubility in oil of such metal oxyquinolates, the lubricant is not effective in applications where high-pressure friction occurs.

 Presently, basically all new engine lubrication oils introduced in Europe are based on API
20 3 base oil. Base oil is characterized by its sulphur content, paraffin content and viscosity index. The lower the sulphur contents the better. Other sources for sulphur and phosphorus compounds are originating from the anti-oxidants and anti-wear additives.

25 In the past fifty years metal-coating lubricants were developed especially for exploitation in harsh environments featuring high temperatures and pressures. Metal-coating lubricants are materials that form a non-oxidising thin metal film, such as a few
30 micrometers thick copper film on the friction surfaces - also on those surfaces not containing the film-forming metals. The protective thin metal film provides significant reduction of the friction coefficient even in marginal lubrication conditions
35 and when friction surfaces are under high pressure.

 Russian patent RU2277579 discloses a metal-containing oil-soluble composition for lubricant

materials. Said composition comprises metal salt of inorganic acid, metal salt of organic acid, aliphatic alcohol, aromatic amine, epoxy resin, succinimide polymer and 2-imine-substituted derivative of indoline. A known disadvantage of said composition is ineffective formation of the protective thin metal film on friction surfaces, thus making such a lubricant useless in applications where it is crucial to achieve a maximum degree of protection as soon as possible.

PURPOSE OF THE INVENTION

The purpose of the present invention is to eliminate the drawbacks mentioned above. The purpose of the present invention is to prolong the lifespan of machines, engines and motors by reducing temperatures of friction surfaces and improving abrasive resistance, thus reducing wear of their moving parts. This is achieved by protecting friction surfaces with a novel lubricant additive composition providing a fast formation of the protective thin metal film on friction surfaces. In addition, a novel method for wear protection of friction surfaces is proposed. The invention is based on research work, the aim of which was to show that a certain concentration of abrasive particles accelerate formation of the protective thin metal film. According to the studies, abrasive particles enhance diffusion of metal ions, which are present in lubricant in the form of metal salts, into the crystal lattice of friction surfaces.

A further purpose of the lubricant additive composition according to the present invention is to provide an environmentally friendly lubricant additive or additive package comprising significantly less toxic and environmentally harmful chemicals or components than the lubricants and lubricant additives currently available on the market. The lubricant

additive composition according to the present invention enables almost complete reduction of sulphur and phosphorus containing additives; said lubricant additive composition does comprise neither phosphorus-
5 nor sulphur -based compounds. When using lubricant additive comprising the composition according to the present invention, there is no need for further addition of such toxic chemicals as e.g. phosphorus and sulphur or their different compounds, which are
10 typically used in the lubricants because of their anti-oxidation and anti-wear properties.

Use of a lubricant additive composition according to the present invention provides improved abrasive resistance of the frictions surfaces without
15 addition of e.g. phosphorus and sulphur based compounds. This development would be in line with coming regulations for low SAP products for further reduction of exhaust gas emissions.

20 SUMMARY OF THE INVENTION

The lubricant additive composition according to the present invention is characterized by what is disclosed in claim 1. The use of a lubricant additive composition according to the present invention is
25 characterized by what is disclosed in claim 6. The method for wear protection of friction surfaces according to the present invention is characterized by what is disclosed in claim 10.

The present invention is focused on a
30 lubricant additive composition (i.e. lubricant additive package), use of a lubricant additive composition for metal surface lubrication and a method for wear protection of friction surfaces. Here, a lubricant means a substance introduced between moving
35 surfaces to reduce the friction between them, i.e. a lubricant is any kind of a natural or a synthetic motor or transmission oil, or a plastic greasing

substance. The compounds of the lubricant additive composition of the present invention react on frictions surfaces and form a non-oxidising thin metal film on said surfaces, thus reducing mechanical wear and tear of the surfaces the lubricant containing the lubricant additive composition or the lubricant additive package has been applied on. Therefore, the lubricant additive composition can be classified as a metal-coating composition.

As well known for those skilled in the art, in order to form a metal film on the metal friction surfaces, the lubricant shall comprise metal ions. In addition, said ions must have higher ionization energy than that of the surface metal ions; i.e. if a friction surface is made of steel, the lubricant must comprise ions of metals having higher ionization energy than Fe. In that case, metal ions present in the lubricant fulfill the vacancies and diffuse inside the frictional surface removing dislocations caused by friction and forming crystals of protective thin metal film on the surface.

