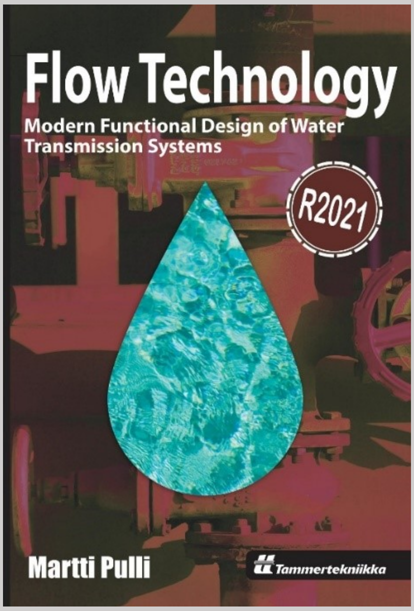
BOOK PRESENTATION

Flow Technology, Modern Functional Design of Water Transmission Systems *has been published February 2021. This writing presents the main contents and targets of the textbook in brief. The book is mainly based to a Finnish edition 2018.*

The author is ***Martti Pulli****. Book has been published by* ***Tammertekniikka.***



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TO WHOM THE BOOK IS FOR

The textbook is intended for international and domestic distribution, universities of applied science and professionals. The book deviates from ordinary textbooks such that theories are linked to real-life projects with detailed examples more comprehensively than done in ordinary textbooks. One important aim of this textbook to enable students, as early as possible, to connect the theoretical framework to the real-life applications to gain professional competence faster and with less effort and ensure that the students are prepared for working life.

ABOUT FUNCTIONAL DESIGN

The functional designer defines the technical boundary conditions, the system with all functionalities, interlockings and dependencies of the equipment and facilities for example with the following working topics.

- Design of the flow technical functionality of the whole system and dimensioning parameters of the main equipment
- Design of the safety systems
- Functional design of the flow technical structurers
- Analysis of pressure and head gradients both in steady and unsteady flow conditions
- Water hammer analysis and protective measures
- Design of the controlling systems
- Task giving for other designers, like pressure loadings, instructions for system controls, instructions for exceptional situations, dimensioning and location data for the main equipment, basic data for risk assessments, etc.

Task giving means instructions which must be considered by the other designers to achieve the desired functions.

DEFINITIONS AND FLOW TECHNICAL SPECIFIC NUMBERS

Theme related physics, flow technical machinery and equipment, structures, dimensioning parameters, and specific numbers are widely discussed in the book. Also, tools for the functional designer are discussed. The most important flow conditions i.e., steady, and unsteady state flow are defined mathematically, and various examples are presented. Theories for rigid and elastic flow conditions are devised.

MODELING OF UNSTEADY FLOW CONDITIONS

Modern modelling uses subject-specific special software. However, the software user must have sufficient prior knowledge of the relevant technology as physics, and mathematics in order to recognise and interpret the results of the calculations and to understand the numerous related physical phenomena, events and their dependencies. Without this knowledge, the project may lead to decisions based on false interpretations and ultimately substantial damages. The book discusses many practical guidelines for the modeller to improve the reliability of the result.

Many of the modelled examples have been accompanied with simplified "manually computed" solution to improve the understanding of the method and phenomena. For example, surge phenomena, dynamic behaviour of check valves, flow dynamics of centrifugal pumps, water hammer calculations in elastic system, etc.

Modelling of water hammer situations and their mitigation are an essential part of the textbook. Ordinary and special reasons for water hammer and their mitigation are illustrated. Important matters on the accuracy and reliability of the computations are presented, for example selection of correct time step dt (numerical method) is discussed comprehensively to prevent faulty results and interpretations. Figure 2.3 presents a case where step time too long caused remarkable error due to large scale cavitation in the pipeline.

