

Bearings and Bearing Lubrication

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Agenda

- Bearing Basics
- Rolling Element Bearing Types and Examples
- Bearing Lubrication
- Mystik Bearing Grease Portfolio
- CITGO Bearing and Circulating Oil Portfolio





Bearing Basics

Bearing Basics

- Bearing Classification
 - Plain Bearings
 - Rolling Element Bearings
- Bearing Lubricant Selection







Sliding or "Plain" Bearings







Plain (Journal) Bearings







Rolling Element or "Antifriction" Bearings



Plain and Rolling Element Bearings

Comparative Geometries



Hydrodynamic Lubrication

Before the rotation commences the shaft rests on the bearing surface.

When the rotation commences the shaft moves up the bore until an equilibrium condition is reached when the shaft is supported on a wedge of lubricant.

The moving surfaces are then held apart by the pressure generated within the fluid film.

Journal bearings are designed such that at normal operating conditions the continuously generated fluid pressure supports the load with no contact between the bearing surfaces.

This operating condition is known as thick film lubrication and results in a very low operating friction and extremely low bearing load.

The rotating shaft drags a wedge of oil beneath it that develops a pressure great enough to support the shaft and eliminate contact friction between the shaft and bearing.



Elastohydrodynamic Lubrication

- Elastic deformation of bearing surfaces (race and rolling elements)
- Very high contact pressures, up to 50,000 psi
- Rolling element bearings, cam rollers, heavily loaded gears



Schematic of the Elastohydrodynamic (EHL Film) in a Ball Bearing. (Roughness under magnification is exaggerated)

Rolling Element Bearing Types and Examples

Rolling Element Bearing Parts

Pitch Diameter = Halfway Between





Deep Groove Ball Bearing

63<u>09</u> <u>09</u>x5 = 45 mm Bore



Ball Bearing – Point Contact

- Light Loads
- High Speeds
- Low Viscosity Required



Roller Bearing – Line Contact

- Cylindrical or Tapered Rollers
- Needle Rollers
- Line Contact
- Lower Speeds
- Higher Loads
- Higher Viscosity Required



Cylindrical Roller Bearing









Needle Roller Bearing







Spherical Roller Bearing – Area Contact

- Spherical Rollers
- Large Contact Area
- Slow Speeds
- Heavy Loads
- Higher Viscosity Required



Double Row Spherical Roller Bearing



Spherical Thrust Bearing















Bearing Lubrication

Lubricant Selection Factors

• Operating Temperature

- Rotational Speed



• Load

Lubricant Selection Factors

- Operating Temperature
- Rotational Speed



- Load
- Bearing Type
- Operating Environment





Lambda (Λ) Ratio

The Lambda Ratio is defined as follows:

 $\Lambda = h_0 / \sigma$

Where h_0 = Lubricant Film Thickness σ = Average Surface Roughness



Lubrication

<u>Λ Ratio</u>	<u>Regime</u>	Wear Observation
<1.0	Boundary	Surface smearing or deformation
1.0 – 1.5	Mixed	Surface distress and surface pitting
1.5 – 3.0	Mixed	Surface glazing with subsurface fatigue
>3.0	EHL	Minimal wear, long life, eventual
		subsurface fatigue failure

Карра (к) Value

 Kappa (K) is the ratio of the viscosity of the lubricant at operating temperature divided by the required viscosity for the bearing

Kappa Lubrication Conditions

- < 0.4 Mixed friction, increased solid contact
 - 1 The basic rating life of the bearing is achieved
 - 4 Full fluid film lubrication
- > 4 Full fluid film lubrication, possible temperature rise due to internal friction



Graphic from Machinery Lubrication

Bearing Speed Factor

Speed Factor = $n \cdot D_m$

Where n = bearing operating speed, rpm $D_m = mean bearing diameter, mm$ $D_m = (ID + OD)/2$ ID = Inside Diameter, mmOD = Outside Diameter, mm

Bearing Type	Oil Lubricated	Grease Lubricated
Radial Ball	500,000	340,000
Cylindrical Roller	500,000	300,000
Spherical Roller	290,000	145,000
Thrust, Ball, and Roller	280,000	140,000

Minimum Viscosity at Operating Temperature



Mystik Bearing Grease Portfolio

Mystik JT-6 High Temp #2 and #1

Mystik JT-6 Heavy Duty SynBlend 460 #2

Mystik JT-6 Low Temp #2

Mystik JT-6 Low Temp SynBlend #2

Mystik JT-6 Synthetic 100 #1

Mystik JT-6 Synthetic 220 #2

Mystik JT-6 Synthetic 460 #2 and #1

Mystik JT-6 Synthetic Electric Motor #2

	Mystik JT-6 High Temp #2	Mystik JT-6 High Temp #1	Mystik JT-6 Heavy Duty SynBlend 460 #2	Mystik JT-6 Low Temp #2	Mystik JT-6 Low Temp SynBlend #2	Mystik JT-6 Synthetic 100 #1	Mystik JT-6 Synthetic 220 #2	Mystik JT-6 Synthetic 460 #2	Mystik JT06 Synthetic 460 #1	Mystik JT-6 Synthetic Electric Motor #2
NLGI Grade	2	1	2	2	2	1	2	2	1	2
Base Oil Viscosity (cSt @ 40°C)	630	630	460	20	70	100	220	460	460	100
Thickener	Lithium Complex	Lithium Complex	Lithium Complex	Calcium	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex
Color	Red	Red	Magenta	Amber	Blue	Blue	Blue	Green	Green	Blue
Temperature Range (°F)	-10 to 325	-10 to 325	-5 to 350	-40 to 250	-20 to 325	-40 to 350	-20 to 350	-20 to 350	-20 to 350	-10 to 325

