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(54) **POWDER LUBRICANT BASED ON ZINC SALTS OF FATTY ACIDS AND USE THEREOF**

(57) The underlying invention consists in a dry lubricant composition in powder form which is especially useful in the production of aluminium cans in a deep drawing process, wherein the formed aluminium cans are immediately further processed to yield thin inorganic and/or organic protective coatings. The lubricating powder is based on a mixture of a lignosulfonate and metal salts of fatty acids, wherein the metal salts represent a combination of zinc and alkali metals. The invention also encompasses the use of the lubricating powder for cold forming of aluminium as well as a process for the deep drawing of aluminium cans.

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Description

[0001] The underlying invention consists in a dry lubricant composition in powder form which is especially useful in the production of aluminium cans in a deep drawing process, wherein the formed aluminium cans are immediately further processed to yield thin inorganic and/or organic protective coatings. The lubricating powder is based on a mixture of a lignosulfonate and metal salts of fatty acids, wherein the metal salts represent a combination of zinc and alkali metals. The invention also encompasses the use of the lubricating powder for cold forming of aluminium as well as a process for the deep drawing of aluminium cans.

[0002] Within the can producing industry the deep drawing of aluminium flats is a well-established process. In such a deep drawing process it is necessary to compensate for friction at the contacting areas of the aluminium material and the forming tool, e.g. punches and dies made from hard steel or tungsten carbide. A huge variety of compositions being based on metal soaps is known to support the cold working of metals. The lubricating components are often dispersed or dissolved in a liquid vehicle and thus may form low viscosity liquids or thicker pastes. It is crucial for the effective compensation of friction between the forming tool and the metal to be formed that a thin lubricating film with high uniformity and integrity can be established during the cold forming process. Hence, the homogeneous application of the lubricant is a first prerequisite to achieve successful lubrication. Although the substances with lubricating properties themselves are well-known, it turns out to be difficult to homogeneously apply these substances when contained in a liquid vehicle. Moreover, it is essential to have essentially all volatile material removed before the cold forming step in order to avoid any defects in the metal caused by the flash evaporation of the volatile liquid. On the other hand the lubricating substances as such, that are mostly solid at room temperature, often raise environmental issues or are by themselves hazardous. Hence, there exists an ongoing need not only to improve the lubricating properties as such but also to improve the applicability as well as to lower the amount of lubricating material needed to perform the cold forming as demanded to meet the specifications of the industry. Another issue consists in the removal of the remainder of the lubricating film on the formed metal surface. Depending on the type of lubricant composition and on the existence of further process steps following the cold forming step, such as painting, the methods of removal may differ essentially and might be selected from purely physical to almost purely chemical treatments.

[0003] For example EP 0638116 B discloses a liquid lubricant composition for the metal working of aluminium that comprises saturated aliphatic monohydric alcohols in an inert volatile liquid organic vehicle. After dipping of the aluminium flat into the liquid lubricant composition, the wet film is dried so that a thin lubricating film is attained that after the cold forming step is removable upon annealing.

[0004] US 2012/0302472 A1 discloses a water-resistant lubricating grease based on calcium lignosulfonates additionally comprising calcium soaps and a base oil as an liquid vehicle suitable for constant velocity joint shafts, rolling bearings and gearboxes.

[0005] Based on this prior art the objective of this invention consists in establishing a lubricant suitable for the deep drawing of aluminium parts that can be easily applied while less amount of lubricant material is necessary to support the deep drawing process. A further necessity arises from the fact that the deep drawn aluminium parts are often to be coated with protective layers and thus have to be cleaned after the cold forming process. Consequently, a suitable lubricant of this invention shall also have the property to be easy to remove from metal surfaces with conventional aqueous cleaners.

[0006] The underlying problem is solved by a lubricating powder comprising

a) at least one zinc and at least one alkali metal salt of a fatty acid,
b) one or more alkali metal lignosulfonates,

wherein the molar ratio of zinc ions to fatty acid residues is at least 0.2.

