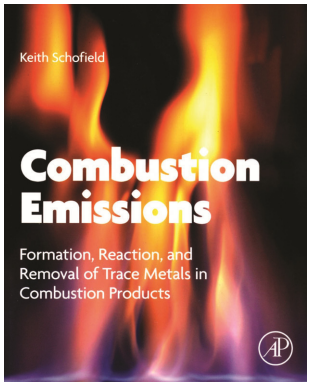

Combustion Emissions: Formation, Reaction and Removal of Trace Metals in Combustion Products. Keith Schofield. Academic Press on Imprint of Elsevier, 125 London Wall, London, EC27, 5AS, UK. 2020. 612 pages. Price: US$ 180.

Understanding the mechanisms of emissions of trace metals from solid fuel combustion systems and its control is of immense importance in the design and operation of thermal power plants and equipment for process industries. The book under review by Keith Schofield provides a comprehensive overview of this subject. The contents of the book can be broadly divided into two parts. Chapters 1–6 forming the first part and the rest of the chapters forming the second part.

In the first part, the commonalities of the behaviour of various trace metals in combustion systems are discussed. It is in these six chapters lie the greatest strength of the book. The most important insight brought out in this part is that, though the fundamental chemistry of the alkali and alkaline earth metals vis-à-vis heavier trace metals is very different, the constraints of residence time, temperature history and kinetics (predominantly heterogeneous) make the behaviour of 'gaseous species in any exhaust or flue necessarily structurally simple'. The similarities and differences in the behaviour of different elements, possible compounds (predominantly oxides, hydroxides, carbonates, halides, oxyhalides and sulphates, as these are the most thermodynamically stable, but also the less common nitrates, hydrides, etc.), factors influencing their formation and structural differences in gas phase and surfaces (of fly ash and metal surfaces) are brought out. Their relation to the basic design parameters and the chemical nature of the fuel is clearly described. This will be a useful guideline for practitioners. The importance of the results from thermodynamic equilibrium analysis and the elucidation of the common pitfalls in interpretation of the equilibrium distribution subject to constraints of kinetics (predominantly heterogeneous in the case of trace metals) brought out in the book is another highlight. That the distribution of complex condensed phase depositions 'do approximate closely to thermodynamics equilibrium expectations, especially if temperatures are not too low' is another useful guideline.

Identification of chemi-deposition as the principal mechanism of formation of condensed species on solid surfaces instead of 'diffusion and/or condensation' is of fundamental importance to the behaviour of trace metals in combustion systems. The similarities in the deposition rates of species of very different molecular masses under different surrounding conditions are shown to be in strong support of the chemi-deposition idea. The observed behaviour of volatile mercury is also in strong support of the idea of chemi-depositon. Another important aspect brought out in the book is the special conditions under which homogeneous reactions can influence trace metal emissions (particularly that of KCl in a sulphur-free environment) and KOH in the absence of sulphur, chlorine and carbon. While these conditions are rarely found in practical systems, where heterogeneous processes dominate, it is important to account for these effects in extrapolating results from laboratory studies to field applications.

In this book, the broad behaviour of trace elements is classified into four systems – alkalis, arsenic, selenium and mercury. The role of temperature and interaction times on the behaviour of these four systems is used to bring out the operational problems and the general strategies to be followed to deal with these in practical systems. The important topic of the role of particles, ash and surfaces is discussed towards the end of this part. The first part of the book is ideally suited as a text/reference for graduate level courses dealing with combustion and emissions.

The rest of the book contains a detailed discussion of the behaviour of a large number of trace metals in combustion processes. These aspects are covered in 34 sections, each dealing with an element (except section 7.1 which deals with the alkali group of elements). Each section, in general, deals with the following topics – (1) health concerns with a particular element, (2) its basic chemistry, (3) gas phase stabilities and transport, (4) laboratory studies and (5) data from combustion power plants. This part of the book will be a valuable source of information on the known aspects, open questions and ongoing studies. An exhaustive list of references including studies as recent as 2019 is included, making this book a ready reference for students as well as practising engineers. Overall, the book is a welcome addition to the combustion literature.

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