

Fluid Film Lubrication

Fluid film bearings are among the best devices for overcoming friction and eliminating wear. They are machine elements and, together with shafts, gears, and cams, constitute the building blocks engineers use in the design and construction of mechanical devices.

This book offers a systematic treatment of the fundamentals of fluid film lubrication and fluid film bearings. The introduction places fluid film bearings within the broader context of tribology, a subject that encompasses friction, lubrication, and wear. The early chapters provide a thorough discussion of classical lubrication theory. The remainder of the book is devoted to critical aspects of fluid film lubrication and bearing design. These later chapters consider the more advanced topics of inertia, thermal and turbulence effects, lubrication of counterformal contacts, and non-Newtonian lubricants. Also included are areas in which future developments are likely and/or desirable, such as lubrication with emulsions. The large number of references throughout the book will guide the reader in further study.

Graduate and senior undergraduate students, researchers, and practicing engineers will appreciate this clear, thorough discussion of fluid film lubrication and fluid film bearings.

Andras Z. Szeri is the Robert Lyle Spencer Professor of Mechanical Engineering and Chair of the Department of Mechanical Engineering at the University of Delaware.

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*To my wife Mary for her continued encouragement,
and to my children, Maria, Cora, and Andrew, for
they have always made me proud.*

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Fluid Film Lubrication
Theory and Design

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Preface

Fluid film bearings are machine elements which should be studied within the broader context of tribology, “the science and technology of interactive surfaces in relative motion and of the practices related thereto.”* The three subfields of tribology – friction, lubrication, and wear – are strongly interrelated. Fluid film bearings provide but one aspect of lubrication. If a bearing is not well designed, or is operated under other than the design conditions, other modes of lubrication, such as boundary lubrication, might result, and frictional heating and wear would also have to be considered.

Chapter 1 defines fluid film bearings within the context of the general field of tribology, and is intended as an introduction; numerous references are included, however, should a more detailed background be required. Chapters 2, 3, and 4 outline classical lubrication theory, which is based on isothermal, laminar operation between rigid bearing surfaces. These chapters can be used as text for an advanced undergraduate or first-year graduate course. They should, however, be augmented with selections from Chapter 8, to introduce the students to the all important rolling bearings, and from Chapter 9, to make the student realize that no bearing operation is truly isothermal. Otherwise, the book will be useful to the industrial practitioner and the researcher alike. Sections in small print may be omitted on first reading – they are intended for further amplification of topics. In writing this book, my intent was to put essential information into a rational framework for easier understanding. So the objective was to teach, rather than to compile all available information into a handbook. I have also included thought-provoking topics; for example lubrication with emulsions, the treatment of which has not yet reached maturity. I expect significant advances in this area as it impacts on the environment.

The various chapters were read by Dr. M. L. Adams, Case Western Reserve University, Dr. M. Fillon, University of Poitiers, France, Dr. S. Jahanmir, National Institute for Standards and Technology, Dr. F. E. Kennedy, Dartmouth College, Mr. O. Pinkus, Sigma Inc., Dr. K. R. Rajagopal, Texas A & M University, Dr. A. J. Szeri, University of California at Berkeley, and Dr. J. A. Tichy, Rensselaer Polytechnic Institute. However, in spite of the considerable assistance I received from various colleagues, the mistakes are mine alone.

The typing was expertly done by my daughter Maria Szeri-Leon and son-in-law Jorge Leon. I am grateful to them for their diligence and perseverance; not even their wedding interrupted the smooth flow of the project. I would also like to thank Ms. Florence Padgett, Editor, Cambridge University Press, for suggesting the project and for having confidence in me. My thanks are also due to Ms. Ellen Tirpak, Senior Project Manager, TechBooks, for providing expert editing of the manuscript.

* British Lubrication Engineering Working Group, 1966.