Preface

The demand for clean energy technologies is increasing because of its environmental benefits, future energy security and diversity in securing energy sources. Research on current and future application of thermo-fluid processes associated with clean energy generation, distribution and conservation is viewed fundamental for seeking solutions for clean energy and a sustainable future.

This edited book volume introduces research works and their findings on how energy efficient technologies and thermo-fluid processes are analysed and applied in engineering practices. It presents a number chapters focusing on cutting edge research work on key issues and recent developments of the thermo-fluid processes, including but not limited to, energy technologies in process industries, application of thermo-fluid processes in mining industries, application of electrostatic precipitator in thermal power plant, biofuel, energy efficiency in building systems.

These chapters will be a valuable resource to researchers, practising engineers, technologist and students and will help the reader to develop intuitive understanding of the relevant concept and solution to the global issues to achieve sustainability in medium- and large-scale industries.

The chapters of this book have been carefully selected, and they include both the relevant technical and social issues that have a significant impact on the society and the stakeholders. This edited book comprises two parts. Part I contains five chapters focusing on energy technologies in process industries, and Part II contains seven chapters emphasizing on the application of thermo-fluid processes in energy systems and the key issues and recent developments for a sustainable future. A brief summary of each part is given below.

Part I Energy Technologies

Chapter "Utilization of Nanofluid in Various Clean Energy and Energy Efficiency Applications" focuses on energy efficiency and utilization of alternative clean energy technologies by replacing fossil fuel as primary source of energy. It also

reviews the uses of nano-fluid in various clean energy and energy efficiency applications such as solar energy, solar thermal collectors and solar water heaters for utilization of nano-fluid for improving solar to thermal energy conversion.

Chapter "Gaseous and Particle Emissions from a Compression Ignition Engine Fueled with Biodiesel-Diesel Blends" investigates the sustainability of rice bran biodiesel from environmental point of view. In this study, 5 and 20% biodiesel was tested in a naturally aspirated four stroke multi-cylinder diesel engine at different load and speed conditions. It was found that all biodiesel-blended fuel reduces the brake power (BP) and increases brake-specific fuel consumption (BSFC) slightly than diesel fuel. Engine emission results indicated that blended fuel reduces the average particulate matter (PM), carbon monoxide (CO) and hydrocarbons (HC) except nitric oxides (NO) emissions than diesel fuel. Finally, the chapter concludes that up to 20% rice bran biodiesel could replace diesel fuel to help in controlling the air pollution to a great extent without sacrificing engine power significantly.

Chapter "Correlation Between Physicochemical Properties and Quality of Biodiesel" introduces biodiesel feedstocks, production process, chemical compositions, standards, physicochemical properties and in-use performance to investigate the relationships between biodiesel properties and chemical composition using a principal component analysis (PCA). The PCA analysis is presented graphically and described in this chapter. Although individual biodiesel properties have a complex relationship with the parameters of chemical compositions, the PCA analysis determines the dominant relationships which were the average number of double bonds and polyunsaturated fatty fractions. This chapter will help the reader to better understanding of the physicochemical properties of biodiesel.

Chapter "A Review of Microalgal Biofuels, Challenges and Future Directions" introduces biofuels from micro-algae that have the potential to provide a sustainable and carbon-neutral energy source, complementing the shortfall of fossil fuels and enhancing the mitigation of global warming. Coupling micro-algae cultivation with wastewater and CO_2 from power plants is considered a promising route for the production of bioenergy and bio-based by-products. This chapter presents a review of current status, challenges and future of biofuel from algae as a renewable source.

Chapter "Performance Assessment of an Electrostatic Precipitator of a Coal Fired Power Plant—A Case Study for Collecting Smaller Particles" presents the collection efficiency of particles affected by different flow distribution and recommends the possible modification in physical model to increase the collection capacity of smaller particles in the existing electrostatic precipitators (ESPs) used in power plants.

