MINIMIZATION AND CONTROLING OF BEARING FAILURE IN ROLLING MILL STAND

Sagar HN[1], K B ARUN kUMAR[2]

[1,2]*Assistant Professor, Dept. of Mechanical Engineering, SKIT Bangalore*

Abstract - *Because of constant breakdown in roller bearing there is loss of significant cost this outcome in decline underway loss of material, so the investigation of bearing disappointment is important to control at the early stage. Considering the parameter, for example, speed, temperature and measure of air oil grease, plan thought by dissecting this bearing disappointment development can be limited by utilizing right mounting strategy and upkeep and furthermore contemplating the working condition we can give a careful steps and recommendation that must be profited to the business.*

***Key Words*: Bearing, Lubrication.**

1. INTRODUCTION

In metalworking, rolling is a metal forming process in which metal stock is passed through a pair of rolls. Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal is above its recrystallization temperature, then the process is termed as hot rolling. If the temperature of the metal is below its recrystallization temperature, the process is termed as cold rolling. In terms of usage, hot rolling processes more tonnage than any other manufacturing process and cold rolling processes the most tonnage out of all cold working processes. Bearing are machine elements which are used to support a rotating member viz, a shaft they transmit the load from a rotating member to a stationary member known as frame or housing. They permit relative motion of two members in one or two directions with minimum friction, and also prevent the motion in the direction of the applied load.

1.1 Bearing Failures

Causes and failure in rolling bearing only 0.35% of rolling bearings do not reach expected life.

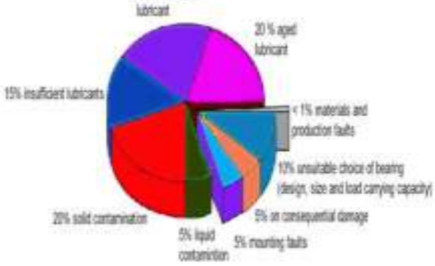

Fig-1: Types of Bearing Failure

No component containing moving parts lasts forever. Rolling bearings are precision and reliable machine elements. The vast majority gives satisfactory service but some do fail before expected life. The service life of a bearing is measured by the number of revolutions (or operating time at some given speed) during which the bearing will perform satisfactorily. Experience show that failures are rare due to faults in the bearings but more due to external causes such as errors in mounting, operation etc.

2. Estimated system requirements

- Maximum compressed air consumption =2152 nm^3/hr
- Air/oil points= 422
- Estimated system lube oil usage per cycle =97.06cc/cycle
- Approx no of cycles/ day =360
- Approx no of lube oil flow =1.46L/hr
- Approx no of lube oil used per day =34.94L
- Air/oil line approx max pressure 4.5bar(65psi)
- oil line approx max pressure 45bar(653psi)
- Air line max pressure 5.0 bar(73 psi)
- Lube oil out per air/oil block outlet is 0.23cc
- All lines shown are for stainless steel tubing
- Pressure switches to be located @ farthest feed point
- Oil cleanliness should as per ISO 4406-1999

Fig-2 Air Oil System

AIR OIL SYSTEM #1

Stand 1 to power slitter

Oil used : HLP68

Tank capacity : 500 litres

Operating pressure : 45.5 bar

Cycle time 90 sec :on

90sec :off

AIR OIL SYSTEM #2

NTM-line A-pinch roller

line B-pinch roller

Oil used : HLP68

Tank capacity : 500 litres

Operating pressure : 45 bar

Cycle time 120 sec :on

120sec :off

AIR OIL SYSTEM #3

RES (rotary entry shear)

Oil used : HLP68

Tank capacity : 500 litres

Operating pressure : 45 bar

Cycle time 120 sec :on

120sec :off

Air oil system cycle time changes variations

AIR OIL SYSTEM #1

Cycle time on=75 sec

Cycle time off=120 sec

1hr=3600sec

Estimated system lube oil usage per cycle =97.06cc/cycle
For 75 sec cycle on time
Estimated system lube oil usage per cycle/cycle time on = 97.06cc/cycle/75=1.29 cc/sec
Estimated system lube oil usage per cycle/cycle time off = 97.06cc/cycle/120=0.80 cc/sec
1.29 cc/sec=0.00129×3600= 4.64L/HR

