Chapter 1
Introduction to Pollutants from Energy Sources: Characterization and Control

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Abstract Energy consumption, environmental pollution, and progress of a country are interconnected. This topic is relevant for engineers, agricultural scientists, environmentalists, ecologists, governmental agencies, and policy makers involved in the area of pollutants from energy sources, environmental safety, and health issues. The topic is easy to understand, comprehensively covered and would continue to serve the researchers/students working in the field of energy and sustainability. The effective utilization of high-grade energy through thermochemical conversion of different wastes is discussed in this book. The methods and techniques to extract energy from e-waste, and biomass and their optimization can support the energy sector and satisfy a fraction of energy demand. With this thought, the book is divided into five sections namely (i) General, (ii) Pollutants from Coal, (iii) Pollutants from Nuclear Energy, (iv) MSW and Disposal, and (v) Coatings.

Keywords Coal · Nuclear energy · MSW · Pollutants · Control

1.1 Introduction

Automobiles account for large part of greenhouse gas (GHG) emissions globally, which are highly legislated. The first part of this book comprises of general introduction, in two chapters. Chapter 1 is the introduction to the book and Chap. 2 introduces the combustion based transportation in a carbon-constrained world. This chapter gives a holistic overview of the current and prospective regulations targeted

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at curbing transport origin CO_2 emissions and pollution. This chapter presents the prospective regulatory framework for road transport, and marine and aviation sectors, aimed at curbing the CO_2 emissions.

The second part of the book is specific to coal-based energy generation and comprises of pollutants from coal power plants, and includes six chapters. Chapter 3 of this part discusses the measurement and control of pollutants from coal-based power plants. This chapter includes an overview of various emitted pollutants from various types of power plants, their measurement and control techniques, both past and present, using various approaches. Various opportunities in the power sector, along with key challenges and issues related to climate change mitigation in this sector are discussed. Most of the electricity demand in India is primarily met by coal-fired power plants and the resulting pollution is the main cause of concern affecting ambient air quality, especially in urban areas. In this context, Chap. 4 in this part covers aerosols generated by coal-fired power plants and their associated environmental impacts. At the point where coal burns, chemical and physical changes take place, and numerous harmful pollutants are formed and emitted. Highlighting this fact, Chap. 5 of this part covers polycyclic aromatic hydrocarbons (PAHs) generated by coal-fired thermal power plants. This chapter discusses their formation mechanism, characterization, and profiling. Combustion of pulverized coal to produce electricity in the thermal power plants results in large quantities of residual ash generation, with varying properties. Ash (Bottom ash and Fly ash) are post-combustion particulate residue. Chapter 6 of this part is related to strategies for collection, treatment, and recycling of fly ash from thermal power plants. This chapter covers a wide spectrum of information on strategies for collection, treatment, and recycling of fly ash from thermal power plants. At present, private sector firms in India are only allowed to mine coal for their own use (captive mining) in cement, steel, power, and aluminum plants. Coal India Ltd. (CIL) is the sole commercial miner in India with 80% market share and it is the world's largest coal producer. Chapter 7 of this part is related to commercial coal mining in India, which is opened for the private sector. In a major "reform" in the coal sector since its nationalization in 1973, the government on 20th February 2018 allowed private companies to mine coal for commercial use, ending the monopoly of state-owned CIL. Chapter 8 of this part covers the development of small-scale thermoelectric power generators using different micro-combustor configurations for stand-alone power applications. Few highly efficient micro-combustors suitable for thermos-electric power generation have been fabricated and evaluated. A detailed experimental investigation on the thermal performance of micro-combustors and thermoelectric generators integrated with the bare surface of the combustor along with the cooling jackets for the power generation is included in this chapter.

