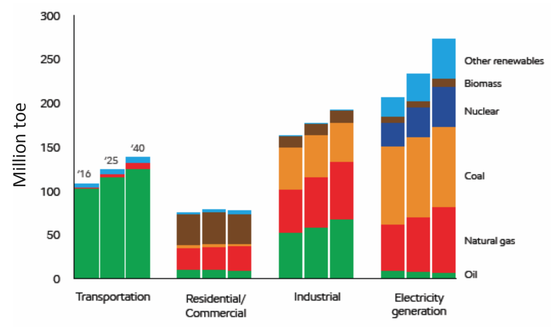
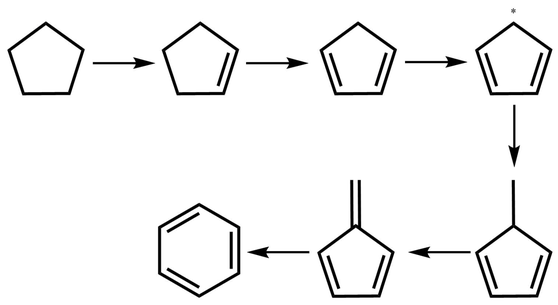
CAMBRIDGE CARES — CAMBRIDGE CENTRE FOR ADVANCED RESEARCH IN ENERGY EFFICIENCY IN SINGAPORE LTD. — CoMo GROUP — C4T

Influence of cyclic fuels on the soot formation process in a co-flow diffusion flame

Introduction



- Reduce the harmful emissions by the used of liquid fuels on transportation.
- It is necessary to understand the role of different compounds in the soot formation and composition.



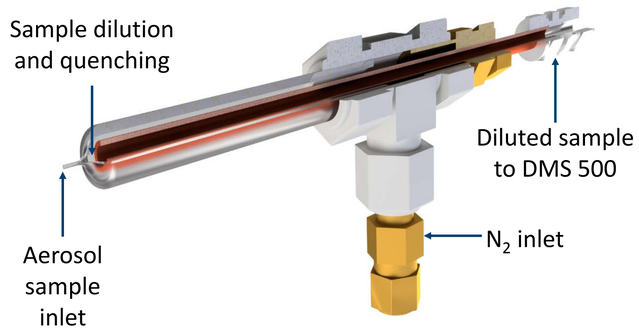
The addition of C5 ring-containing compounds in fuels has significant implications for soot formation as well as the emission of aromatic and harmful compounds from the combustion process [1].

The aim of this investigation is to systematically study the correlation between the fuel-structure of cycloalkanes and cycloalkenes, and the particle size distribution and nanostructure of the soot produced in an *n*-heptane laminar co-flow diffusion flame.

