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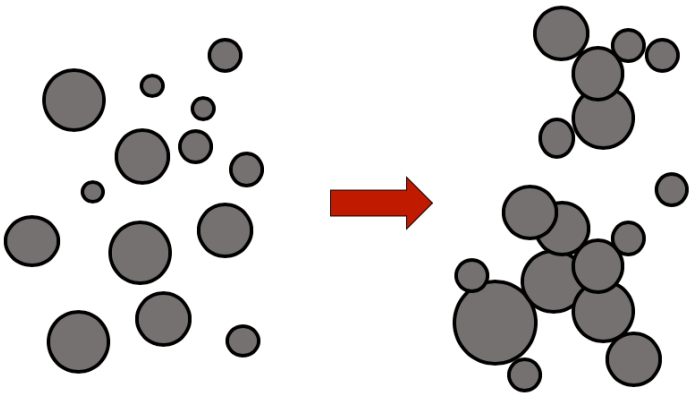
HiWi / Bachelor / Master thesis

Pressure effect numerical analysis on soot formation in combustion processes

Soot is a particulate byproduct of combustion of hydrocarbon-rich mixtures. Due to its hazardous nature and the increasing restrictions in emission regulations, it is crucial to understand its formation and growth process to design modern low-impact combustion devices. Soot formation and evolution is characterized by complex processes involving several mechanisms and fractal agglomerate structures (Fig. 1.), therefore statistical methods (i.e. Method of Moments) are often used to describe it. Polycyclic Aromatic Hydrocarbons (i.e. Naphthalene) have been widely indicated as potential precursors of soot formation. Most of the soot studies in the literature have been performed at ambient pressure, also because of experimental complications for higher pressures, and often in laminar conditions. This is in contrast with usual combustion application, where larger pressures are employed together with turbulent flow conditions to increase the combustion efficiency. In this work, a deeper focus will be on pressure effects on soot precursors (PAH), soot formation and evolution (i.e. surface growth, oxidation), in order to improve its prediction in more realistic combustion conditions.



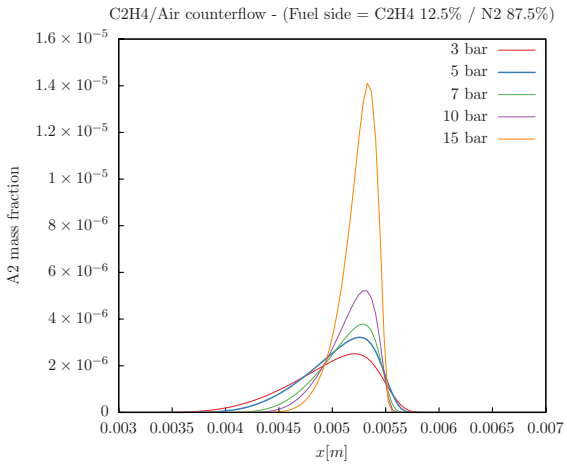


Fig 1. Soot formation sketch from elementary particles to fractal agglomerates
Fig 2. Naphthalene (PAH) mass fraction profile for different pressures in a C2H4 laminar counterflow diffusion flame simulation

Your Tasks:

- Literature review on pressure effects on soot.
- 1D laminar flames simulations with detailed chemistry and soot model (with FlameMaster code, C++). 2D/3D diffusion flames simulations (with CIAO code, Fortran).
- Results analysis and discussion.

Ideal candidate should have:

- Understandings of thermodynamics and fluid mechanics. Prior basic knowledge of combustion phenomena would be helpful.
- Motivation and willing to learn new topics. Capability of producing and analyzing scientific results.
- Basic Linux and programming skills are appreciated. C++ and Fortran based codes will be used. Matlab knowledge would be useful as well.

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