AIR OIL SYSTEM #2

Cycle time on = 56sec

Cycle time off = 30 sec

Estimated system lube oil usage per cycle = 97.06cc/cycle

For 56 sec cycle on time
Estimated system lube oil usage per cycle/cycle time on = 97.06cc/cycle/56 = 1.73 cc/sec
Estimated system lube oil usage per cycle/cycle time off = 97.06cc/cycle/30 = 3.23 cc/sec
1.73 cc/sec = 0.00173×3600 = 6.288L/HR

AIR OIL SYSTEM #3

Cycle time on = 45sec

Cycle time off = 90 sec

Estimated system lube oil usage per cycle = 97.06cc/cycle

For 45sec cycle on time
Estimated system lube oil usage per cycle/cycle time on = 97.06cc/cycle/45=2.156 cc/sec
Estimated system lube oil usage per cycle/cycle time off= 97.06cc/cycle/30=1.07 cc/sec 2.156 cc/sec=0.002156×3600= 7.7616L/HR

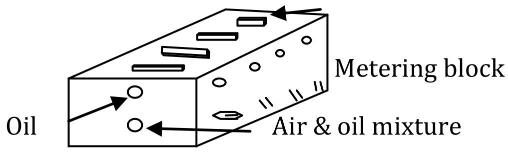

Fig -3 four outlet distributor block

As per present working conditions (for 16 stand)

1 cycle=97.06cc=90 sec

For 1 stand =6.06 cc

1 distribution block=1.2cc

Pressure of air = 2 to 3 bar

1 metering block volume capacity =230mm^3=0.23 cc

4 metering block volume capacity =920 mm^3 =0.92cc

2.1 Mode of operation:

The distributor leads the lubricant volumes supplied by the metering elements to the various outlets separately. Every outlet an air adjustment screw is assigned such screw enables the required compressed air volume to be adjusted

Calculation required for oil

NH 20 bearing stand

NH-20(4 row cylinder bearing)

ID=200mm, OD=270mm, width (B) =200

Q=W.d.B

W=coefficient of friction

D=bearing diameter in mm

B=bearing width in mm

Q=0.0018×200×200

Q=72mm^3/hr =0.072cc/hr

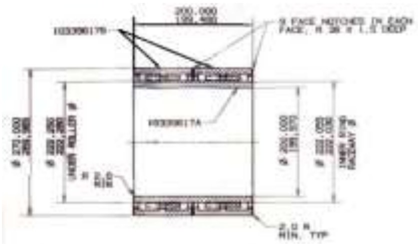

Fig-4 NH-20(4 row cylinder bearing)

NH23 bearing stand

NH-23(4 row cylinder bearing)

ID=230mm, OD=330mm, width (B)=206

Q=W.d.B

W=coefficient of friction

D=bearing diameter in mm

B=bearing width in mm

Q=0.0018×230×206

Q=85.254mm^3/hr =0.08532 cc/hr

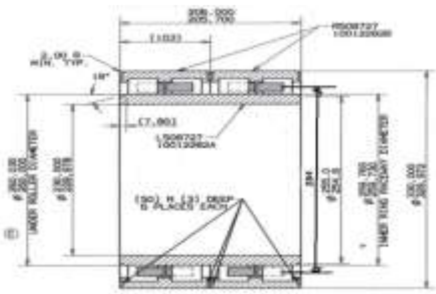

Fig-5 NH-23(4 row cylinder bearing)

NH 28 bearing stand

NH-28(4 row cylinder bearing)

ID=280mm, OD=390mm, width (B)=220

Q=W.d.B

W=coefficient of friction

D=bearing diameter in mm

B=bearing width in mm

Q=0.0018×280×220

Q=110mm^3/hr =0.11016 cc/hr

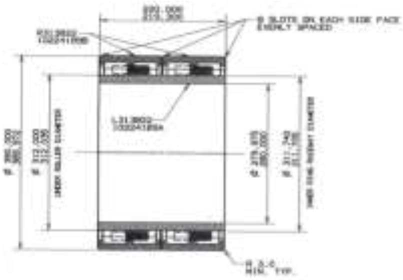

Fig-6 NH-23(4 row cylinder bearing)