[0007] Such a lubricating powder shows excellent lubricity especially in the deep drawing of aluminium such as the shaping of cylindrical cans from a disc-shaped aluminium sheet. Such deep drawing can be accomplished with comparatively minor amounts of the lubricant. Furthermore, the solids stemming from the lubricating powder that adhere to the surface of the cold formed articles can be easily removed through rinsing with an aqueous cleaner.

[0008] A powder according to this invention is to be understood to be a heterogeneous mixture of different pulverised solids, wherein the content of compounds with a softening point below 25 °C is below 1 wt.-%. A powder of this invention can be easily adhered to metal parts through vibrating or tumbling of a container inclosing the powder and the metal parts. In a preferred embodiment the lubricating powder being constituted of solid particles has a D50 value of less than 20 μm, more preferably less than 10 μm. Nevertheless it is preferred in order to ensure the formation of a lubricating film with high uniformity and integrity during the cold forming process that the D50 value of the lubricating powder is at least 1 μm, preferably at least 5 μm. The D50 value indicates that that 50 vol.-% of the overall solid particles of the powder have a diameter below the given value. The D50 value can be derived from cumulative particle size distributions being measured with static light diffraction methods.

[0009] A minimum amount of zinc ions as counter ions to the fatty acid residues is mandatory in order to attain powder coatings with sufficient lubricity. In this respect, it is preferred that the lubricating powder shows a molar ratio of zinc ions to fatty acid residues of at least 0.35, while the remainder of the fatty acid residues originates preferably to at least 80 mol%, more preferably to at least 90 mol% from alkali metal salts of fatty acids. On the other hand it is crucial for the underlying invention that the lubricating powder coating can be easily removed with conventional aqueous cleaners after the cold forming process. For this reason it is beneficial that a lubricating powder of this invention does preferably have a molar ratio of zinc ions to fatty acid residues of not more than 0.7, more preferably of not more than 0.5, while the remainder of the fatty acid residues originates preferably to at least 80 mol%, more preferably to at least 90 mol% from alkali metal salts of fatty acids.

[0010] The alkali metal salts of component a) are preferably selected from lithium, potassium and/or sodium salts, more preferably from sodium salts.

[0011] Lubricating powders of this invention show the best lubricating results for those salts from fatty acids that are selected from C10-C22, preferably from C14-C20 fatty acid salts, being thus preferred, such as linoleates. In this context, the fatty acid salts of component a) of the lubricating powder are preferably selected from fatty acids with not more than one unsaturated carbon-carbon bond, such as oleates, more preferably from saturated fatty acids, even more preferably from salts of stearates.

[0012] In the context of this invention a C10-C22 or C14-C20 fatty acid contains from 10 to 22 or from 14 to 20 carbon atoms in the longest aliphatic chain excluding the carbon atom that constitutes the carboxyl-functionality.

[0013] In a lubricative powder of this invention component a) preferably amounts to at least 40 wt.-%, more preferably to at least 60 wt.-%, but preferably does not contain more than 90 wt.-%, more preferably not more than 85 wt.-% based on the total composition of the powder.

[0014] Component b) of a lubricating powder of this invention stems from the sulfonation of lignins being a natural biopolymer derived from wood. As such, lignosulfonates are a by product from the production of wood pulp using sulfite pulping.

[0015] Preferred lignosulfonates within a lubricating powder of this invention reveal a weight average molecular weight of at least 2,000 g/mol, but preferably not more than 20,000 g/mol, more preferably not more than 10,000 g/mol.

[0016] The alkali metal ions of component b) are preferably selected from lithium, potassium and/or sodium ions, preferably from sodium ions.

[0017] In a lubricative powder of this invention component b) preferably amounts to more than 2 wt.-%, more preferably more than 5 wt.-%, but preferably amounts to less than 20 wt.-%, more preferably less than 15 wt.-% based on the total composition of the powder.

[0018] It was observed that especially good lubricity in the deep drawing of aluminium can be attained for lubricating powders of this invention that reveal a certain weight ratio of the components a) and b). Hence, those lubricating powders of this invention are preferred wherein the weight ratio of component a) to b) is in a range of from 8 : 1 to 2 : 1, preferably of from 3 : 1 to 6 : 1.

