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(713) 943-9100
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Quick-reference guide & fact sheet

It should be noted that these are "Rules of Thumb," and intended to give a measure of guidance only since all machines and operations are not created equal. It is important to do an in-depth investigation if questions or problems arise.

Babbitt & Temperature Related Topics:

Note: For a more detailed discussion on temperature detectors see our article in our first *Bearing Journal* (4th quarter 1998). For more information on babbitt see our second *Bearing Journal* (1st Quarter 1999).

1. TCE standard alarm and trip (journal and thrust):
   a. Alarm @ 230 °F, Trip @250 °F
   b. FYI we normally design bearings to run below 200 °F
   c. These temperatures assume the temperature detector is located at the "API 670" recommended location (see #2 below).
   d. Note that babbitt begins to melt at 450°F, and will creep at 270°F when loaded to a unit load of 1000 psi. Also note that babbitt strength and fatigue resistance decrease at elevated temperatures. Because of this both static and dynamic loads can contribute to babbitt failure.
   e. Also note that peak pressures in bearings are usually 3 to 5 times the unit loading (e.g. if a journal bearing has a unit loading of 200 psi the peak film pressure will be around 600-1000 psi).
   f. It should also be noted that mineral oils and their additive packages can breakdown at these temperatures (1a), resulting in deposit buildup and load capacity reductions.
2. Temperature detector placement: TCE follows the intent of API 670 guidelines. This means we place the detector as follows (in all cases the detector is located 1/16" below the bond line - NEVER INTO THE BABBITT):
   a. For ball & socket tilting pad journal bearings (B&S TPJ) we place it 75% from the leading edge on the axial centerline.
   b. For TPJ bearings that have pivots that do not have axial alignment capability (line contact pivots) and if the L/D ratio (pad length to journal diameter) is over 0.5 we will straddle the axial centerline (locate one at each 1/3 point).
   c. For sleeve bearings we locate 30° from the load vector and locate axially as for TPJ's.
   d. For thrust bearing we always try to locate at the 75-75 location (75% from leading edge and 75% up from the ID).

Journal Bearings:

1. Journal Bearing Clearances:
   a. (over 3" to 14") will run at 1.5 mils diametral clearance per inch of shaft diameter. For example: a 6" bore bearing should have about 9 mils diametral clearance (1 mil = .001").
   b. For small bearings (3" and under), run D+2 mils (a 1" bore would run 1+2 mils =3 mils clearance)
   c. Bearings 14" and over will run 1 ¾ mils/inch
   d. For high speed:
      i. 20,000 rpm: 1 ¾ mils/in
      ii. 35,000 rpm 2 mils/in
      iii. Of course these will be smaller bearings, use the larger of this or the value from b above.
   e. For higher loads (over 250 psi) increased clearances may be required.
2. Preload, m=1-Cb/Cp, where Cb is the bearing set clearance and Cp is the pad clearance. Common values are .2 to .5 for tilt pad journal bearings.

Note: For a more detailed discussion on preload see our article in the 1st Quarter 2000 *Bearing Journal*.

3. Elliptical bearings usually have vertical clearance at 1.3 to 1.5 mils/in and horizontal twice the vertical (this equates to a .5

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All TCE e-mail addresses and past issues of Bearing Journal are available on our website: www.tce1.com

TCE introduces new logo and brochure

TCE's new logo makes its debut this month on a new brochure as well as the newsletter, website and stationary.

TCE is proud to announce that after nearly ten years of faithful service we are retiring our logo and introducing a new look. Our new logo embodies the company's evolution and engineering focus.

In addition to its new home at the top of this newsletter, the logo will begin appearing in the usual places: business cards, stationery, TCE's web site, booth graphics, etc. For the complete story, be sure to request your own copy of our new brochure and get the engineering edge for your turbomachinery or stop by our booth at the Texas A&M Turbomachinery Symposium (September 19-21, 2000 in Houston) and pick up a copy.

The brochure is your guide to the products and services TCE offers the rotating equipment industry. There are a number of case histories that illustrate some of the many ways we've helped customers solve machinery problems and improve productivity.

Reference

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preload)

4. Crush checks: TCE designs all journal bearings to have 0 to 2 mils crush (unless they are flange mounted), where crush is an interference between the OD of the bearing and the ID of the housing the bearing fits into.

