SKF engineering solutions applied to pulp & paper mill

Rodrigo Yoshiaki Fujimoto* and Hilário Jacob Sinkoc*

Keywords: Rolling Bearings, Design of Improvements, Engineering Solutions, Failure Analyses, Paper Machine, Motors, Lubrication, Gear Box.

ABSTRACT

There are several rotating equipments that employ rolling bearings in pulp&paper mills. These equipments may consist of press rolls, dryer cylinders and guide rolls of paper machines, pumps, fans, motors, among others. Several problems seen in these equipments occur with rolling bearings, such as water, solids and chemical contamination of lubricating oil, problems associated with lubrication failure, design of bearing rated life, mounting procedure, among others. After several studies performed in pulp&paper mills where SKF has service contracts, several improvements were applied to increase the availability, reliability and maintainability of these equipments. In this paper, we present some of these solutions applied in motors, machine rolls, fans, gear boxes, etc., that have allowed to solve the recurrent faults and get longer bearing life from machines.

INTRODUCTION

In several pulp and paper mills, there are mechanical failures which cause breakdown of mill or machine. Usually, this breakdown results in great losses of productivity and influences the mill results.

Most of the mechanical failures are associated to bearings. These can be considered as being the "fuse" of equipments. When a bearing begins its failure process, it shows its abnormal condition (through equipment predictive analyses) before occurrence of a catastrophic failure (or breakdown) of equipment and we can make plans for its maintenance activities.

When we come across a frequent mechanical failure, there arises a great opportunity to increase reliability and mill production. In this case, we have a large database to analyze the real cause of the failure.

A mechanical failure of bearing can be due to several causes such as poor lubrication, contamination, operational parameters variation, design, transportation, storage, and many others.

In order to obtain the solution for these failures, we must employ a methodology that uses bearing failure analyses to identify the failure, design reanalyses, research and seek possible improvements, implement the improvements and control the results obtained.

In this paper, we intend to present some solutions used in industrial equipment that uses bearing and they were introduced because of equipment failure. These solutions were applied in equipment installed in pulp and paper mills where SKF has a service contract.

Rolling bearing failure analyses

The bearing failures can be associated with several causes that can be related to:

- lubrication (lack, excess, procedure,…);
- operational condition (overloading, excessive speed, vibration, …);
- environment (high/low temperature; contamination, …);
- mounting/handling (mounting/dismounting procedure, improper tools, …) and;
- others (transportation, storage, design,…).

In order to obtain the best solution, we must identify the underlying cause of failure. Thus, we will minimize the modifications to be done and we will have better results and lesser collateral effects of the equipment.

Moreover, we must make it clear that there are main causes and also secondary ones. In failure analyses, we will verify different causes, therefore, we will have few primary causes (including among them the root cause) that result in main or most important failure and other, secondary failures.

We can analyze the problem by means of two ways to solve the failure:

- solving the main cause - eliminating or avoiding the root cause of problem, hindering the sequence of full failure;
- solving the symptom - eliminating or avoiding the secondary causes before the occurrence of failure that results in equipment breakdown.

Considering these modes for so-

Author's references
*SKF do Brasil - Barueri, SP, Brasil

Figure 1 - Detail of rolling bearing with degraded grease because of water contamination.

Figure 2 - Detail of rolling bearing raceways with corrosion from water contamination.

lution of frequent failures, we present hereunder some solutions used to eliminate these failures, avoiding a new occurrence.

SOLUTIONS

Solutions for paper machine rolls

Among the main problems of rolls installed in the wet section of paper machines, the main problem is the contamination of bearing and lubricant by water. This contamination produces lubrication failure with breakage of lubrication film and corrosion of rolling bearing raceways. Because of these failures caused by water contamination, we can point to water contamination as the main concern of rolls installed in this section.

Usually, housing have no-contact seals (labyrinth) that permit a considerable axial movement. Therefore, this seal type has a poor performance when exposed to water.

The cheapest and the easiest current solution is installing of flingers in housing. This flinger avoids water from hitting the labyrinth and entering inside the housing. It must have an internal hole to avoid accumulation of water inside the flinger.

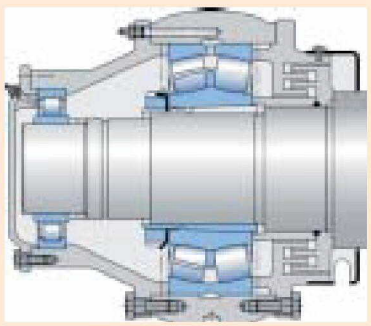

Figure 3 - Detail of a deflector flinger installed in bearing housing to avoid accumulation of water on the labyrinth seal.

