FAG Self-Aligning Ball Bearings for Fly Rolls in Calenders

FAG
Rolling Bearings

Examples of Application Engineering

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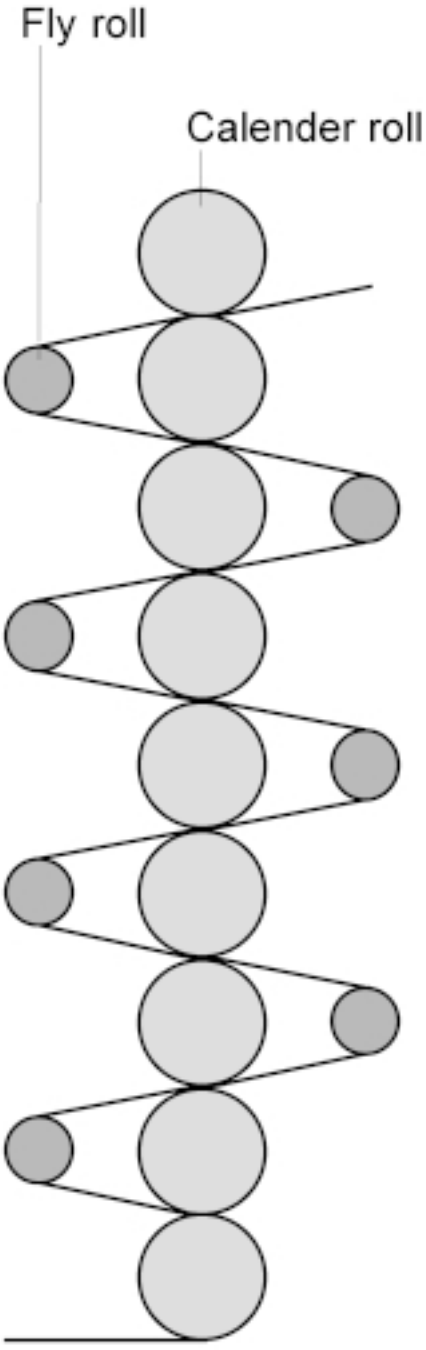


Fly rolls turn the paper web as it passes through a calender. Depending on the specific requirements, a calender consists of a series of 8 to 14 rolls for smoothing the paper surface.

The fly rolls usually consist of three segments; each of the individual segments is supported by two spherical roller bearings. The spherical roller bearings do take up the deflection of the roll, but due to increased friction they also generate heat. This additional heat around the bearings alters the web in an unwanted manner.
FAG developed special self-aligning ball bearings as a substitute for the spherical roller bearings. These bearings produce a lower friction and internal heating so that they meet the special requirements of this application better than the previously used spherical roller bearings.

Technical data

Roll diameter	360 mm
Roll length (3 segments)	8 500 mm
Weight per roll segment	400 kg
Wrap angle	168°
Web tension	0.5 N/m (2.78 kN)
Web speed	1 800 m/min
Tilting resulting from deflection	0.5°
Rotating bearing outer ring	

Special requirements

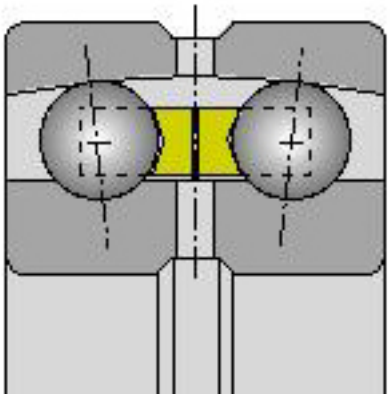
If the calender is integrated in the paper machine, a machine standstill must not cause a production loss.
If there is a separate calender the roll can be replaced more easily – relatively slight production losses result.
No temperature must be generated at the bearing locations which causes the generation of stripes (discoloured, differently smoothed surface) on the paper web.

