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SKF Pulp & Paper Practices

Welcome to the first edition of “SKF Pulp & Paper Practices”

The challenge today is that the pulp and paper industry, globally, has become extremely competitive. Companies everywhere are trying to get the most from their machines. Whether mills are using state-of-the-art machines or older ones that have been in operation for decades, all are facing the challenge of developing new people or retaining the knowledge of those that are retiring. As a result, the knowledge of best practices related to maximizing bearing service life is not available in some regions and is being lost in others.

So, what can SKF do to help? We can provide our customers with our knowledge on how to increase service life by using the right techniques and tools. Our intention with this regular newsletter is to do just that.

Let’s start with some techniques from the experts. Techniques developed, over time, to establish best practices. In this issue, we will cover using the feeler gauge method to achieve appropriate clearance in bearings. In the next issue we will look at the basics of why you need clearance in bearings. Everyone knows what results they want, but it is sometimes good to refresh our memory of how to achieve it and why it is so important.

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Feeler gauge method for mounting bearings with tapered bores

In this first issue of SKF Pulp & Paper Practices, I want to cover the feeler gauge method for mounting bearings with tapered bores. The reason being, despite being the best known and most widely used approach, I have seen a lot of misunderstanding about it and bad practices when using it.

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Before looking at the feeler gauge method in detail, let's discuss on interference fits and other mounting methods.

Interference fits

Bearings with tapered bores are always mounted with an interference fit (i.e. a tight fit) on their seat. The correct interference fit is obtained by driving the bearing axially up its tapered seat.

The first question is what is the correct interference fit? Well, an insufficient interference fit will lead to fretting corrosion (→ **fig. 1**) which is due to micro displacement between two surfaces and/or creeping which is due to ring deformation under high load. With time, the inner ring works loose and can rotate on its seat leading to heavy wear and smearing. In general, we can say that the higher the load on the bearing, the tighter the fit that will be needed.

However, too high an interference fit will create high stresses in the inner ring which, when combined with the stress due to load, can reduce fatigue life. It may also cause ring fracture with some steel qualities and certain heat treatment methods especially if there is raceway surface damage.

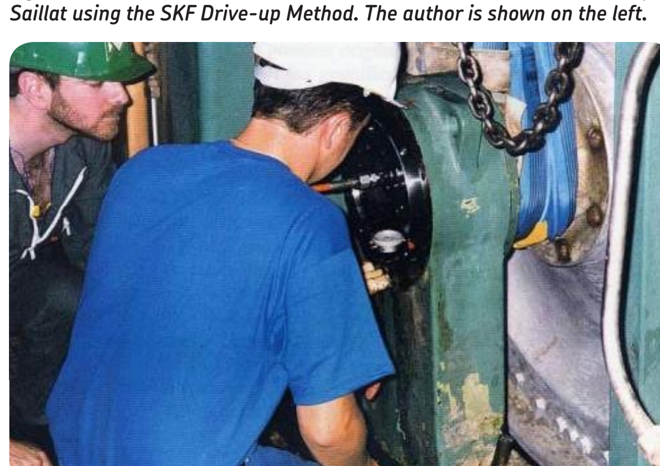
Fig. 1. Inner ring of a spherical roller bearing showing fretting corrosion in the bore because of an insufficiently tight fit .

So, what is the correct interference fit? Well, it depends. I know some people hate this sort of answer, but it is true. It depends on the application and on the operating conditions. Shaft material, load, speed, the lubrication regime and the temperature are all important. As are many other things.

SKF, in our General Catalogue, gives generic recommendations for obtaining a correct interference fit on solid steel shafts. This may seem vague, but the recommendations are based on years of experience in the field even if they don't always give the optimum fit.

Certain applications in pulp or paper mills need more precise recommendations. Examples include modern press roll bearings and felt rolls where tension has been increased due to increased speed or the conversion to a felt-driven drive system. These exceptions explain why there can be differences between SKF general recommendations and those given by one of our engineers for a specific application.

Fig. 2. The first CARB mounted in France. This was at International Paper Saillat using the SKF Drive-up Method. The author is shown on the left.



For those who want more information on how to chose the correct interference fit for an application, I will explain further in the next issue of this newsletter.