[0019] The lubricating powder may additionally comprise as a component c) at least one compound known to the skilled person to be an "extreme pressure additive". These additives release low molecular weight compounds selected from sulphurous and phosphorous compounds during the cold forming process under tribological wear and thereby prevent from fusing of the to be formed metal and the forming tool. In the context of this invention extreme pressure additives were found to additionally support the formulation of "dust-free" lubricating powders through adsorption of the additive to the solid particles of the powder. The reduction of dust formation is desirable to ensure minimum dust particle content in respiratory air when the lubricating powder is handled to be applied to the metal parts. Preferred extreme pressure sensitives that can be additionally comprised in a lubricating powder of this invention and effectively serve to provide "dust-free" powders are selected from sulfides, polysulfides and/or dialkyldithiophosphates, preferably from dialkyldithiophosphates with not more than 12 carbon atoms in each alkyl chain, most preferably from sodium and/or zinc dialkyldithiophosphates with not more than 12 carbon atoms in each alkyl chain.

[0020] In a lubricating powder of this invention component c) preferably amounts to at least 1 wt.-%, more preferably to at least 2 wt.-%, but preferably does not contain more than 8 wt.-%, more preferably not more than 5 wt.-% based on the total composition of the powder.

[0021] The lubricating powder of this invention preferably comprises less than 2 wt.-%, preferably less than 0.1 wt.-% of free fatty acids.

[0022] Moreover, it is essential that the amount of metal salts of fatty acids other than those of component a) is limited in a lubricating powder of this invention. Hence, a lubricating powder of this invention preferably comprises in total less than 1 wt.-%, more preferably in total less than 0.1 wt.-% of earth alkaline metal salts or aluminium salts of fatty acids based on the total composition of the powder. In an even more preferred embodiment, the lubricating powder comprises in total less than 1 w.t-%, preferably in total less than 0.1 wt.-% of any earth alkaline metal salts or aluminium salts based on the total composition of the powder.

[0023] Another aspect of this invention consists in the use of a lubricating powder as described herein for the cold

forming of aluminium parts, especially for the deep drawing of aluminium.

[0024] Depending on the further use, the lubricative coating on the deep-drawn aluminium articles oftentimes need to be removed prior to further processing. This can be accomplished either by pyrolysis or wet-chemical treatment, e.g. with a water-based cleaner.

[0025] One major advantage of the underlying invention consists in a high coating efficiency of the lubricating powder material compared to lubricating liquids or pastes. This advantage is especially important in processes where a multitude of metal parts has to be coated with a lubricating composition in a short period of period, such as in the beverage can producing industry.

[0026] Consequently, the underlying invention also encompasses a process for the production of deep-drawn aluminium cans comprising the subsequent steps of

a) placing a multitude of aluminium flats and a lubricating powder of this invention in one container, preferably barrel, wherein the lubricating powder amounts to not more than 5 grams per square meter of the surface of the aluminium flats;
b) vibrating or tumbling the container, preferably barrel, in order to coat the aluminium flats with a lubricating film of the powder lubricant;
c) deep-drawing of the aluminium flats into cans through punching, preferably through impact extrusion.

[0027] In a preferred embodiment of this preferred process of can production the deep-drawn cans are of cylindrical shape and the aluminium flats are in the shape of discs.

Examples:

[0028] Different powder lubricants of this invention (Table 1) have been applied to aluminium discs prior to the forming cylindrical thin walled aluminium cans through impact extrusion.

Tab. 1
Lubricant Powder Compositions of this Invention

	E1	**E2**	**E3**
	amount / wt.-%	amount / wt.-%	amount / wt.-%
Component a)			
Zinc stearate	55	65	65
Sodium stearate	30	10	20
Sodium palmitate	-	15	-
Component b)			
Sodium lignosulfonate	10	5	10
Component c)			
Sodium dialkyldithiophosphate	5	-	-
Zinc dialkyldithiophosphate	-	5	5

[0029] A thin layer of this lubricant was applied to the surface of aluminium slugs by tumbling a specific amount of lubricant powder with the metal parts for 20 minutes at 20 rpm. The lubricated slugs were then subjected to impact extrusion to form the body of a spray can with a defined length L of the cylindrical axis and wall thickness W of the can. For this specific type of cold forming a horizontal impact extrusion press operated at a punching speed of 80 to 220 impacts per minute. The punch and the die were made of tungsten carbide.

