Some standard and special self contained bearing designs

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SYNOPSIS The paper discusses some of the methods available for the circulation of oil in self contained bearings and their cooling. Three specific designs are considered and used to illustrate how both standard and very special requirements can be satisfied.

Recent innovatory design work includes the use of heat pipes for oil cooling and the development of a unique self-pressurised low power loss bearing. These features may find wider application in future projects.

1 INTRODUCTION

The objective for designers of self contained bearings is to supply a product to a performance specification which is able to provide itself with a continuous supply of cool oil for the bearing surfaces. The bearing has to be able to carry out from within its own engineered resources the functions of circulating and cooling an amount of oil fixed within the confines of the bearing. There are a range of techniques available to assist in fulfilling these functions. Oil circulation is often achieved for example by fixed or loose rings dipping into the sump and conveying oil from these to the top of the bearing. In many cases water is available as a cooling medium and may be introduced into the bearing casing using suitably designed cooling tubes.

In this paper a number of methods useful in self-contained bearings are discussed by reference to three specific designs. These designs have been chosen to illustrate both some of the range of ideas available to meet standard requirements and also how it is possible with new design thinking to accept very special duties.

2 VERTICAL BEARINGS

Many machines, pumps, motors, turbines, have vertical shafts and require bearings capable of withstanding axial loads and providing radial restraint. Usually the radial load is small but on occasion it may be considerable. Traditional oil ring circulation is not an option for vertical shaft bearings. It is usual instead to immerse the bearing faces in a bath of oil and use the natural pumping action of the radial grooves between the pads. Figure 1 is a cutaway illustration of a typical standard range thrust and guide bearing showing its essential features. Figure 2 is a sectional elevation of the same bearing and the circulation route of the oil, from thrust face to radial bearing to water cooler and back to the eye of the bearing beneath the thrust face can be seen clearly. The design of this bearing is such that all the oil is constrained to a single path over both thrust and journal surfaces. There is thus no risk of the guide bearing becoming starved under certain operating conditions as was the case in some earlier designs in which there was a division of the oil, some going to lubricate the thrust face and some to the journal.

Oil circulation utilizing the pumping action of the thrust face has been found to be extremely powerful particularly in the single oil path form illustrated. Rapid circulation of the oil is important in ensuring a sufficiently high velocity past the cooler. In this case cooling is provided by water passing through wire wound tubes immersed in the oil. In those cases where water is not available or when the performance required of the bearing is not so arduous, bearings can be air cooled by the addition of fins to the outside of the casing. Further improvement in air cooling capability can be obtained by the use of a shaft mounted fan above the bearing and a cowl around the fins.

Vertical bearings such as the one illustrated form part of a standard size range and there are many installed at sites all over the world. The same principles that apply to standard bearings are equally applicable to vertical bearings outside the standard size range. All vertical bearings are members of the same family and are recognisable as such. In contrast, the other two bearings to be described are out and out specials designed to satisfy particular customer requirements. In both cases the bearing and its functioning was well established but it was necessary to undertake innovatory design and development work to establish satisfactory cooling and oil circulation arrangements.

3 COOLING USING HEAT PIPES

The emergency feed and cooling water pumps in nuclear power stations are devices which may never need to be called upon during their service life. But, when they are required, it is essential that they operate in a completely reliable way with the minimum of outside services. The specification for the thrust bearings in this application called for a normal thrust load of 42 kN to be accommodated at 3000 r/min. It was further specified that air cooling was the only form permitted and that the oil bath temperature should be no more than 70 degrees centrigrade for a maximum ambient temperature of 25 degrees centrigrade.

The technology to accommodate this load and speed is well known using an IR ring for oil circulation as shown in Figure 3. In an IR ring. oil is collected from the inside of the rim thus counteracting the centrifugal effect of oil being thrown from the outside of a conventional oil ring at high speeds. The difficulty facing designers in this case was to find a way of providing sufficient cooling to enable the bearing to operate at a reasonable temperature for a performance level normally appropriate to water cooled bearings. The solution was found in the development of heat pipes specifically for the extraction of heat from the bearing sump.

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