Different mounting methods

Once the correct interference fit is known there are several ways of achieving it:

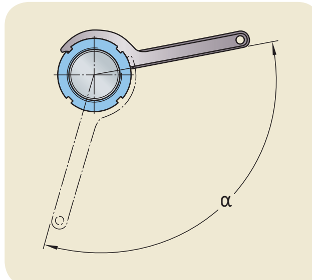


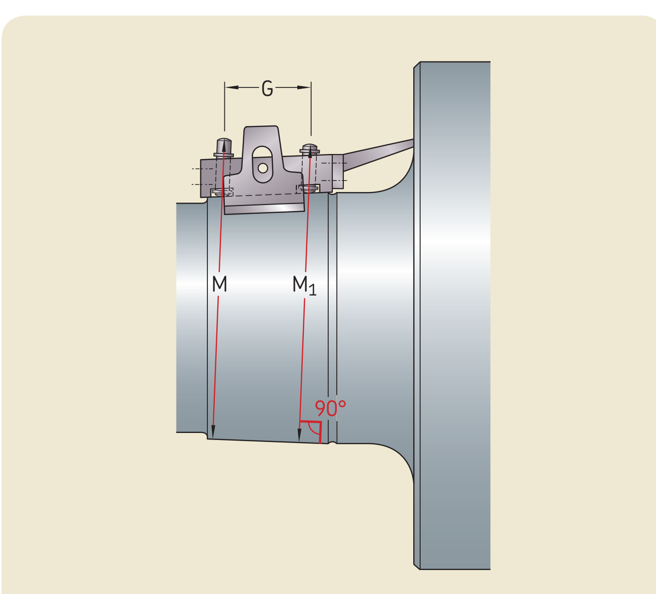
Fig. 3. Locknut tightening angle method.

1 Measuring axial drive-up. The difficulty is to find the starting position when the inner ring, after smoothing the asperities and getting in intimate contact with its inner ring, begins to expand radially. This is why measuring axial drive-up is quite imprecise unless the quick and precise SKF Drive-up Method it used (→ **fig. 2**).

2 Measuring locknut tightening angle (→ **fig. 3**). If you know the nut thread and the tightening angle, you know the axial displacement. Here, again, the lack of precision is due to the difficulty to find the starting position. It's one of the most popular methods when mounting self-aligning ball bearings. Most of the time these bearings are mounted with a higher interference fit than is needed.

3 Measuring inner ring expansion (→ **fig. 4**). This is a quite common method for cylindrical roller bearings in machine tool spindles, but I never saw it used in the pulp and paper industry until SKF launched the SKF SensorMount method for large size bearings e.g. press roll bearings. This method uses a sensor integrated in the inner ring. It's very accurate and fast.

Fig. 5. SKF 9205 gauge.



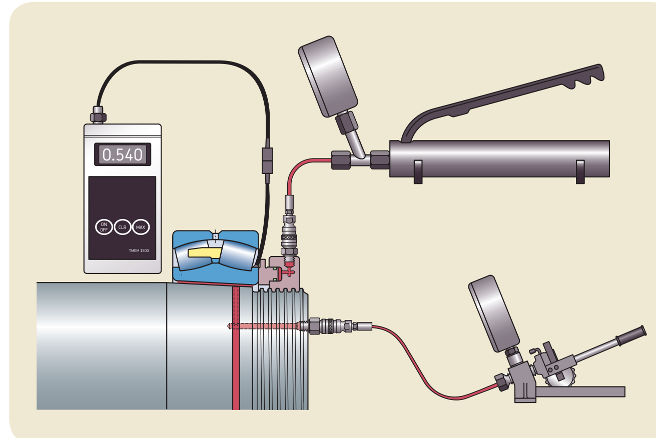


Fig. 4. SKF SensorMount method.

4 Measuring the exact dimensions and position of the bearing taper seat and creating a spacer against which the bearing is pushed into place (→ **fig. 5**). This is only valid for 240 and 241 series spherical roller bearings and for some high-precision printing machinery spherical roller bearings that are sometimes used in tissue converting equipment. This method needs special training, especially when using the 9205 SKF gauge. However, once the

Fig. 6.

spacer is created, and if the bearing seat is in a good condition, the replacement bearing is simply pushed against the spacer and the correct interference fit is achieved.

5 Measuring clearance reduction with the help of feeler gauges. This method is explained later on and you will see that it isn't accurate and fast.