5. TPJ lift check for a 5-pad bearing is 1.118 times the actual clearance, 4-pad load between pads is 1.414.

Note: For a more detailed discussion on measuring the bore of tilting pad journal bearings see our article in the 4th Quarter 1999 *Bearing Journal*.

Other Topics:

1. Materials:

a. Babbitt is ASTM B23 grade (or Alloy) 2. This is tin based with some copper and antimony. For journal bearings in high-speed industrial sized machinery we use 7 mils thick babbitt on bronze back pads (for increased fatigue strength) and 25 mils on copper thrust pads. We normally use 1/16" babbitt thickness on steel pads (journal and thrust).

b. Bronze used for some sleeve bearings and some ball & socket tilt pads is a bearing grade bronze that is babbitted. Bronze is 50% more heat conductive than steel.

c. Copper (for thrust shoes) is 99% cu, 1% chrome (chrome added for stiffness and strength). This copper is 450% more heat conductive than steel. This upgrade alone (from steel to copper) can drop hot running thrust bearing temperatures as much as 35°F.

2. Common maximum design unit loading on journal bearings is 200 psi (load divided by projected area, where projected area = babbitt length times journal diameter). Loads up to 350 psi are not uncommon in gearboxes. Thrust bearing maximum design loads are usually kept below 250 psi with center pivot and steel pads, custom designed thrust bearings can run with much higher loads.

3. Laby seal leakage: Clearance is a strong factor in labyrinth seal performance. Most calculations assume leakage is proportional to clearance cubed. That is, if you double your clearance your leakage will go up by a factor of 8! Hence the great success archived with polymer seal upgrades.

Note: For a more detailed discussion on polymer seals see our article in the 3rd Quarter 1999 *Bearing Journal*.

4. Oil:

d. Most common oil is an ISO 32 (aka: 150 SSU at 100 °F, SAE 10, or light turbine oil (LTO)).

e. Other common weights (heavier) are ISO 46 and 68, sometimes used with oil ring fed bearings and geared units.

i. Oil is usually supplied at 110-120°F and 15-25 psig. Note that bearings are designed for specific oil supply temperatures and pressures.

5. Thrust Float: A good rule of thumb is to use similar values as for journal bearings - substituting the thrust OD for the journal diameter. For example a 10.5" OD thrust bearing should have about 16 mils float.

Featured tech paper deals with polymer seal upgrades

Our featured technical paper this month is *Upgrading Centrifugal Compressors with Polymer Seals in an Ethylene Plant - A Case History*.

Presented in this paper is a discussion on thermoplastic use as a labyrinth seal material in centrifugal process compressors. Labyrinths made from engineering thermoplastics are used to improve efficiency, reliability, and installation time. An introduction to the polymer materials commonly used for these applications is followed by a discussion on polymer labyrinth seal engineering. Finally, the case history is discussed. This particular case history involves the upgrading of seven compressors at an ethylene plant in Orange, Texas. The process involved upgrading and evaluating one compressor then converting the remaining six. A discussion on this process is presented followed by coverage of the installation and subsequent efficiency gains. Included is the presentation of results from an advanced Computational Fluid Dynamic (CFD) analysis of two labyrinth seal designs. This paper will be presented at this year's Texas A&M Turbomachinery Symposium, at 10:30 am Tuesday, September 19, 2000. Reprints will be available after the Symposium so let us know if you would like a copy.

Labyrinths made from engineering thermoplastics are used to improve efficiency, reliability, and installation time

News and Recent Orders

1. Supplied spare Torlon seals for 6 cracked gas compressors and 3 methane compressors.
2. Worked with Kaydon Ring and Seal on rebuilding four 8" mechanical compressor seals.
3. Engineered and manufactured a custom non-equalized 16" ball & socket tilt pad thrust bearing with copper pads and offset pivots to lower the thrust bearing temperature.
4. Repaired 56" thrust bearing pads for an air preheater in a large utility plant.
5. Repaired 8 1/2" Hitachi steam turbine journal bearings and 15 1/2" thrust bearings for a co-gen unit.

TCE
8730 Meldrum
Houston TX 77075

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