Addition of oil soluble metal salts of inorganic and organic acids to lubricants is crucial for formation of a protective thin metal film on friction surfaces where lubricant was applied. Said metal salts provide metal ions which fulfil the open vacancies and diffuse inside the frictional surface forming a thin metal film. This is a known practise in the art, with a composition disclosed in RU2277579 being an example. However, as an essential difference from the prior art, the additive composition according to the present invention comprises abrasive particles which enhance diffusion of metal ions, present in the composition in the form of metal salts, into friction surfaces and thus accelerate formation of protective metal film.

The lubricant additive composition according to the present invention comprises oil soluble metal salts of inorganic and organic acids and further comprises from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles.

When added to friction surfaces, lubricant additive comprising the lubricant additive composition according to the present invention forms a protective layer at the friction surfaces through physical bonding between the metal ions of the salt and the friction surfaces. The abrasive particles enhance diffusion of metal ions into friction surfaces and thus accelerate formation of protective metal film, as they remove oxide films from the friction surfaces. In other words abrasive particles, by removing oxidized films from the friction surface, they catalyse the build-up of the protective metal film through physical bonding between the metal ions of the salts and the friction surfaces. Oxide films, which typically form on metal surfaces due to air exposure, make the metal more resistant to chemical reactions. With no oxide films on the surfaces the protective metal film forms faster.

By abrasive particles it is meant here either naturally occurring or fabricated granular material composed of finely divided hard particles, such as mineral or metal particles. It shall be noted that the exact chemical composition of abrasive particles is of secondary importance; however, the crucial matter is the concentration of abrasive particles in an additive composition. According to the extensive studies, the optimal concentration of abrasive particles in the additive composition varies from about 0.005wt% to about 0.1wt%, where wt% is mass percentage. The optimal concentration depends on factors such as the composition of the lubricant and the additives, the

size of abrasive particles, etc. Studies show that when the additive composition comprises from about 0.01wt% to about 0.05wt% of abrasive particles, the protective metal film forms within about 30 seconds from the start of the friction between the lubricated surfaces (i.e. from the moment the lubricated engine or motor starts running). Measurements preformed for similar lubricant additive compositions without abrasive particles indicate that in these cases the protective metal film forms in about five minutes, which is a considerably longer period.

In another preferred embodiment of the present invention the average diameter size of abrasive particles ranges from 0.5 μ m to 20 μ m, preferably from 1 μ m to 10 μ m, most preferably from 1 μ m to 3 μ m. The exact chemical composition of abrasive particles may vary, however the average diameter size of the abrasive particles ranges approximately from 0.5 μ m to 20 μ m, preferably from 1 μ m to 10 μ m, most preferably from 1 μ m to 3 μ m. This means that statistically the majority of the abrasive particles has said diameter, however, variations around these values are possible. Therefore, in a lubricant additive composition one can find the majority of the abrasive particles having a diameter of about 1 μ m; however, the same lubricant additive composition may as well comprise abrasive particles having a diameter of about 5 μ m or 20 μ m. Similarly, the majority of abrasive particles found in another lubricant additive composition may have a diameter of about 10 μ m; however, the same lubricant additive composition may also comprise abrasive particles having a diameter of about 3 μ m. Studies show that abrasive particles having a diameter from 0.5 μ m to 20 μ m remove oxide films from the friction surfaces most efficiently and thus accelerate protective film formation.

In another preferred embodiment of the present invention abrasive particles have a hardness of at least 7 on the Mohs scale. Therefore, abrasive particles comprise finely divided particles of ceramic materials, minerals, metals and/ or other compounds having a hardness of 7 or more on the Mohs scale. Amongst others, the following minerals have a hardness of at least 7 on the Mohs scale, thus being suitable for use as abrasive particles: quartz, garnet, beryl, chrysoberyl, topaz, emerald, spinel, corundum, boron and diamond. In addition, at least the following metals have a hardness of at least 7 on the Mohs scale, thus also being suitable for use as abrasive particles: osmium, steel, tungsten, chromium and titanium. Further, at least the following ceramic materials having a hardness of at least 7 on the Mohs scale can be used as abrasive particles: silicon carbide, tungsten carbide, titanium carbide, rhenium diboride and titanium diboride. According to the preferred embodiment of the present invention, abrasive particles comprise any of the above mentioned ceramic materials, minerals or metals, or mixtures thereof, in a form of a fine powder or a granular mixture.