In some cases, this configuration is not enough to keep the contamination (liquid and/or solid) out of housing. Where there is greater contamination level, another alternative is the use of one more contact seal to minimize the water spray on the labyrinth of housing. In the test carried out, we used the flinger and V-ring together.

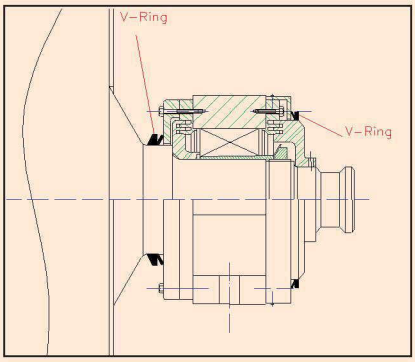

Figure 4 - Detail of two V-ring seals installed on flinger to minimize the contaminations spray on the labyrinth seal.

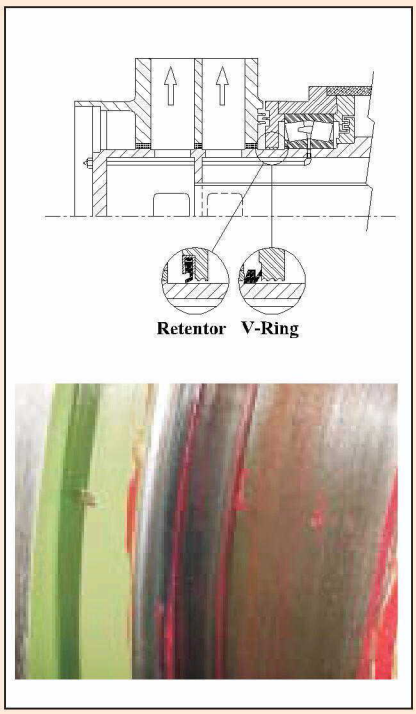

Figure 5 - Detail of installation of seal composed by shaft seal and V-ring. The detail shows the installation inside the bearing housing. In this case, we installed this seal in Pickup Suction roll, close to suction box.

However, there are some specific conditions where its performance is diminished (e.g. when there is a relubrication with high quantity of grease, and this grease pushes the V-Ring out of contact). In this case, another option is the use of a shaft seal.

In order to use this seal type, it is necessary to coat the shaft with hard metal to avoid the occurrence of shaft wear because of pressure of shaft lip seal. Moreover, this special seal design does not have spring. Therefore, we can minimize the wear due to the pressure of lip of the seal. The shaft seal type is HD7 (CR Seal Handbook - Size and Type Listings for all Seal Applications).

Finally, another concern is the increase of the frequency of relubrication to repel the water contamination that enters through labyrinth. An initial recommendation related to quantity and relubrication frequency can be obtained in reference. (SKF Rolling Bearings in Paper Machine).

Figure 6 - Detail of damage of rolling bearing and shaft because of high temperature condition.

Figure 7 - Detail of rolling bearing broken cage used in gearbox because of inadequate lubrication.

Solutions for motors

There are several motors used in pulp and paper mill. We can enumerate several failure modes in this equipment. However, we will only present some failures and solutions to solve these failures.

The first failure observed on field was an overheating of bearing shaft/housing that caused severe damage to these components. In this specific case, the motor drives a centrifugal pump through coupling. The standard configuration of this motor (frame 355 M/L) uses a cylindrical roller bearing at coupling side (NU 322 C3) and a deep groove ball bearing at opposite side (6319 C3). This is the ideal configuration for transmission of power by belt.

Through failure analyses, we discovered that the failure cause was smearing (sliding of rolling element in entry of load zone of raceway) originated by low radial minimum load. Usually, this failure is observed in motors that use coupling. In addition, this problem is aggravated by other application characteristics (e.g. high lubricant oil viscosity, among others).

