

OH* and NL(NH₂*) in an ammonia/n-heptane dual-fueled compression ignition engine

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Due to the high auto-ignition temperature and low flame speed of ammonia, an ignition promoter or secondary fuel is required for efficient combustion. In this work, high-pressure injection of ammonia with a high-reactivity heptane is studied using an optically accessible compression ignition chamber [1] to reveal relations between excited species. The three targeted excited species in the ammonia flames are OH*, NH*, and NH₂*. By combining the optical measurements with numerical simulations, we can further enhance understanding of flame behaviour, particularly the influence on combustion performance by altering the conditions and injection parameters such as injection timing, spray interaction, and spray direction. To pursue this, newly available kinetic schemes [2,3] are employed to identify intermediate species and assess their correlation with excited species in the flame. Validation is conducted for both speciation profiles and for excited species.

The pilot n-heptane flame is injected prior to the main ammonia injection. It generates an intense OH* signal alongside a bright NL signal from soot. Once the ammonia is injected, it ignites in the chamber center, evolving to form a diffusive combustion flame. Our setup enables an ammonia flame to burn independently for 25.5 CADs, including a 6–7 CAD window with a stabilized diffusive flame, suitable for detailed analysis of intermediate species and their correlations. The outcome of the experiments will strengthen the validation process of CFD simulations, leading to a more reliable and predictive model. Once validated, we will further explore the relationships between excited and intermediate species and combustion outcomes in a 3D domain under varying temperature and pressure conditions.

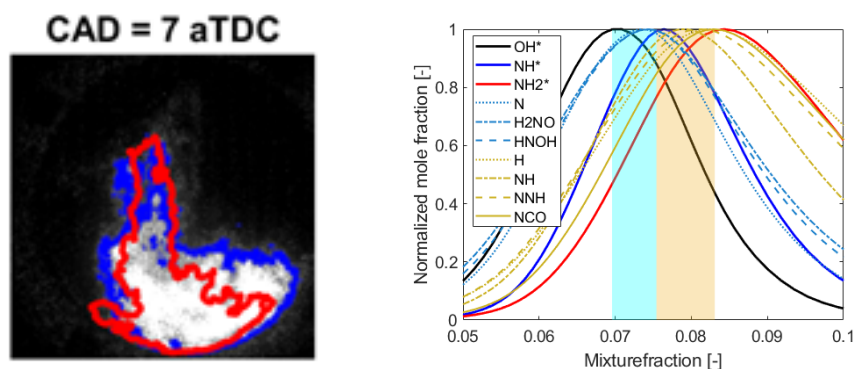


Figure: contours of NL (red) and OH* (blue) at 20% of their maximum intensity, overlaid on the OH* image (left), and mole fractions from flamlet simulation including excited species and the species that operate within the same area (right).

[1] K. O. P. Bjørgen, D. R. Emberson, T. Løvås, *Energy Fuels* 33 (8) (2019)

[2] K. P. Shrestha, et al., *Fuel* 289 (2021)

[3] A. A. Konnov, *Combust. Flame* 253 (2023)