New horizons for vertical shaft bearings

Michell Bearings, a Vickers plc company, has achieved a breakthrough in providing an increase of up to 70% in load carrying capacity with their new 'AV' range of while metal bearings for vertical shaft machines. This article by Eur. Ing. R.T. Knox shows how this challenge has been met providing the pump and motor manufacturer with a superior product with no increase in cost.

Introduction

The successful use of tilting pad fluid film bearings for the support of vertical shaft machines dates from the very invention of the tilting pad concept by A.G.M. Michell in 1905. The first tilting pad bearing in service, Figure 1, was built under Michell's supervision in 1907 in Australia for a centrifugal pump at Cohuna on the Murray River. According to contemporary documents the vertical thrust load was 13.3 kN (3000 lbf), equivalent to a specific bearing pressure of 1.5 MPa (220 psi), and the running speed was 220 rpm. The success of the installation was such that by 1916 it was recorded that, '... a large number of the bearings have since been fitted to pumps of this kind'.

Michell Bearings was established as a company in Newcastle upon Tyne in 1902 and has been part of Vickers plc since 1969. The company continued to develop its designs for vertical shaft bearings keeping abreast of continuously changing requirements of machine builders and their end users. Throughout this period the growth of the company's reputation was such that today Michell Bearings is recognised as a world leader in the design and supply of numerous bearing types including tilting pad bearings for vertical shaft machines.

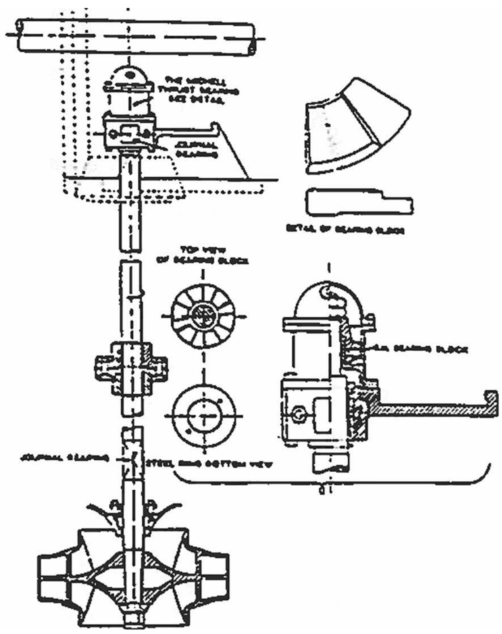

Figure 1. Michell vertical thrust bearing for a centrifugal pump. Installed at Cohuna on the Murray River, Victoria 1907.

Modern designs

Since Michell's pioneering days, fluid film tilting pad bearings have become standard supply for an enormous range of vertical shaft pumps and electric motors. Present day use includes applications as diverse as the sea-water injection pumps and fire safety pumps used in the offshore oil and gas extraction industries, and the pumps used for water and sewage movement in many civic amenity schemes.

Figure 2 is a cutaway illustration showing the essential features of a typical standard vertical bearing drawn from a range in current widespread use which was first introduced in the 1970s. Axial load is transmitted via a collar, keyed to the shaft, to a ring of tilting thrust pads. Tilting journal pads are situated around the periphery of the collar to withstand any radial load. Modern journal pads are preloaded, that is to say they are provided with a radius of curvature very slightly larger than that of collar surface against which they act. The effect is to ensure that there is always a positive pressure created in the convergent volume between collar and pad even when the externally applied load is zero. In this way the journal pads are able to

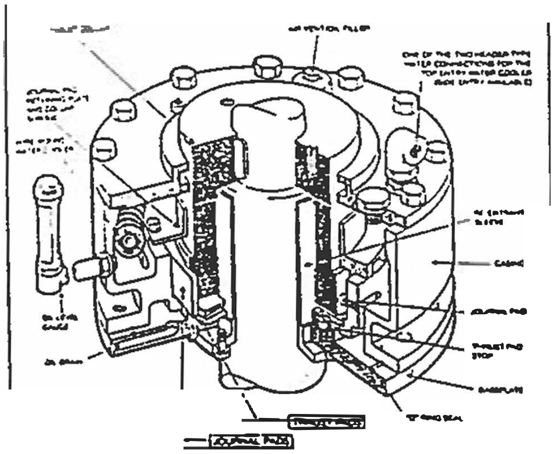

Figure 2. Cutaway of a typical standard vertical bearing.

provide a very effective and accurate location for the shaft regardless of the magnitude of the radial load. Lubricating oil is contained within the bearing casing which is filled to a level so that both sets of pads are always immersed.

All bearings generate heat at their working surfaces which must be dissipated if overheating leading to damage to the bearing and the equipment it supports is to be avoided. In the case of the vertical bearings of the type illustrated, the most common way for heat to be conveyed from the bearing is by means of a water cooler immersed in the oil as shown. It is the purpose of the bearing designer to ensure that there is a continuous circulation of the oil within the bearing from working surfaces to the cooler and back again. In the vertical bearing this essential circulation is achieved by means of the natural pumping action which occurs in the radial grooves between the thrust pads as a result of shaft rotation. The sectional elevation, Figure 3, shows the circulation route of the oil, from thrust face to the radial bearing past a water cooler and back to the inner diameter of the thrust face by means of passages machined in the baseplate which supports the thrust pads.

Oil circulation using the pumping action of the thrust face has been found to be extremely effective and reliable, particularly in the single oil path form illustrated. All the oil circulating is required to pass through the chamber surrounding the journal pads ensuring maximum lubrication conditions. Efficient circulation of the oil is important in guaranteeing high external fluid velocity past the cooling tubes and optimum values of heat transfer. As rotational speed increases, so does the amount of heat generated in the bearing. In the design illustrated, the oil circulation rate, and hence the velocity past the cooling coils, also increases automatically as shaft speed increases Satisfactory dissipation of heat is thus ensured over a wide range of rotational speeds up to those of two pole electric motors without the addition of any of the contacting or wearing parts a conventional oil circulation pump would require.

Although the most usual means of heat dissipation from vertical bearings is by means of water coolers immersed in the bearing casing, there are some lower speed or more lightly loaded cases for which cooling by natural convection to the surrounding atmosphere is sufficient. Cooling coils are dispensed with and the casings provided with a series of external fins to assist in heat transfer to the surroundings. Rates of heat transfer in these cases may be further augmented by the addition of a shaft driven axial flow fan designed to ensure rapid air flow over the external surface of the casing.