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Standard Terminology for Rolling Element Bearings¹

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1. Scope

1.1 This terminology covers terms and their definitions relevant to the materials and processes associated with rolling element bearings.

2. Terminology

2.1 Definitions:

absolute viscosity (η), n —(sometimes called **dynamic viscosity** or just **viscosity**)—a measure of the tendency of the fluid to resist shear.

acid number, n —measure of the quality of a lubricant. High acid numbers (much higher than the fresh oil) are an indication of lubricant oxidation/degradation.

DISCUSSION—Oils with high acid numbers should not be used. Acid number is measured as milligrams of KOH needed to neutralize 1 g of oil.

additive, n —any chemical compound added to a lubricant to improve or meet special needs necessary for service (formulated lubricants). The most important additives are antioxidants, rust, and corrosion inhibitors, and extreme pressure (EP) and antiwear (AW) additives.

antioxidants (oxidation inhibitors), n —chemical compounds used to improve the oxidation stability and subsequent deterioration of lubricants.

average life (L_{50}), n —for a radial roller bearing, the number of revolutions that 50 % of a group of bearings will complete or exceed before the first evidence of fatigue develops.

DISCUSSION—The average life may be as much as five times the rating life.

ball gage (S), n —prescribed small amount by which the lot mean diameter should differ from nominal diameter, this amount being one of an established series of amounts.

DISCUSSION—A ball gage, in combination with the ball grade and nominal ball diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.

ball gage deviation (ΔS), n —difference between the lot mean diameter and the sum of the nominal diameter and the ball gage.

ball grade (G), n —specific combination of dimensional form and surface roughness tolerances. A ball grade is designated by a grade number followed by the letter “C” indicating silicon nitride ceramic.

boundary lubrication, n —condition of lubrication in which the friction between two surfaces in relative motion is determined by the roughness of the surfaces and by the properties of the lubricant other than viscosity.

DISCUSSION—Antiwear and extreme pressure additives reduce the wear of components operating under this regime.

case depth, n —thickness, measured radially from the surface of the hardened case to a point at which carbon content or hardness becomes the same as the ball core.

centipoise, n —unit of dynamic viscosity.

DISCUSSION—The unit in the cgs system is 1 centipoise (cP). The SI unit of dynamic viscosity is 1 Pa·s and equivalent to 10^3 cP.

centistoke, n —unit of kinematic viscosity.

DISCUSSION—The unit in the cgs system is 1 centistoke (cSt). The SI unit of kinematic viscosity is $1 \text{ m}^2/\text{s}$ and is equivalent to 10^6 cSt.

compatibility, n —measure of the ability of a lubricant to be mixed with other lubricants or bearing preservatives (fluids that form films on metal surfaces to prevent corrosion during storage) to form a uniform mixture without causing any resultant reaction or precipitation of material. Compatibility is also a measure of the ability of a lubricant not to cause any detrimental effect to metal, plastic, or elastomer materials.

DISCUSSION—It is recommended that any preservative material be removed from bearings before lubrication.

contamination, n —(1) presence of mostly solid foreign materials like sand, grinding powder, dust, and so forth, in a lubricant that might cause an increase in wear, torque, and noise and result in reduced bearing life; and (2) presence of fluids like water, solvents, and other oils that might cause accelerated oxidation, washout, rusting, or crystallization of the additives and other phenomena that reduce a bearing's life.

corrosion, n —gradual destruction of a metal surface as a result of chemical attack caused by polar or acidic agents like

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humidity (water), compounds formed by lubricant deterioration, or contaminants from the environment.

corrosion inhibitors, n —corrosion inhibitors protect metal surfaces against corrosion or rust by forming a protective coating or by deactivation of corrosive compounds formed during the operation of a bearing.

density, n —mass per unit volume of a substance.

DISCUSSION—The cgs unit of density (ρ) is 1 g/cm³, and the SI unit of density is 1 kg/m³. Density depends on the chemical composition and in itself is no criterion of quality. It is a weak function of temperature and pressure for liquids and solids.

deviation from spherical form (ΔR_w), n —greatest radial distance in any radial plane between a sphere circumscribed around the ball surface and any point on the ball surface.

DN value, n —product of the bearing bore diameter in millimetres multiplied by the speed in revolutions per minute (compare to nD_m value).

dynamic viscosity, n —another name for **absolute viscosity**.