[0030] The minimum amount of lubricant powder necessary to yield a thin walled cylindrical container with even thickness having no streaks and carbonaceous residues on its surface has been determined for each lubricant powder of Table 1. For comparison the consumption of a liquid lubricant based on a metal soap in an alcoholic vehicle (Lubrimet GTT-X from Sapilub Ltd.) often used in the industry of aluminium cans extrusion was as well determined. For this purpose the metal soap was grinded to parts of less than 2mm, dried and then as well applied to the aluminium slugs in a tumbling barrel for 20 minutes at 20 rpm. The results are shown in Table 2. Two test runs have been made with aluminium discs of different diameter (Test 1: 53.0 mm; Test 2: 74.5 mm)

Tab.2
Minimum amount of lubricant per surface area of aluminium discs necessary to sufficiently support the impact extrusion process

	Amount of Lubricant Composition / g m^{-2}			
	CE1	E1	E2	E3
Test 1 L = 230mm W = 0.29 mm	5.1	2.5	2.5	1.9
Test 2 L = 300mm W = 0.55 mm	12.2	-	-	5.1

[0031] It is evident from Table 2 that the relative amount of lubricant necessary to support the impact extrusion of aluminium cans is significantly decreased by making use of the lubricating powders of this invention (CE1 vs. E1-3). Moreover, an increase of the relative amount of zinc ions compared to the fatty acid residues gives rise to a further improvement of the lubricating performance (E3 vs. E1).

Claims

1. Lubricating powder comprising

a) at least one zinc and at least one alkali metal salt of a fatty acid,
b) one or more alkali metal lignosulfonates,
wherein the molar ratio of zinc ions to fatty acid residues is at least 0.2.

2. Powder according to claim 1, wherein the molar ratio of zinc ions to fatty acid residues is at least 0.35, but preferably not above 0.7, more preferably not above 0.5.

3. Powder according to any one of the preceding claims, wherein the salts of fatty acids are selected from C10-C22 fatty acids, preferably from fatty acids with not more than one unsaturated carbon-carbon bond, more preferably from saturated fatty acids, especially preferred from stearates.

4. Powder according to any one of the preceding claims, wherein component a) is present in a range of from 40 to 90 wt.-%, preferably in a range of from 60 to 85 wt.-% based on the total composition of the powder.

5. Powder according to any one of the preceding claims, wherein component b) amounts to more than 2 wt.-%, more preferably more than 5 wt.-%, but preferably amounts to less than 20 wt.-%, more preferably less than 15 wt.-% based on the total composition of the powder.

6. Powder according to any one of the preceding claims, wherein the weight ratio of component a) to component b) is in a range of from 8 : 1 to 2 : 1, preferably of from 3 : 1 to 6 : 1.

7. Powder according to any one of the preceding claims additionally comprising as component c) an extreme pressure additive being preferably selected from dialkylditiophosphates, more preferably from sodium and/or zinc dialkyldithiophosphates with not more than 12 carbon atoms in each alkyl chain.

8. Powder according to claim 7, wherein component c) is present in a range of from 1 to 8 wt.-%, preferably from 2 to 5 wt.-% based on the total composition of the powder.

9. Powder according to any one of the preceding claims wherein the overall amount of powder particles has a D50 value of less than 20 μm, preferably less than 10 μm, but preferably a D50 value of at least 1 μm.

10. Use of a lubricating powder according to any one of the preceding claims for the cold forming of aluminium parts.

11. Process for the production of aluminium cans comprising the subsequent steps of

a) placing a multitude of aluminium flats and a lubricating powder according to any one of the claims 1 to 9 in one container, wherein the lubricating powder amounts to not more than 5 grams per square meter of the surface of the aluminium flats;
b) vibrating or tumbling the container in order to coat the aluminium flats with a lubricating film of the powder lubricant;
c) deep-drawing of the aluminium flats into cans through punching.

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 3028

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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