

Lubrication

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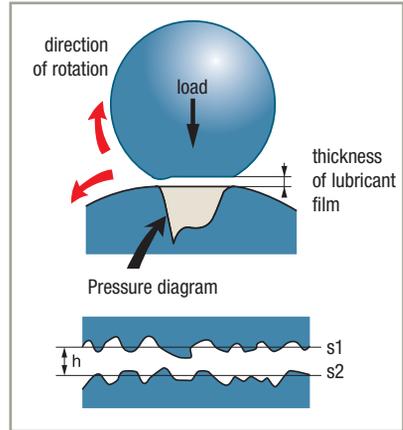
General principals of lubrication

Lubrication is essential for optimum bearing performance.

70% of bearing failures are due to lubrication problems.

The aim of lubrication is to provide a film of lubricant (oil film) between the rolling elements and the raceway of the bearing in order to prevent wear and seizure of the components in contact.

The lubricant also provides protection against oxidation and external contamination, and can have a cooling effect in the case of recirculating oil.



The service life of the bearing is directly related to the efficiency of the lubricant film, which depends on:

- the nature of the lubricant and its speed and temperature capabilities...
- the load and speed of rotation of the bearing

The influence of lubrication on the bearing life can be determined page 77.

→ Choosing the type of lubrication

	Oil lubrication	Grease lubrication
Advantages	<ul style="list-style-type: none"> ▶ Good penetration in the bearing ▶ Good physical and chemical stability ▶ Cooling possibility ▶ Easy monitoring of the lubricant: condition and levels 	<ul style="list-style-type: none"> ▶ Cleanliness of the mechanism ▶ Sealing easier to secure ▶ Protection barrier ▶ Assembly simplicity ▶ Ease of manipulation ▶ Reduction or elimination of relubrication ▶ Possibility of using pre-greased bearings
Disadvantages	<ul style="list-style-type: none"> ▶ Necessary to effectively seal the assembly ▶ Poor protection against oxidation and moisture in case of long stops ▶ Starting delay when circulation of oil is necessary prior to rotation 	<ul style="list-style-type: none"> ▶ Higher friction coefficient than for oil ▶ Poorer dissipation of heat ▶ Replacement (if necessary) requires dismantling and washing of the bearing ▶ No possibility of checking the level of grease, therefore it requires reliable grease retention or periodic addition to compensate for leaks, contamination or ageing

Grease lubrication

Characteristics of greases

■ Grease is a product whose consistency ranges from semi-fluid to solid and which is obtained by dispersing a thickening agent (soap) in a liquid lubricant (mineral or synthetic oil). Additives can be included to bring certain specific properties.

The increasing use of grease-lubricated bearings combined with the development of the life-lubrication concept, has made grease an integral component of the bearing. The service life of the bearing and its behaviour in diverse environments are largely determined by the properties of the grease.

■ Physical and chemical characteristics:

Consistency

- ▶ NLGI (National Lubrication Grease Institute) grades correspond to a value of penetration in the kneaded grease (per test specification ASTM/D217).
- ▶ The consistency generally chosen for bearings is grade 2.

NLGI grades	Kneaded penetration	Consistency
0	385 - 355	Semi-fluid
1	340 - 310	Very soft
2	295 - 265	Soft
3	250 - 220	Moderate
4	205 - 175	Semi-hard

Viscosity of the basic oil: usually defined in cSt (mm²/s) at 40°C (104°F).

Density: 0.9 approx.

Drop point: temperature at which the first drop of a grease falls from a sample.

Approximate temperature: 180°C (356°F) to 260°C (500°F) depending on the constituents of the grease. The maximum service temperature of the grease is always far below the drop point.

■ Functional characteristics

The conditions under which the lubricant works (rolling, kneading) require special bearing greases that cannot be selected only on the basis of the physical and chemical characteristics.

The SNR Research and Test Centre constantly performs qualification tests on bearings that enables us to give advice on the recommended grease for the application.

The qualification specification concerns the following basic criteria:

- endurance in ball bearings
- endurance in roller bearings
- water resistance
- high and low temperature resistance
- adherence when exposed to centrifugal forces
- vibration resistance (false Brinell effect)
- high speed adequacy, etc.



These criteria may be met in order to satisfy the customer's goal. The selection for an application is a compromise between the required specifications and the available greases.

