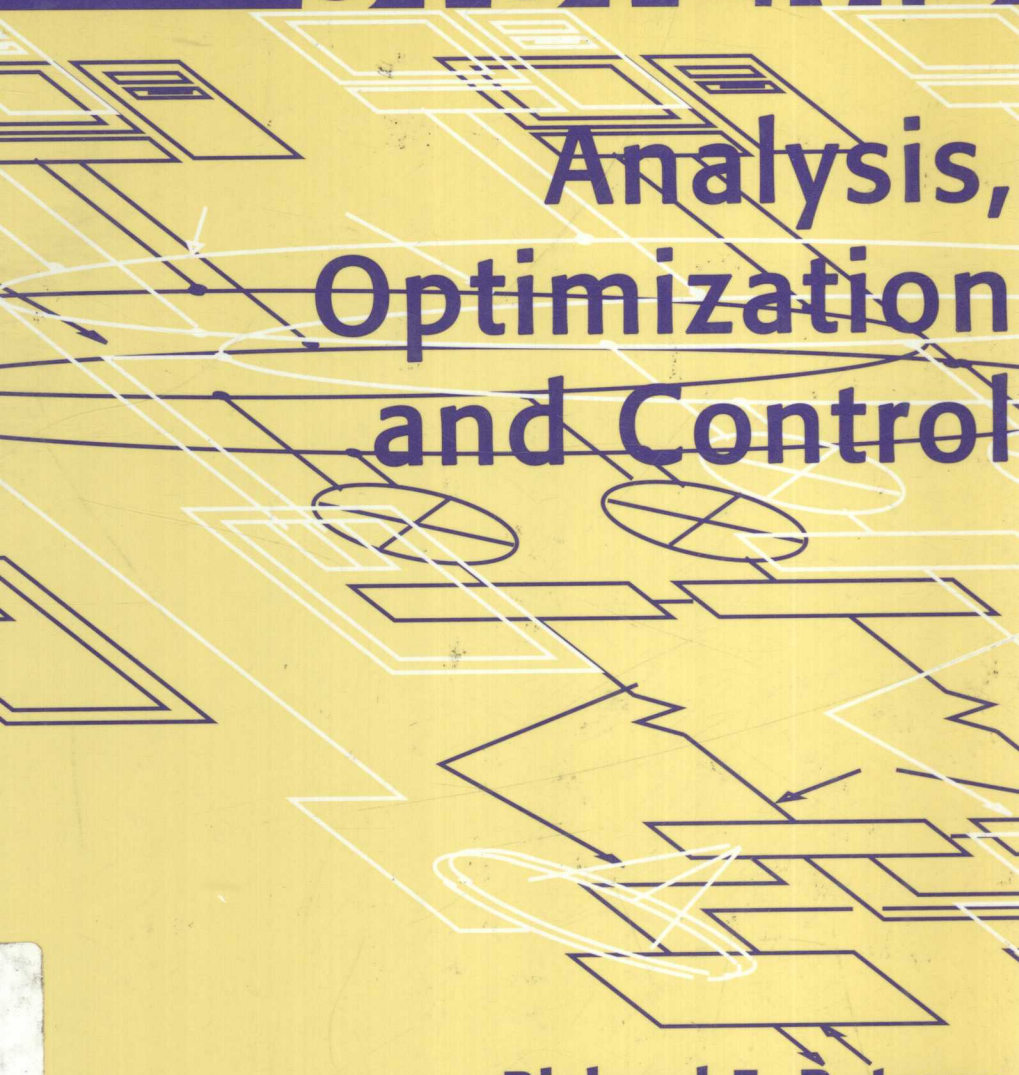
INDUSTRIAL ENERGY SYSTEMS

Analysis, Optimization and Control



Richard E. Putman

INDUSTRIAL ENERGY SYSTEMS: ANALYSIS, OPTIMIZATION AND CONTROL

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To Agnes
Wife and Mother to Caroline and William
Best Friend and Constant Companion
for nearly 40 years and a
Fellow-Student in the University of Life

Acknowledgement

ASME Press would like to acknowledge the generous assistance of Richard Putman's colleagues and friends, Frederick C. Huff and George Saxon, Jr., in completing this important publication after the author's untimely passing. Without their kind efforts, this book may never have been published.

Tribute to the Author

Richard E. J. Putman, the author of this book, was known as Dick to his friends. Unfortunately, Dick passed away before this book was published. He died on Easter Sunday, April 20, 2003, at his residence in Charlotte, N.C., after a long and courageous battle with cancer. Dick was born in London, England on June 18, 1925. He received his degree in Mechanical Engineering from Paddington Engineering College, London, U.K., in 1945. Dick became a Chartered Mechanical Engineer in 1952. He was also a member of ASME and both the IEEE and ISA. Dick was elected Fellow of ASME in 2002.