In a future issue of SKF Pulp & Paper Practices, I will come back to the SKF Drive-up Method, SKF SensorMount and the 9205 gauge method.

Before mounting the bearing, check the shaft geometry. Without going into details on this subject, I would recommend using the Prussian Blue method. It's quick and, in most cases, is enough when you do not have the correct tools and information. The surface in contact should be at least 80% (90% for new bearing seat). For heavy bearings needing a bridge crane, add a spring between the bearing and the hook (→ **fig. 6**).

The feeler gauge method

When driving up a bearing on its taper seat, the inner ring expands radially. As the inner ring expands, the clearance in the bearing decreases. There is a direct relation between the drive-up and the clearance reduction.

The feeler gauge method measures the internal clearance reduction by passing the gauge between the rollers and the raceway. With this method, you do not adjust the internal clearance as some believe. You adjust the correct ring expansion to have the correct tight fit.

Using a feeler gauge isn't accurate. It depends on experience and feeling. Each person is different. Some consider that they have the correct clearance when the feeler gauge is slightly loose, others when it is slightly tight but still moves and some when it feels like trying to move the feeler in grease. This explains how two experienced fitters can get different values for the same measurement.

We all measure with a certain degree of error.. Trying to get the exact value of a clearance with a feeler gauge is a waste of time. However, as a specific fitter has the same feeling, and thus the same error, the clearance reduction value (i.e the difference between two clearances with the same error), will be quite close to reality.

Rule number 1: The bearing internal clearance and clearance reduction during mounting must be done by the same person.

In addition to the poor accuracy based on the "feeling", I have to add that the clearance between a roller and the raceway can change depending on roller position in the bearing and on the ring's position in relation to each other. For example, if somebody passes next to the bearing during the mounting procedure and accidentally moves the outer ring, the measured clearance before and after this "accident" can change and make the clearance reduction inaccurate.

Introducing a feeler gauge in the bearing can make a roller move. Very small movements have small effects. The best thing is to hold the roller with your fingers, or by a slight pressure with one finger against the roller end face, and avoid using a thick feeler gauge at the beginning.

Rule number 2: During clearance reduction measurement, the bearing elements (rollers and rings) must not move in relation to one another.

Fig. 7. Rotating the outer ring with a clean screwdriver.

Bearing rings can easily deform, especially rings from the large thin section bearing series such as the 238 and 239 series (used on some deflection controlled press rolls and some suction rolls bearings) or 248 and 249 series (less common in the paper industry). For a 239/500 (500 mm bore bearing), it has been shown that it is possible to force a gauge that is approximately 0,1 mm too thick between the roller and the outer ring.

Rule number 3: Start taking the clearance measurement with a thinner feeler gauge than the clearance that you expect to find.

The best roller ring position during measurements, especially if the true clearance is wanted, is their normal equilibrium position. To obtain this position, the bearing should be rotated a few times.

It's easier to rotate, avoiding varying misalignment, the outer ring than the inner ring. Misaligned spherical roller bearing outer rings aren't a problem since the outer ring raceway is a sphere. However, varying misalignment during rotation makes the roller move axially along the raceway as they roll and their position in the zone with clearance may not be the equilibrium position.

It was easier to find the correct roller position with the old, obsolete, spherical roller bearings with asymmetrical rollers and/or with middle integrated flange in the inner ring. You could just push the rollers against the flange. With modern, high-performance spherical roller bearings with symmetrical rollers and floating guide ring, you must first rotate the bearing. Then, if a roller moves during measurement, just gently push it back against the floating guide ring, but don't force it! The guide ring mustn't move.

Rule number 4: Find the equilibrium position by rotating the outer ring (if possible).

Recommendation: mount the bearing on the shaft and rotate the outer ring. For large, heavy bearings, place a clean rod in the lubricating holes on the outer ring. It will help you rotate the ring. **Fig. 7** shows one of my colleagues, retired now, using a clean screw driver to do this.

The CARB toroidal roller bearing is a tricky bearing since its clearance changes as soon as one ring moves in relation to the other due to misalignment and axial displacement and/or as soon as rollers move axially. As such, we recommend that that the feeler gauge method should be avoided when mounting CARB toroidal roller bearings unless the fitters are well-trained and very experienced.

Well-trained fitters and engineers, knowing how spherical roller bearings and CARB toroidal roller bearings work, are able to put the elements of a bearing back in position to continue the clearance reduction after an unexpected movement.

