

Magnetohydrodynamic flow in rectangular ducts

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The paper presents an analysis of laminar motion of a conducting liquid in a rectangular duct under a uniform transverse magnetic field. The effects of the duct having conducting walls are investigated. Exact solutions are obtained for two cases, (i) perfectly conducting walls perpendicular to the field and thin walls of arbitrary conductivity parallel to the field, and (ii) non-conducting walls parallel to the field and thin walls of arbitrary conductivity perpendicular to the field.

The boundary layers on the walls parallel to the field are studied in case (i) and it is found that at high Hartmann number (M), large positive and negative velocities of order MV_0 are induced, where V_0 is the velocity of the core. It is suggested that contrary to previous assumptions the magnetic field may in some cases have a destabilizing effect on flow in ducts.

1. Introduction

The design of magnetohydrodynamic generators, pumps and accelerators requires an understanding of the flows of conducting fluids in rectangular ducts with finitely conducting walls under transverse magnetic fields. At the present time even the case of uniformly conducting incompressible laminar flow with no variation in the flow direction has not been fully analyzed. In this paper we confine ourselves to problems of this type alone. The main characteristics of such flows that need to be known are:

- (1) the volumetric flow rate q through the duct for given pressure gradient and magnetic field;
- (2) the potential difference between electrodes placed in the walls;
- (3) the stability of the flow.

Three exact solutions have been found for incompressible laminar flows in ducts with transverse magnetic fields:

- (1) rectangular ducts with non-conducting walls and the field perpendicular to one side (Shercliff 1953);
- (2) rectangular ducts with perfectly conducting walls (Chang & Lundgren 1961; Uflyand 1961);
- (3) circular pipes with non-conducting walls (e.g. Gold 1962 and Fabri & Siestrunk 1960).

Approximate methods have been developed for the physically interesting

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Magnetohydrodynamic Flow In Ducts

D. Küchemann, P. Carrière, N. Rott



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Magnetohydrodynamic Flow in Ducts Herman Branover,1978 Magnetohydrodynamic Flow in Ducts Herman Branover,1978 **Numerical simulations of MHD flow transition in ducts with conducting Hartmann walls : Limtech Project A3 D4 (TUI)** Krasnov, D.,Boeck, T.,Braiden, L.,Molokov, S.,Buehler, Leo,2016-10-26 **Boundary Element Method for Magnetohydrodynamic Flow** Münevver Tezer-Sezgin,Canan Bozkaya,2024-05-20

Boundary Element Method for Magnetohydrodynamic Flow offers one of the first systematic and detailed treatments of the application of boundary element method BEM to magnetohydrodynamic MHD flow problems It aims to fill in the gaps left by the earlier books on the application of BEM to some physical problems such as fluid dynamics elasticity and geophysics An overview of the theory of MHD flow and a comprehensive mathematical formulation of BEM for convection diffusion type differential equations are provided by the authors who heavily rely on their research and experience in the disciplines of BEM and MHD flow The book first discusses the basic principles of the BEM approach for the MHD duct flow problems in coupled form with the fundamental solution derived by the authors Specifically the BEM solutions of MHD flow in pipes of rectangular or circular cross sections and MHD flow in infinite regions are all covered emphasizing the convergence of infinite boundary integrals This book especially concentrates on the MHD flow in regions with partly insulated partly perfectly conducting boundaries by BEM giving also the parabolic boundary layer thickness emanating from the points of discontinuities on the walls The book secondly includes the dual reciprocity boundary element technique DRBEM an alternative form of BEM that expands the applicability of BEM to MHD flow and heat transfer problems as well as buoyancy MHD flow with magnetic potential and inductionless MHD flow The purpose of the book is to serve as a research book for applied mathematicians engineers scientists and graduate students who wish to learn in depth about the formulation and application of BEM in MHD flow problems As such it is an invaluable resource and a major contribution to the numerical solution of MHD flow problems

Magnetohydrodynamics Sergei S. Molokov,R. Moreau,H. Keith Moffatt,2007-08-26 Magnetohydrodynamics MHD studies the interaction between the flow of an electrically conducting fluid and magnetic fields It involves such diverse topics as the evolution and dynamics of astrophysical objects thermonuclear fusion metallurgy and semiconductor crystal growth etc Although the first ideas in magnetohydrodynamics appeared at the beginning of the last century the explosion in theoretical and experimental studies occurred in the 1950s 60s This state of the art book aims at revising the evolution of ideas in various branches of magnetohydrodynamics astrophysics earth and solar dynamos plasmas MHD turbulence and liquid metals and reviews current trends and challenges **Magnetohydrodynamics** Peter A. Davidson,Andre Thess,2002-07-30 This book is an introduction to terrestrial magnetohydrodynamics It is a compendium of introductory lectures by experts in the field focussing on applications in industry and the laboratory A concise overview of the subject with references to further study Three-dimensional Magnetohydrodynamic Flow in Diverging Rectangular Ducts Under Strong Transverse Magnetic

Fields John Scott Walker,1970 **Metallurgical Technologies, Energy Conversion, and Magnetohydrodynamic Flows**
Herman Branover, Yeshajahu Unger,1993 **Liquid Metal Magnetohydrodynamics** J.J. Lielpeteris,R.J.