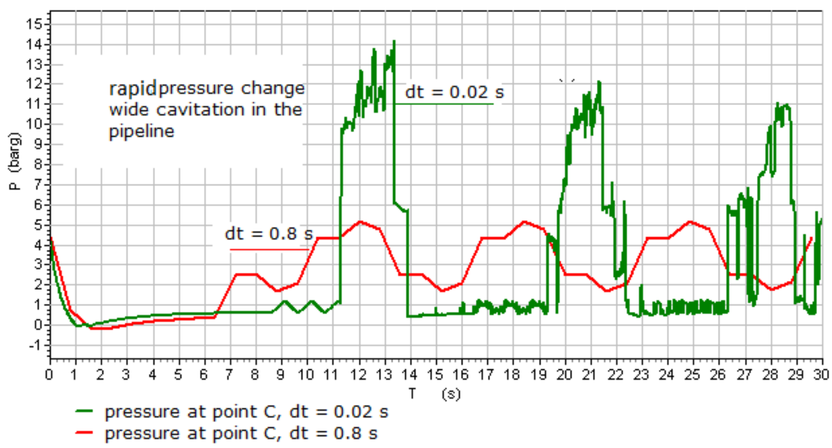

Figure 2.3 The Significance of the Time Step dt for the Calculation Accuracy in Rapid Changes.

FLOW TECHNICAL EQUIPMENT, LIQUID AND STRUCTURAL DYNAMICS

Equipment, machines, and other components are illustrated in depth. For example, stable and unstable capacity curves of centrifugal pumps and complete pump model according to Suter curves are discussed with examples and explanations. Cavitation both steady state and dynamic state cases of pumps, pipelines, valves, and hydraulic structures are discussed. Dynamic loads on pipes and structures are presented as one of many topics in the book. Air accumulating in the pipelines and the negative effect are discussed widely. Figure 2.58 presents unevenly distributed air effect on water hammers.

