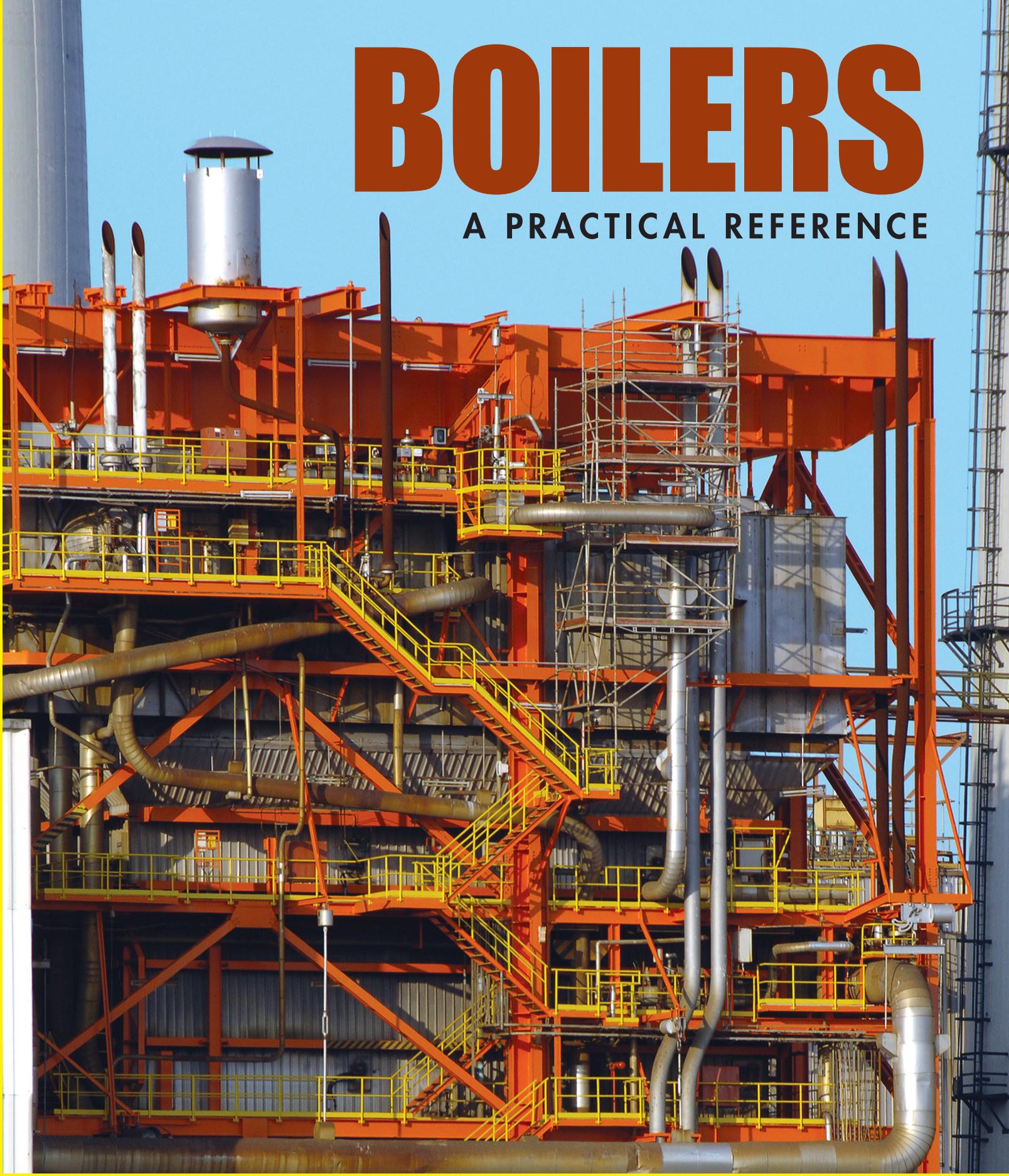
BOILERS

A PRACTICAL REFERENCE



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KUMAR RAYAPROLU

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To my late parents for all that they had done

To my wife Usha

and daughters Ramya and Amulya

without whose tacit support and help this book would not have been possible

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Preface

In his long association with boilers, the author has always found that there have been very few books on the subject of boilers for practising engineers. Books from the academic community tend to have more stress on theory, which does not quite sustain the interest of practising engineers, as the issues in the actual field are very different. There are a few books by working professionals but they are more on operational aspects.

To contribute to this acute shortage of literature on boilers, the author compiled his first book, *Boilers for Power and Process,* which was published in the USA in early 2009 by CRC Press. This was a structured exposition of the subject covering the fundamentals, engineering and major types of boilers based on different combustion techniques. Since then, there were several requests that another book be written, which should be even more user friendly, where one can get to the subject matter straightaway without having to search in the usual manner. This book, written in the format of an encyclopaedia, is the result of such a suggestion.

The word 'boiler' means different things to different people. From a small device to heat domestic water to the gigantic generators producing steam at supercritical conditions in large power stations, all of them pass for boilers. However, to provide focus and bring out the personal expertise, this book restricts itself to water tube boilers as found in the process industries and power plants. This includes fired and unfired process waste heat boilers and those behind gas turbines. Specifically excluded are fire tube (except for a passing mention), marine and miniature boilers as well as the boilers for nuclear power plants.

There are around 550 key boiler words in the book which are elaborated along with nearly the same number of illustrations in support. It was a revelation of a kind to learn that in these few words, almost the entire boiler technology can be covered.