EP lubricants (extreme pressure lubricants), n —lubricants (oil or greases) that contain extreme pressure additives to protect the bearings against wear and welding (scoring).

esters, n —esters are formed from the reaction of acids and alcohols. Esters form a class of synthetic lubricants.

DISCUSSION—Esters of higher alcohols with divalent fatty acids form diester lubricants while esters of polyhydric alcohols are called the polyol ester lubricants. These latter esters have higher viscosity and are more heat resistant than diesters.

evaporation loss, n —lubrication fluid losses occurring at higher temperatures or under vacuum, or both, as a result of evaporation.

DISCUSSION—This can lead to an increase in lubricant consumption and also to an alteration of the fluid properties of a lubricant (especially an increase in the viscosity of blended lubricants). The evaporation loss is expressed as a weight loss in milligrams (10⁻⁶ kg) or wt %.

fire point, n —lowest temperature at which the vapor or a lubrication fluid ignites under specified test conditions and continues to burn for at least 5 s without the benefit of an outside flame. The fire point is a temperature above the flash point.

DISCUSSION—Perfluoropolyethers have no fire point.

flash point, n —lowest temperature of a lubrication fluid at which the fluid gives off vapors that will ignite when a small flame is periodically passed over the liquid surface under specified test conditions.

DISCUSSION—The flash and fire points provide a rough characterization of the flammable nature of lubrication fluids. Perfluoropolyethers have no flash point.

fretting corrosion, n —special type of wear produced on materials in intimate contact that are subjected to the combined action of oscillatory motions of small amplitudes and high frequencies. Fretting corrosion appears similar to atmospheric corrosion (rust) as a reddish-brown layer on steel surfaces.

interfacial tension, n —when two immiscible liquids are in contact, their interface has many characteristics in common with a gas-liquid surface. This interface possesses interfacial free energy because of the unbalanced attractive forces exerted on the molecules at the interface by the molecules within the separate phases. This free energy is called the interfacial tension.

kinematic viscosity, n —ratio of absolute viscosity to fluid density.

DISCUSSION—This ratio arises frequently in lubrication analyses, and thus, kinematic viscosity has become a separate term describing the viscosity of a fluid. Many experimental measurements of viscosity of fluids result in a measure of kinematic viscosity from which absolute viscosity is calculated. See **absolute viscosity**. The cgs unit of kinematic viscosity is cSt and the SI unit is m²/s. The viscosity of a PREB oil is a major factor in lubricant selection. The viscosity is directly involved in frictional, thermal, and fluid film conditions that reflect the influence of load, speed, temperature, and design characteristics of the bearing being lubricated.

marking increments, n —standard unit steps to express the specific diameter.

mineral oil, n —oils based on petroleum stocks. These oils come in two types, naphthenic and paraffinic. The naphthenic oils contain unsaturated hydrocarbons, usually in the form of aromatic species. The paraffinic oils are primarily saturated hydrocarbons with only low levels of unsaturation.

nD_m value (index), n —also called *speed index*—relative indicator of the lubricant stress imposed by a bearing rotating at a given speed, where n is the rotational speed of the rolling element bearing in revolutions per minute and D_m is the mean diameter in millimetres (arithmetic mean of bore diameter d and outside diameter D).

DISCUSSION—The speed index is multiplied by a factor k_a depending on the roller element bearing type:

$k_a = 1$ for deep groove ball bearings, angular contact ball bearings, self-aligning ball bearings, radially loaded cylindrical roller bearings, and thrust ball bearings;

$k_a = 2$ for spherical roller bearings, taper roller bearings, and needle roller bearings; and

$k_a = 3$ for axially loaded cylindrical roller bearings and full complement roller bearings.

The factor k_a takes into account the various rates of sliding friction that usually occurs during the operation of a rolling element bearing. The nD_m value is an aid in choosing a suitable lubricant viscosity for a given bearing speed and is particularly applicable to grease-lubricated bearings.

neutralization number, n —measure of the acidity or alkalinity of a lubricating fluid. The test determines the quantity of base (milligrams of potassium hydroxide) or acid (also expressed as milligrams of potassium hydroxide) needed to neutralize the acidic or alkaline compounds present in a lubricating fluid.

DISCUSSION—Actually, the neutralization number is not one number but several numbers: strong acid number, total acid number, strong base number, and total base number. The neutralization number is used for quality control and to determine changes that occur in a lubricant in service.

oxidation stability, n —stability of a lubricant in the presence of air or oxygen is an important chemical property.