Part II: Thermo-fluid Process Applications

Chapter "Experimental Investigation and Molecular-Based Modeling of Crude Oil Density at Pressures to 270 MPa and Temperatures to 524 K" investigates new experimental density data for crude oil sample obtained from the Gulf of Mexico

region, and these density data were measured at pressures to 270 MPa and temperatures to 524 K. These conditions simulate those encountered from ultra-deep formations to platforms. These density data points are then used to validate both empirical-based and molecular-based equation of state models. Results show that the molecular-based perturbed chain statistical associating fluid theory (PC-SAFT) models, without the use of any fitting parameters, produced crude oil density predictions within 1% of the experimental data. These results represent an improvement over high-temperature, high-pressure density predictions from volume-translated cubic equations of state.

Chapter "Heat Transfer Enhancement in a Baffled Attic-Shaped Space" numerically investigates the natural convection heat loss in an attic-shaped enclosure introducing a single baffle under the top tip, which is a cost-effective approach. The chapter examines a wide range of governing parameters such as Rayleigh number, aspect ratio, baffle length. It is observed that the heat transfer due to natural convection in the enclosure reduces when the baffle length is increased. The chapter also discusses the effects of other parameters on heat transfer and flow field in this study.

Chapter "Enhanced Thermo-fluid Dynamic Modelling Methodologies for Convective Boiling" presents the logical development of novel thermal and dynamical enhancement approaches that overcome existing modelling limitations, and creates a precise and realistic foundation for advanced boiling design methodology with applicability over the entire boiling flow regime. The effectiveness and advantages of these model enhancements are highlighted through three special cases of boiling processes, namely convective boiling typically occurring in a straight pipe, convective boiling in a curved pipe influenced by secondary flow and pool-to-convective transitional boiling. Finally, the potential for energy saving by these techniques is identified that contributes to cleaner thermal energy generation.

Chapter "A Method of Three-Dimensional Thermo-fluid Simulation of the Receiver of a Standard Parabolic Trough Collector" develops a three-dimensional (3D) computational conjugate heat transfer (CCHT) model of a bare receiver of Luz Solar 2 (LS2) PTC. The chapter also describes the method of this CCHT modelling and its verification. The CCHT model was developed applying finite volume (FV) technique of the state-of-the-art computational fluid dynamics (CFD). The solar irradiance profile (IP) around the receiver surface of the collector was calculated using the Monte Carlo ray tracing (MCRT) technique. Moreover, the MCRT calculated-IP functions specific to the Luz Solar 2 (LS2) collector are given for facilitating further CCHT modelling of the collector system.

Chapter "Enhancement of Confined Air Jet Impingement Heat Transfer Using Perforated Pin-Fin Heat Sinks" examines the effects of fin perforations on the thermal performance of pin fin heat sinks. Results show that thermal resistance decreases and fin efficiency increases with the increase of Reynolds number due to perforation and also reduces cooling power consumption rate.

Chapter "Multiphase Flow in Porous Media: Cake Formation During Extreme Drilling Processes" emphasizes on multiphase flow in porous media to closely mimic the actual drilling fluid composed of fine particles and viscous fluid rather

than focused only on single-phase flow phenomena in porous media and also simulates the fluid flow and cake formation in extreme drilling processes.

Chapter "Optimising Pyrolysis Conditions for Thermal Conversion of Beauty Leaf Tree (*Calophyllum inophyllum* L.) Press Cake" focuses on biodiesel production from beauty leaf tree (BLT) as it can thrive well in degraded soils and produces up to 3600 l of non-edible oil that can be readily converted into biodiesel. The current study tested thermal conversion of BLT press cake using a batch reactor. This study showed that up to 93% of the energy contained in the BLT press cake be recovered as biochar, bio-oil, bioliquor and syngas. The results also show that the additional products (biochar, bio-oil) from BLT press cake can make a significant contribution to the economic viability of BLT biodiesel production. It is suggested that the use of a portable and continuous feeding auger reactor could be conveniently used to convert BLT whole fruits, press cake or husks into biofuels.

We hope the selected chapters will help in enhancing your understanding and practicing of current and future application of thermo-fluid processes associated with clean energy generation, distribution and conservation and sustainability and the environment.

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