The word Tribology is derived from the Greek root "tribein", meaning rubbing or sliding. Tribology is becoming more and more interdisciplinary, embracing physics, chemistry, metallurgy, biology and engineering. After gravity, tribology is the second most important property of matter; it is a complex science that impacts every person in almost every situation and has a tremendous effect on industry at large, from energy consumption and wear in the largest machines to the joints in our bodies. It includes technological relevant phenomena such as friction, wear and lubrication. Tribology applies on operational analysis to problems of great economic significance, such as, reliability, maintenance and wear of technical equipments ranging from household to spacecraft appliances. Much of the tribological research is applied or commercially orientated and already a wide range of wear resistant or friction reducing materials have been developed. The basic concept of tribology is that friction and wear are best controlled with a thin layer of intervening film of material separating sliding, rolling and impacting bodies. The aim of tribology is either to find the optimum film material for a given application, or to predict the sequence of events when a sliding/rolling/impacting contact is left to generate its own intervening film.

Bearings are required wherever there is permanent relative contact between two surfaces, no matter how lightly loaded the surfaces are. The purpose of the bearing is to reduce friction and wear and to reduce repair costs when the component is refurbished.

Friction is in principal cause of wear and energy dissipation. On the other hand friction can only occur when two bodies are in relative rubbing motion, and rubbing
means that the bodies are in actual contact resulting in unsmooth relative motion of the surface and wear. Consequently, this results in the reduction of machine life. In order to reduce friction and wear between moving machine elements, a lubricant is introduced between them. The objective of the lubrication is to reduce friction, wear and heating of machine parts, which are in relative motion.

During the last 15-20 years the importance of using a magnetic fluid as lubricant has been realized. To improve the overall performance of the bearing systems the magnetic fluids are employed. A magnetic fluid can be positioned by a constant magnetic field. So it is quite natural to use the magnetic fluid as a lubricant. Control of the position of such a medium and its supply to a friction zone, present no difficulties; however, a problem arises, concerning its lubricating properties. Magnetic fluids are functional ones to respond to a magnetic field and widely investigated in the basic and applied fields. In the application of magnetic fluids, many studies for development of magnetic fluid damper, actuator and other various equipments have been conducted. Magnetic fluid based bearing system has attained considerable importance because of its contribution towards the industrial applications in a variety of engineering devices and systems, such as, in lubrication and sealing of bearings. With many specific and particular physical and chemical properties, magnetic fluids have been widely used in grinding, separation, ink-jet printing, damper support and matching gears. Moreover, it is also applicable in bio-sciences such as skeletal joint, surgical cancer treatment and movement of blood flow in human system.

In most of the lubrication theories the bearing surfaces are assumed to be smooth, which is far away from bearing true in real practice. In fact, after having some run-in and wear the bearing surfaces develop roughness. Even sometimes the contamination of lubricants and materials used in design contribute to roughness. Roughness plays an important role in determining how a real object will interact with its
environment. Rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces. Although, roughness is usually undesirable, it is difficult and expensive to control in manufacturing. Decreasing the roughness of a surface will usually lead to an increase in manufacturing costs.

The Discussions in the Thesis is Spared Over to Eight Chapters

- Initially, we will concentrate on the basic concepts of Tribology, which is the science and practice of interacting surfaces in relative motion and of the practices related thereto. It includes technological relevant phenomena such as friction, lubrication and wear. Irrespective of the contact geometry, a key role of lubrication is to reduce the friction acting on rubbing surfaces during operation. Bearing this in mind, the control of friction in contacts lubricated with magnetic fluids and operating in the hydrodynamic lubrication regime is taken as the main objective of the present work. Next, we focus on squeeze film action which plays a prominent role in the dynamics of fluid film bearing where loads vary appreciably. In the context of Christensen and Tonder’s stochastic theory for the rough surfaces, one-dimensional roughness patterns would be our plan to consider. Finally, it will be our endeavour to study and analyze the combined effects of magnetic fluid lubricant and surface roughness on the performance of the respective bearing system. A brief review of the relevant literature is included in Chapter 1.

- Chapter 2, discusses the method of deriving the generalized Reynolds type equation for the pressure distribution in a bearing system. This modified Reynolds equation incorporates the effect of magnetic fluid, geometry of surface and surface roughness. Mathematical models have been developed for understanding the lubrication characteristics of porous squeeze film bearings in which fluid flow is governed by the Neuringer-Rosensweig fluid model and surface roughness characterized by stochastic theory. Since the viscous lubricant has the resistance to
extrusion, a pressure is thus built-up in the squeezed film, which supports the load. To obtain equation for friction this requires that the integral of the pressure should balance the applied load. The mathematical investigation carried out in the rest of the thesis is based on the discussion conducted in this chapter.