In another preferred embodiment of the present invention abrasive particles comprise carbonates, nitrides, carbides and/ or oxides of elements of boron, carbon and/ or alkaline earth metal groups. Here, the boron group is a periodic table group consisting of boron (B), aluminium (Al), gallium (Ga), indium (In), thallium (Tl), and ununtrium (Uut); the carbon group is a periodic table group consisting of carbon (C), silicon (Si), germanium (Ge), tin (Sn), lead (Pb), and ununquadium (Uuq); and alkaline earth metals consist of beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba) and radium (Ra). Examples of compounds fulfilling the above

conditions are, amongst others, silicon dioxide, boron carbide, boron nitride and aluminium dioxide. According to the preferred embodiment of the present invention, abrasive particles comprise any of the
5 above compounds separately, or a mixture thereof, in a form of a fine powder or a granular mixture.

In another preferred embodiment of the present invention the additive composition comprises, in addition to abrasive particles and oil soluble
10 metal salts of inorganic and organic acids, at least one of the following: an aliphatic alcohol, a succinimide derivative, an aromatic amine, an epoxy resin and/ or a 2-iminosubstituted indoline. According to the present invention the oil soluble metal salts
15 of inorganic acid comprise oil soluble metal salts, i.e. chlorides, bromides and/ or iodides of at least one of the following metals: Cu, Co, Pb, Sn, Ni. Further, according to the present invention the oil soluble metal salts of organic acid comprises metal
20 salts of organic acids having from 15 to 18 carbon atoms in their molecular formula, such as metal salts of oleic acid $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$; another example of a metal salt of organic acids being tin oleate $\text{C}_{36}\text{H}_{66}\text{O}_4\text{Sn}$. It shall be noted that said oil soluble
25 metal salts of inorganic and organic acids are completely dissolved in the end product, i.e. in a lubricant comprising lubricant additive having a composition according to the present invention.

In another preferred embodiment of the present invention the succinimide derivative comprises
30 S-5A polyalkenyl succinimide, the aromatic amine comprises homotype diphenylamine and the epoxy resin comprises commercially available aliphatic epoxy resin ДЭГ-1, produced by condensation of epichlorohydrin
35 with glycol.

According to the use aspect of the present invention, any of the compositions in accordance with

the above definitions is used as a lubricant additive composition (i.e. lubricant additive package). Further, there is provided the use of a lubricant additive composition comprising salts of inorganic and organic acids and abrasive particles for wear protection of the friction surfaces. In addition, there is provided the use of a lubricant additive composition comprising salts of inorganic and organic acids and abrasive particles for metal surface lubrication.

According to another aspect of the present invention there is provided the use of a composition comprising oil soluble metal salts of inorganic and organic acids and from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles for wear protection of the friction surfaces.

According to another aspect of the present invention there is provided the use of a composition comprising oil soluble metal salts of inorganic and organic acids and abrasive particles, wherein the average diameter size of abrasive particles ranges from 0.5µm to 20µm, preferably from 1µm to 10µm, most preferably from 1µm to 3µm.

According to another aspect of the present invention there is provided the use of a composition comprising oil soluble metal salts of inorganic and organic acids and abrasive particles, wherein abrasive particles have a hardness of at least 7 on the Mohs scale.

According to another aspect of the present invention there is provided the use of a composition comprising oil soluble metal salts of inorganic and organic acids and abrasive particles, further comprising at least one of the following: an aliphatic alcohol, a succinimide derivative, an aromatic amine, an epoxy resin and/ or a 2-iminosubstituted indoline.

According to another aspect of the present invention there is provided a method for wear protection of friction surfaces comprising applying to friction surfaces a lubricant comprising from 1wt% to 5wt% additive composition, said additive composition comprising oil soluble metal salts of inorganic and organic acids and from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles. In other words, a method for wear protection of friction surfaces comprises applying to friction surfaces a lubricant such as a base oil, which lubricant or base oil comprises from 1wt% to 5wt% an additive (i.e. an additive package); which additive comprises from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles in addition to oil soluble metal salts of inorganic and organic acids.

In general, the lubricant additive composition according to the present invention can be manufactured by any techniques known in the field, such as conventional mixing techniques, the different variations thereof being well known for those skilled in the art.

25

BRIEF DESCRIPTION OF THE FIGURES

In the following, embodiments of the present invention are explained in detail with reference to the accompanying figures showing measurement results for different lubricant additive compositions.

