

# **Chapter 1 Preface / introduction**

## **1.1 Background**

This text contains primarily the material for the course *Gas clean-up technology / Savnukaasujen puhdistustekniikka / Gasreningsteknik* (ENE-47.153) as it is being presented at Helsinki University of Technology, Faculty of Mechanical Engineering, since Spring 1998. The course was originally intended as a sequel to the course *Combustion and gasification technology* (ENE-47.132), but so far has attracted a larger audience since it has a wider range of application.

In 1997/1998 the material for the course had to be collected from a large number of widely scattered sources. Comprehensive textbooks that cover the area were (and are still) not available. Funding from the Nordic Energy Research Programme and from Helsinki University of Technology allowed for the preparation of this e-book, accompanied by overhead sheets as presented during the lectures. All material can be downloaded as .pdf documents from the internet-address <http://www.hut.fi/~rzevenho/gasbook>, hence the qualification e-book. Updates will be produced chapter-by-chapter in the future.

## **1.2 Objectives and scope**

Textbooks on this subject are, in general, limited to what can be called "conventional" flue gas cleaning for conventional pulverised coal combustion processes, *i.e.* wet flue gas desulphurisation (FGD), bag filters and electrostatic precipitators for fly ash and selective catalytic reduction (SCR) for NO<sub>x</sub> control. Other books address waste incineration within a discussion on waste management. The scope of this material we tried to make more up-to-date and therefore wider than these texts.

Apart from pollutant control the formation of the pollutants is briefly addressed, which often provides the key to abatement methods as an alternative to control methods.

Secondly, more species are addressed such H<sub>2</sub>S in addition to SO<sub>2</sub>; N<sub>2</sub>O, HCN and NH<sub>3</sub> in addition to NO<sub>x</sub>; alkali metals and trace elements such as mercury; halogenic compounds such as HCl and dioxines and furanes; and volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Also greenhouse gases, mainly CO<sub>2</sub>, and ozone-depleting gases, such as CFCs, are briefly discussed.

The motivation for this was to cover flue gases from combustion as well as fuel gases from gasification processes, using various types of furnaces and boilers, and to extend the range of chemical compounds to those found in the product gases in waste incineration and energy-from-waste processes. Finally, not only "cold" gas cleaning but also "hot" gas cleaning is addressed. All this in an attempt to cover the wide spectrum of pollutants found in gas streams in modern thermal power generation processes, being based on combustion or gasification, with a fossil fuel, biomass or waste-derived fuel as input. Recovery boilers for black liquor are, however, not specifically dealt with.

For preparing the material the most important sources were the reports from IEA Coal Research in London, UK; Chapters 9, 10 and 11 of the Finnish textbook "Poltto ja palaminen" by Raiko *et al.* (Gummerus, Jyväskylä, 1995), and the articles, papers and theses (co-)produced by the authors themselves since the 1990s.

### 1.3 About the authors

Ron Zevenhoven (1963) holds an M.Sc. (Chem. Eng.) and a Ph.D. from Delft University of Technology, Delft, the Netherlands. Currently he is Assoc. Prof. at Helsinki University of Technology, working in the subject area *Technology and chemistry of combustion and gasification processes*, including waste processing and (multi-phase) fluid dynamics, and is Marie Curie Fellow under the Commission of the European Communities.

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Both authors have (co-)written approx. 50 refereed papers in technical journals and conference proceedings.

Of the material that follows, chapter 4 was written by Pia Kilpinen with several additions by Ron Zevenhoven. All other chapters were written by Ron Zevenhoven.

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In response to wishes from our contacts, a second limited printed edition was produced in April 2002. In this second printing, corrections were implemented to Chapter 4 and to the List of Abbreviations: the authors are grateful to those who tracked down these errors.

In January 2002, this material received the *Best New Course Material 2001 of Helsinki University of Technology, Faculty of Mechanical Engineering* - award.

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