- **Chapter 3**, focuses on the performance of a rough exponential slider bearing under the presence of a magnetic fluid lubricant. A stochastic random variable with non-zero mean, variance and skewness characterizes the transverse roughness of the bearing surfaces. A magnetic fluid is taken as the lubricant and the magnetic field is oblique to the stator. The concerned stochastically averaged Reynolds equation is solved with appropriate boundary conditions to arrive at the expression for the pressure distribution leading to the computation of the load carrying capacity. Moreover, the friction at the runner plate and bearing surface has been calculated. It is established that not only the load carrying capacity but also the friction increase with increasing magnetization. The negatively skewed roughness induced increased load carrying capacity goes a long way in mitigating the adverse effect of the standard deviation taking recourse to suitable values of magnetization parameter. Some measures are suggested to reduce the friction through the positive effect of magnetization, in case, negative variance occurs. Besides, the bearing can support a load even when there is no flow. This article may also provide some measures for extending the life period of the bearing system.

- **Chapter 4**, describes the performance of a porous rough secant shaped slider bearing under the presence of a magnetic fluid lubricant. The concerned stochastically averaged Reynolds equation is solved to get the pressure distribution, which is then used to get the expression for the load carrying capacity. Consequently, the friction is also calculated. Computed values of dimensionless load carrying capacity and friction are displayed in graphical forms. The figures presented here tend to establish that the use of magnetic fluid as a lubricant increases the load carrying capacity and decreases
the friction. However, the present study reveals that the negative effect of porosity and standard deviation can be reduced to a large extent by the positive effect of the magnetization parameter in the case of negatively skewed roughness. Further, this reduction becomes more evident when the negative variance is involved.

Chapter 5 deals with the surface roughness effect on the performance of a magnetic fluid based hyperbolic slider bearing. The transverse roughness of the bearing surfaces is modeled by Christensen's stochastic theory. The associated Reynolds equation is averaged with respect to the random roughness parameter. The concerned non-dimensional differential equation is then solved with suitable boundary conditions in dimensionless form to get the pressure distribution, which in turn, is used to find the expression for the load carrying capacity paving the way for the calculations of friction. It is seen that the load carrying capacity increases while friction decreases due to the magnetic fluid lubricant. It is noticed that positively skewed roughness and variance (+ve) decrease the friction. Thus, this article offers some scopes for reducing the friction while increasing the load carrying capacity at the same time. Beside, a measure is mooted to extend the life period of the bearing system.

In Chapter 6 an approach to deal with the study of rough tilted pad slider bearing lubricated with a magnetic fluid is provided. A mathematical model based on the stochastical averaging process, is developed. The expressions for non-dimensional pressure, load carrying capacity and friction are derived. The computed results make it clear that the bearing working with magnetic fluid as a lubricant has a better performance than that of an identical bearing working with a conventional lubricant. In addition, it is concluded that the adverse effect of transverse roughness can be reduced to some extent by the positive effect of the magnetic fluid lubricant. However, this reduction gets larger due to negatively skewed roughness, especially when variance (-ve) occurs.
Lastly, in Chapter 7 efforts have been made to investigate the performance of an infinitely long rough porous journal bearing in the presence of a magnetic fluid lubricant. The random surface roughness of the bearing surfaces is characterized by a random variable with non-zero mean, variance and skewness. With the aid of suitable boundary conditions the associated stochastically averaged Reynolds equation is solved for various performance characteristics such as pressure, load carrying capacity and friction. The graphical results suggest that the bearing system registers an enhanced performance as compared to that of a bearing system working with a conventional lubricant. In this investigation the role of eccentricity ratio is equally crucial. Further, the Petroff's equation is found to be true at the end.

Finally, in Chapter 8 important general conclusions based on the investigation presented in the earlier chapters of this thesis are summarized and are reported. Moreover, this chapter also includes the recommendation for future work.

The results incorporated in this thesis underline that the bearings can support a load even when there is no flow. In addition, this dissertation makes it mandatory to account for roughness while designing the bearing system, especially, from bearings life period point of view.

All most, the entire matters incorporated in the thesis, have been published in various International Journals.

1. “Performance of a magnetic Fluid Based Exponential Slider Bearing and Surface Roughness Effect”

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2. “Surface Roughness Effect on the Performance of a Magnetic fluid Based porous Secant Shaped Slider Bearing”

   S.D.SHUKLA and G.M.DEHERI
3. “Surface Roughness Effect on the Performance of a Magnetic fluid Based Hyperbolic Slider Bearing”

S.D.SHUKLA and G.M.DEHERI


4. “Rough Tilted Pad Slider Bearing Lubricated with a Magnetic Fluid”

S.D.SHUKLA and G.M.DEHERI


5. Performance of a magnetic fluid based infinitely long rough porous journal bearing

S.D.SHUKLA and G.M.DEHERI