Mystik CalSuPlex Multi-Purpose #2 Mystik Lithium Extreme Pressure #2 and #1 Mystik LithoPlex Industrial Grease #2 and #1 Mystik LithoPlex Multi-Purpose #2 and #1 Mystik LithoPlex Multi-Purpose Red #2 Mystik LithoPlex Power Tool #2 Mystik LithoPlex Red Tacky #2 and #1

		Mystik CalSuPlex Multi-Purpose #2	Mystik Lithium Extreme Pressure #2	Mystik Lithium Extreme Pressure #1	Mystik LithoPlex Industrial Grease #2	Mystik LithoPlex Industrial Grease #1	Mystik LithoPlex Multi-Purpose #2	Mystik LithoPlex Multi-Purpose #1	Mystik LithoPlex Multi-Purpose Red #2	Mystik LithoPlex Power Tool #2	Mystik LithoPlex Red Tacky #2	Mystik LithoPlex Red Tacky #1
ſ	NLGI Grade	2	2	1	2	1	2	1	2	2	2	1
E (Base Oil Viscosity cSt @ 40°C)	150	170	170	440	440	230	230	230	630	500	500
1	Thickener	Calcium Sulfonate Complex	Lithium	Lithium	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex
(Color	Green	Dark Amber	Dark Amber	Green	Green	Gray	Gray	Red	Amber	Red	Red
T	Temperature Range (°F)	-5 to 325	5 to 275	5 to 275	5 to 300	0 to 300	0 to 325	0 to 325	0 to 325	5 to 325	0 to 325	0 to 325

CITGO Bearing and Circulating Oil Portfolio

CITGO Bearing and Circulating Oil Portfolio

- R&O Oils
 - Pacemaker®
- Turbine Oils
 - Pacemaker® T
 - Pacemaker® XL
 - Pacemaker® ST
- Circulating Oils
 - Pacemaker® SD
 - CITGEAR[®] XCO



Pacemaker[®] Oils

- Grades: 19, 32, 46, 68, 100, 150, 220, 320, 460, and 680
- ISO Grades: 22, 32, 46, 68, 100, 150, 220, 320, 460, and 680
- Inhibited against rust and oxidation
- Applications:
 - Air line oil
 - Circulating oil
 - Gear oil (non-EP)
 - Compressor oil
 - Rust and oxidation inhibited (R&O) oil
 - Low pressure hydraulic fluid
 - "Non-detergent" oil

CITGO Turbine Oils

Pacemaker[®] T – Steam Turbine Oils

- Pacemaker T-32, T-46, T-68, and T-115
- ISO 32, 46, 68, and 100
- ISO 68 primarily for hydroelectric turbines
- All grades formulated with API Group II base oils
- Excellent oxidation and thermal stability
- Excellent rust and corrosion prevention
- Excellent water separation
- Excellent foam resistance and air release properties

CITGO Turbine Oils

Pacemaker[®] XL-32 – Specialty Turbine Oil

- ISO 32
- Formulated with white mineral base oils
- Excellent oxidation and thermal stability
- Excellent rust and corrosion prevention
- Excellent water separation
- Excellent foam resistance and air release properties

CITGO Turbine Oils

Pacemaker[®] ST-32 – Gas Turbine Lubricant

- ISO 32
- Formulated with synthetic PAO fluids
- Includes a solvency enhancing additive
- High viscosity index
- Excellent oxidation and thermal stability
- Excellent rust and corrosion prevention
- Excellent water separation
- Excellent foam resistance and air release properties
- Antiwear properties for use in geared turbines
- <u>Not</u> for use in aeroderivative or aviation engines!

CITGO Circulating Oils

Pacemaker[®] SD

- ISO 220, 320, 460, and 680
- "Super Demulsibility" Excellent water separation properties
- Exceed Siemens AG Morgoil[®] Advanced Bearing Lubricant "Super Demulsibility" specification
- Long service life, excellent filterability
- Corrosion protection, foam and deposit control
- Applications:
 - Gear oil (non-EP)
 - Compressor oil
 - R&O oil
 - Roll bearing lubricant
 - Siemens Morgoil[®] and MESTA[®] systems

CITGO Circulating Oils

CITGEAR® XCO

- ISO 100, 220, 320, and 460
- Excellent water separation properties
- Excellent anti-wear properties
- Rust and corrosion protection, oxidation stability, foam resistance
- High thermal stability resists formation of sludge and varnish
- Applications:
 - Danieli rod mills
 - Morgan (Siemens AG) rod mills

Questions

• Please post your questions using the Q&A function.

How to Contact Us

• Lubes Answer Line

800-248-4684

8:00 AM - 12:00 PM, 1:00 PM – 5:00 PM CT Monday through Thursday

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The Roadmap to Certification Success