Figure 1 is a graph showing total wear of a specimen in a friction and wear laboratory study. Different graphs represent total wear of the specimen after applying to friction surfaces a lubricant

comprising the additive composition further comprising from 0.0wt% to 0.07wt% of abrasive particles;

Figure 2 is a graph showing the diameter of wear of the specimen's surface as a function of applied pressure for six different lubricant additive compositions.

Figure 3 shows temperature variation ratio of a specimen under constant applied pressure of 2600 MPa. As above, different graphs represent the results measured for lubricants comprising the additive composition further comprising from 0.0wt% to 0.07wt% abrasive particles; and

Figure 4 is a diagram showing total temperature change of the specimen during the friction and wear study. Lubricants comprising the additive composition comprising from 0.0wt% to 0.07wt% of abrasive particles were studied.

20 DETAILED DESCRIPTION OF THE INVENTION

EXAMPLE 1

The following examples illustrate the invention further. Table 1 shows different additive compositions for lubricants according to the present invention. The lubricant additive composition according to the present invention enables fast formation of a thin metal film on friction surfaces. Said metal film protects the surfaces against mechanical wear and hydrogen embrittlement. Studies show that a lubricant containing the additive composition according to the present invention provides desirable results, amongst other, on the following friction surfaces: steel-steel, steel-iron and steel-bronze. Table 2 shows preferred compositions for lubricants according to the present invention.

Table 1.

	<i>Amount in wt%</i>
abrasive particles	0.005-0.1
metal salt of organic acid	10-90
metal salt of inorganic acid	1-25
aliphatic alcohol	3-55
aromatic amine	1-20
epoxy resin	2-18
succinimide derivative	2-50
2-iminosubstituted indoline	0.5-6

Table 2.

	<i>Amount in wt%</i>		
abrasive particles	0.01	0.02	0.01
metal salt of organic acid	90	50	7.8
metal salt of inorganic acid	1.4	9.8	1
aliphatic alcohol	3	3	1
aromatic amine	1	3	15
epoxy resin	2	6	14
succinimide derivative	2	26	60
2-iminosubstituted indoline	0.59	2.18	1.19

5 As embodiments of the present invention six samples of a lubricant additive composition according to compositions presented in Table 2 were produced. The amount of abrasive particles varied in each sample; said amounts are presented in Table 3.

Table 3.

<i>Sample #</i>	<i>Abrasive particles</i>
Sample 1	0.0 wt%
Sample 2	0.01 wt%
Sample 3	0.02 wt%
Sample 4	0.03 wt%
Sample 5	0.05 wt%
Sample 6	0.07 wt%

The abrasive particles comprised boron carbide powder composed of a large number of boron carbide particles; the average diameter size of the boron carbide particles varied from 1 μ m to 3 μ m. The samples were further added to 10W40 base oil so that the base oil contained 2.2wt% of the additive.

Antifrictional properties of the obtained lubricants, i.e. the base oil comprising lubricant additive comprising different amounts of abrasive particles, were determined in the following laboratory study. The measurement setup comprised a steel specimen arranged on top of a steel cylinder, the rotation axis of which lay in the horizontal plane. Different weights were loaded on top of the specimen pressing it against the rotating surface of the cylinder. The pressure applied on contact surfaces of the specimen and the cylinder was, naturally, proportional to the mass of the weight. The study was performed for three different pressures, i.e. three different weights. In total, 18 test runs were performed; six lubricants comprising different additive compositions were applied to the point where the surface of the specimen was in contact with the rotating cylinder. Rotating speed of the cylinder was kept constant in each 60 minute test run; during that period the specimen remained pressed against the

cylinder's rotating surface. Both the cylinder and the specimen were made of class mx-15 steel (corresponding to US A295 52100).

5 Different properties of the specimen were measured after each test run, after that the specimen was replaced and a new test cycle performed. The following properties were measured:

- 10 • the mass of the specimen was measured before and after the test in order to determine the mechanical wear, i.e. the amount of steel removed from the surface of the specimen by the rotating disk,
- 15 • the mechanical wear of the specimen at the point where the specimen was in contact with the rotating cylinder was estimated optically with a microscope,
- the temperature of the specimen at the contact surface was monitored with a thermocouple.