Grease lubrication *(continued)*

Greasing recommendations

Sealed and shielded bearings are fitted with grease before packing. With the other bearings, the grease must be added with great care in order not to reduce bearing performance.

■ Method to apply the grease

Cleanliness is essential

Any foreign body in the grease can cause the premature destruction of the bearing.

- Thoroughly clean the area around the bearing
- Protect the grease containers against contamination
- The use of a grease gun provides a guarantee of cleanliness

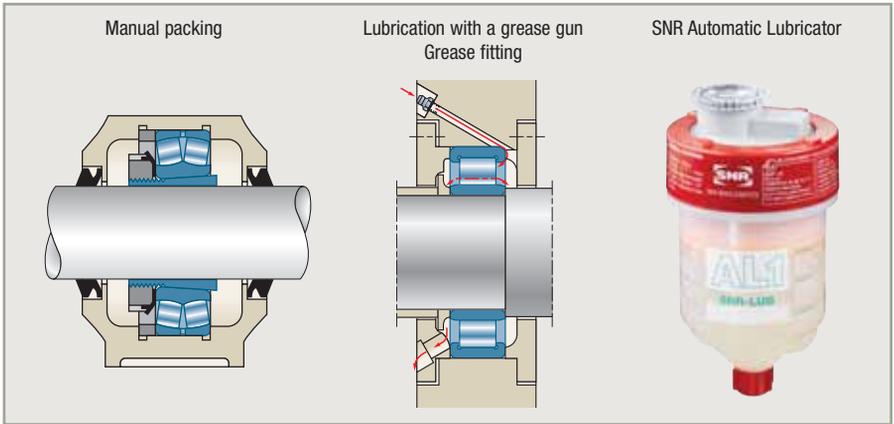
The grease must be applied as close as possible to the active parts of the bearing (raceways and rolling elements)

Insert the grease between the cage and the raceway of the inner ring, especially where angular-contact or spherical or self-aligning bearings are concerned.

For each assembly, record the date of past and future lubrications, and the type and weight of grease

- ▮ Assemblies and bearings with lubrication devices
 - Clean the lubricator head
 - Get rid of all foreign particles
 - Check and clean the spout of the grease gun
 - Introduce the grease
 - Pay particular attention to the quantity introduced
 - Remove the old grease at every 4th or 5th relubrication
 - When relubrication is very frequent, provide a system for removing the old grease
- ▮ Assemblies and bearings without a greasing device
 - Carefully clean the assembly before opening it
 - Remove the old grease with a non-metallic spatula
 - Introduce the grease between the rolling elements on both sides
 - Grease the shields and seals

■ Greasing devices



Choice of grease according to the application

■ The choice of grease is based on the knowledge of the operating conditions, which must be carefully considered: temperature, rotation speed, load, environment, vibration, application-specific constraints.

Ask your SNR ROULEMENTS contact for assistance in choosing the grease for your application. The table on the following page will help to make an initial choice.

■ There are two types of operation

Normal operating conditions

SNR recommends two types of greases:

- ▶ SNR LUB MS: for assemblies on machines, agricultural machinery, electric motors, handling equipment, pumps
- ▶ SNR LUB EP: for heavily-loaded bearings (iron and steel industry, civil engineering)

Special operating conditions

The application specifications will be studied in close cooperation with SNR ROULEMENTS in the following cases:

- Continuous operating temperature above +100°C (212°F) or below -30°C (-22°F)
- Speed greater than 80% of the bearing maximum speed
- Moist environment
- Centrifugal forces (outer ring rotating) or vibration
- Low torque
- Presence of hydrocarbons
- Nuclear radiation, etc.

The viscosity of the base oil is of great importance for lubrication efficiency. The diagram on page 78 can be used to check lubrication efficiency for your application.

The majority of general-purpose greases can be mixed with one another. However, to obtain the best result avoid mixing greases (the mixing of certain special application greases is forbidden).

SNR can supply sealed and shielded bearing pre-greased with a type of grease that is appropriate for the application (see technical range bearings or check minimum order quantity).