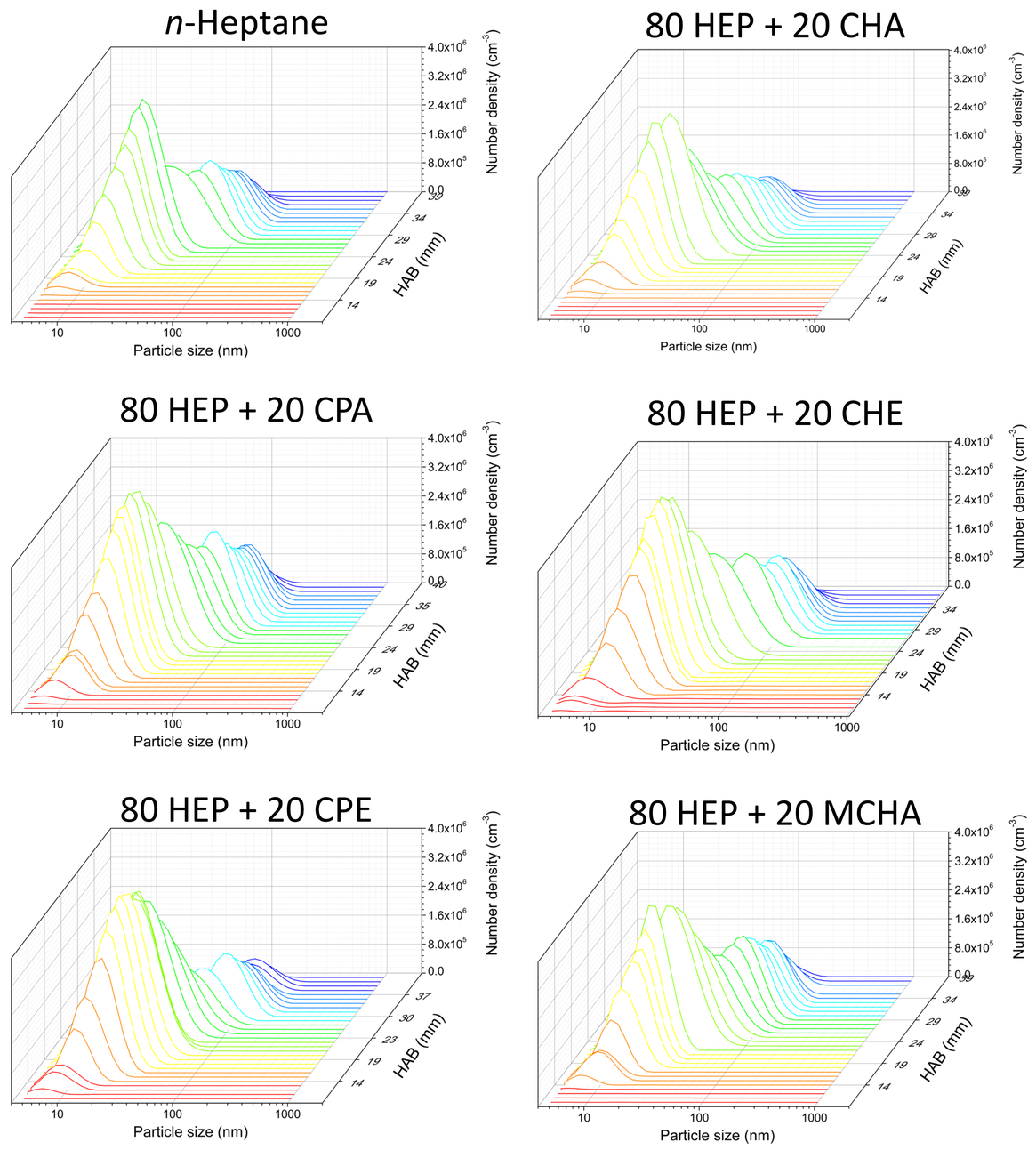
Methodology

- Co-flow diffusion flames were stabilized in a Yale-like burner
- *n*-heptane (HEP) was chosen as base fuel, 20% mol/mol was replaced by cyclic fuel:
  - Cyclopentane - CPA
  - Cyclopentene - CPE
  - Cyclohexane - CHA
  - Cyclohexene - CHE
  - Methylcyclohexane - MCHA

A new probe [2] was used to measure the particle size distribution (PSD) in real-time with a Differential Mobility Spectrometer 500 (DMS 500). Temperature measurements were done by rapid insertion of a R-type thermocouple.



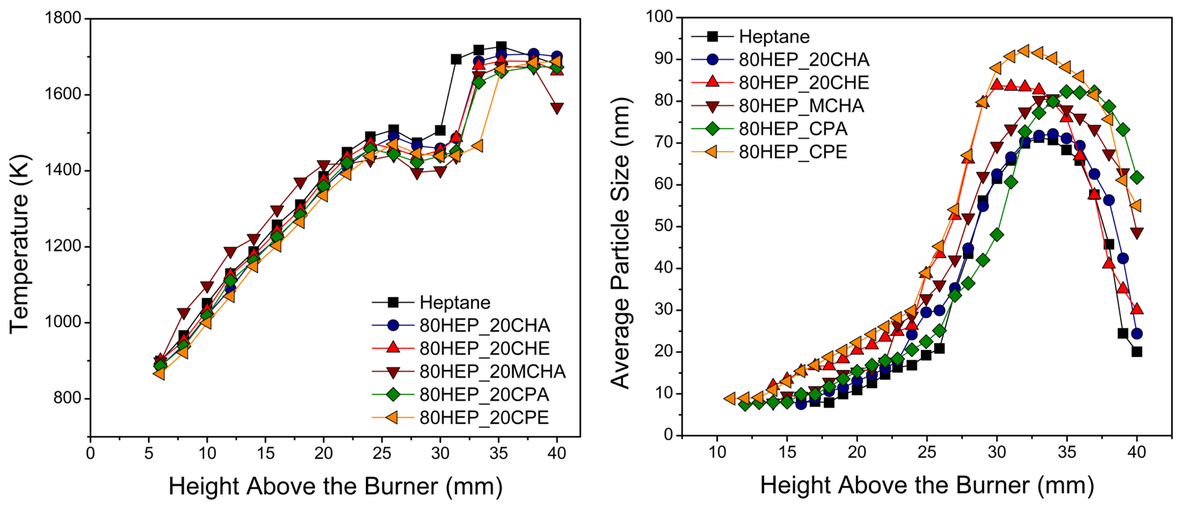
Results – Particle size distribution



The addition of the cyclic fuels, except the cyclohexane, promote the formation of soot particles at a lower height above the burner, a more significant effect is observed for the cyclic fuels with double bonds (CHE and CPE).

The addition of C5 cyclic fuels promotes the formation of particles, possibly through the fulvene pathway, as proposed by McEnally [1]. However, this route may not be significant for methylcyclohexane.

Results – Flame temperature



The addition of the cyclic fuels does not significantly affect the temperature in the initial part of the flame. The flame temperature changes as larger particles are formed in flames as a function of the different fuels.

The average particle size is influenced by the kind of cyclic fuel added to the *n*-heptane. The double bond has a more significant effect than the carbon atoms number in the cyclic fuel.

Preliminary conclusions and further work

- Particle size distribution is a function of the fuel structure; double bond has a more significant effect than the carbon atoms number in the cyclic fuel.
- Soot nanostructure will be studied by using Raman Spectrometry and High-Resolution Transmission Electron Microscopy.
- Correlation between fuel structure, particles size distribution, and soot nanostructure will allow having new insight into the soot formation process

References

[1] C.S. McEnally, L.D. Pfefferle. Combustion Science and Technology 131 (1998) 323-344
[2] H. Hepp, K Siegmann. Combustion and flame 115 (1998) 275 - 283

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