Atomic energy is important for clean-air and carbon-free electricity generation. It does not produce GHG emissions or other air pollutants. The third part of this book comprises of pollutants emanating from nuclear energy, in two chapters. Chapter 9 in this part is related to sources of nuclear pollutants and their controls. Nuclear pollution is harmful for human health hence it is quite essential to take all necessary steps for its prevention. This chapter gives an overview of various undesirable

radioactive materials or substances, which affect the atmosphere and their control methods, both past and present, using different approaches. Chapter 10 in this part is related to advanced source inversion module of the EU nuclear emergency response system (RODOS). In this chapter, authors describe the development of the source inversion algorithm, in which measurements of gamma dose rate and other quantities taken at a wide range of distances from the nuclear power plant (from ~1–1000 km) are used to establish time-dependent source rates of different nuclides at unknown heights.

Waste disposal is a major problem in most countries. The fourth part of this book comprises of municipal solid waste (MSW) and its disposal, in five chapters. Chapter 11 of this part is related to the effective utilization of high-grade energy through thermochemical conversion of different waste streams. Waste-to-energy conversion will be catering the future energy demand as well as resolving the pollution issue. This work mainly involves extensive study of pyrolysis and gasification of biomass, and hazardous e-waste into useful energy and its impact on the environment. Chapter 12 of this part is related to matrix method for evaluation of existing solid waste management processes in the city of Jalandhar, Punjab, India. This chapter highlights the existing status of MSW management practices in Jalandhar, considering a dumpsite of Wariana and Suchipind villages and suggests remedial measures for the major problems faced by the existing system of MSW management. Coal-based fly ash is a significant threat across the globe, and there is rapid advancement in technology to control the fly ash and utilize it for various economic activities. Chapter 13 of this part is related to turning fly ash into zeolite for effective waste management The toxic nature of this atmospheric pollutant obtained by burning coal posed a serious threat to mankind. Authors covered a broad spectrum of information pertained to the synthesis of zeolite from fly ash so that the reader can understand its utilization aspects. Chapter 14 of this part covers production and characterization of teak tree saw-dust and rice-husk biochar: Authors explained about the production of biochar from teak tree saw-dust (TTSD) and rice-husk (RH) and their characterization. The biochars were produced from TTSD and RH at pyrolysis temperature of 450 °C with the heating rate of 15 °C/min in a fixed bed reactor. Open dumping of MSW causes environmental degradation including air, soil, and groundwater pollution, leading to an adverse impact on public health. In this context, Chap. 15 of this part is related to the parametric evaluation of leachate generated from a non-engineered landfill site and its contamination potential of the surrounding soil and water bodies. This study provides the physico-chemical characterization of groundwater, leachate, and surface water being affected by the percolation of leachate into aquifers in the study region of Solan, Himachal Pradesh, India.

The fifth part of this book comprises of Chap. 16 related to coatings. This chapter is related to sustainable coating design and role of liquid-mediated contact, wherein the development of new technological innovations needs more reliable and cost-effective materials.

Overall, this book covers a wide range of topics related to pollutants from energy sources and will be of interest to researchers in the field. Specific topics covered in this book include:

1. Introduction to pollutants from energy sources and their control
2. Combustion-based transportation in a carbon-constrained world
3. A Review on pollutants from coal-based power sector: Measurements and control
4. Aerosols generated from coal-fired power plants and associated environmental impacts
5. Polycyclic aromatic hydrocarbons (PAHs) pollution generated from coal-fired thermal power plants: formation mechanism, characterization, and profiling
6. Strategies for collection, treatment, and recycling of fly ash from thermal power plants
7. Commercial coal mining in India opened for the private sector: A boon or inutile
8. Development of small scale thermoelectric power generators using different micro-combustor configurations for stand-alone power applications
9. Sources of nuclear pollutants and their controls
10. Advanced method for source term estimation in the EU nuclear emergency response system RODOS
11. Effective utilization high-grade energy through thermochemical conversion of different wastes
12. Matrix method for evaluation of existing solid waste management processes in Jalandhar city, Punjab, India
13. Turning coal fly ash into zeolite for effective waste management
14. Production and characterization of teak tree saw-dust, and rice-husk biochar
15. Parametric evaluation of leachate generated from a non-engineered landfill site and its contamination potential of surrounding soil and water bodies.
16. Sustainable coating design and role of liquid-mediated contact.