The book explains, broadly, the following topics:

- Almost the whole range of boilers and main auxiliaries, along with steam and gas turbines
- Traditional firing techniques like grates, oil/gas and PF and modern systems like FBC, Hrsg and so on
- Industrial, utility, waste heat, MSW and bio-fuel-fired boilers, including supercritical boilers
- The underlying scientific fundamentals of combustion, heat transfer, fluid flow and so on as relevant
- Basics of fuels, water, ash, high-temperature steels, structurals, refractory, insulation and so on
- Other engineering topics like boiler instruments, controls, welding, corrosion, wear and so on
- Air pollution, its abatement techniques and their effect on the design of boilers and auxiliaries
- Emerging technologies like carbon capture, oxy-fuel combustion, PFBC and so on

Any effort of this type is sure to fall short of expectations simply because of the vastness of the subject. Also, there is no 'syllabus'. However, in the experience of the author, almost all topics needed by boiler engineers in process and power plants are covered here.

For want of a more appropriate word, the book is titled as a 'reference'. It would be more appropriate to name this work as an encyclopaedia but it would fall short in size and therefore the expectations of the readers. By naming it as 'Practical Reference', the author hopes to convey that the book is a reference manual directed more towards practising engineers.

By its size and focus, it is a regular professional book, to be used by boiler engineers of all walks as a desk book for constant reference. Design, project, operation, consulting engineers connected with boilers should find the book of good use. Students in power plant and heat power engineering, seeking a secondary reference, would also find the volume useful. It is strong on fundamentals and design aspects, besides being elaborate on the practical side. The numerous pictures should greatly aid in enhancing understanding, as they are very carefully chosen to add to the explanation and not serve as repetition.

Finally, it is hoped that this unique book of reference, the like of which is not there in the market, besides adding to the sparsely filled gallery of practical books on boilers, serves the needs of serious readers well.

Kumar Rayaprolu

Acknowledgements

Both active and passive support from various quarters is involved in compiling a volume of this size and breadth. The least that a grateful author could do is to acknowledge their contribution for wider appreciation. Accordingly, I would like to thank the following organisations for lending their support by allowing their pictures to be incorporated, which greatly enhances the value of the book. A list of such illustrations is attached in picture credits.

Boiler Makers:

The Babcock and Wilcox Company, USA
Foster Wheeler Corporation, USA
Riley Power Inc., USA
Innovative Steam Technologies, Canada
Hitachi Power Europe GmbH, Germany

Fuel Feeding Equipment Makers:

Maschinenfabrik Besta & Meyer GmbH & Co. KG M.A., Germany

Fan Makers:

TLT-Turbo GmbH, Germany

I should also place on record the help offered by Mr. Y.M. Joshi in the secretarial area and Mr. Pawan Umarji in providing many pictures.

Author

Kumar Rayaprolu has been associated with boilers of various types in different capacities since his graduation in 1969, starting as a postgraduate trainee with the erstwhile ACC-Vickers-Babcock Limited (AVB). This was a subsidiary of the former Babcock and Wilcox Limited of the UK, established in the mid-1960s in India for making utility and industrial boilers. After a year on the shop floor, he was selected for a two-year post-graduate training with the parent company at Renfrew (Scotland) and London and also various construction sites, where he could get to learn boilers and firing equipment design and boiler commissioning. B&W Ltd. at that time was Europe's largest boiler maker and naturally could provide some excellent learning opportunities.

After returning to India, he spent the next five years in commissioning and proposals of utility and industrial boilers with AVB. He moved on to work with a boiler company making industrial boilers (mainly stoker-, oil- and bagasse-fired boilers) to the designs of Foster Wheeler (Canada) in 1978 and then with a consulting engineering company, Engineers India Ltd., which was originally founded as Bechtel India. Each assignment lasted for two to three years.

FBC boilers made their first entry into India in the early 1980s and the author moved to a JV formed for making ignifluid boilers with the former Fives-Cail-Babcock of France, to head their Engineering and later both Engineering and Projects. After six years, there was an opportunity to head the marketing function of the new JV–Thermax Babcock Limited, formed for a variety of industrial boilers with Babcock and Wilcox of the USA. After three years, the author received the opportunity to head the newly formed boiler division at Krupp Industries Limited in 1990, which obtained the licence to make CFBC boilers from the former Deutsche Babcock of Germany.

The 10-year period that followed was very creative as it provided a pioneering opportunity of building CFBC boilers in India, besides establishing a new business unit and nurturing it to health and growth. He moved in 2000 to India's largest engineering company, Larsen and Toubro Limited, to head their Captive and Cogeneration Power and Hrsg divisions for five years. Finally, he spent the last three years as the president of utility boilers trying to establish a new business line.

The author considers himself rather fortunate in having an early mover advantage in the 1970s when boiler manufacturing had started gathering momentum in India. Naturally, he enjoyed the benefits of extensive interaction with European and American boiler makers, who were the technology partners those days. This helped in an accelerated learning and vast exposure. As part of the technology transfer process, the author could visit the manufacturing and engineering facilities of many leaders in the industry such as Babcock of UK, USA, Canada and Germany, Foster Wheeler of Canada and the USA, LLB of Germany and so on. The author has gathered a well-rounded and overall experience of design, development, engineering, project execution, estimation, proposals, marketing, manufacturing and commissioning. He was a business head for more than 15 years but managed to retain engineering function all through his career. The author has had an uninterrupted association with boilers for over four decades and has naturally developed some deep technical and business insights.

The author's first book on boilers, *Boilers for Power and Process*, was published in April 2009 by CRC Press in the USA and was well received. This is the author's second book.