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An Engineer's Guide to Desalination

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Foreword

Within the next years keywords such as water scarcity, water pollution and water aid projects will become more and more familiar to the broad public as well as put into focus. On the Global Environment Day in Beirut 2003, it was reported that the available water quantity per person in the MENA region (Middle East North Africa) in 1960 averaged out to 3,300 cubic metres. In 2003, this quantity had decreased to only 1,200 cubic metres. Water projects are discussed and realised all over the world. Already today water supply is closely connected to politics. In the future, the distribution of the limited water resources will depend worldwide on the sense of responsibility of international politics and the globalized society.

The author, Dr.-Ing. Joachim Gebel, has been involved in the field of seawater desalination and water treatment plant design for more than twenty years. Together with the co-author, Dr.-Ing. Süleyman Yüce, he founded the engineering company S.T.E.P. Consulting GmbH in 1996. During his job experience and as a result of the close cooperation with RWTH Aachen University and KRAFTWERKSSCHULE E.V. (POWERTECH TRAINING CENTER) he realised, that not only an appropriate technology to desalt seawater and a sufficient number of plants are essential for the water supply of a country suffering with water scarcity, but that the human factor, i.e. the personnel operating the facilities, is of crucial importance for a successful project. To fulfil this responsible and challenging task the skilled workers, technicians and engineers ought to be highly qualified.

With their book “An Engineer’s Guide to Seawater Desalination” the authors present a comprehensive elaboration that reflects on all important subjects of seawater desalination technologies, from the thermo- and hydro-dynamical fundamentals to material problems as well as from the process design of MED, MSF and RO plants to the layout of the main components. A historical overview and a foresight complete the book.

Most parts of the book are field-tested and well proven in numerous training courses at KRAFTWERKSSCHULE E.V. where managing and operating personnel of seawater desalination plants have gone through training for several weeks. Many calculation examples and figures resulting from the fruitful discussions with the participants of these courses in conjunction with the great experience of the authors turn this book into a useful tool in order to assist all involved in the area of seawater desalination.

KRAFTWERKSSCHULE E.V. is pleased to offer to its students such a modern and detailed guide for further training programs in seawater desalination. Surely it will help skilled workers, technicians, engineers and managers to improve their understanding of the technology as well as do a better job.

Heinrich Nacke, POWERTECH TRAINING CENTER

Preface

During the last 30 years desalination of seawater and brackish water has become an irreplaceable pivot of the fresh water supply to the population, industry and agriculture in many countries. At the turn of the millennium the installed capacity in seawater desalination exceeded an amount of 25,000,000 m³ per day - theoretically an equivalent to the water demand of 150 million human beings, assuming a consumption of 150 litres per day and capita.

Since the renewable water sources of most the countries concerned are almost exploited, the expected population and industrial growth will lead inevitably to water scarcity. Desalination of seawater is an efficient and effective option to meet the demand. According to the assessment of the experts new seawater desalination plants with a capacity of about 50 million cubic metre potable water per day will be erected during the next decade.

Such a task does not only require enormous efforts in financing but also well-trained specialists for the design, erection and operation of these plants. Approximately 10,000 managers, operators and workers will be needed for plants in the future.

Recent experience has shown clearly that the availability of a desalination plant whose complexity is comparable to that of a power station or a chemical plant is closely related to the qualification of the operating staff. Low availability means reduced water production and increased water production cost. Failures and downtimes in desalination plants can often be explained by a lack of proper understanding of the thermo- and hydrodynamic processes in and around the plant which leads to misjudgement and misoperation.

This book has been written for all people which are, in their different ways, involved in the desalination business – from the worker to the manager – and includes all information which is necessary to understand the seawater desalination process, so that a knowledge base is established to meet the task of designing, operating and optimizing seawater desalination plants.

The approach of the book is not to cover all aspects of desalination. Special scientific problems (i.e. the calculation of the heat transfer coefficient at the surface of a horizontal tube or the calculation of the pressure drop through a rectangular orifice) are not discussed here in detail but are sufficiently explained to give an understanding of the processes in the plants. There is much additional literature available for each of these special questions, if needed.

In line with this approach the handbook confines itself therefore to the state-of-the-art desalination processes:

- Reverse Osmosis
- Multi-Stage-Flash Evaporation
- Multiple-Effect Distillation

The knowledge base of this handbook traces back to the work of Prof. Robert Rautenbach, head of the Department of Chemical Engineering at RWTH Aachen University from 1967 to 1996. The authors have worked with Prof. Rautenbach from 1985 up to his death in 2000.

The authors themselves have held many courses on seawater desalination plant design at RWTH Aachen University and with POWERTECH TRAINING CENTER, Essen/Germany in the last six years. During these courses the idea of this handbook was born.

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