Choice of grease according to the application

Predominant operating conditions	Service limits		General recommendation	Examples of applications	SNR LUB recommendation
	Temp. °C (°F)	Speed			
Standard use	-30 (-22) up to +120 (+248)	< max. speed of bearing	<ul style="list-style-type: none"> ▶ Mineral oil ▶ Traditional soap (lithium, calcium...) ▶ Consistency: usually grade 2, grade 3 for large bearings or bearings with particular operating characteristics ▶ Drop in performance above 80°C (+176°F) in continuous operation, certain applications can require a better suited grease 	<ul style="list-style-type: none"> ▶ Automobiles ▶ Agricultural machinery ▶ Common mechanisms ▶ Handling equipment ▶ Electric tools 	LUB MS
High load	-30 (-22) up to +110 (+230)	< 2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Similar to standard greases with extreme pressure additive 	<ul style="list-style-type: none"> ▶ Iron and steel industry ▶ Civil engineering equipment 	LUB EP
High temperature	-30 (-22) up to +130 (+266)	< 2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Traditional soap with high-viscosity mineral-base or synthetic oil 	<ul style="list-style-type: none"> ▶ Class-E electric motors ▶ Class-F electric motors ▶ Alternators 	LUB HT
	-20 (-4) up to +150 (+302)				
	-20 (-4) up to +200 (+428)	≤ 1/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Entirely synthetic greases ▶ Greases with silicone-base oil have reduced resistance to loads 	<ul style="list-style-type: none"> ▶ Furnace equipment ▶ Class-H electric motors ▶ Couplers 	LUB THT
	-20 (-4) to +250 (+482)	< 1/5 max. speed of bearing	<ul style="list-style-type: none"> ▶ Synthetic products in solid or paste form ▶ Poorly miscible products 	<ul style="list-style-type: none"> ▶ Furnace equipment ▶ Kiln cars 	Consult SNR
Low temperature	up to -50 (-58)	≤ 2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Basic oil of very low viscosity ▶ Marginal retention of grease if temperature above 80°C (+176°F) 	<ul style="list-style-type: none"> ▶ Aviation ▶ Special machines 	LUB GV*
High speed	-20 (-4) up to +120 (+248)	≤ 4/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Oil of very low viscosity 	<ul style="list-style-type: none"> ▶ Machine-tool spindles ▶ Wood-working machines ▶ Textile spindles 	
Moisture	-30 (-22) up to +120 (+248)	≤ 2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Conventional grease heavily treated with anti-corrosion additives 	<ul style="list-style-type: none"> ▶ Washing machines 	LUB MS LUB EP
Centrifugal forces/ Vibration/ Outer ring rotating	-20 (-4) up to +130 (+266)	≤ 2/3 v2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Grease with strong adherence consistency (grade 2) 	<ul style="list-style-type: none"> ▶ Alternators ▶ Civil engineering equipment ▶ Loose pulleys 	LUB VX
Food industry	-30 (-22) up to +120 (+248)	≤ 2/3 max. speed of bearing	<ul style="list-style-type: none"> ▶ Compatible with food processing applications 	<ul style="list-style-type: none"> ▶ Food-processing industry 	LUB AL1
High load and low speed	-5(+23) up to +140 (+284)		<ul style="list-style-type: none"> ▶ Suitable for very low speed operation under very high loads 	<ul style="list-style-type: none"> ▶ Heavy industry : Steel industry, paper mill Industry, Quarries 	LUB FV

Note : The grease must be chosen in collaboration with SNR.