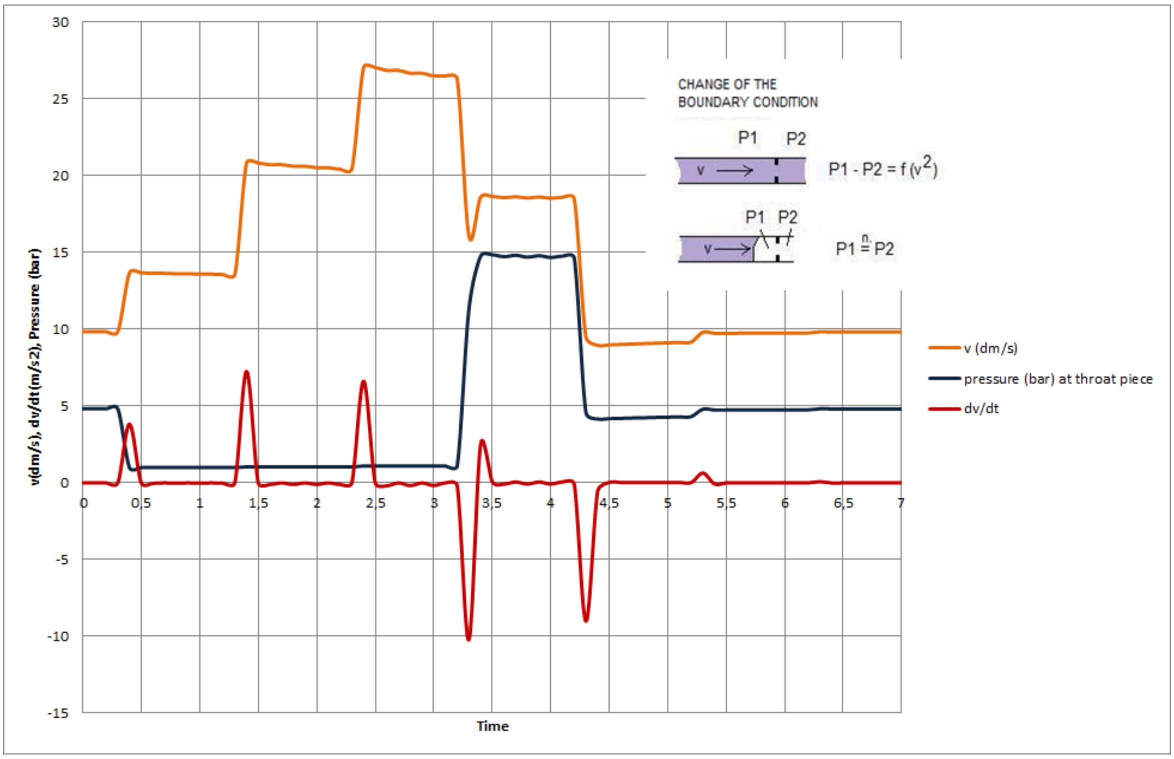

Figure 2.58 The Changes in the Pressure and Flow Rate States Calculated by Using the Method of Characteristics.

ABOUT ENERGY EFFICIENCY

Energy efficiency issues have been lately discussed widely and detailly due to its high importance. Pumping processes in water technology; communal and industrial, are remarkably energy users, and thus developing these processes may save huge amount of energy. It is researched that electric motors consume about 70% of all electrical energy in Europe, 22% of which are used in pumping applications. With different kind of equipment and control solutions possible energy saving could be 30…50% in pumping systems. This is due to, that the total efficiency of the existing pumping systems is only 40 %[1] or less.

[1] study report ISBN 978-952-214-982-4, Technical University of Lappeenranta, LUT

There are plenty of examples on energy efficiency and related topics discussed in the book. A table presenting observations, causes and corrective measures about most common cases is a good tool for the engineer.

Figure 4.35 presents the specific number of energy efficiency in an unrepaired and repaired pumping station while conditions change in the pumping environment. The specific number is detailly described in the book.

