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Oxyfuel Combustion for Clean Energy Applications

Springer

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Preface

The problem of global warming is becoming one of the most important problems facing mankind because of its direct effect on the entire planet (coastal flooding, heat waves, rainfalls, wildfires, food production, and many others). The emission of greenhouse gases resulting from the burning of fossil fuels has been identified as the main cause of current climatic changes. Currently, about 80% of the global energy demand comes from the burning of fossil fuel, resulting in the emission of a huge amount of CO_2 to the atmosphere. Also, the burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions. Researchers and scientists are currently striving to find different means for tackling this problem either by increasing the efficiency of all equipment involved in the processes of energy production or energy consumption. Also, increasing the utilization of clean energy sources such as solar energy, hydroelectric power, and geothermal energy represents another way to reduce CO_2 emissions. The third option is to achieve clean combustion through the modification of various combustion processes in order to enable carbon capture and its utilization in other industries or its sequestration in underground aquifers.

This book is intended to be a basic reference for graduate students, practicing engineers, and young researchers in the area of clean combustion. The motivation for writing this book originates from the current international thrust for reducing greenhouse gas emission to the atmosphere for the sake of reducing global warming. As a result, very many industries worldwide start modifying their existing processes/equipment to comply with the Paris Agreement (Paris Climate Conference, December 2015) adopted by 195 countries. Accordingly, it becomes essential for engineers and scientists to develop green combustion systems that are friendly to the environment. Currently, gas turbines used for power generation, boilers used for steam generation, and cogeneration plants are the largest sources of greenhouse gas emissions. This book contains an extensive review of different carbon capture methodologies associated with fuel combustion. Novel approaches for clean combustion are introduced including design and performance analysis of burners. The feasibilities of different combustion technologies are also presented and discussed. Special emphasis is given to basic formulation of various combustion processes and computational modeling of conventional combustors together with applications to gas turbines and boilers supported by numerical results and detailed discussions for a number of case studies.

This book consists of six chapters: The first chapter is an overview of the greenhouse gas emission problem and brief presentation of the current carbon capture and sequestration technologies. The second chapter introduces oxy-fuel combustion technologies with emphasis on system efficiency, combustion and emission characteristics, applications, and related challenges. The third chapter focuses on the recent developments in ion transport membranes and their performance in oxygen separation units and oxygen transport reactors. The fourth chapter presents novel approaches for clean combustion in gas turbines. The fifth chapter presents the computational modeling and optimization of combustion in gas turbine combustors with some numerical results and detailed analyses. The sixth chapter presents the replacement of conventional combustion systems by oxygen transport reactors of distinctive designs together with applications in gas turbine combustors and furnaces of fire tube boilers.

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