Characteristics of the SNR LUB product range

Colour	MS	EP	HT	GV*	VX	THT	AL1	FV
	Amber	Amber	Light brown	Light yellow	Blonde	White	Transparent yellowish	
Composition	<ul style="list-style-type: none"> ▸ Mineral oil ▸ Lithium soap 	<ul style="list-style-type: none"> ▸ Mineral oil ▸ Extreme pressure ▸ Lithium soap 	<ul style="list-style-type: none"> ▸ Synthetic oil ▸ Barium soap 	<ul style="list-style-type: none"> ▸ Di-ester oil ▸ Lithium soap 	<ul style="list-style-type: none"> ▸ Mineral paraffinic oil ▸ Lithium soap 	<ul style="list-style-type: none"> ▸ Thickening perfluorin fluid ▸ Teflon 	<ul style="list-style-type: none"> ▸ Mineral paraffinic oil ▸ Complex aluminium soap 	<ul style="list-style-type: none"> ▸ Mineral oil ▸ Lithium + calcium
Viscosity of base oil	105	105	150	15	310	390	200	950
Consistance Grade NLGI	2	2	2	2	2	2	2	2
Service temperature °C (°F)	-30 (-22), +120 (+248)	-30 (-22), +110 (+230)	-30 (-22), +150 (+302)	-50 (-58), +120 (+248)	-20 (-4), +130 (+266)	-20 -20 +250*	-30 (-22), +120 (+248)	-5 (-23), +140 (+284)
Moderate loads P < C / 5	G	VG	G	G	G	VG	G	G
High load P > C / 5	NR	VG	NR	NR	VG	VG NR	G	VG
Low speed N.Dm < 100000	G	G	NR	NR	VG	VG	G	VG
High speed N.Dm > 100000	G	G	G	VG	NR	G G	G	NR
Moisture, Presence of water	VG	VG	G	VG	G	G	G	G
Low amplitude oscillations	G	G	VG	G	VG	VG	G	G
Vibration when stationary	NR	NR	NR	VG	NR	NR	NR	NR
Adherence	G	G	VG	G	VG	VG	G	VG
Low torque	G	G	G	VG	NR	NR	G	NR
Low Noise	G	G	G	VG	NR	NR	NR	NR
Anti-corrosion protection	VG	VG	G	VG	G	G	G	G
Resistance to chemical agents	NR	NR	NR	NR	NR	VG	NR	NR
Pump wise	VG	VG	VG	VG	VG	VG	VG	G
Remarks			<ul style="list-style-type: none"> ▸ Service life of grease is linked with working temperature 	<ul style="list-style-type: none"> ▸ Pay special attention to: <ul style="list-style-type: none"> - quantity - shaft position - close active parts - grease retention 			<ul style="list-style-type: none"> ▸ Approved by US Food and Drug Administration - as H1 class 	

N.Dm : Product of the RPM times the mean diameter
VG : Very good performance – **G** : Good performance
NR : Not recommended

* Under low load, the THT grease sustains up to +250°C (+482)
Under higher load, thermal strength is limited to +220°C (+428)

Grease lubrication *(continued)*

Quantity

■ Initial greasing

The quantity of grease necessary for optimum operation of a bearing must be equal to 20 to 30% of its free internal volume.

Approximate amount of grease
to be introduced into an open bearing

$$G = 0.005 D \cdot B$$

G: Quantity of grease in g or cm³

D: Outside diameter of bearing in mm

B: Bearing width in mm.

The quantity of grease may be increased by 20% for assemblies provided with a hole for drainage of the old grease.

A bearing that rotates at very low speed can be fully packed with grease, which favours its protection in highly contaminated environments (conveyor rollers, etc.)

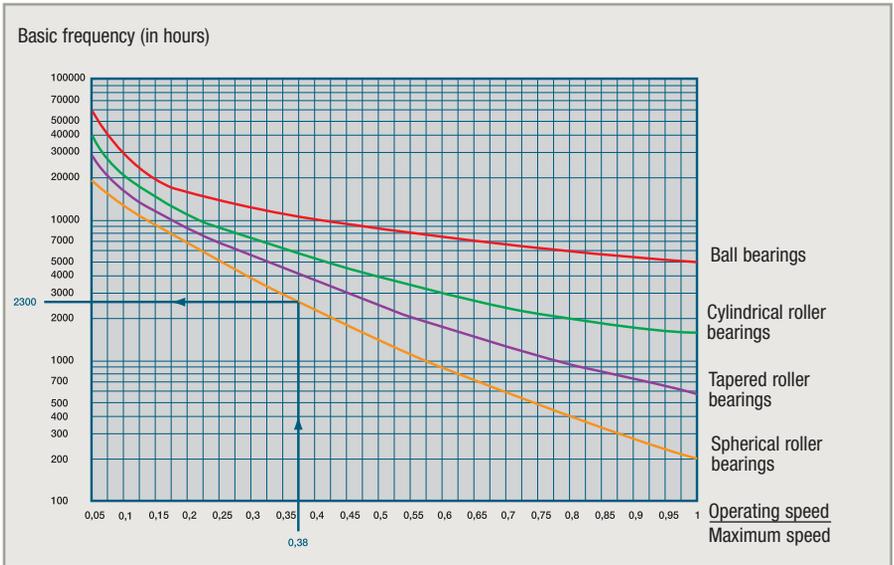
It is very important that this quantity should be maintained inside the bearing. Check that the adjacent parts (seals, shields) are capable of limiting the transfer of grease. If there is an adjacent free space, fill it to 50% with grease.

One can verify that the quantity of grease is adequate if the bearing temperature stays at a level of 10°C (50°F) to 30°C (86°F) above the room temperature, after a transient state of less than one hour during which the temperature has peaked at a higher level.