Measuring the real internal radial clearance isn't always needed. It is needed when there is a risk that the residual radial clearance after mounting could be below the permissible values indicated in the SKF General Catalogue.

Minimum permissible clearance value?

During operation, due to temperature differences between the bearing rings, the internal clearance will decrease. Bearings can run with no clearance or a small preload which increases the bearing life, but in this case the clearance has to be adjusted very accurately and the operating conditions need to be well known. In general, it is preferable to recommend a minimum residual clearance to avoid the risk of too high preload especially when a mounting method isn't accurate enough.

Please remember that the choice of the correct interference fit depends on the application and the operating conditions. Normally, the clearance reduction shouldn't depend on the initial clearance and the residual permissible clearance value. Instead, it should be based on the operating conditions and the interference fit needed. The radial clearance class of the bearing should be chosen to have the correct operating radial clearance (or preload).

When no information about running conditions are available and/or there isn't someone able to confirm that the residual radial clearance after mounting is sufficient, it's preferable to keep a radial clearance above the minimum recommended by SKF.

Unfortunately, some people focus too much on the minimum permissible clearance value. Maybe it should be ignored?

It's worth stressing that the minimum permissible clearance value isn't the clearance that you have to reach. If you want to reach that clearance, you will probably be obliged to drive-up the bearing much further than is recommended. For instance, it can be more than twice the maximum recommended drive-up for C5 clearance bearings. This would create high stresses in the inner ring.

Rule number 5: The minimum permissible clearance value is not a clearance that you have to reach. It is a minimum value given as a general recommendation.

When mounting a spherical roller bearing on a drying cylinder with the feeler gauge method, I don't waste my time trying to find the true radial clearance. I know to aim for a clearance reduction in the lower half of the recommended range as, due to “light” load, you do not need a very tight fit. Furthermore, because it is a C4 clearance class, I will never get a residual radial clearance after mounting under the minimum permissible. The important thing is to achieve the correct clearance reduction.

Anyway, if you look carefully at the SKF recommendations, you will see that the minimum clearance for a C4 bearing minus the maximum recommended clearance reduction always gives the minimum permissible clearance. That means that with a C4 class or a C5 spherical roller bearing, as long as the clearance reduction is within the recommended range, the residual clearance after mounting will always be above the minimum permissible. So, don't waste your time trying to find the true clearance in such cases.

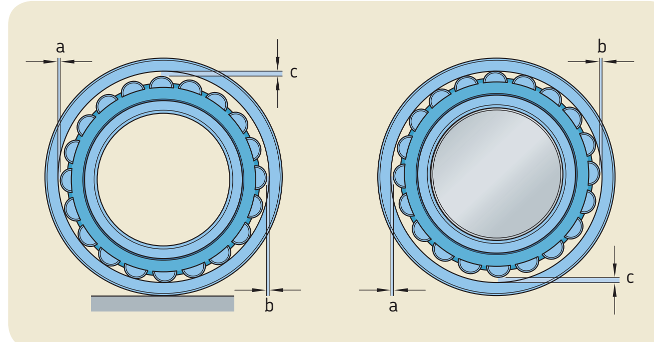


Fig. 8.

Rule number 6: For C4 and C5 clearance class spherical roller bearings, you only need to have accurate clearance reduction. You don't need to bother about the true clearance.

If you do not feel comfortable deciding that the residual clearance after mounting can be below the minimum permissible, you better take the time to find the true clearance of the unmounted bearing.

Finding the true clearance:

To be able to measure the true clearance, the bearing has to have its rollers in their normal equilibrium position. That said, outer and inner rings don't need to be perfectly concentric if the bearing is a spherical roller bearing.

One major problem is that the bearing is flexible. It deforms under its own weight. This means that the clearance measured at the 12 o'clock position in a bearing standing upright on the shop floor is smaller than the clearance measured at the 6 o'clock position in the same bearing hanging from a strap or loosely fitted on a shaft. The thinner section the bearing is and the bigger it is, the larger the deflection and the variation between the true clearance and the measured one.

To approach the true clearance, check the clearance at 12 o'clock (**c**) of a bearing standing on the floor, or at 6 o'clock for a bearing hanging on a shaft. Then measure simultaneously the clearance at position 3 o'clock (**b**) and 9 o'clock (**a**) (→ **fig. 8**).

