How to keep spherical roller bearings in your paper machine's dryer section operational

CHARLES L. STRICKLAND

Under optimum operating conditions, spherical roller bearings used in paper machine dryers can literally last for decades. Still, a number of maintenance-related problems, ranging from incorrectly measured drive-up clearances to a leaking oil circulation system, can cause a bearing to fail, posing a danger to the bearing journal and adjacent machine components.

The cost of failure can be high. At one paper mill, a dryer bearing was mounted without sufficient interference fit on the journal. During operation, the bearing inner ring began to loosen and spin, gradually wearing down the journal. Eventually, the wear allowed the dryer cylinder supported by the bearing to slip out of position. The slippage damaged the gear mesh and affected the 20 other cylinders in the section. The failure, which took three weeks to repair, forced the entire mill to shut down and cost several million dollars in lost production time.

At the rate of US$ 5000–10,000 per hour (depending on the mill and the type of paper being produced), even short periods of downtime are very expensive. When a dryer bearing fails, technicians may have to wait and allow the extremely hot dryer components to cool before attempting repairs. The changeout can take 4–5 hours and cost up to US$ 50,000. If the bearing journal has also been damaged, repairs can take twice as long, doubling the cost. The journal—in most cases a casting that serves as the end head of the dryer cylinder—must often be remachined and fitted with a sleeve.

Because of the high cost of failure, maintenance technicians should give careful consideration to the procedures and systems that can prevent problems from occurring. The main areas of concern are bearing selection and installation, lubrication, and inspection/monitoring.

Selection and installation

Paper machine dryers contain a series of cylinders, ranging from 4–6 ft in diameter, that are filled with steam. Normally, a pair of spherical roller bearings support each cylinder. These bearings can be subjected to superheated steam that can reach temperatures as high as 400°F when first introduced. Average dryer temperatures range from 275–350°F. Since these temperatures are transferred through bearing journals into the bearings themselves, this must be considered when selecting and installing a bearing.

The temperature extremes can cause standard bearing inner rings to expand rapidly,resulting in axial fractures. Case-hardened inner rings, developed over the past 30 years to prevent such fractures, are recommended for all dryer applications.

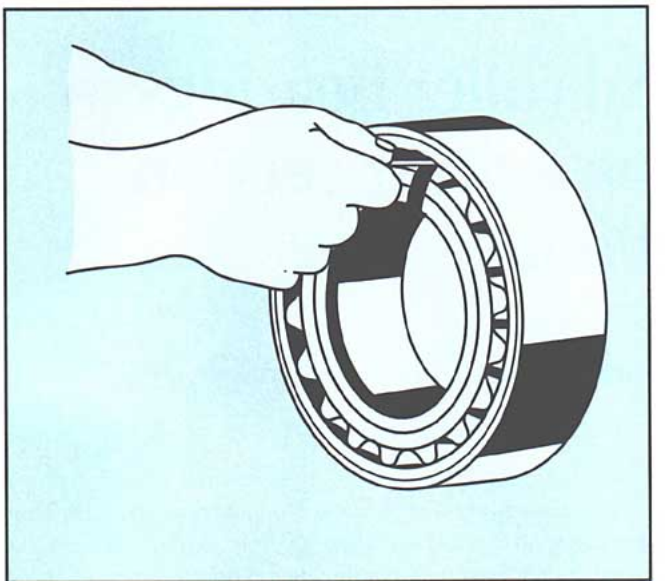
Dryer bearings are mounted directly on a tapered journal or in some cases on a straight journal with a tapered adapter sleeve. During installation, high temperatures can make bearing clearance measurements difficult to interpret. In an unplanned shutdown, a bearing at room temperature may be placed on a journal that is as hot as 200°F. As soon as the bearing is placed in position, it begins to expand. Because the inner ring expands at a faster rate than the outer ring, the internal radial clearance is reduced, sometimes by as much as 0.003 in.

Neglecting to consider this change can result in insufficient drive-up. For example, take the case of a bearing whose radial clearance measures 0.020 in. when removed from its packaging. Soon after being slid onto the journal, however, the clearance measures only 0.017 in. due to the heat. Bearing installation instructions recommend reducing the initial clearance by 0.005 in. to obtain the proper interference fit on the journal. Using the measurement of 0.020 in. as a starting point, a technician drives up the bearing on the journal until the radial clearance measures 0.015 in., which is insufficient to hold the bearing securely on the shaft. The starting point should have been 0.017 in.

