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Tribotronic control of tilted pad bearings

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Tribotronic components consist of elements such as bearings, seals and gears, that incorporate sensors, intelligence and actuators to modify their performance in order to establish optimal operation. This paper introduces the concept of a tribotronic tilting pad bearing, optimised to operate with minimum power loss.

Keywords: tribotronics, tilting pad bearings, energy conservation.

1. Introduction

It is estimated that around 549 EJ (1 EJ =1018 J) of energy is produced across the globe annually [1]. Approximately one-third of this is consumed in energy production, leaving around 373 ET for use. Of this, one third is consumed by industry and about 20% of that (approximately 25 EJ) is used to overcome friction. Oil lubricated contacts are widely used in industry now and for the foreseeable future. Such contacts in bearings, gears, pumps, slideways, etc. are designed for minimal wear. However, they are not generally optimised for energy saving. A typical tilting pad bearing in a power station steam turbine may consume 2 MW to overcome viscous shear and this paper explores how actively controlled "tribotronic" tilting pad bearings, for applications such as this, may be optimised for minimum power loss to achieve significant energy savings.

2. Method

The term "tribotronics" has been coined [2] to describe a feedback control system comprising a sensor, a controller and an actuator that is used to dynamically modify the performance of a tribological element. The principle is similar to mechatronics, but it can additionally include the control of the physical and chemical properties of solids and fluids which are part of such a system. A schematic tribotronic system is illustrated in figure1.

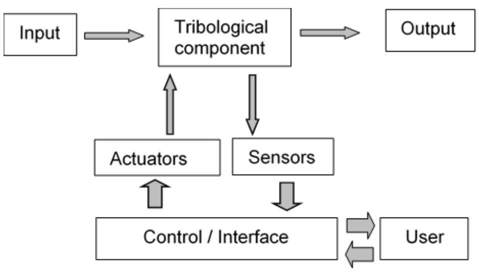

Figure 1 Schematic tribotronic system

Tribotronics can enhance the functional capability and maintainability of a component or system and can offer many opportunities for optimisation or functional improvement. These include control of stiffness or frequency response, dynamic control of lubricating film thickness, control of lubricant condition, lubricant formulation, activation of smart materials/coatings, etc. to manage physical properties such as friction.

3. Discussion

The principles of tilting pad bearing operation are well-established, and evaluating their operating state is straightforward if specific geometric and operating parameters are known. The aim here is to apply real time control in order to minimise energy loss due to changes in operating load, speed, lubricant viscosity, etc. This requires the implementation of both actuators and sensors. In order to collect pad operating data, a range of sensors will be used. Some sensors are routine to incorporate. However, while measuring some crucial tribological data, such as operating film thickness, is relatively simple in the laboratory, it is more challenging in field operation. To address this issue, parameters such as lubricant temperature will be considered as a proxies for use with embedded intelligence in order to establish the operating condition. The use of thin film sensors in an arrangement which could be implemented in field operating bearings will also be evaluated.

The design of actuators, for components that are conventionally passive, probably represents the biggest challenge in tribotronics, However, their evolution has now begun. A number of actuators for tilting pad bearings have been used by other investigators, these include hydraulic systems and piezo-electric arrangements for changing pad inclination as reviewed in [3].

4. Conclusion

This investigation is in its early stages. The final extended abstract will present the design features of the test equipment, along with details of the transducers and actuators to be evaluated for the system. It will also consider the principles of the control system to be implemented to minimise power loss.

5. References

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