The best estimation of the true clearance is given by: (a+b+c)/2.

If the rings were perfectly round, a=b=c/2. This is why the formula is (a+b+c)/2 and isn't (a+b+c)/3.

Rule number 7: Clearance = (a+b+c)/2

Some people try to pass long feeler gauges over two rollers, one on each row of the spherical roller bearing. I don't like this approach and only do it if I have no access to one of the rows. I would recommend checking one row and then the other. If I do not find roughly the same clearance on the two rows, I rotate the outer ring again and take new measurements.

Clearance reduction value

In the SKF General Catalogue, SKF doesn't give one clearance reduction value, but a range.

Example: Bearing 23040 CCK/W33. This bearing has a 200 mm bore diameter.

Based on **table 1**, **page 7**, the clearance reduction recommended is between 0,090 and 0,130 mm to have enough, but not too much, interference fit in general applications.

So, should the reduction be near the minimum value of the range (0,090) or near the maximum (0,130)? It depends on the operating conditions. Take another look at what I wrote about the interference fit. That said, if you do not know the operating conditions, my advice is to focus on the middle of the range and a little bit above (0,110–0,120 mm) and be careful about the minimum permissible clearance.

Rule number 8: Table 1 should be considered as a general guideline that can be followed (or not) based on known operating conditions and the fitter's experience.

The clearance reduction range is valid whatever the clearance class of the bearing (normal, C3, C4 etc.). The clearance class of a bearing is chosen based on the operating conditions and for an adequate interference fit. The interference fit isn't chosen based on the clearance class.

Some believe that the clearance should be reduced to half of the true clearance. This is wrong and can lead to too high drive-up. This will then create high stresses in the inner ring.

Rule number 9: The clearance reduction range is valid whatever the clearance class of the bearing. It can be modified so ensure that the residual clearance after mounting isn't lower than the permissible clearance.

This means that with our example of the 23040 CCK/W33, the 23040 CCK/C3W33 and/or the 23040 CCK/C4W33 will be mounted with the same clearance reduction range (0,090 to 0,130 mm), except if the operating conditions (or lack of knowledge about operating conditions) oblige us to select above minimum permissible clearance.

Minimum permissible clearance, from **table 1**, for :

23040 CCK/W33	(normal clearance class)	0,070 mm
23040 CCK/C3W33	(C3 class)	0,100 mm
23040 CCK/C4W33	(C4 class)	0,160 mm

Note that we don't really care about the minimum value for the C4 or C5 class.

Let's continue with the 23040 CCK/W33 example to show how the minimum permissible clearance can influence the clearance reduction.

If the bearing has a true clearance of 0,210 mm, the radial residual clearance after drive up should be between:

0,210 – 0,130 = 0,080 mm
and
0,210 – 0,090 = 0,120 mm

The minimum value of the calculated residual clearance is 0,080 mm, which is above the 0,070 mm (the minimum permissible). So, in this case, the clearance reduction range is kept between 0,090 and 0,130 mm.

But, if the bearing has a true clearance of 0,170 mm, the radial residual clearance after drive up should be between:

0,170 – 0,130 = 0,040 mm
and
0,170 – 0,090 = 0,080 mm

Unfortunately, the minimum value of the calculated residual clearance is 0,040 mm, which is below the 0,070 mm (the minimum permissible). So, in this case, the clearance reduction range has to be changed and reduced to be between 0,090 and 0,100 mm (170 – 70 = 100). The residual clearance after drive up will then be in a smaller calculated range, from 0,070 to 0,080 mm.

Now that the clearance reduction range is known or calculated, it is time to do the drive-up of the bearing.

You don't need to take care of the true clearance value anymore. The important thing is to get the correct clearance reduction.

For the bearing 23040 CCK/W33, the true clearance is 0,170 mm and the clearance reduction between 0,090 and 0,100 mm. The fact is that once the bearing is on the shaft, if the fitter measures 0,160 mm or 0,180 mm over one roller after rotating (if possible) the bearing to put the rollers in their equilibrium position, it isn't a problem.

If a fitter measures 0,160 mm, the residual clearance should be between:

0,160 – 0,100 = 0,060 mm
and
0,160 – 0,090 = 0,070 mm

If another fitter measures 0,180 mm, the residual clearance should be between:

0,180 – 0,100 = 0,080 mm
and
0,180 – 0,090 = 0,090 mm.