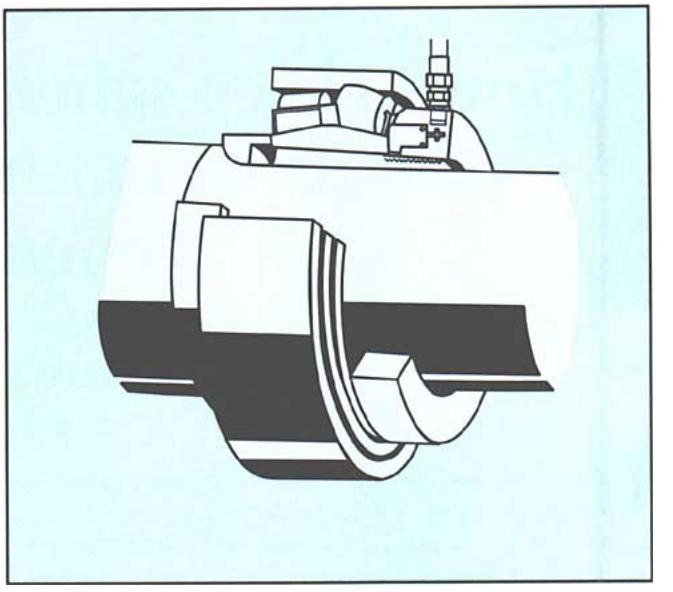
To obtain the correct fit, place the bearing on the journal and allow it to sit and warm to a steady-state temperature with the journal. Then measure the internal radial clearance. Use this measurement as the starting point for the final drive-up procedure (**Fig. 1**).

Other factors may also affect the internal clearance. Bearings on the front side of a dryer section are normally mounted in split housings that are supported on rockers. When the dryer

1. After rotating the inner ring a few times, measure the initial bearing radial clearance with a feeler gauge. Measure again after the bearing has been placed on the journal.



2. The hydraulic nut is often used to mount spherical roller bearings in dryer sections.



cylinder and bearing are placed back in the bottom half of the housing during installation, the bearing may temporarily develop a slightly oval shape. Internal clearances may increase by as much as 0.002 in., giving the impression that the bearing has loosened on the journal. Actually, it has not. Once the housing cap has been put in position and bolted down, the bearing will tend to round back into shape.

Dryer bearings are generally mounted by using a hydraulic nut. Since the nut exerts axial force only through the bearing inner ring, the outer ring sometimes drags in the housing bore, making radial clearance measurements unreliable. To prevent this, tap lightly on the outer ring face during mounting to move it axially at the same rate as the inner ring (**Fig. 2**).

Lubrication

Virtually all spherical roller bearings in dryer applications are lubricated via circulating oil systems. The oil is generally stored in a reservoir. Provisions are made to either heat or cool the oil to provide the appropriate oil inlet temperature. The oil temperature entering the bearings is usually about 120–135°F. After lubricating the bearings, oil returns to the reservoir via gravity flow.

The oil serves not only as a lubricant for the bearings, but also as a coolant to prevent them from overheating. It is important to maintain a consistent oil flow to the bearings. Bearings on 4- to 5-ft-diam. dryers typically require six pints of oil per minute on the back, or drive, side and four pints on the front side.

The method of removing oil from the bearing and housing and returning it to the central reservoir is critical. Piping should be designed to take full advantage of gravity flow. If oil is not removed efficiently, it may leak out around the housing seals.

When leakage occurs, technicians should look closely at the entire system rather simply reducing the oil flow. The latter approach will increase bearing operating temperature. Oil will begin to carbonize and form a sludge, sticking to the pipe walls and constricting oil flow still further.

The quality of oil reaching the bearings is as important as the quantity. Oil circulation systems generally have excellent filtration devices that filter out particles that might contaminate the oil and bearings. But because of the nature of the dryer application, water poses a continual threat. Steam leaks at the bearing journal can introduce water into the system. Leaks in the oil reservoir's steam coils can also be a problem.

Water in the system can rapidly degrade the oil's viscosity and lubricating qualities. When viscosity drops below the minimum level required for the application, metal-to-metal contact can occur between the bearing's rolling elements and raceways. This will begin to damage the bearing and eventually lead to failure.

Inspection/monitoring

Careful inspection and monitoring will help prevent costly bearing-related breakdowns in dryer applications. Evaluate oil quality at least once a month. Water content in the oil should ideally be less than 200 ppm. Most oil suppliers can provide a complete analysis of water content, mineral content, and metallic element content. High measurements may indicate a problem in the system.

Be sure to examine the steam system for leaks that can affect the bearing or the lubricant. For example, the pipe, or in some

cases an insulating sleeve, that delivers steam through the journal to the dryer cylinder is normally surrounded by a small air gap. This dead-air gap and the insulating sleeve functions as thermal insulation for the bearing journal. If a leak develops in the gap's seal, the area will fill with condensate or water, destroying its insulating qualities and exposing the bearing to higher temperatures.

Dryer bearing vibration should also be carefully monitored. Hand-held condition monitoring instruments can be used to analyze bearing condition and, through trending software, schedule maintenance for periods of planned shutdown. It is advisable to check bearing vibration levels at least once every three months. The frequency of monitoring should increase as warning signs increase. Troublesome bearings should be monitored as often as once or twice a month.

When the steam systems and circulating oil systems in dryer sections are regularly checked, and the correct bearing installation procedures are followed, the spherical roller bearings in dryer applications will provide years of reliable service. Ultimately, maintenance-conscious organizations will benefit from significant cost savings associated with reduced paper machine downtime. ◼

Strickland is manager of industry specialists for pulp and paper, SKF USA Inc., 1100 First Ave., King of Prussia, PA 19406.