Preface

The term "Tribology" is derived from Greek word, "TRIBOS", which means "rubbing", and "OLOGY" means science of "TRIBEN" or science of rubbing surfaces. The dictionary of the English language defines Tribology as the Science and Technology of Interacting Surfaces in relative motion and associated matters. In 1966, the British Lubrication Engineering Working Group defined Tribology as "The science and technology of interacting surfaces in relative motion and the practices related thereto". One of the better definitions of "Tribology" is that, it is an integrated study of Friction, Wear and Lubrication. The importance of Tribology has greatly increased during its long history, and modern civilization is surprisingly dependent on sound tribological practices.

Tribology deals with the technology of lubrication, the control of friction and prevention of wear of surfaces having relative motion under load. Moreover, it provides solutions to the problems which are of great economic significance namely, maintenance, reliability, and wear of equipment starting from small household appliances to spacecrafts. This subject is truly multidisciplinary because it is necessary to have an in depth knowledge in many areas such as chemistry of lubricants, physics of material science, mathematics and mechanical engineering for a thorough understanding of Tribology. Recently, Tribology is a decisive factor to a
A wide range of applications including high temperature engines made of ceramic, bio-technology, biomedical and environment. An important part in machine design to move different parts of the machine is bearing. In designing of bearings, one has to consider the geometrical conditions, the rotational speed, the elastic deformation and the load, the physical and chemical characteristics of the material, lubricants and temperature and many other factors.

The history of the subject dates back to the studies of friction by ancestors 350 BC who found that the friction for sliding was greater than that for rolling, which led to the understanding in modern terms that the static friction coefficient is greater than the kinetic coefficient of friction. Friction is a force that resists relative motion between two surfaces in contact.

Wear is much younger member in the Tribology family than friction and bearing development. It is defined as the progressive damage resulting in material loss due to relative contact between two adjacent working parts. However, it can be reduced by appropriate machinery design, precision machining, material selection and proper maintenance, including lubrication.

The lubricants generally, reduce wear and heat between contacting surfaces in relative motion. Any material used to reduce friction is called lubricant. Lubricants are available in solid, liquid and gaseous forms. The
scientific study of lubrication began with *Rayleigh-Stokes*, discussed the feasibility of theoretical treatment of film lubrication.

During the last two decades, the use of magnetic fluid as a lubricant modifying the performance of the bearing system has attracted a good number of investigators. Recently, considerable attention has been focused on the use of magnetic fluid as a lubricant. In fact, the magnetic fluid is a suspension of solid magnetic particles in a liquid carrier.

It is well known facts that after receiving some run-in and wears the bearing surfaces develop roughness which appears to be random in character and it may not follow any particular structural pattern. The contamination of the lubricant is also responsible for making a bearing surface rough through chemical degradation. The surface roughness of the bearing surfaces significantly affects the performance of the bearing system. The transverse surface roughness has been a matter of discussion in various recent investigations because of its adverse effect. The effect of roughness on the performance of the bearing system may be different for different geometrical shapes.

When sufficient amount of load is applied to a metal or other structural material, it will cause the material to change shape. This change in shape is called deformation. A temporary shape change that is self-reversing after the force is removed, so that the object returns to its original shape, is called elastic deformation. In other words, elastic
deformation is a change in shape of a material at low stress that is recoverable after the stress is removed.

The present study is concerned with the investigations of performance of a magnetic fluid based squeeze film between two rotating transversely rough porous circular plates, annular plates and the performance of a magnetic fluid based rough short bearing considering the bearing deformation.

The content of the thesis is distributed in seven chapters. A brief introduction appears in Chapter 1. It includes the role of bearings in machine with the important factors for the process of lubrication such as types of bearing, geometry of surfaces, types of lubricant, types of loading etc. The necessary modification in the mathematical modeling of the bearing system is developed which follows by a discussion on bearing design characteristics. Porous rough bearings in particular, have been discussed in details incorporating the deformation. At the end of the chapter, the review of the related literature is given.