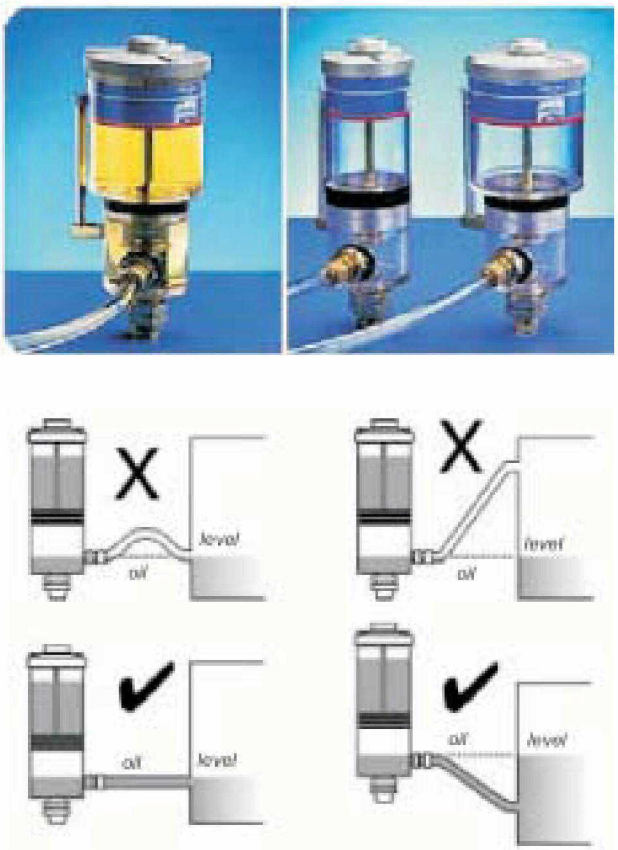

Figure 8 - Oil leveller to reservoirs. Some recommendations have been presented for installation of the level and oil leveller.

We proposed to substitute the cylindrical roller bearing (NU 322 C3) either by deep groove ball bearing (6322 C3) or by smaller cylindrical roller bearing (NU 1022 M/C3) (these bearings have a smaller minimum load). Moreover, we re-analyzed the lubricant specification to obtain the optimized grease for this application.

This problem is a good example of the influence of application condition on the bearings configuration and lubrication parameters.

Solutions for gearboxes

Several gearboxes have been used in paper machine. The most usual failure mode of this equipment is the leakage of lubricating oil that results in lubrication defects to rolling bearing and gears (and, consequently, a short life of equipment) and it could provoke paper contamination.

The symptoms of insufficiency of lubricant are the breakage of cages of rolling bearing and the breakage of the teeth of the gear.

In order to improve equipment reliability, we can keep a constant lubrication (guaranteeing the oil level inside the bearing or gearbox) using oil leveller (Produtos da SKF para Manutenção e Lubrificação). This leveller supplies a constant flow of oil to bearing or gear in cases where some oil leakage occurs.

There are several recommendations to install the oil leveller to avoid lubricant fault. The most important concern is the installation of an outflow pipe from reservoir bellow the oil level and this pipe must not have a syphon shape.

If these recommendations are not followed, we will face problems to inspect the oil level and, consequently, the oil supply to machine will be deficient.

However, there are several situations where the oil leakage produces the contamination of paper on machine. In this case, the availability of equipment and the product quality are jeopardized. In order to solve the leakage of large oil volume, we need to improve the seal preventing the output of oil.

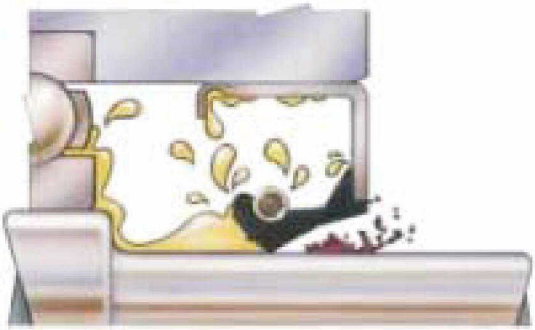

Figure 9 - Example of shaft seal installation with lip to avoid leakage of lubrication.

Figure 10 - Example of shaft wear on the contact with shaft seal lip. The scheme of mounting of wear sleeve is also shown.

The first recommendation for this problem is verifying the oil level, for a very high level can produce the leakage through the seal. Moreover, another cause of leakage is the shaft wear or improper mounting of shaft seal.

With regard to shaft seal installation, this must be complying with the purpose of the seal. In order to avoid the outflow of lubricant, the shaft seal lip must be mounted directed towards the inner side of reservoir.

However, after a long time of work, the shaft will wear on the contact with the shaft seal lip, resulting in deficient sealing. In this case, we recommend using a wear sleeve Speedi-Sleeve (CR Seal Handbook - Size and Type Listings for all Seal Applications).

This wear sleeve corrects the shaft wear; and it avoids the wear forming in new shaft.

CONCLUSION

The recommendations presented above were applied in several equipments used in pulp and paper mills to solve their failures. They are not specific to this segment; however, a detailed analyses of application is necessary to decide if they can be applied.

LITERATURE

CHICAGO RAWHIDE (2002). CR Seal Handbook - Size and Type Listings for all Seal Applications, Catalog 457010, September.

SKF (2001). Catálogo Geral 4000 PB, ver.2.

SKF (2003). General Catalogue 5000 E, June.

SKF Maintenance Products (2001). Produtos da SKF para Manutenção e Lubrificação, November

SKF (2002). Rolling Bearings in Paper Machine 4690 E.