Total number of stand=16

Which consists of NH-20+ NH-23+ NH-28

(1-5) (6-12) (13-16)

=0.11016×5+0.08532×7+0.072×4

= .43× 10^{-6}m^3/hr

Oil consumption for horizontal and vertical shaft for a NH-20

Horizontal shaft

Q=0.085DR/A

D= stressed bearings

R= no of rows in one stand each contain four

A=speed coefficient

=0.085×200×16/0.719= 378.302× 10^{-6} m^3/h

Vertical shaft

Q=0.17DR/A = 0.17×200×16/0.719= 756.606× 10^{-6} m^3/h

Oil consumption for horizontal and vertical shaft for a NH-23

Horizontal shaft

Q=0.085DR/A = 0.085×230×16/0.784= 398.979× 10^{-6}m^3/h

Vertical shaft

Q=0.17DR/A = 0.17×230×16/0.784=797.595× 10^{-6}m^3/h

Oil consumption for horizontal and vertical shaft for a NH-28

Horizontal shaft

Q=0.085DR/A

$=0.085\times280\times16/0.947 = 402.11\times 10^{-6}m^3/h$

Vertical shaft

Q=0.17DR/A

$=0.17\times280\times16/0.947 = 804.22\times 10^{-6}m^3/h$

So for NH (NON –HOUSING) 20 consists of 2 horizontal shaft and 2vertical shaft for horizontal shaft $=2\times378.302=756.604\times 10^{-6}m^3/h$,

for vertical shaft $= 3\times378.302=2269.818\times 10^{-6} m^3/h$,

for NH(NON –HOUSING)23 consists of 2 horizontal shaft and 2vertical Shaft

for horizontal shaft $= 4\times398.979=1595.916\ cm^3/h$

for vertical shaft $= 2\times797.595= 1595.19cm^3/h$

and for NH(NON –HOUSING)23 consists of 2 horizontal shaft and 2vertical shaft

for horizontal shaft $= 2\times402.11=804.22\ cm^3/h$

3. CALCULATION OF BEARING LOAD

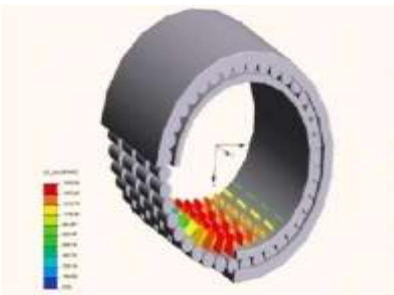

Fig-7 Visualization of the pressure acting on the four row cylindrical roller bearing on the back up roll

Since the pressure of bearing takes maximum at the bottom rather than the top. Due to variation in stock temperature the load varies at the bottom of the bearing in 10 regions which is seen in the figure having different colors.

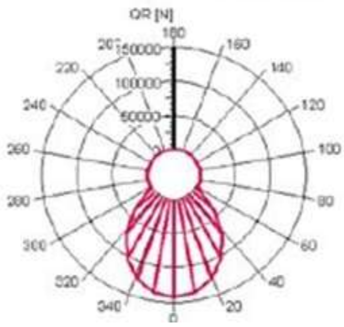

Fig-8 Force distribution in rolling element

- In rolling mills the load is of constant direction. Only a quarter of the outer race is under load. For this reason, the side face of the outer races are divided into four zones indicated by I to IV
- When the bearing is mounted for the first time it is usual to position zone I in the direction of action of load.
- After a period of approximately 1000 operating hours , outer race turned 90^o

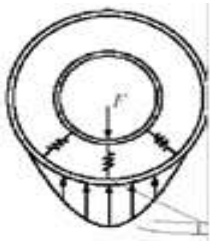

Fig-9 Load distribution within the four row cylindrical roller bearing on the back –up roll

Oil viscosity between ISO VG 46, ISO VG 68, ISO 100

The viscosity ratio k is used as a measure of the quality of the lubricant film. K is the ratio of kinematic viscosity v of the lubricant at operation temperature to the reference viscosity v_1 $k=v/ v_1$

