



Adjustable self-lubricating bearings overcome challenges for pump-turbine applications

Pump-turbines, in particular reversible Francis units, have in the past represented a big challenge for bearing manufacturers. The high vibration levels that the bearings, mainly in the guide vanes and linkages, are submitted to during operation in the pumping mode have always represented a key cause of failures.

Using modern design tools, turbine manufacturers have progressively been able to improve turbine design, to achieve a significant reduction in these vibrations.

The increasing demand today for pumped-storage plants has encouraged Federal Mogul Deva to invest in the development of engineering solutions to assist turbine manufacturers to minimize the impact of vibrations on the pump-turbine distributor mechanism, that is, on the guide vane and linkage bearings.

The company's studies in this field have led to the development of a broader solution, which can combine two products and two design solutions:

- an adjustable sleeve bearing system, using a suitable self-lubricating bearing material to cope with the vibration; and,
- a spherical bearing, also using an appropriate self-lubricating bearing material to cope mainly with deflection, but vibration as well, since the contact area of a well aligned bearing should be the optimum.

As background to this development, it may be useful to outline some basic concepts taken into consideration, as there are a number of different requirements for adjustable sleeve bearings.

• *Achieving precise guidance:*

Some applications (for example, robot arms) which involve very precise positioning functions depend on the elimination of any clearance. If pre-tensioned, tapered, roller bearings cannot be used because of shock, vibration or a corrosive environment, then adjustable sleeve bearings can represent an alternative.

• *Eliminating clearance for controlled friction:*

Whenever a rotational or axial sliding movement is required not to run under low friction, for example, to achieve a damping characteristic or a brake effect, adjustment of the clearance after assembly, as well as during the service life, is essential.

• *Preventing the shaft from pulsating or vibrating as a result of dynamic load:*

This is of importance, as noise as well as damage by the 'hammering effect' depends on the clearance to move. The shaft movement caused by vibration follows a sinus-characteristic. The 'released energy' leads either to noise, or in the worst case to damaged

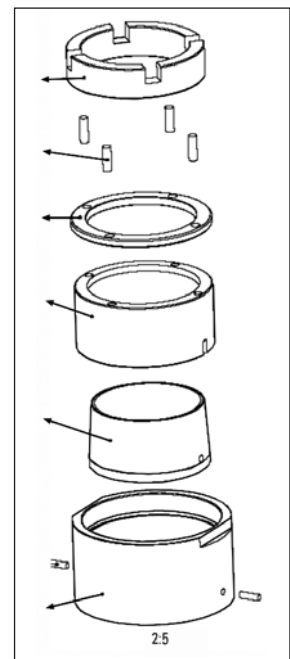
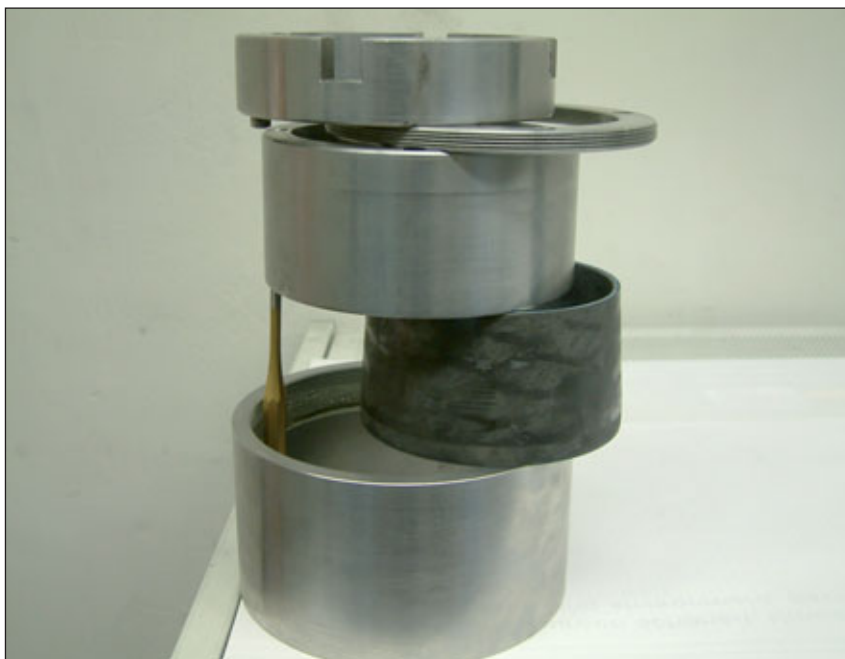
surfaces. Reduction or elimination of the clearance is the solution in such cases.

The adjustable sleeve bearing system developed by Federal Mogul Deva is based on a metal housing and a polymer-based sliding layer. The challenge was to provide the turbine designer with both the possibility to adjust the clearance between the shaft and bearing during assembly and also afterwards throughout the service life. In addition, it was necessary to ensure that the bearing's cylindrical shape would not be affected by the initial assembly pre-tensioning, and by later adjustments during its operating life.

Based on the self-lubricating material deva.tex[®] 552, a special version of this material was developed to ensure a reasonable combination of accuracy and compatibility. This adjustable bearing system consists of a double cone-shaped system, which permits the transfer of an axial re-adjustment into a radial diameter correction, as shown in the picture below.

The damping (shock absorbing) characteristic capability of deva.tex 552 material, resulting from its very low Young's Modulus, represents a great advantage for its application for pump-turbine bearings.

This bearing system solution can be applied both in guide vane and linkage systems. A spherical bearing made with deva.tex 552 material can also be used in the linkages.



The adjustable bearing system based on the self-lubricating material deva.tex[®] 552.