20 Different parameters of the test setup are shown in Table 4.

Table 4.	
Thickness of the cylinder	3.5±0.5mm
Diameter of the cylinder	24±0.5mm
Diameter of the specimen	6.3±0.5mm
Hardness of the specimen	HRC 62-64
Parallel misalignment of contact surfaces	< 1mm
Degree of contact surface roughness	Ra ≤ 0.63
Axial rotation frequency of the cylinder	1400RPM
Radial deviation (radial motion variation)	0.1µm
Weight added to the ball w_1 (corresponding to pressure p_1)	0.124kg (= 700MPa)
Weight added to the ball w_2 , (corresponding to pressure p_2)	1.32kg (= 1600MPa)
Weight added to the ball w_3 (corresponding to pressure p_3)	6.32kg (= 2600MPa)

Figure 1 shows total wear of contact surface of the specimen, Δm , as a function of applied pressure for six different additive compositions for lubricants. Each graph corresponds to an additive composition comprising from 0.0wt% to 0.07wt% of abrasive particles. Results for studies where pressure of 700MPa was applied on contact surfaces of the specimen and the cylinder show that the total wear is similar for all tested lubricant additive compositions, showing that the exact amount of the abrasive particles in the lubricant additive is not relevant for pressures around 700MPa.

Results for studies where pressure of 1600MPa was applied on contact surfaces show that there is no mechanical wear of the specimen in the cases where lubricants comprising additive compositions comprising 0.01wt%, 0.02wt% and 0.05wt% of abrasive particles were applied on contact surfaces. Additional mass of about 0.05mg to about 0.1mg, observed in these cases, is explained by formation of protective metal film on the surface of the specimen.

Results for test runs performed at a pressure of 2600MPa show that after the test run the mass of the specimen increased in four cases and decreased in two cases. Lower mass, indicating mechanical wear and tear of the specimen, was observed for lubricant comprising additive compositions comprising 0.0wt% and 0.07wt% abrasive particles. Results for lubricants comprising additive compositions comprising 0.01wt%, 0.02wt%, 0.03wt% and 0.05wt% abrasive particles show that the mass of the specimen increased from about 0.1mg to about 0.2mg due to formation of protective metal film on its surface.

Figure 2 shows the diameter of wear of the specimen at the contact point with the rotating cylinder, i.e. the friction point, as a function of

applied pressure for six different lubricant additive compositions. Results show that after the test runs performed at a pressure of 2600MPa, the diameter of wear observed on the specimen was 0.5mm or less in cases where the lubricant contained an additive composition comprising from 0.01wt% to 0.07wt% abrasive particles. More wear was observed on the surface of the specimen when the used lubricant comprised an additive composition without abrasive particles. In that case, the diameter of wear was 0.6mm.

Figure 3 shows the specimen's temperature variation ratio as a function of test time, $\Delta T/\Delta t$, at applied pressure of 2600MPa during the first five minutes of each test run. Temperature variation of a specimen in a friction test indicates conversion of the kinetic energy of the system (here: of the rotating cylinder) into heat. The higher the temperature rise of the specimen during the test run, the more friction there is between the specimen and the rotating cylinder. In industrial applications, low temperature variations are obviously desirable. The lowest temperature variation ratios are observed for additive compositions comprising 0.01wt% and 0.02wt% abrasive particles, indicating that in these conditions the protective thin metal film forms on friction surfaces faster than in the other studied cases. Further, Figure 2 shows that for additive compositions comprising 0.01wt% and 0.02wt% abrasive particles the steady temperature variation ratio of about 1.2°C/min is achieved in about 30 seconds from the start of the test run. When lubricants comprising additive compositions comprising 0.0wt% or over 0.03wt% abrasive particles are used, the temperature variation ratio decreases to about 1.2°C/min in three to five minutes, a considerably longer period.

Figure 4 shows total temperature change of the specimen, ΔT , during each 60 minute test run. The results confirm that additive compositions comprising from 0.01wt% to 0.03wt% abrasive particles decrease the total temperature change of the specimen during the test run and thus decrease the energy loss due to friction between the specimen and the rotating cylinder, as compared to additive compositions comprising 0.0wt% or over 0.05wt% abrasive particles. It is important to note that, as is clear for a person skilled in the art, the invention is not limited to the examples described above. The actual embodiments of the present invention can freely vary within the scope of the claims.