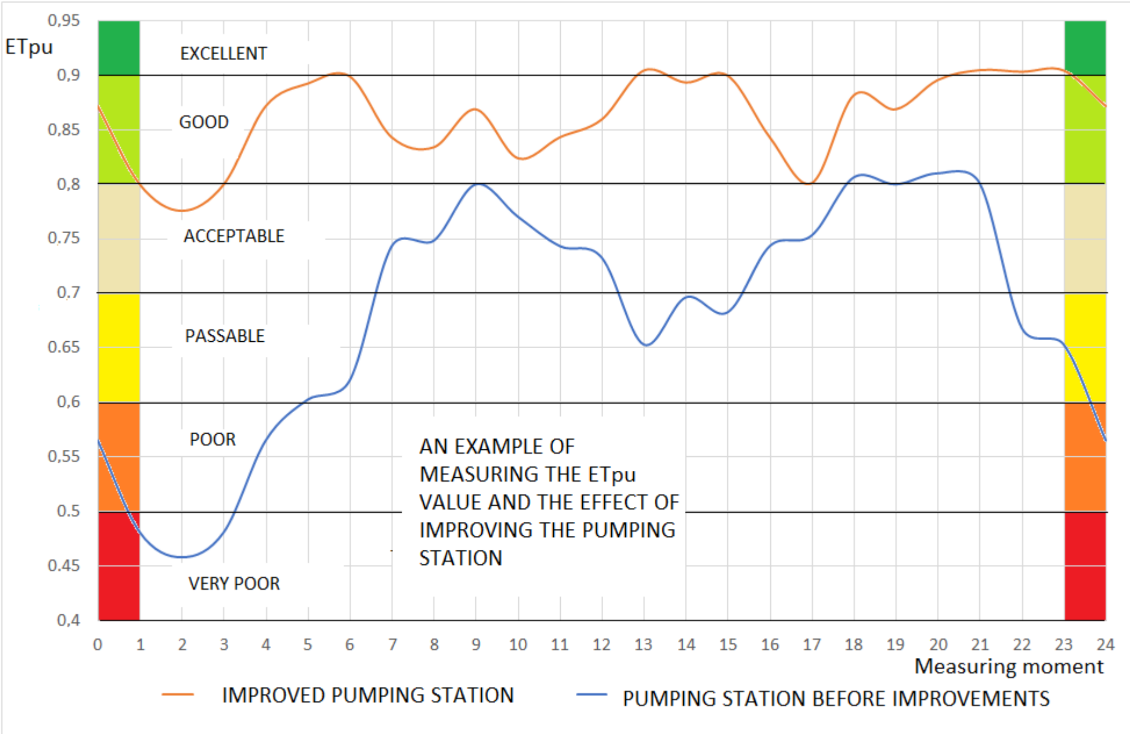

Figure 4.35 The Specific Number of the Energy Efficiency at the Pumping Station ETpu = f(t).

Energy recovery from a gravity main using small hydro-power plant is illustrated with a real-world case. Different kinds of turbines and their application areas are discussed widely. Figure 2.87 presents an impulse turbine plant located at the end of DN1200/60 km gravity main in South West Finland.

Figure 2.87 A Crossflow Turbine at the Discharge End of a Long Gravity Line.

CONTROL TECHNOLOGY, DYNAMIC MODELLING

The modelling and analysis of the effects of the control functions, the resultant hydraulic responses and the reaction responses impacting the control systems are extremely demanding tasks. The best and most realistic dynamic models can be achieved by using modelling software that are based on the method of characteristics or equivalent behaviour that consider the elastic and inertial properties of the system. This topic is widely discussed in the book.

DAMAGE AND MALFUNCTION ANALYSES

Modelling software can be used to reconstruct the damage or malfunction event to find the causes for the damages or malfunctions.

According to the author's experience the reconstruction has enabled several damage analyses to locate the malfunctions and damages of significant water transmission systems (cooling water systems, fire water/sprinkler, raw water tunnel systems, wastewater discharge systems of the processing industry, etc.) The design, reliability and efficiency of the corrective measures adopted based on the fault analysis improve significantly after the actual cause of the fault has been established.

EXAMPLES USED IN THE TEXTBOOK

There are plenty of functional design examples discussed in the book. The examples are connected to the theoretical framework and the real-life applications, for example to whole water distribution systems, partial processes, energy efficiency topics and their improvement measures and several special tasks.

THEORETICAL TOPICS

The final chapter presents devising of the methods used in unsteady state computations e.g., the method of characteristics, which is widely tested and proved as reliable method. The method is used almost in all remarkable modelling software. The user however must be aware of the application areas and limitations and boundary conditions of the method to be able correctly to interpret the results. There are plenty of instructions concerning this matter presented in the book.

AUTHOR

During his work at Finnish consulting firms (Vesi Hydro Oy, Soil and Water Ltd. and Pöyry Environment Oy), **Martti Pulli** specialised in hydraulics and machinery design, which are central to managing water transmission systems and flow rates. He has extensive experience in areas such as the functional review, design and failure analysis of long pipelines and their connected pumping and control stations.

Pulli has provided special reviews and designs for several notable municipal and industrial projects both in Finland and abroad as well as published numerous articles on flow technology in professional journals.

He was involved in the functional design of water transmission systems and worked as an expert on various project-related matters for the Turku Region Water Ltd. artificially recharged groundwater project. Another significant duty included the hydraulic grade line and operation analysis and various expert work for the extensive renovation of the Päijänne Water Tunnel. His special task entailed the feasibility analysis and functional design to ensure energy recovery in large and long potable water pipelines by using water turbines. This work also involved tasks such as the functional modelling of the turbine operation in different operating conditions and fault situations.

While working at Pöyry Environment Oy, Pulli's duties also expanded to large-scale, international projects.

Flow Technology *book is available in our webstore:* ***https://www.amk-kustannus.fi/p/flow-technology***

FLOW TECHNOLOGY

Modern Functional Design of Water Transmission Systems

Martti Pulli

Tammerteknikka

FINLAND

FLOW TECHNOLOGY

Modern Functional Design of Water Transmission Systems

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