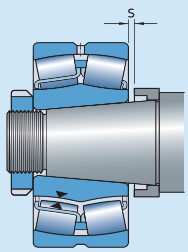
These two fitters have done the same clearance reduction and thus the same drive-up giving the same interference fit for the same bearing.

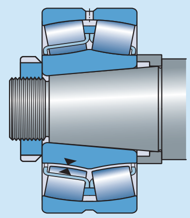
Rule number 10: Rules number 1 and 2 are really important.

Rule number 11: During drive-up, the true clearance of the bearing isn't important, the chosen and/or calculated clearance reduction is.

Some important points

The narrower the range of the clearance reduction, the slower the bearing must be driven up its taper seat to avoid exceeding the maximum value of the clearance reduction range. To avoid too high drive-up, and to avoid moving the bearing suddenly during drive-up and exceeding maximum clearance reduction value, oil the sliding surfaces. The sliding surface is the contact surface between the bearing and its seat. If the bearing is mounted on an adapter sleeve or a dismounting sleeve, there can be a second sliding surface be-





Bore diameter		**Reduction of radial internal clearance**		**Axial drive-up**[1]				**Residual**[2] **radial clearance after mounting bearings with initial clearance**			**Lock nut tightening angle**
d				s Taper 1:12		Taper 1:30					α Taper 1:12
over	incl.	min	max	min	max	min	max	Normal	C3	C4	
mm		mm		mm				mm			degrees
24	**30**	0,015	0,020	0,3	0,35	–	–	0,015	0,020	0,035	110
30	**40**	0,020	0,025	0,35	0,4	–	–	0,015	0,025	0,040	120
40	**50**	0,025	0,030	0,4	0,45	–	–	0,020	0,030	0,050	130
50	**65**	0,030	0,040	0,45	0,6	3	4	0,025	0,035	0,055	110
65	**80**	0,040	0,050	0,6	0,7	3,2	4,2	0,025	0,040	0,070	130
80	**100**	0,045	0,060	0,7	0,9	1,7	2,2	0,035	0,050	0,080	150
100	**120**	0,050	0,070	0,75	1,1	1,9	2,7	0,050	0,065	0,100	–
120	**140**	0,065	0,090	1,1	1,4	2,7	3,5	0,055	0,080	0,110	–
140	**160**	0,075	0,100	1,2	1,6	3	4	0,055	0,090	0,130	–
160	**180**	0,080	0,110	1,3	1,7	3,2	4,2	0,060	0,100	0,150	–
180	**200**	0,090	0,130	1,4	2	3,5	5	0,070	0,100	0,160	–
200	**225**	0,100	0,140	1,6	2,2	4	5,5	0,080	0,120	0,180	–
225	**250**	0,110	0,150	1,7	2,4	4,2	6	0,090	0,130	0,200	–
250	**280**	0,120	0,170	1,9	2,7	4,7	6,7	0,100	0,140	0,220	–
280	**315**	0,130	0,190	2	3	5	7,5	0,110	0,150	0,240	–
315	**355**	0,150	0,210	2,4	3,3	6	8,2	0,120	0,170	0,260	–
355	**400**	0,170	0,230	2,6	3,6	6,5	9	0,130	0,190	0,290	–
400	**450**	0,200	0,260	3,1	4	7,7	10	0,130	0,200	0,310	–
450	**500**	0,210	0,280	3,3	4,4	8,2	11	0,160	0,230	0,350	–
500	**560**	0,240	0,320	3,7	5	9,2	12,5	0,170	0,250	0,360	–
560	**630**	0,260	0,350	4	5,4	10	13,5	0,200	0,290	0,410	–
630	**710**	0,300	0,400	4,6	6,2	11,5	15,5	0,210	0,310	0,450	–
710	**800**	0,340	0,450	5,3	7	13,3	17,5	0,230	0,350	0,510	–
800	**900**	0,370	0,500	5,7	7,8	14,3	19,5	0,270	0,390	0,570	–
900	**1 000**	0,410	0,550	6,3	8,5	15,8	21	0,300	0,430	0,640	–
1 000	**1 120**	0,450	0,600	6,8	9	17	23	0,320	0,480	0,700	–
1 120	**1 250**	0,490	0,650	7,4	9,8	18,5	25	0,340	0,540	0,770	–
1 250	**1 400**	0,550	0,720	8,3	10,8	21	27	0,360	0,590	0,840	–
1 400	**1 600**	0,600	0,800	9,1	11,9	22,7	29,8	0,400	0,650	0,920	–
1 600	**1 800**	0,670	0,900	10,2	13,4	25,4	33,6	0,440	0,720	1,020	–

