PREFACE

Fluid transients is a very important topic both to scientists and scholars, as well as to practising engineers in the water supply field. Pressure surge or waterhammer phenomena can be a harrowing experience for the operator of a hydraulic system. Accordingly, the dynamic response of an automatic or regulated fluid conveyance system can be the key to a successful complex engineering scheme.

Research into aspects of theoretical and experimental unsteady flow in pipes, channels and rivers has been under continuous study for more than a century. Field tests on pressure pipes were systematically carried out by Joukowsky in Moscow and, in 1897, he demonstrated that the pressure rise produced in water flow in a pipe caused by the sudden closure of a valve, was identical to acoustic phenomena. Special protection devices like air chambers and safety valves were also studied by Joukowsky and a formula for the maximum pressure rise caused by waterhammer was found by him (as well as by Frizell in the USA, in 1898).

The basic waterhammer equations were deduced and first solved by Allievi in the early years of the 20th century. Graphical techniques produced by Schnyder (1929) and Bergeron (1931) allowed practical analysis of pressure control along pipes with different boundary conditions.

The advent of the computer allowed much more detailed analysis. It became possible to have smaller time and space steps, complex boundary conditions and two-phase flow. The analysis of large pipe networks also became possible. Nowadays, the node-element or component concept is a very powerful technique and allows a global analysis of 1-D flow systems. In pressure pipes, it allows for the more general ability to solve different kinds of hydraulic systems; from pumping to hydropower systems, from single gravity pipe systems to large water distribution pipe networks. Special advanced computational techniques are also being developed for rapid transient free surface flows.

Wave propagation phenomena are a common feature in different kinds of unsteady flows and a more unified reference frame can now be used which benefits from a better physical understanding, and from efficient numerical techniques derived from a global and multidisciplinary analysis.

This book presents well tried modelling and computational techniques for fluid transients in pipe networks, including open channel flow. Examples of special cases, including accidents and general incidents, are also presented as well as new fields of research. The book is divided into three parts, treating the following topics.

Section 1 – Pressure transient modelling and analysis techniques, as well as operational control techniques

Section 2 – Control of pressure surges or protection against waterhammer and case studies

Section 3 – Introduction to free surface transient flows in channels

A general bibliography section is included at the end of the book for further reading.

The present book reflects the authors' experience during the last 15 years in teaching, research and as consultants. It is a unique work linking two professional involvements in Portugal and Brazil on advanced analysis and design of hydraulic systems. The authors have tried not to present vague guidelines and criteria or false general solutions, but rather to show how practical cases were solved by them and what can be expected from up-to-date theoretical developments and research work.

A. Betâmio de Almeida and E. Koelle