Drying and Yankee cylinder bearings and their lubrication (Part 1)

SKF engineers working with paper mills get asked a lot of questions about bearing clearance, inner ring heat treatment and lubrication for drying and Yankee cylinder applications. In fact, after issues relating to corrosion and contamination from process water in the wet section, these are probably the most common things they have to deal with. As such, this issue of SKF Pulp & Paper Practices will focus on them. It's a broad subject so, in order to cover this matter in sufficient depth, we will also dedicate the next issue of our newsletter to it as well.

Bearing operating conditions

From the bearing perspective, drying and Yankee cylinder applications are rather similar. Bearings don't rotate at high speeds and they aren't heavily loaded. The steam used to heat such cylinders does create some challenges however.

Steam passing through the bore of the journal on which the bearings are mounted (→ **fig. 1**) causes radial and axial thermal expansion of both the journal and the cylinder.

Axial thermal expansion creates the need for a bearing or housing that can accommodate relatively large axial expansion of the journal relative to the machine frame on the front side.

As steam also heats journals and bearings, and because the former will be hotter than the latter, bearing inner rings have to be able to withstand radial expansion. This creates additional stresses in inner rings on top of those created by mounting them with a tight fit on the seat. Due to the temperature difference between the inner and outer rings of the bearings, larger than normal radial internal clearance is required to maintain some clearance and to avoid preload.

The maximum internal clearance reduction and inner ring stress are experienced during start up with a cold machine. The accompanying drawings (→ **fig. 2, 3, 5** and **6**) show the calculated temperature distribution over the cross section of an arrangement during start up. These results were tested against an actual drying cylinder – on which temperatures were monitored – and confirmed for oil flows of between one and two litres per minute with slight deviations at high and low oil flow rates. The bearing in our simulation model is a 23052 CCK/C4W33 spherical roller bearing with a rotational speed of 130 rpm and an oil flow rate of 2 l/min. Our model assumes a steam temperature of 180 °C (356 °F) during start up and 130 °C (266 °F) under normal operating conditions.

With the temperature distribution shown in **fig. 2**, the hoop stress in the inner ring is increased by some 60% i.e. nearly 220 Mpa instead of 136 Mpa after mounting.

Fig. 1 A typical drying cylinder bearing arrangement.

9 1 2 7 8 6 5 3 4

Drying cylinder arrangement
- ***1*** *Drying cylinder*
- ***2*** *Steam joint*
- ***3*** *Steam inlet*
- ***4*** *Siphon*
- ***5*** *Condensation*
- ***6*** *Journal insulation*
- ***7*** *Drive side bearing*
- ***8*** *Front side bearing*
- ***9*** *Gear drive*

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2.2.1 Nominal journal diameter

The dimension, Ba, is used as a basis when measuring a tapered journal with a SKF 9205 taper gauge. It's the distance from the centre of the bearing as finally mounted to the reference face of the journal (→ **figure 6**).

Note:
After mounting, the centre of our SKF 241/600 ECAK30/C083W33 bearing is 490 mm from the journal shoulder reference face and the taper width, B_e, is 370 mm.

Knowing B_a and the bearing dimensions, it is possible to calculate

Knowing B_a and the bearing dimensions, it is possible to calculate the nominal journal diameter, d_a, and its distance, B_d, from the reference face.

The nominal journal diameter, d_a, is bigger than the bearing bore diameter, d.

The bearing nominal bore, d, is the diameter of the inner ring bore taper in the radial plane passing by the ring face. In reality, between the ring face and the bore there is a chamfer and there's no contact between the journal and bearing. There is contact further up the bore after the chamfer. If B_f is equal to the chamfer radius, then contact occurs at a distance of B_f from the ring face (→ **figure 6**).

The diameter of the taper increases by a value equal to B_f/K. Remember that K equals either 12 or 30 depending on the taper angle. The default value for B_f can be found in **table 1**. For SKF 241/600 ECAK30/C083W33, B_f = 10 mm.

Note that bearings are manufactured with tolerances for both the nominal bore diameter and the taper deviation (→ **figure 7**).

Fig. 4 Complete SKF 920512 taper gauge set.

I
G
B_c
I
d_a
M
M_1
d_b
B_e
B_f
90°
B_d
B
B_b
B_a

Fig. 5 Example of a plain press roll bearing arrangement from the SKF Rolling bearings in paper machines handbook.

Fig. 6 The dimensions required for using the SKF 9205 taper gauge.