[1] Valid only for solid steel shafts and general application. Not valid for the SKF Drive-up Method
[2] The residual clearance must be checked in cases where the initial radial internal clearance is in the lower half of the tolerance range, and where large temperature differentials between the bearing rings can arise in operation

Table 1. Recommended values for reduction of radial internal clearance, axial drive-up and lock nut tightening angle.
Table 6, page 711, SKF General Catalogue 6000/1.

tween the sleeve and the shaft, if the sleeve moves along the shaft during drive-up.

Rule number 12: Oil the sliding surfaces.

For small bearings mounted with a locking washer, do not drive up the bearing by tightening the lock nut with the locking washer in place. Friction between the lock nut and the locking washer can force the washer to rotate which can damage it. The bore tongue can be torn away, leaving the nut without being locked in rotation.

Rule number 13: Do not drive up the bearing with the locking washer between the bearing and the lock nut.

When drive-up is finished, do not unscrew the lock nut or release hydraulic pressure too quickly. The excess of oil in the contact surface must escape. Otherwise, the bearing can move axially down the taper. Depending on bearing size, let the bearing settle for 10 or 20 minutes.

Rule number 14: Once the clearance reduction is done, take a coffee break.

If a too thick feeler gauge is used, it will be difficult to get it to follow the curvature of the raceways and roller and clearance measurement accuracy will be decreased. It is better to use two thinner feeler gauges to take the measurement. So, use a 0,300 mm and a 0,200 mm gauge rather than a 0,500 mm one.

Checking bearing wear a with feeler gauge.

Checking bearing wear with a feeler gauge isn't recommended.

1. You need to measure the clearance with the same load (direction, intensity) on the bearing. Under load, the bearing deforms and the clearance increases. So, it is useless to compare the residual clearance of the bearing just after drive-up (no load) and the clearance of a loaded bearing on the machine.
2. Because of thermal expansion and/or axial load, the outer ring might not be in the same position in the housing and/or the inner ring might not be in the same relative position compared to the outer ring between two measurements. If clearances on both roller rows aren't measured, large differences can be found.
3. Spalls or/and dents might not be big enough to make the clearance increase, but the bearing is damaged.
4. You cannot accurately compare measurements done with feeler gauges if the measurements are done by two different people.

Conclusions

The feeler gauge method for mounting bearings with tapered bores is an old method that has been proven to be accurate enough for many, but not all, applications. This method relies mainly on the fitter's experience and feeling. Furthermore, too often this method has been transmitted from one person to another by word of mouth thereby increasing the risk of bad practices.

Trying to find the clearance without moving the rollers with feeler gauges is old-fashioned. Try the SKF Drive-up Method or SKF SensorMount and you will understand this.

The case of the failed shaker screen bearing

Sam, the maintenance man, was on the first of several daily routine tours of the mill, a five machine with integrated kraft pulp mill. He headed first to the brown stock area knowing that last night a call in to replace the bearings on the deknotter rejects vibrating screen had taken place. He wanted to know more about the circumstances before the morning meeting at 09:00. The best way to find out was to visit the site and ask Marvin.

Marvin was the area Basic Care Mechanic (BCM). Each operating area in the mill had a full time mechanic who took responsibility for monitoring the equipment's condition and tweaking the performance when applicable, for example, adjusting packing gland water flow or tightening packing, changing filters on ventilating systems, etc. Marvin knew every piece of equipment in his assigned area better than anyone else in the mill and there were more like him in every other area.

"Morning, Marvin." Sam said as he approached Marvin at the brown stock elevator. "Heard you had a problem last night."

"You heard right." Marvin responded, looking to see if Sam would make eye contact. Sam always made eye contact, with everyone, every time.

"So, tell me, what happened?'

"Lost the bearings on the knotter shaker screen, again." Marvin responded.