■ Relubrication

Relubrication frequency

The following table can be used to establish the basic frequency in hours according to the type of bearing and speed of rotation.



■ Correction of relubrication frequency

The **basic frequency (F_b)** must be corrected using factors taken from the table below, according to the particular operating conditions of the mechanism, using the relation:

$$F_c = F_b \cdot T_e \cdot T_a \cdot T_t$$

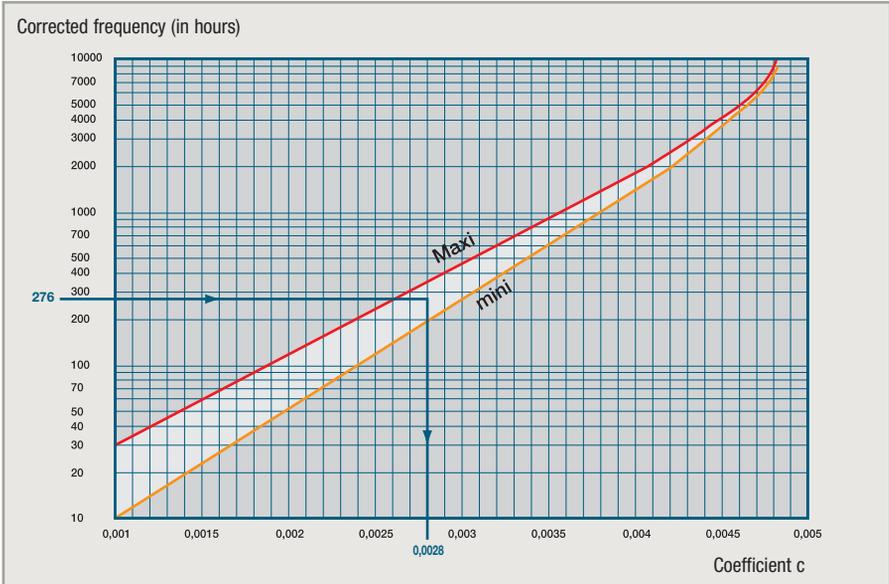
Factor	Conditions	Level	Value of factor	
T _e	Environment - dust - humidity - condensation	- moderate	0.8	
		- high	0.5	
		- very high	0.3	
T _a	Application - with impacts - with vibration - with vertical shaft	- moderate	0.8	
		- high	0.5	
		- very high	0.3	
T _t	Temperatures	75°C	0.8 0.5 0.3	With standard grease
		75° à 85°C		
		85° à 120°C	0.8	With high temperature grease
		120° à 170°C	0.5 0.3	

Grease lubrication (continued)

■ Weight of grease

The opposite table can be used to determine the factor **c** to be applied, depending on the corrected frequency in hours to obtain the weight of grease to be added from the relation.

$$P = D \times B \times c$$



Example

A 22212 EA bearing lubricated with a standard grease and rotating at 1,500 RPM in a dusty environment at 90°C (194°F) with no other application constraints:

22212 – Spherical roller bearing

Service speed/Maximum speed = 1,500 rpm / 3,900 rpm = 0.38

hence the basic frequency: $F_b = 2,300$ hours (see table of the preceding page)

Coefficients

$T_e = \longrightarrow 0.5$ dust
 $T_a = \longrightarrow 0.8$ normal
 $T_t = \longrightarrow 0.3$ 90°C (194°F)

$c = 0,028$

Diameter $D = 110$

Width $B = 28$

Weight of grease:

$P = 110 \cdot 28 \cdot 0.0028 = 9$ grams



Corrected frequency: $F_c = F_b \cdot T_e \cdot T_a \cdot T_t = 2,300 \cdot 0.5 \cdot 0.8 \cdot 0.3 = 276$ hours

Oil lubrication

Oil lubrication is generally used when the bearing is adapted in a mechanism that is already lubricated (gear reducer, gearbox) or else when it can benefit from a central lubrication system where the oil is also used as a coolant.

■ Type of oil

Principal oil types used to lubricate bearings.

