Offer of research internship 2026, 6 months
Post flame CO-oxidation modelling in large-scale industrial burners using the Lattice-Boltzmann method.

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In our recent simulations of a semi-industrial-scale burner using the Lattice-Boltzmann method, the reduced chemistry comprised of one-step schemes for methane and hydrogen, with NOx estimated a posteriori using the extended Zeldovich mechanism. Because these schemes produce CO but omit post-flame CO $\rightarrow$ CO_2 oxidation pathways, CO is systematically over-predicted, affecting temperature and radiative heat-transfer fields. Therefore, this internship will be dedicated to the development of a computationally affordable treatment of post-flame CO oxidation for CH_4/H_2 premixed combustion within an LBM–LES framework, and demonstrate its effect on predicted CO levels, temperature, wall heat flux, and NOx assessment.

THE INTERNSHIP

Rapid decarbonisation and pollution reduction requires designing industrial burners that run on lower-carbon fuels - such as H_2-enriched natural gas - while preserving safety, operability, and performance. To this extent, a semi-industrial burner designed to operate on hydrogen-enriched natural gas (CH_4/H_2 blends) has been developed by Fives to provide a pragmatic pathway for near-term decarbonisation of industrial burners while remaining compatible with existing plant constraints. However, this leads to altered flame stabilisation, post-flame oxidation, and radiative heat-transfer characteristics.

Under the Liberty project, the Lattice-Boltzmann method (LBM)[1] is employed to simulate this geometry, owing to its computational efficiency on complex industrial meshes and its compatibility with LES-based combustion closures. Within this framework, a gray P_1 radiation model has been implemented and applied to the Fives burner (6 m), establishing a baseline for radiation-flow-chemistry coupling in a confined, high-temperature configuration. In this study, a reduced chemistry comprising one-step schemes for methane and hydrogen, with NO_x estimated a posteriori via the extended Zeldovich mechanism, was used. As a result, post-flame CO $\rightarrow$ CO_2 oxidation[2] was not represented, leading to systematic CO over-prediction, and potential discrepancies in the recovered temperature field and wall heat-flux distribution.

The proposed internship is situated within the broader effort to deliver predictive, cost-effective modelling tools for hydrogen-enriched industrial combustion. It will address the identified gap by developing and integrating a computationally affordable treatment of post-flame CO oxidation compatible with LBM-LES of CH_4/H_2 burners, validating it against canonical and semi-industrial cases, and quantifying its implications for CO levels, temperature, wall heat flux, and downstream NO_x assessment. The results will also be used to review the limitations of the gray P_1 closure and to propose higher-fidelity radiation models as the basis for a subsequent PhD.

This 5-6 month research internship will take place in 2026 at Laboratoire de Mécanique, Modélisation & Procédés Propres (M2P2), UMR7340, Centrale Méditerranée, Plot 6, 38 rue Joliot-Curie 13451 in Marseille, under the supervision of Pierre Boivin and Song Zhao, and in cooperation with Uday Chikkabikkodu.

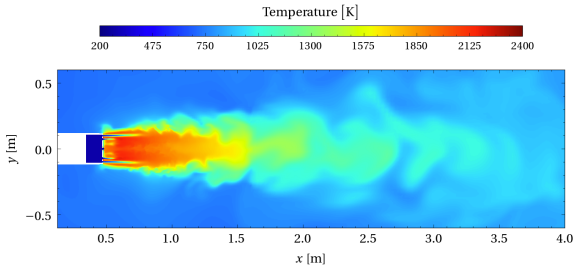

FIG. 1 Instantaneous temperature field.

THE CANDIDATE

You are a final year École d'Ingénieur or Master 2 student specializing in fluid mechanics, numerical simulations, or energetics. The candidate must have experience or interest in programming, particularly C++. Excellent English communication skills, both spoken and written, are required.

Your CV and grades for the last two years are to be sent to:
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BIBLIOGRAPHY

[1] M. Tayyab, *Development of Combustion Modelling within Lattice Boltzmann Framework.*, Ph.d. thesis, Aix-Marseille University (2020).
[2] B. Adams, M. Cremer, and D. Wang, "Modeling non-equilibrium co oxidation in combustion systems.".