Actually the equipment was a vibrating conveyor with perforated plates that conveyed the knots, fibre bundles that wouldn't pass through the perforations, in to a tank for further refining or disposal. The stream of brown stock entering the head end of the screen was the rejects line from the deknotter. Fibre losses were reported daily and thus managed by the various area operations managers. This incident would be reported in the morning meeting.

"So, Marv, what do you suppose caused the failures?"

"I don't suppose anything; I know what caused the failures." Marvin was the type of person that when responding to a question had two answers, the truth and silence.

"I'm listening." Sam had learned how to coax the conversation along without drawing the ire of Marvin. Wasn't an easy lesson, but it was a quick one.

"Cages failed."

"Cages failed?"

"Yes."

"Why?"

"That's the right question."

"I'm listening."

"They were brass."

"What?"

"They weren't steel."

"This has happened before."

"Yes."

"I thought we had stopped that from happening again." Several years ago, these same bearings had failed and Marvin realized, almost immediately that the bearings being provided by the storeroom were supplied with brass cages. Caustic and brass don't react well. Sort of like sucking on a piece of hard candy, eventually there is nothing left.

At the time, the solution was to specify that this bearing was never to be supplied with a brass cage, only steel.

"Seems not."

"How did these get put in?"

"Call in a couple of weeks ago."

"So this is what was in stores?'

Silence. "Okay, Marv, I'll check it out, thanks."

Back in his office, Sam logged on to the CMMS, found the shaker screen in the hierarchy and brought that up. In big bold letters in the bill of materials was the note to use only bearings with a steel cage (actually identified by manufacturer).

Sam went to the storeroom inventory screen and looked up the bearing. Recent transactions showed a shipment received from the vendor in order to bring the inventory back up to the correct stocking levels. Sam went to the purchasing module and found the purchase order for the bearings and a lot of other stuff from one of the local power transmission vendors. There was no specific bearing manufacturer identified.

During the morning production meeting, the pulp mill manager explained that their fibre losses were higher than usual because the knotter screen bearings had failed, again, resulting in bypassing the knotter rejects recirculating tank. The mill manager looked at Sam for an explanation.

"Seems the action we took a year or so back wasn't the complete solution." Sam said looking around the table and making eye contact with those staring back. "We had made a note in the asset record that only Brand X bearings were to be used because they supplied a steel cage and not a brass cage, which as you know dissolves in the presence of caustic. The assumption, a poor one obviously, was that anyone working on the replacement of the bearings for whatever reason would check the asset record in the CMMS before performing the work and find this note."

"The other assumption, again erroneous, was that the store's request for replenishment would have the manufacturer specified so that purchasing would specifically request that brand. That did not happen." Sam continued. 'Seems we have some training issues, perhaps a cultural issue and I will follow through on this personally, but I will also make sure it is entered into the LTA (Lost Time Analysis program used for root cause analysis in the mill)."

Looking at the pulp mill manager, Sam said, "I'm sorry our fibre losses were high as a result of this failure and I hope that doesn't have any further consequences. I'm glad we didn't suffer any downtime, although it's conceivable the same mistake could have been used on critical equipment."

"Good enough, Sam," the mill manager injected, "report back to us on any progress made."

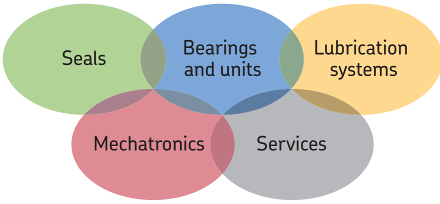
Sam learned that typically on call ins, few of the mechanics went to the CMMS to look up information about the equipment in question. They would simply start the job, in this case dismantle the screen basket to get to the bearings, use the remains of the bearing to identify the part number (bearing number) and go directly to the storeroom for a replacement.

Sam learned that although there was a note in the asset record, there was no corresponding note in the bearing's inventory record stating a preference for the manufacturer.

Sam determined the technology (CMMS) would support all of these requirements and more, however the business process defined had simply been incorrect and incomplete, and the culture had not adjusted to the new correct process and technology.

As usual follow up had been needed, but had not been performed. A lesson learned, and now the learning needed to be applied.

John Yolton is approaching his 46th year in the industry. A many-journeyed, seasoned veteran of pulp and paper manufacturing, Yolton currently assists global paper industry clients with asset reliability improvement strategies. He can be contacted at john.yolton@skf.com.



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