Moreau,2012-12-06 Liquid metal MHD is within the scope of two series of international conferences One is the International Congress on MHD Power Generation held every four years which includes technical and economical aspects as well as scientific questions The other is the Beer Sheva Seminar on MHD Flows and Turbulence held every three years in Israel In addition to these well established meetings an IUTAM Symposium was previously organized in Cambridge UK in 1982 on Metallurgical Applications of MHD by the late Arthur Shercliff It was focussed on a very specific subject developing rapidly from the middle of the 1970 s The magnetic field was generally AC including frequencies high enough for the skin depth to be much smaller than the typical length scale of the liquid pool And the development of new technologies or the improvement of existing ones was the main justification of most of the researches presented and discussed Only two participants from Eastern countries attended this Symposium By the middle of the 1980 s we felt that on this very same topic ideas had reached much more maturity than in 1982 We also realized that a line of research on MHD flows related to fusion reactors tokamaks was developing significantly with particular emphasis on flows at large interaction parameter **MHD flow in a prototypical manifold of DCLL blankets** Mistrangelo, Chiara,Buehler, Leo,2014-07-23

Magnetofluidynamics in Channels and Containers U. Müller,L. Bühler,2013-03-09 The contents of this book has been the subject of a lecture course which the first author has held regularly for engineering students at the Technical University of Karlsruhe beginning in 1987 The book serves two purposes It introduces students in their fourth year study of basic engineering and graduate students to the fundamentals of magnetohydrodynamics Furthermore it may be used by engineers and physicists in research establishments and industry as a practical tool to become familiar with the particular phenomena of magnetohydrodynamics that they may encounter in technical liquid metal flows under the influence of magnetic fields The contents and structure of the book are motivated by the research and development work for a self cooled liquid metal blanket of future nuclear fusion reactors The research requirements for such a challenging project naturally lead to the frontiers of magnetohydrodynamic research This is reflected in the book by references to several publications and reports performed at the Forschungszentrum Karlsruhe and other research establishments However we are convinced that the advancement of magnetohydrodynamic knowledge gained within the framework of the Fusion Reactor Project may be utilized in other fields of engineering sciences **Progress In Astronautics and Aeronautics** Herman Branover,1998 **Annual Report 2014 of the Institute for Nuclear and Energy Technologies** Schulenberg, Thomas,2015-10-27 **Energy Research Abstracts** ,1995 **Scientific and Technical Aerospace Reports** ,1971 **Nuclear Science Abstracts** ,1975 **NIC Symposium 2014 - Proceedings** K. Binder, ,G. Münster,M. Kremer,2014-03-21 **Applied Mechanics Reviews** ,1974 *Progress in Aeronautical Sciences* D. Küchemann,P. Carrière,N. Rott,2014-12-02 Progress in Aeronautical

Sciences Volume 9 presents the vibrational characteristics of certain aircraft. This book supplements the comprehensive account of matrix methods of structural analysis. Organized into five chapters, this volume begins with an overview of the different schemes of the numerical method of characteristics for calculating three dimensional steady supersonic gas flow about bodies moving at incidence. This text then examines the flow of a perfect gas and provides the generalization for the case of equilibrium and non equilibrium flow of real gas. Other chapters consider the various aspects of the aerodynamic design of aircraft and discuss the application of modern computer methods to fluid mechanics. This book discusses as well the prospects for further development of the existing types and for the establishment of the as yet hypothetical types of aircraft. The final chapter shows how the evolution of the aerodynamic shape leads to a complete spectrum of major types of aircraft. This book is a valuable resource for engineers. *Progress in Applied Mechanics* Yeh Kai-Yuan, 2012-12-06

Prof W Z Chien was born on 9 October 1912 and 1982 saw the 70th anniversary of his birth. Some of his friends, colleagues and former students prepared this special volume in honour of his outstanding contribution to the field of mechanics. The volume does not contain contributions from all of his students and friends and for this we apologize. Prof Chien's family have lived in Qufangquiao Village Hongshengli Wuxi County Jiangsu Province for generations. Many members of his family have been teachers in this village. When he was 14 years old his father died and for a time it appeared necessary to terminate his education but fortunately an uncle Chien Mu who later became a very famous historian in China came to his aid and he was able to continue his studies. In 1931 he took entrance exams and was simultaneously admitted to five prestigious Chinese universities. Of these he chose to enter Tsing hui University in Beijing with major work in physics. He received his baccalaureate in 1935 and taught at middle school for a time until he was awarded a Sino British scholarship to study abroad. In the competition for this award three of the recipients were in the field of mechanics: Prof C C Lin, Prof Kuo Yung huai and Prof Chien Wei zang. All three arrived in Toronto in August 1940 and entered the Department of Applied Mathematics of the University of Toronto to study under Prof J L Synge.

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