journal of lubrication technology

book reviews

Design of Film Bearings, by P. R. Trumpler. The Macmillan Co., New York, N. Y., 1966, 258 pp. $9.95.

REVIEWED BY J. F. BOOKER[1]

It has been some years since any *textbook* has been able to make current research activity and literature in fluid film bearings intelligible to the general practicing engineer or student. *Design of Film Bearings* is an aptly named and very worthwhile assault on that goal.

The author, Professor of Mechanical Engineering at the University of Pennsylvania, notes in his Preface that the present volume is based on course notes from many years of teaching and "has a dual objective: to provide guides for the practicing engineer engaged in the design of film bearings and to serve as a textbook for college or university students in engineering design." Though two such different audiences of necessity have conflicting requirements which no single book can meet completely, this seems a balanced effort, perhaps favoring the student. Teachers will be interested by the preface exposition of the author's philosophy of engineering design education, which might be best characterized as "application of applied mechanics." Particularly interesting are the *changes* in engineering education reflected in two preface versions, the first written eleven years ago to accompany the original class notes.

The text itself consists of some 36 sections grouped within four main parts: Foundations, Slider-Pad Bearing, Journal Bearing, and Compressible-Fluid Bearings. Part One is limited to some introductory remarks and a summary of relevant material from fluid mechanics and rheology. Parts Two and Three, which take up 80 percent of this book, contain the meat of the author's subject matter—the development and application of the incompressible-film Reynolds equation to a representative variety of self-acting thrust and journal bearing problems. Part Four provides a very short (20 pp.) parallel treatment for compressible films, largely confined to numerical results.

A few somewhat unconventional features of the treatment (besides the spelling of Reynolds' given name) should be mentioned. The Reynolds equation is treated via an annotated reproduction of Reynolds' original derivation (in modern notation), a commendable tactic likely to instill in the student some appreciation of the generality *and* difficulty of the original work. The discussion is excellent, noting each simplifying assumption and the necessity (or lack) thereof. Important matters often overlooked elsewhere include the possibility of noninertial reference frames as well as the *difference* between relative normal velocity and the partial time derivative of film thickness—a common source of published error and a matter upon which Reynolds himself was anything but clear. Unfortunately, the author omits the excellent velocity profile sketches offered in the original work to explain the basic mechanism(s) of film lubrication. In fact, the book in general is somewhat lacking in such "plausibility arguments," a factor which may limit its usefulness for self-study.

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The modern "design" orientation of the author is shown by the fact that a digital computer solution (by finite differences) follows immediately the derivation of the Reynolds equation, with the usual one-dimensional closed-form solutions put off until later. The text treatment includes some ten pages on machine-language computations, while an Appendix (of apparently later vintage) on FORTRAN implementation of the same problem requires only a page or two. The latter would probably be more useful in selling the novice on the very considerable value of the computer in such applications.

A few relatively unimportant features of the treatment bothered this particular reviewer, as for example the use of the symbol n for eccentricity ratio (except in Part Four) and a treatment of "finiteness" (end-leakage) which seems overly dependent on a multiplicity of "end-leakage correction factors" (an emphasis apparently acknowledged by the footnote on p. 151).

An unusual feature for such a book is an excellent and quite detailed account of the journal stability problem, based largely on the published work of Reddi and Trumpler.

There is also a welcome section on bearing film "cavitation," carefully distinguishing it from the damage-causing phenomenon which normally carries the name in the general literature (though there is evidence to suggest that the footnote on p. 123 may go a bit *too* far in this distinction).

One can always quarrel with an author's choices of topics for inclusion and omission, particularly in a *textbook* purposely limited in size and scope. One might look in vain for mention of any of the "farther-out" subjects which indicate the breadth of the field: turbulence, porous bearings, elasto-hydrodynamic and magneto-hydrodynamic lubrication. This reviewer is more concerned that of the major mechanisms of fluid film lubrication only the wedge-film receives any serious attention. Both externally pressurized bearings and the simpler squeeze-film cases (e.g., in thrust bearings and/or wrist-pins) are largely neglected though their theoretical basis is carefully maintained.

References are quite adequate and appropriately chosen for an introductory text, though one wishes some kind of listing had been used as a supplement to scattered footnotes. Considering the probable audience, the only serious shortcoming is the lack of reference to any of the other general works besides Gross presently in print. The two-page index seems barely adequate for even so short a book.

Very definitely on the plus side are the problems which close each of the 36 sections. Problems can be an integral part of a textbook or merely extraneous. Professor Trumpler's are integral extensions of the main themes, a cross between what other authors call "problems" and "worked examples." Some are conventional enough, but many are open-ended, leaving unanswered a series of provocative questions which can be argued in the halls outside many future lubrication symposia.

Professor Trumpler presents his subject as fascinating unfinished business. Certainly the text is one designers and college-level instructors will want to consider as a place to begin the serious study of hydrodynamic lubrication.