Preface

Di Mare, Francesca; Pini, Matteo; Spinelli, Andrea

Publication date
2020

Document Version
Final published version

Published in
Lecture Notes in Mechanical Engineering

Citation (APA)
Di Mare, F., Pini, M., & Spinelli, A. (2020). Preface. *Lecture Notes in Mechanical Engineering*, v-vii.

Francesca di Mare · Andrea Spinelli ·
Matteo Pini
Editors

Non-Ideal Compressible Fluid Dynamics for Propulsion and Power

Selected Contributions from the 2nd International Seminar on Non-Ideal Compressible Fluid Dynamics for Propulsion & Power, NICFD 2018, October 4–5, 2018, Bochum, Germany

Springer

Editors
Francesca di Mare
Ruhr University Bochum
Bochum, Germany

Andrea Spinelli
Politecnico di Milano
Milan, Milano, Italy

Matteo Pini
Delft University of Technology
TU Delft, The Netherlands

ISSN 2195-4356 ISSN 2195-4364 (electronic)
Lecture Notes in Mechanical Engineering
ISBN 978-3-030-49625-8 ISBN 978-3-030-49626-5 (eBook)
https://doi.org/10.1007/978-3-030-49626-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The progressive replacement of traditional, fossil fuel-based energy transformation processes through a worldwide increase in the usage of alternative, renewable primary energy sources has boosted interest for thermodynamic engines operating with fluids other than steam, air and flue gases. Especially, the availability of low-quality (i.e. low temperature) heat sources, as it is the case concentrated solar systems, geothermal and biomass plants, makes use of classic working fluids, such as water, no longer viable. Similarly, efforts to move to delocalized, small-capacity (about 0.1–10 MW) power plants and mobile powertrains still running on C-based fuels but with a virtually vanishing C-footprint as backup for volatile renewable sources have brought renewed attention to waste heat recovery applications based on unconventional technologies involving non-ideal fluid flows mostly centred on the concept of the organic Rankine cycle (ORC) and of supercritical CO_2 (sCO_2) technology.

Such systems operate with working fluids (e.g. siloxanes, refrigerants, CO_2) and in thermodynamic states exhibiting thermo-physical behaviour largely departing from that of an ideal gas, often close to the critical point, either in vapour or in two-phase conditions. Though technologies exploiting the properties of non-ideal flows find already a widespread application in space propulsion (rocket engines) and in the oil and gas industry, their relevance and popularity are also growing in residential applications especially due to the advent of the next generation of heat pumps. Whilst representing an attractive evolution of energy transformation processes, the migration to trans- or supercritical and generally unsteady operations poses new challenges for the design, optimization and maintenance of systems and their components. The predictability of the performance and life cycle of individual components requires in particular an accurate description of the thermodynamic and transport properties of the working fluid, on one side, and a faithful modelling of all relevant flow features on the other side, especially in combination with turbulence, compressibility and possibly phase change effects, as it is the case in turbomachinery (compressors and expanders).

The NICFD conference series has been thought as a biennial forum to promote the exchange of scientific information, to encourage and consolidate the interaction between researchers and professionals in the field of non-ideal compressible fluid dynamics (NICFD), a sector of fluid mechanics dealing with flows of dense vapours, supercritical fluids and two-phase fluids, whose properties significantly depart from those of ideal gases. A Special Interest Group (SIG 49) was established in 2019 in the frame of ERCOFTAC, the European Research Community On Flow, Turbulence And Combustion.

Key topics of the conference focus on: experiments, fundamentals, numerical methods, optimization and uncertainty quantification (UQ), critical and supercritical flows, turbulence and mixing; multi-component fluid flows, applications in organic Rankine cycle (ORC) power systems, applications in supercritical carbon dioxide (sCO_2) power systems, steam turbines; and cryogenic flows, condensing flows in nozzles, cavitating flows, supercritical/transcritical fluids in space propulsion. More information about the conference is available on the website at www.rub.de/nicfd2018.

Four keynote lectures reviewed the state-of-the-art and illustrated future studies and applications. Professor Matthias Ihme, Stanford University, USA, spoke about the "Progress and challenges in the modeling of transcritical combustion: molecular structure, numerical methods, and applications", Prof. Michael Pfitzner, Universität der Bundeswehr München, Germany, gave an interesting talk about "Large-Eddy Simulations of inert and reacting transcritical real gas flows", Dr. Alexis Giauque, École Centrale de Lyon, France, reported on "Turbulent dense gas flow modelling using DNS" and Prof. Jeong Ik Lee, Korea Advanced Institute of Science and Technology, South Korea, discussed "Issues with non-ideal fluid properties for developing supercritical CO_2 power cycle technology".

The submissions presented in this volume offer a focused and systematic selection of works spanning a broad spectrum of topics within the domain of non-ideal compressible flows, from the development of suitable numerical tools for high-fidelity flow modelling and simulation and fundamental research in the behaviour of turbulence in dense gases, to the construction of reduced models for turbomachines and chemical reaction, and to the challenge and potential of large-scale experiments in rocket engines. All of these submissions went through a rigorous peer review process. In all, 18 contributions were presented at the conference in 2018; eight were selected for the lecture series; each of them was reviewed by three members of the Scientific Committee and finally accepted.

We would like to thank all the authors and participants of NICFD 2018 and the members of the Scientific Committee, for providing guidance during the organization of the conference and for managing the revision of the papers. We are also grateful to all reviewers for their invaluable help to attain the high scientific quality of the contributions collected here. Special thanks to Emre Karaefe, Pascal Post and

Dr. Andreas Schramm for their great technical and editorial support at the conference and during the review process and also to the complete TTF team for their assistance.

October 2018

Francesca di Mare
Conference Chair

Matteo Pini
Andrea Spinelli
Co-chairs