GOBIERNO DE ESPAÑA · MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD · Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas · Grupo de Modelización de Procesos de Combustión y Mecánica de Fluidos

PhD Position in Modeling Flame Dynamics in Micro Burners

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CIEMAT (*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*) is a public research center assigned to the Ministry of Economy, Industry and Competitiveness, focusing on energy and environment and the associated technologies. Its mission is to contribute to sustainable development of the country and to the quality of life of its citizens through the generation and application of scientific and technological knowledge. Its goal is to maintain its position as a center of excellence in energy, environment and technology and in basic research.

The Fluid Mechanics and Combustion Modeling Group at CIEMAT carries out research in the modeling of chemically reacting flows, including topics in clean combustion technologies, combustion at the micro scale and combustion in solid energetic materials. Our studies involve numerical analysis of fundamental problems combining fluid mechanics, heat and mass transport processes and chemical kinetics. We use in-house-developed numerical simulation tools, ranging from asymptotic methods to direct numerical simulations, often involving high performance (parallel) computing. http://rdgroups.ciemat.es/web/grupocombustion

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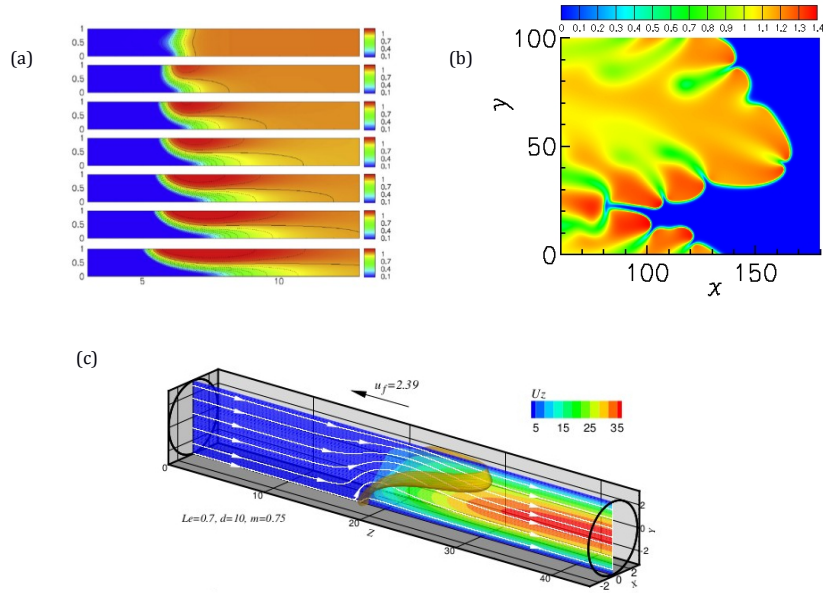
Motivation: The miniaturization of electro-mechanical devices (phones, computers, unmanned aerial vehicles, GPS, etc.) and the resulting need for micro-power generation (miliWatts to Watts) based in small size, low weight, long life devices, has led to the recent development of the field of combustion at micro-scale for power generation. Since traditional batteries have low specific energy and hydrocarbon fuels have a very high specific energy, a miniaturized combustion-based device, even with a relatively inefficient conversion of chemical to electrical or mechanical power, could result in an increased autonomy and reduced weight as compared to current batteries. Unfortunately, as the size of a combustor is reduced, combustion performance and stability are decreased.

Project: The aim of this project is to contribute to the improvement of the efficiency of energy conversion systems in small devices by studying in detail the structure and dynamics of flames in simplified configurations. The European Union targets of 20% improvement in energy efficiency by 2020 and 80% reduction in emissions by 2050 require new solutions, including the use of alternative fuels and innovative technologies. The final goal of this investigation will be the assessment of existing designs and the recommendation of improvements in one such new concept, the combustion of gaseous (biomethane) and liquid (ethanol, methanol and blends) biofuels in portable power devices.

The project covers the development and implementation of reduced combustion chemical kinetics of biofuels (reduced, accurate chemical kinetics of easy implementation in numerical codes), the investigation, using numerical analysis, of fundamental aspects of biofuel combustion in geometries that mimic the conditions found in portable power-generating systems (combustion in micro-channels emerges as an important field, in particular, flame structure, ignition, extinction and stability properties) and the use of experimental studies in simplified configurations to acquire knowledge that should contribute to improve future designs.

This project, financed by the Spanish National I+D Plan as part of the Societal Challenges Program (Grant ENE2015-65852), is a collaborative research between Carlos III University and CIEMAT.



Direct Numerical Simulations (DNS) of flames at small scales in simple configurations : a) asymmetric flames found in lean hydrogen-air premixed flames propagating in micro channels, b) Cellular structures found in lean hydrogen-air mixtures propagating in quasi-2D confined geometries, c) Non-axisymmetric shapes found in flames propagating in micro ducts.

Position: The PhD-student will join the Fluid Mechanics and Combustion Modeling Group at CIEMAT in Madrid and receive a salary as a pre-doctoral researcher (the position is equivalent to National Plan pre-doctoral positions). Doctoral students are expected to engage in full-time study and research. The candidate should have finished his/her Masters studies by September 2017. **A solid background in Fluid Mechanics and Numerical Methods is highly desirable.**

Academic details: The successful candidate is expected to engage in the Inter-University Program in Fluid Mechanics, a joint doctoral degree of the Carlos III University (Madrid) and several leading Spanish Universities:
(http://www.uc3m.es/ss/Satellite/Doctorado/en/Detalle/Estudio_C/1371210621693/1371210298470/Fluid_Mechanics_Interuniversity_PhD_Program#home).

Duration: 4 years (full time).