Nordic Flame Days 2025

Book of Abstracts

Technical University of Denmark, November 26-27, 2025

Preface

It is our pleasure to welcome you to Nordic Flame Days 2025 (NFD 2025) and to present the Book of Abstracts. This volume contains the collected abstracts for all oral presentations.

NFD 2025 brings together researchers, industry specialists, and students working across a wide range of topics central to energy, combustion, and thermal conversion processes. The topics cover advances in turbulent flame modelling, chemical kinetics, reactive flow simulations, biomass and waste conversion, IC and jet engines, ash chemistry, electrification and plasma processes, particle flow and production, NOx and SOx abatement, and carbon management and utilization. The diversity of contributions demonstrates both the maturity of traditional research areas and the rapid growth of new themes such as ammonia combustion, plasma-assisted processes, and sustainable fuel pathways, highlighting the important role of our research in accelerating the transition toward cleaner, more efficient, and more resilient energy systems.

We hope this collection of abstracts will facilitate fruitful discussions, inspiration, and collaboration throughout the conference and beyond.

The Organising Committee

Nordic Flame Days 2025

About Nordic Flame Days 2025

The Nordic Flame Days is the Nordic meeting point for everyone involved in combustion processes and other thermal conversion–related technologies. The Combustion Institute, Scandinavian-Nordic Section (CINS), the Swedish Flame Research Committee (SFRC), and the Finnish Thermal Energy Research Association (FTERA) are pleased to host Nordic Flame Days 2025 on 26–27 November 2025 in Copenhagen, Denmark.

The event is hosted by the Technical University of Denmark (DTU), one of Europe's leading technical universities, recognized for excellence in science, engineering, interdisciplinary research, and strong partnerships with industry and international collaborators.

The 2025 programme includes keynote lectures and oral presentations covering recent progress in the area.

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3A.2 Injection Strategy for Ammonia Lean Combustion with Hydrogen Pre-chamber Jet Ignition

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1. Introduction

Ammonia is a promising alternative option for maritime applications. As a carbon-free energy carrier, when produced from renewable energy, creating a fully carbon-neutral pathway. Its high auto-ignition temperature, low flame speed, and narrow flammability limits make conventional spark ignition strategies inefficient or unstable [1]. Pre-chamber jet ignition technology represents a promising alternative approach for enhancing ammonia combustion [2]. This study focusses on determining a suitable injection strategy that achieves stable lean operation of an optical chamber equipped with hydrogen pre-chamber jet ignition system. For all the tests, ammonia is the main fuel and was directly injected into the main chamber with hydrogen injected into the pre-chamber to serve as a combustion promoter.

2. Methodology

The experiment was conducted in an optically accessible compression ignition chamber (OACIC), which is a based upon a modified four-stroke compression ignition engine. The original cylinder head is replaced by a custom-designed optical chamber to allow visual access to the combustion process. The chamber incorporates two fused-silica windows located in the cylinder head, providing a line-of-sight view for capturing combustion phenomena within the chamber [3]. The pre-chamber has a volume of 4.2 cc which corresponding to 3% of the main chamber clearance volume was used to initiate the combustion. One of the windows was removed and the pre-chamber installed, allowing full optical access to the combustion process inside the chamber. Optical analysis was conducted using OH* chemiluminescence and natural luminosity imaging to visualise flame patterns, and jet emanate characteristics.

3. Results and Discussion

1.1. Ammonia injection timing

The later injection of the ammonia lead to a more stable and efficient combustion. As the later timing prevented excessive ammonia ingress into the pre-chamber, allowing more complete combustion of the hydrogen-air mixture in the pre-chamber. This resulted in the later injection timings (40–90 CAD bTDC) of ammonia having an improvement in the engine performance compared to earlier timings (120–165 CAD bTDC), with a peak in-cylinder pressure of 80 bar compared to 50 bar with early injection.

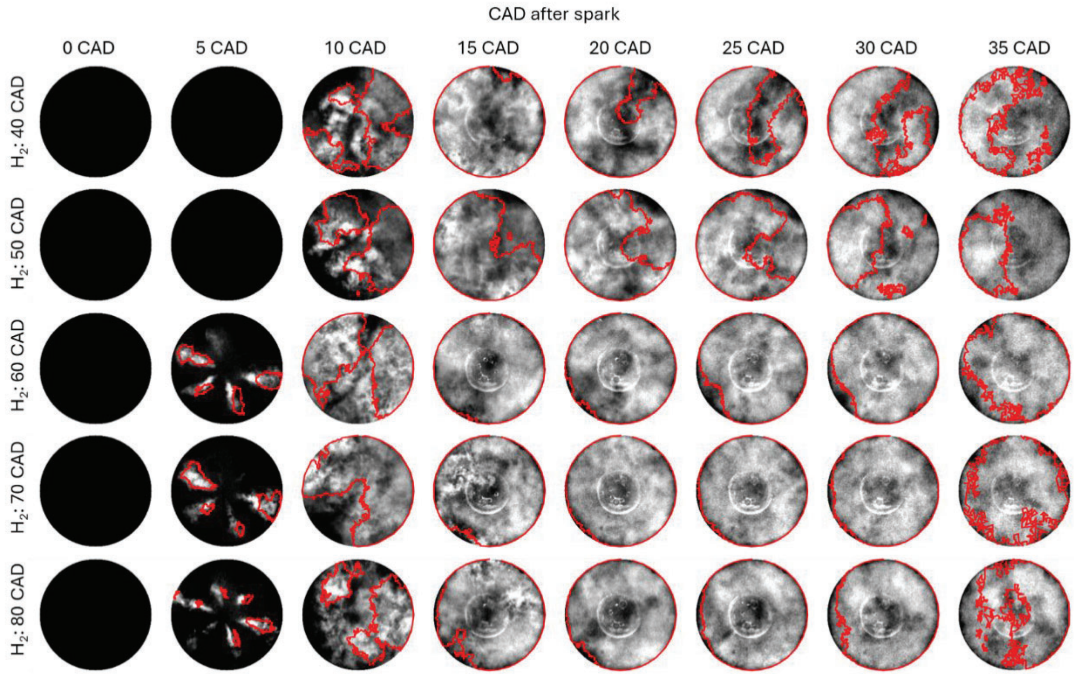

Figure 1. The temporal development of combustion of OACIC in the case of 8.5% hydrogen energy share. The red line indicates the contour of the OH chemiluminescence measurement.*

1.2. Hydrogen injection timing

Early injection of hydrogen lead to a more homogeneous mixture in the pre-chamber, resulting in a higher pressure after ignition. However, injecting hydrogen too early (80 CAD BTDC) lead to reduced combustion stability. The hydrogen injection timing between 60–70 CAD BTDC was the optimal hydrogen injection timing for the HES of 7% and 8.5, respectively. Figure 1 shows the combustion process of OACIC with pre-chamber.

Conclusion

The stable lean ammonia combustion can be achieved through the pre-chamber by adjusting ammonia injection timing, and hydrogen injection timing. The late ammonia injection strategies show an improvement in the combustion compared to early injection. The hydrogen injection timing is crucial in ensuring pre-chamber jet formation and effective distributed ignition throughout the main chamber.

References

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