Bearings

Every segment (D = 360 mm, L = 2 800 mm) is supported by two FAG self-aligning ball bearings 804501.C3 (with an increased bearing clearance). The bearing dimensions 220 x 300 x 60 mm are identical with those of spherical roller bearings 23944.
The bearings are loaded by the segment weight of 400 kg and by the web tension of 2.78 kN which acts at a 90° angle to this weight. The maximum speed is 1593 min^{-1}.

Bearing type

FAG self-aligning ball bearings are best suited for the special requirements of this application such as compensation of misalignment, as slight revolving masses as possible, and low friction.



The central roll segment is supported by the shaft; it cannot be adjusted. The two outer segments are in addition adjusted laterally to ensure that the paper web is not creased.
The deflection of the roll axis causes the bearing's inner ring to tilt, and at the same time the roll O.D. is also tilted, although more slightly. This results in a 0.5° tilt of the inner ring relative to the rotating outer ring (dynamic misalignment).

While the rolling elements are rolling in circumferential direction they must simultaneously shift axially in the outer ring raceway.
These axial sliding effects are compensated more smoothly by the self-aligning balls than by barrel rollers. With rollers, these axial motions would involve sliding friction and consequently the development of higher temperatures in the bearing.

Due to the low bearing load of 2.44 kN there is a risk of slippage (balls sliding as they enter and pass through the load zone).
The dynamic load rating $C_{dyn.}$ = 600 kN requires a minimum load
- 12 kN/bearing for spherical roller bearings
- 3.5 kN/bearing for self-aligning ball bearings.

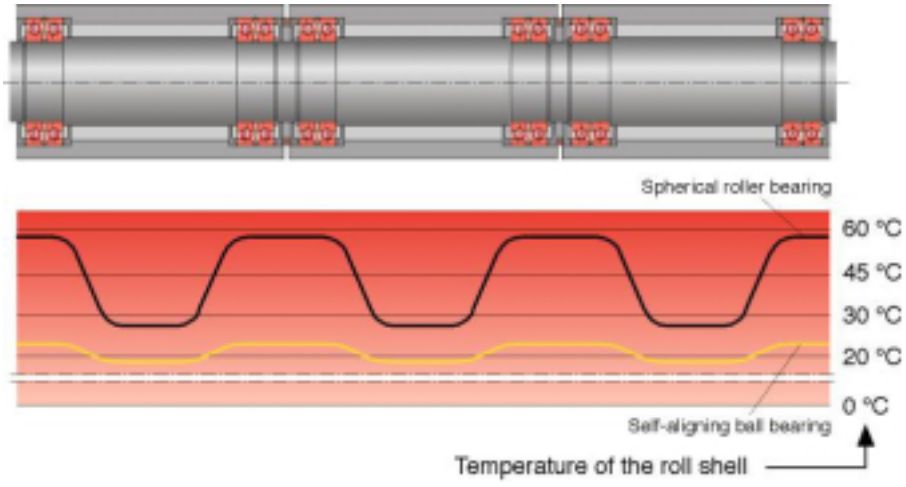
The risk of slippage is reduced considerably by the slighter revolving masses of self-aligning ball bearings (low ball weight, reduced number of balls).

Bearing lubrication and sealing

The self-aligning ball bearings are lubricated with a low-friction grease, which also contributes to a reduction of the overall friction.
Relubrication is effected through the lubricating groove and the six lubricating holes in the stationary inner ring and supplies fresh grease directly to the contact areas in the bearings. Large amounts of grease can be stored in cavities on both sides of the bearings.
As the outer ring rotates with a speed index of n x D = 400 000 $min^{-1} \cdot$ mm, effective seals (pressed-on shields with an inserted O-ring toward the outer ring faces) are required. They prevent base oil extracted from the grease by centrifuging from escaping.

Result

The following diagram shows very graphically the clearly lower temperatures developing in self-aligning ball bearings (FAG 804501) as compared with spherical roller bearings (FAG 23944).



FAG OEM und Handel AG
Steel, Pulp & Paper
P.O. Box 1260
D-97419 Schweinfurt
Tel.: +49 9721 91 38 87
Fax: +49 9721 91 49 08
e-mail: pulp_paper@fag.de
Internet: www.fag.de

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