The derivation of the modified generalized Reynolds' equation with suitable boundary conditions for the pressure distribution in different bearing system is presented in Chapter 2. The modified Reynolds' type equations encompass the effect of magnetic fluid with different geometry of surfaces and surface roughness along with rotation and deformation.
Chapter 3 deals with the exploration of performance characteristics of a magnetic fluid based squeeze film between two rotating transversely rough porous circular plates along with the bearing deformation. The graphical representations indicate that the roughness of the bearing surfaces adversely affects the performance characteristics, even if, the magnetic fluid lubricant results in an improved performance. It is observed that the rotation and deformation cause reduced load carrying capacity. At the same time this study establishes that the negative effect of porosity, deformation and standard deviation can be minimized up to certain extent by the positive effect of the magnetization in the case of negatively skewed roughness by suitably choosing the curvature parameters and the rotation ratio. It is also observed that in this type of bearing system the overall effect of the deformation is nominal. Moreover, the adverse effect of roughness and porosity appears to be reduced due to the hydromagnetic effect. The presence of bearing deformation tends to make it mandatory that from the bearing’s life period point of view, the roughness must be accorded priority while designing this type of bearing system, albeit, the magnetization parameter, rotational inertia and curvature parameters are suitably chosen.

Chapter 4 is devoted to analyze the behaviour of a magnetic fluid based squeeze film between rotating transversely rough porous annular plates incorporating elastic deformation. The results indicate that the
roughness of the bearing surfaces affects the performance adversely although; the bearing registers an improved performance owing to the magnetic fluid lubricant. It is seen that the deformation causes reduced load carrying capacity. This investigation reveals that the adverse effect of porosity and standard deviation become quite critical when large values of deformation are involved. For overall improved performance, this study suggests for evaluating the roughness aspect while designing bearing system. This is all the more necessary because of the presence of bearing deformation.

Chapter 5 covers the studies dealing with Ferrofluid based squeeze film performance in rotating curved transversely rough porous circular plates taking bearing deformation into consideration. The results suggest that the transverse surface roughness induces an adverse effect on the performance characteristics while the magnetic fluid lubricant increases the viscosity thereby, leading to an improved performance. It is found that the combined effect of rotation and deformation cause significantly reduced load carrying capacity. This reduction in load carrying capacity comes at a critical phase when higher values of porosity and standard deviation are involved. However, it is revealed that the adverse effect of porosity and standard deviation can be reduced to some extent by the magnetic fluid lubricant, at least in the case of negatively skewed roughness even for higher values of bearing deformation and rotational
An endeavor has been made in Chapter 7 to discuss the squeeze film performance between rotating transversely rough curved porous annular plates in the presence of magnetic fluid lubricant considering the effect of elastic deformation. A stochastic random variable with nonzero mean, variance and skewness characterizes the random roughness of the bearing surfaces. With the aid of suitable boundary conditions the associated stochastically averaged Reynolds’ equation is solved to obtain the pressure distribution in turn, which results in the calculation of the load carrying capacity. The graphical interpretations establish that the transverse roughness in general, adversely affects the performance characteristics. However, the magnetization registers a relatively improved performance. It is found that the deformation causes reduced load carrying capacity which gets further decreased by the porosity. This search tends to indicate that the adverse effect of porosity, standard deviation and deformation can be recompensed to certain extent by the positive effect of the magnetic fluid lubricant in the case of negatively skewed roughness by choosing the rotational inertia and the aspect ratio especially, for suitable ratio of curvature parameters. Lastly, it is noted that even a judicious choice of the aspect ratio may play an important role in improving the performance of this type of bearing system considering the moderate values of deformation and rotational inertia.
The occurrence of bearing deformation tends to suggest strongly that the roughness must be given due consideration while designing this type of bearing system, even if, magnetic strength has been chosen suitably, as there are several factors affecting the system adversely. It is important to note that the bearing can support a load even in the absence of flow, unlike the traditional lubricants. The importance of this work lies in the fact that it offers an additional degree of freedom from design point of view in terms of the magnitude's form of the magnetic field.

Entire portion of the thesis has been published in various peer reviewed International Research Journals. Details of the papers included in this thesis are listed below in order:


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