Dick met his wife Agnes in Budapest, Hungary in 1961. They were married and shortly after Dick helped Agnes and her family flee from the former Communist Hungary. He went behind the Iron Curtain for her, persevering through the red-tape and danger, then secreting her out of Hungary, through Sweden, the UK, Australia, then Cleveland and finally to Pittsburgh. For the first two years that Dick and Agnes knew each other they had to communicate in Latin since Agnes did not know English and Dick did not speak Hungarian.

Between 1948 and 1964, Dick was engaged in the boiler control industry in the U.K. and Canada. From 1965 until 1990, he was an employee of Westinghouse where he became responsible for equipment performance analysis, advanced computer control technologies, and plant optimization strategies. He retired from Westinghouse in 1990 and became the Technical Director of Conco Consulting Corporation.

While at Westinghouse Dick became a pioneer in the field of Industrial Energy Management systems. During this time period he was awarded 38 U.S. patents to go along with his

6 British and one Canadian patent. He also authored more than 80 published technical papers and articles. Continuing his career with Conco, Dick became an expert in the areas of heat transfer and condenser performance.

Dick was always a gentleman and a technocrat of the highest order. While he worked at Westinghouse if there was ever a subject that the division needed an expert on Dick was always selected. He would give a technical explanation (deep enough to have lost you early-on) and would frequently close with a cheerful statement of, "..it's really quite simple". He never showed anger or frustration with his fellow employees or customers. He was so bright and articulate that he was always called on to talk to customers at every opportunity to help sell our products and services. He was reliable, always there, and was a truly positive influence on the people that worked with him. In the 1970's Dick was chosen to accompany former Westinghouse CEO Doug Danforth on a visit to China right after President Nixon opened trade between the US and China.

Dick excelled as a mentor and teacher. He always led by example and never asked any of his subordinates to do anything he wouldn't do himself. He willingly shared his knowledge and boundless enthusiasm with his co-workers. He freely offered his friendship and he really cared for the people with which he worked. There are many people today whose careers were greatly enhanced and whose lives were positively impacted by knowing and working with Dick.

After his formal retirement Dick continued to work as a consultant and an author. In 2000 the Electric Power Research Institute published "Condenser Inleakage Guideline," with Dick as a principal author, and in 2001 ASME Press published his book entitled "Steam Surface Condensers: Basic Principles, Performance Monitoring, and Maintenance".

The Latin expression "Carpe Diem" summarizes the way Dick lived his life. He seized every moment - he made the most out of every opportunity and day that he lived.

Introduction

During the 1970s and 1980s, a body of knowledge was developed and applied to the on-line optimization and control of the energy systems to be found in industrial plants. The motivation for this activity was two-fold: (a) the cost of energy was relatively high so that by reducing the amount of energy consumed it was beneficial to the bottom line of the business and (b) the OPEC crisis of 1973 developed a general awareness that the conservation of energy was a laudable social goal and further helped to justify the installation of these systems. Today, the possible impact of energy emissions on global warming adds an additional stimulus to energy conservation.

Unfortunately, during the 1990s, the cost of energy fell to the point where management obtained a better return-on-investment on process productivity improvements so that there was a diminished interest in installing systems for the conservation of energy. As a result, there was a loss of familiarity in the U.S. with this technology and its application, on the part of both users and vendors. However, as we enter the Third Millennium, there are new pressures to conserve energy. The global warming debate has focused on the need to reduce carbon dioxide emissions while political instability in the Middle East has questioned the dependence on oil and its derivatives. As a result, those who manage energy in industrial plants in both developed and developing countries are being forced to re-evaluate the need for energy conservation.

This book is intended to capture the body of knowledge that was developed by a group of engineers within what was then the Process Control Division of the Westinghouse Electric Corporation and is now part of Emerson Electric. The techniques described have been applied successfully in many

industries throughout the United States as well as in several industrialized countries in the Middle and Far East. The techniques for analysis can be especially useful in identifying possible avenues in equipment selection or flowsheet adjustments that would tend to reduce plant energy consumption without affecting the productive capacity of the plant. The term "optimization" describes a process in which a cost function is minimized through the wise selection of an operating strategy from among several. Thus, for optimization to be meaningful, there must be several valid ways of operating the equipment involved and its interconnections, each with a different cost. The tools described here will allow an analyst to evaluate the possibilities and identify the configuration that is most cost-effective. Other material in this book will help engineers who are responsible for the management of energy systems within their plants to apply techniques that have been used successfully elsewhere.

The writing of this book was greatly encouraged by George E. Saxon, Senior Chairman of Conco Systems, Inc. of Verona, PA. The support of Edward G. Saxon, President of Conco Systems Inc. is also greatly appreciated. The author would also like to express his indebtedness to those who have contributed to the text, especially Frederick C. Huff of Emerson Electric and George E. Saxon, Jr., Vice-President of Conco Systems. The original work was a team effort in which a group of engineers from a variety of disciplines enthusiastically worked together to build and apply this body of knowledge. This team has since become dispersed, but the author would like to take this opportunity to thank them all for their contributions.

Finally, no man is an island and the author offers heartfelt thanks his wife, Agnes, for her generous cooperation and for the time we might have otherwise spent together during the writing of this book.

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