Book Review


This book presents a review of the acoustic theory of mufflers for piston engines and for ventilation systems, but excluding flanking transmission. It is addressed to graduate students and designers specialising in this area of technical acoustics. There is a natural bias towards basic analytical methods with which the author is most familiar, thus other methods available in the current literature have been intentionally omitted. It is divided into eight chapters with a useful bibliography at the end of each. These again are often intended to be illustrative of the text rather than exhaustive, while the publications cited are all restricted to those written in English.

The first chapter begins with the derivation of the basic linearised equations for the propagation of plane acoustic waves in ducts, with an inviscid stationary medium and unyielding boundaries. Consideration is then given to non planar waves, fluid viscosity, mean flow and compliant boundaries. This provides the foundation for later chapters.

Chapter 2 presents linear acoustic filter theory for a stationary medium based on lumped elements and draws the well documented analogy with lumped electrical networks. It concludes with a novel approximate method for the description of higher-order modes in simple expansion chambers.

Chapter 3 extends the linear analysis of chapter 2 to include the convective effects of mean flow. It then gives consideration to perforated tube elements. It presents approximate methods for simplifying the evaluation of the transfer matrices for such elements by a decoupling technique, followed by some considerations of the acoustic impedance of the perforate.
Chapter 4 describes an alternative to linearised acoustic wave analysis by presenting an outline of the method of characterisation. The application to piston engine breathing calculations follows the scheme developed by Benson and others. The treatment is necessarily somewhat superficial, but provides a clear summary of all the relevant theory for this application. The modelling of conditions at area discontinuities is rudimentary and probably inadequate for noise calculations, while the problems introduced in such applications by restricted temporal resolution are also ignored.

Chapter 5 provides the theoretical background of a limited selection of acoustic measurement techniques appropriate to flow ducts. It concludes with a review of some attempts to quantify the acoustic source characteristics of the exhaust process, a difficult and perhaps fruitless task at the low frequencies where the bulk of the wave energy is concentrated. The text may be misleading in places, since it gives little indication of the practical precautions or the checks in the experimental procedures that are essential for meaningful measurements.

Chapter 6 is concerned with the theory of wave propagation through dissipative ducts. The emphasis is on methods applicable to the lowest order mode with conditions appropriate to ventilation systems. Chapter 7 gives a clear and concise introduction to the fundamentals of finite element methods as applied to mufflers of general shape. This provides an effective starting point for a student or new researcher, while the concluding list of references cover an in depth investigation of this topic. Chapter 8 presents an outline of muffler design with some consideration of the conflict between acoustic and engine operational requirements with other matters of practical significance.

Within the guidelines set by the author in his preface, the book represents a concisely written useful compilation of selected theoretical methods for wave analysis in exhaust and ventilation ducts. Many of these are reproduced from published material written by himself, or by his associates, so the book provides a useful summary of this material. The style of presentation is theoretical rather than practical. There are, for example, no illustrative examples of the application of the theory to a practical design process and neither are there details of the effectiveness with which such theoretical methods can predict installed system performance. This may reduce the practical usefulness of the book to a designer, although given sufficient experience to guide his judgement, he may find the details of the analytical techniques both of interest and of value.

The assumptions from which the analysis develops sometimes appear to have been adopted for their mathematical convenience rather than their physical realism. In any case, many of the basic premises are merely stated without any effective discussion of their validity or range of practical
application. Furthermore, some fundamental definitions are incomplete, including for example that for insertion loss. Here the essential invariance of the source is taken as read and not made explicit. Similar examples of imprecision in definition in the physical modelling exist throughout the text. Again, this is not serious perhaps for the experienced reader with an appropriate background of physical knowledge and understanding. Such sloppiness in definition and the frequent absence of clear indications of the physical implications implicit in some simplifying assumptions, represents a serious defect to the inexperienced reader, particularly when his interest extends beyond mathematical technique to practical application.

Despite these comments, the stated basic aim of the book is to present those theoretical methods which the author considers to be of practical value in muffler analysis and this it accomplishes. The material covered has been consolidated and presented in a consistent and coherent manner, which will be of both interest and value to all those involved in muffler design.

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