UPGRADING MARGINAL THRUST BEARINGS

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Abstract

One of the most common causes of hydraulic turbine unscheduled shutdowns is the failure of the thrust bearing. The logical technical solution would be the installation of a contemporary thrust bearing but unfortunately the cost is prohibitive due in part to the major structural changes required to install the new bearing in the existing generator. During the last few years the author, with the cooperation of a PTFE bearing manufacturer has successfully supplied new pads that are a modification of flat type bearings to tilting pad type. The installation of the modified bearings did not involve structural changes and were not costly. In addition, the load carrying capacity of the upgraded bearing is estimated to have been doubled.

Introduction

One of the most common causes of hydraulic turbine unscheduled shutdowns is the failure of thrust bearings, commonly referred to as a 'wipe'. Often the failure is catastrophic, sometimes requiring weeks to bring the unit back on line. Even when the failure is limited, when the unit can be brought to a stop before the bearing is completely damaged, it still involves costly repairs in terms of manpower, materials, and generation losses. This situation is sometimes aggravated by chronic or serial failures. Under pressure to return the unit to service, the failed bearing is replaced by another bearing of the same design setting the stage for a new failure. The operating strategy simply consists, at best, on having a spare bearing on hand, cleaning the oil pot and installing the spare. It should not be surprising that the bearing wipes again either on start up or shortly thereafter. Yet, there are good alternatives to this process.

Causes

At times, the causes of failure are improper installation, misalignment, vibration or simply insufficient maintenance. In these instances the return to good practice may solve the problem. However, often the root of the problem is that the bearing is of insufficient load carrying capacity. Contemporary tilting pad bearings have large load capacity but there are many turbines in North America, some of them large units installed as far back as the twenties or earlier and as late as the forties, that are still equipped with one or two piece flat type bearings mounted on a bed of springs. Some of those bearings are still serviceable especially when they operate on an almost continuous basis. However, changes in the electricity market such as deregulation demand new operating rules which are impose frequent stops and starts leading to an increased number of failures .This trend is going to continue with the result being more frequent failures.

Contemporary Thrust Bearings

The logical solution is to replace the obsolete bearing with a contemporary thrust bearing, often available as a standard unit equipped with high pressure oil lift for safe starts and stops. Unfortunately, the cost is prohibitive due in part to major structural changes required to install the new bearing in the existing generator and the cost of a high pressure oil lift.

Modified Flat Type Bearings

During the last four years, with the cooperation of a PTFE (PolyTetraFluoro-Ethylene) bearing manufacturer, several flat type bearings have been successfully modified to tilting pad type bearings. The modifications did not involve structural changes and were not costly although it required the purchase of new bearing shoes. The load carrying capacity of the upgraded bearing is estimated to have been doubled while the added simplicity of avoiding the use of high pressure oil lift has reduced the chances of failure and reduced the cost of the upgrade significantly.

Upgrade Procedure

To successfully carry out an upgrade we must modify three components: bearing pads, runner plate and support system. With the exception of the new bearing pads, this work can be done by any good machine shop.

To upgrade the thrust bearing we must usually modify the thrust runner plate. In flat plate bearings, the shoe has six or eight grooves or channels to facilitate the movement of oil, while the runner plate has a similar set of grooves. To ensure a continuous oil film in the new bearing, the runner plate must be free of grooves as well as comply with the standard requirements regarding flatness, parallelism and finish common to all runner plates. If the runner plate of the existing bearing is made of good quality steel, it is often possible to machine down the plate and eliminate the grooves. This results in a thinner runner plate. In order to keep the thrust block face at the same level, either the new shoes or the spring bed must be made thicker by the same amount. Occasionally a new steel runner plate is made if the unit is kept in operation until the complete new bearing has been manufactured.

The next components to be changed are the springs and spring plate assembly. The spring number must be reduced and the springs re-rated since the shoe surface has been reduced. Although the weight of the rotating equipment is usually well documented, the hydraulic thrust must be estimated. Fortunately there is some latitude in the need for accuracy on the value of the design load. Furthermore, the high load capacity of the PTFE bearings offers a considerable margin of safety in cases where the load has been underestimated.

There are a variety of spring plates. In some units the spring plate or base is a rather thick iron casting and can be reused although the number of springs and spring pattern must be changed. As with the runner plate, sometimes it is necessary to manufacture a new spring base if the existing spring base is very thin.

The last item, the bearing shoes must be supplied by a specialized manufacturer. The bearing design follows the established principles for thrust bearing design with the only exception being the different material for the pad surface which in this case is a PTFE brass composite instead of Babbitt metal.

Four bearings have been modified and upgraded in Ontario using this cost effective solution. They have been operating satisfactorily for the past four years. Another two, also in Ontario, Canada will be commissioned shortly.

Author

Alfred Mohino, P. Eng is a Senior Mechanical Engineer with Hydro Tech Inc. and has over 28 years of experience. Prior to his employment with Hydro Tech Inc. he was a Mechanical Maintenance and Field Services Engineer with Ontario Power Generation and previous to that was manager of Turbine Design with Barber Hydraulic Turbine. He holds an Engineering Degree from the University of Waterloo and an Engineering Degree in Land and Aerial Surveys from the University of Madrid.