		Mineral oils	Synthetic oils	
			ester	perfluoroalkylether
Comments		Standard use	Special use, usually at high or low temperature	
Density		0,9	0,9	1,9
Viscosity	Index	80 - 100	130 - 180	60 - 130
	Variation with temperature	high	low	low
Freezing point		-40 up to -15°C (-40 up to 5°F)	-70 up to -30°C (-94 up to -22 °F)	-70 up to -30°C (-94 up to -22 °F)
Flash point		< 240° C (464°F)	200 up to 240°C (392 up to 464°F)	non inflammable
Resistance to oxidation		average	good	excellent
Thermal stability		average	good	excellent
Compatibility with elastomers		good	to be checked	good
Price level		1	3 - 10	500

■ Viscosity

The choice of the oil viscosity is very important for the efficiency of lubrication. The choice can be made using the diagram in page 78.

It can be seen from this diagram that life duration increases with the viscosity of the lubricant. This advantage is nevertheless limited because a more viscous lubricant raises the operating temperature of the bearing.

■ Additives

The most commonly used additives are the Extreme Pressure, anti-wear and anti-corrosion additives. Great care must be used in choosing an additive. One must check with the lubricant manufacturer to check the influence of the additive on the bearing performance.

Extreme pressure

- Protects metal surfaces against micro-welding
- Necessary when the bearing is highly loaded

Oil lubrication *(continued)*

Anti-wear

Reduces the wear of the metal surfaces by forming a protective surface layer

Anti-corrosion

Protects metal surfaces against corrosive attacks

■ Contamination

The lubrication oil must be clean.

■ Special lubricants

In certain assemblies the bearing can be lubricated by the liquid carried in the assembly (hydraulic fluid, diesel fuel).

In such cases, and for all the lubrication problems mentioned here, check with SNR.

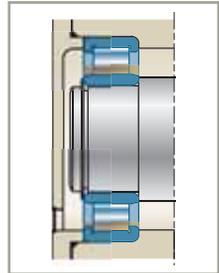
Lubrication systems

■ Oil bath

Used in closed and sealed mechanisms.

Oil level at the level of the lowest rolling element of the lowest bearing.

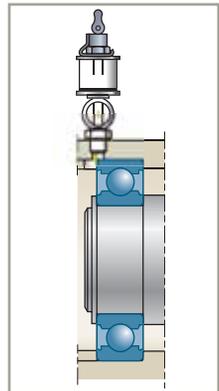
Moderate rotation speed as heat dissipation is limited.



■ One time usage oil

Shaft rotating at high speed.

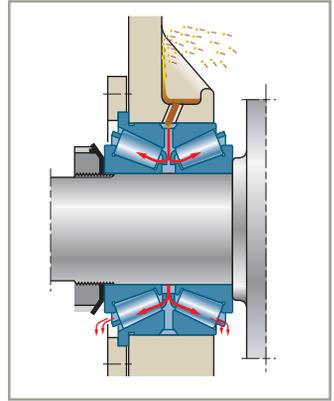
Necessary evacuation of the old oil.



■ Dripping and splashing

Oil usually thrown up by the gears.

The oil can be directed to the bearing by channels.

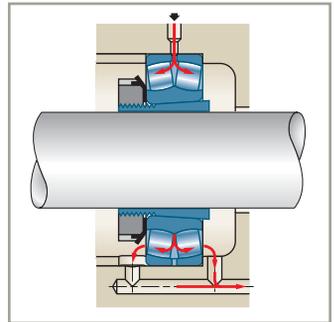


■ Oil circulation

A pump ensures a constant flow, a reserve compensates for the priming delay starting.

The oil can be filtered and cooled in a heat exchanger to give better performance.

Oil circulation can sometimes be intermittent.

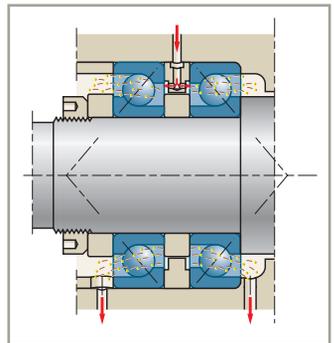


■ Oil spray

This is also a low-consumption method of one time usage lubrication. The oil under pressure spray reaches all parts of the bearing, prevents the entry of foreign bodies and acts as a coolant.

Used for high precision bearings rotating at very high speed.

Consult the SNR catalogue of high precision bearings for machine-tool spindles.



Important: Most oil lubrication systems do not secure an adequate film during the first few rotations of the bearing. It is therefore strongly recommended to oil new bearings after installation.

Oil lubrication *(continued)*

Quantity of oil

The diagram below gives an idea of the minimum safe flow rate under normal service conditions for bearings.