CLAIMS

1. Lubricant additive composition comprising oil soluble metal salts of inorganic and organic acids, characterized in that the additive composition
5 comprises from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles.
2. Lubricant additive composition according to claim 1, characterized in that the average diameter
10 size of abrasive particles ranges from 0.5 μ m to 20 μ m, preferably from 1 μ m to 10 μ m, most preferably from 1 μ m to 3 μ m.
3. Lubricant additive composition according to any of claims 1 to 2, characterized in that abrasive
15 particles have a hardness of at least 7 on the Mohs scale.
4. Lubricant additive composition according to any of claims 1 to 3, characterized in that abrasive
20 particles comprise carbonates, nitrides, carbides and/or oxides of elements of boron, carbon and/or alkaline earth metal groups.
5. Lubricant additive composition according to any of claims 1 to 4, characterized in that the
25 additive composition comprises at least one of the following: an aliphatic alcohol, a succinimide derivative, an aromatic amine, an epoxy resin and/or a 2-iminosubstituted indoline.

6. Use of a lubricant additive composition comprising oil soluble metal salts of inorganic and organic acids and from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt%
5 abrasive particles for wear protection of friction surfaces.

7. Use of a composition according to claim 6, characterized in that the average diameter size of abrasive particles ranges from 0.5 μ m to 20 μ m,
10 preferably from 1 μ m to 10 μ m, most preferably from 1 μ m to 3 μ m.

8. Use of a composition according to any of claims 6 and 7, characterized in that abrasive particles have a hardness of at least 7 on the Mohs scale.

15 9. Use of a composition according to any of claims 6 to 8, characterized in that the additive composition comprises at least one of the following: an aliphatic alcohol, a succinimide derivative, an aromatic amine, an epoxy resin and/ or a 2-iminosubstituted indoline.

20 10. A method for wear protection of friction surfaces comprising

- applying to friction surfaces a lubricant comprising from 1wt% to 5wt% additive composition, said additive composition
25 comprising oil soluble metal salts of inorganic and organic acids and from 0.005wt% to 0.1wt%, preferably from 0.01wt% to 0.05wt%, most preferably from 0.01wt% to 0.03wt% abrasive particles.