The reference viscosity v_1 is determined from diagram as a function of mean bearing diameter $d_{m=}$ (D+d)/2 and the operation speed n. the operating viscosity v of a lubricant oil is obtained from the V-T diagram as a function of operation temperature t and nominal viscosity of the oil at 40 ^oC

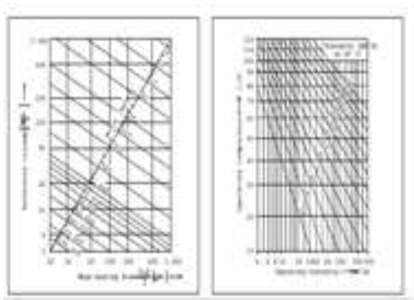

Fig-10 Reference viscosity and v-t diagram for mineral oils

From the above table it shows the viscosity required for different bearing diameter

For the NH-20 stand of inner dia(d) = 200mm, outer dia (D) = 270mm

Mean bearing diameter $d_{m=}$ (D+d)/2 = (200+270)/2=235mm

From the 235 diameter it is advisable to select the viscosity 45

Table-2 Dynamic Viscosity of Bearings

Bearing type	Dynamic viscosity mm^2/s
Ball bearings, Cylindrical roller bearings, Needle roller bearings	13
Spherical roller bearings, Tapered roller bearings, Needle roller thrust bearings	20
Self-aligning roller thrust bearings	30

In bar mill the cylindrical rolling bearing temperature ranges from 40^0 to 60^0 then from above table select the ISO viscosity grade(VG) corresponding to 45 select the ISO VG 46.

For the NH-23 stand of inner dia(d)=230mm ,outer dia(D)=330mm

Mean bearing diameter $d_{m=}$ (D+d)/2 =(230+330)/2=280mm

From the 235 diameter it is advisable to select the viscosity 50

bearing temperature ranges from 40^0 to 60^0 then from above table select the ISO viscosity grade(VG) corresponding to 50 select the ISO VG 68.

3.1 Bearing mounting procedure

Any burrs, cutting chips, rust, or dirt should n first be removed from the bearing mounting surfaces. Installation can be simplified if the clean surfaces are lubricated with spindle oil.

Fig-11 Bearing mounting procedure

3.2 CAUSES OF BEARING FAILURE AND COUNTERMEASURES

Some of the bearing failure caused due to lubrication

Fig-12 Bearing Failure Caused Due To Excessive Friction between Bearing and Inner Race.

So oil of higher viscosity grade should be used depending upon the type of load and considering speed requirement

3.4 Cage Failure

Table-7 Counter Measures for cage

Possible Causes	Damage	Counter Measures
Cage damage includes: Cage deformation, Fracture and Wear Fracture of cage pillars Deformation of side face Wear of pocket surface Wear of guide surface	Poor mounting (Bearing misalignment) Poor handling Large moment load Shock and large vibration Excessive rotation speed, sudden acceleration and deceleration Poor lubrication Temperature rise	Check the mounting method Check the temperature, rotation and load conditions Reduce the vibration Use an appropriate shaft shape Select a different cage type Select a different lubrication method and/or lubricant

Fig-13 Uneven Rupture of cage damage due to poor lubrication

If the incoming billet temperature and entry before the stand causes the more torque on the motor and simultaneously affect the bearing

Fig-14 Failure of the Race

4. CONCLUSIONS

The report that the precautionary measures that has to be followed by the borrower before purchasing the bearing from the vender.

1] It should meet required standards.

2] The design consideration an operating condition should be matched.

3] The test procedure should be followed before putting into the operation.

4] The modification changed by the vender after design can be accepted by the borrower.

Future Scope

- Life of the bearings can be increased by varying other parameters like different maintenance policies.
- By changing the bearing material life can be analyzed.
- By changing the lubricant oil of different viscosity bearing life can analyzed.
- By using the grease of extreme pressure and anti wear additives.

REFERENCES

[1] SKF general catalogue, publication 5000E.2003

[2] SKF bearing installation and maintenance guide. Publication 140-710.january2000

[3] SKF bearing maintenance handbook publication 4100 E1991