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Editors

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Springer

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Preface

The topic of non-ideal compressible fluid dynamics (NICFD) for propulsion and power deals with studying the fluid dynamics of compressible flows for which the ideal gas law does not apply, with an emphasis on reactive and non-reactive flows within power and propulsion systems. The study of NICFD effects finds application within industries that are critical to ensure the provision of clean and secure energy, which includes power generation, refrigeration, heat pumps and clean combustion amongst others.

To understand the field of NICFD, we can break the topic into its constituent parts. The term *non-ideal* relates to the fundamental thermodynamic behaviour of unconventional fluids where the behaviour cannot be predicted assuming the fluid behaves as an ideal gas. Such thermodynamic behaviour can be observed in flows in supercritical states, flows close to the saturation curve, flows close to the critical point and two-phase vapour–liquid flows.

Secondly, we have *compressible fluid dynamics* which relates to the study of fundamental fluid dynamic aspects such as compressible high-speed flows, shockwave formation, boundary layers, turbulence modelling, acoustics and phase change, amongst others. Combining this with non-ideal relates to understanding such fluid behaviour within thermodynamic regions where non-ideal effects are expected. Hand-in-hand with understanding these effects comes the need for computational fluid dynamic, experimental and measurement techniques, developed specifically for such flows.

Finally, *power & propulsion* relates to the application of this knowledge to practical engineering systems operating with non-ideal fluids. This relates to a range of technologies that are becoming, or are likely to become, increasingly important to ensure the provision of clean and secure energy, alongside efficient propulsion. This includes power cycles such as organic Rankine cycles and supercritical carbon dioxide power cycles, refrigeration systems, heat pumps, clean combustion, rocket engines, alongside subsequent system components such as turbomachinery, heat exchangers and combustors.

With this in mind, the seminar themes range from theoretical foundations, to advanced numerical and experimental practices, and to applications. The seminar provides an exciting platform to bring together researchers and scientists who are pioneering theoretical, numerical and experimental advancements in order to share, learn and discuss the latest insights in this field. The key themes of the conference include the following areas: experiments; fundamentals; numerical methods; optimisation and uncertainty quantification; critical and supercritical flows; turbulence and mixing; multi-component fluid flows; applications in ORC power systems; applications in supercritical CO_2 power systems; steam turbines; cryogenic flows; condensing flows in nozzles; cavitating flows and super- and trans-critical fluids in space propulsion.

The biannual NICFD seminar was established in 2016 due to the growing interest in NICFD effects, particularly stemming from advances in propulsion and power applications. The seminar aims to bring together researchers working in the field to discuss

the latest advancements in the field. In 2019, the ERCOFTAC Special Interest Group on Non-Ideal Compressible Fluid Dynamics (SIG-49) was founded (SIG-49), which was setup to further promote the exchange of scientific information and to encourage and consolidate the interaction between NICFD researchers and professionals.

This volume contains the proceedings from NICFD 2022: The 4th International Seminar on Non-Ideal Compressible Fluid Dynamics for Propulsion & Power, which was held during 3–4 November 2022, and hosted by the Thermo-Fluids Research Centre at City, University of London, UK. Further details of the conference can be found here: NICFD2022. The published proceedings are composed of 23 papers reporting on the latest developments in the thematic areas of: Fundamentals; Numerical Modelling and Methods; Multi-phase Flows; Reacting Flows and Experiments.

The conference organisers are extremely grateful to everybody that helped make NICFD 2022 a success. This includes all the authors of the submitted papers, as well as the reviewers and members of the scientific committee, who together ensured a high-quality of the contributions collected here, alongside the accompanying technical presentations. Thanks also go to the City Events team, the session chairs and the student helpers who ensured that the event ran smoothly.

Martin White
Chair

Tala El Samad
Ioannis Karathanassis
Abdulnaser Sayma
Matteo Pini
Conference Co-chairs

Alberto Guardone
Founding Chair

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