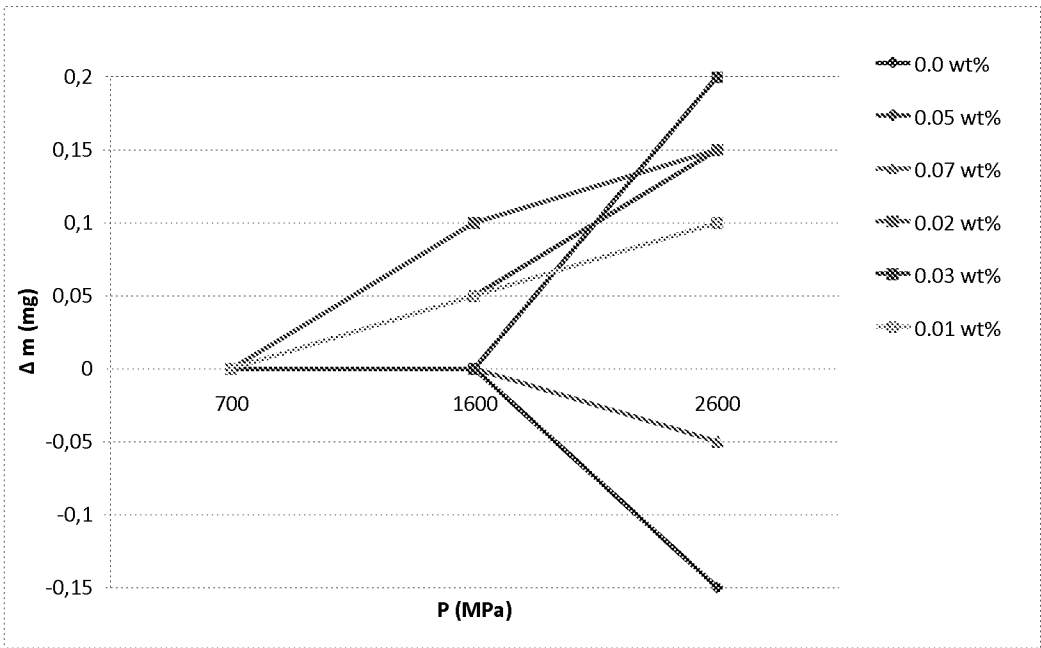


Figure 1

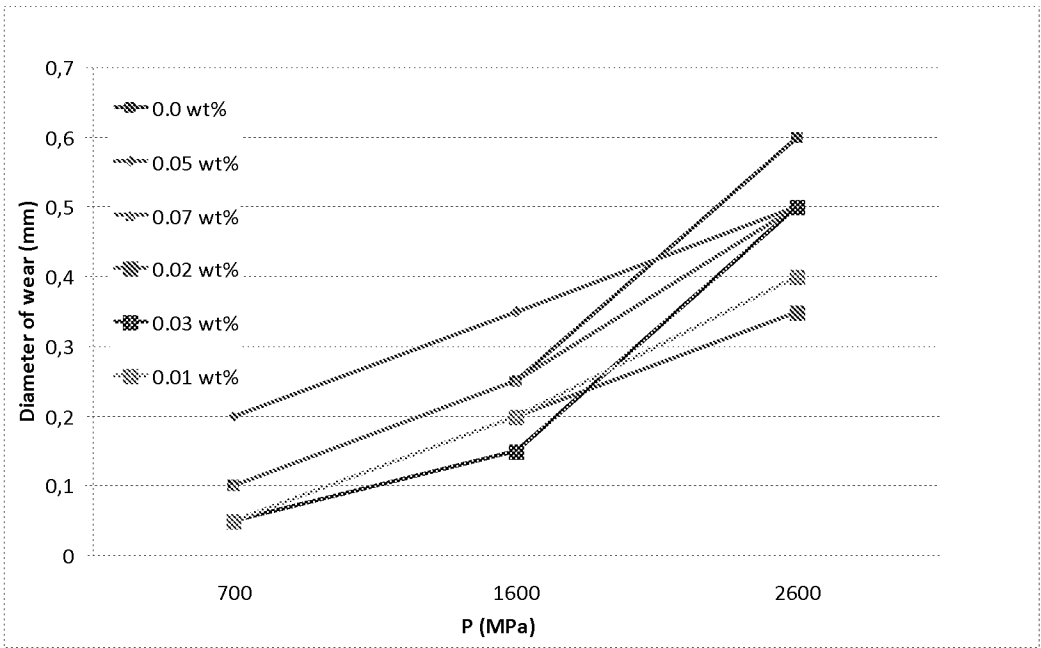


Figure 2

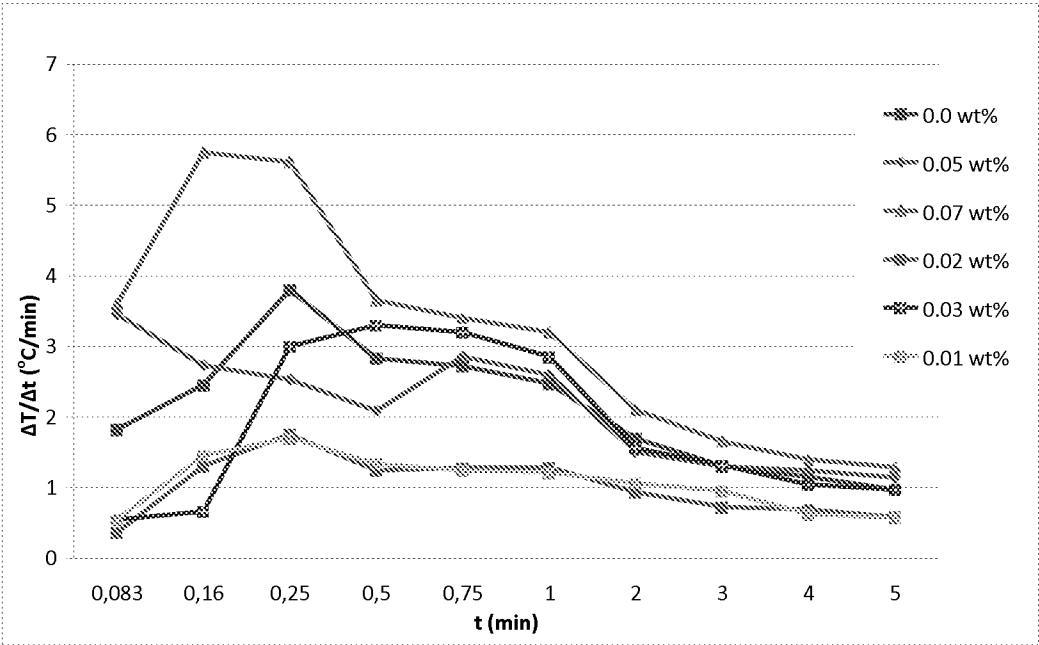


Figure 3

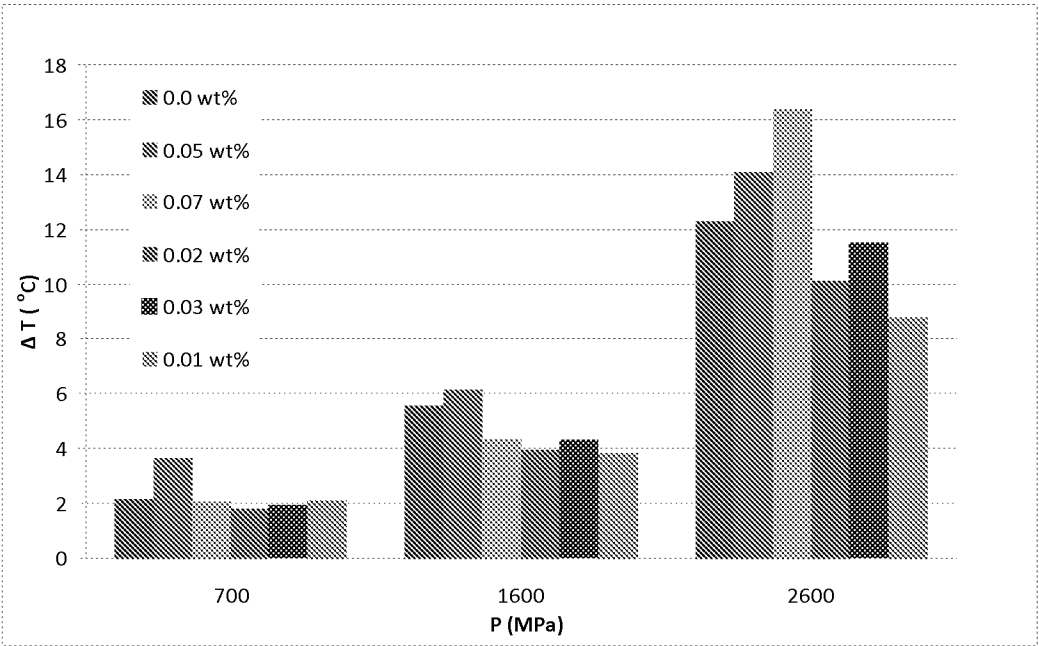


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2012/050131

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

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

EPO-Internal, WPI, XPESP, XPESP2, COMPDX, INSPEC, CAPLUS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2010107334 A1 (BABEL VALENTINA GRIGORIEVNA et al.) 23 September 2010 (23.09.2010)	1, 5-6, 9-10
A	& abstract [online] EPOQUENET WPI	2-4, 7-8
Y	EP 2135925 A1 (AFTON CHEMICAL CORP) 23 December 2009 (23.12.2009)	1, 5-6, 9-10
A	claims 1-9 and 11-14; chapters [0009] and [0064]; table 1 and table 2, example 1	2-4, 7-8
A	US 2008269086 A1 (ADHVARYU ATANU) 30 October 2008 (30.10.2008) claims 1-13 and 18-20; chapters [0003], [0019] and [0025]	1-10
A	EP 0007703 A1 (TAPTRUST LTD) 06 February 1980 (06.02.1980) claims 1-2 and 11-14; chapters [0011] and [0023]	1-10



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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"&" document member of the same patent family

Date of the actual completion of the international search

14 June 2012 (14.06.2012)

Date of mailing of the international search report

19 June 2012 (19.06.2012)

Name and mailing address of the ISA/FI
National Board of Patents and Registration of Finland
P.O. Box 1160, FI-00101 HELSINKI, Finland

Facsimile No. +358 9 6939 5328

Authorized officer
Saara Mustamäki

Telephone No. +358 9 6939 500

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2012/050131

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
WO 2010107334 A1	23/09/2010	RU 2009109342 A	27/09/2010
.....			
EP 2135925 A1	23/12/2009	AT 538194T T	15/01/2012
		US 2009318318 A1	24/12/2009
.....			
US 2008269086 A1	30/10/2008	JP 2008274283 A	13/11/2008
		DE 102008021097 A1	12/02/2009
.....			
EP 0007703 A1	06/02/1980	AR 223680 A1	15/09/1981
		JP 55016080 A	04/02/1980
		BR 7904149 A	25/03/1980
		PT 69837 A	01/07/1979
		ES 481978 A1	01/09/1980
		NO 792141 A	22/01/1980
		ZA 7903153 A	27/08/1980
		DK 266279 A	20/01/1980
		AU 4837079 A	24/01/1980
		GB 2026024 A	30/01/1980
.....			

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2012/050131

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

C10M 141/00 (2006.01)

C10M 171/06 (2006.01)

C10M 125/00 (2006.01)