RESUMEN EUROHPC SUMMIT WEEK 2022

# NUMERICAL INVESTIGATION OF SOOT FORMATION IN AIRCRAFT ENGINES

The need of decarbonization in aero-engines, aligned with the objective from the European Union of reaching zero net emissions by 2050, boosted the creation of the EU H2020 project ESTiMatE, a consortium that groups seven public leading institutions in the field of combustion from Europe with Rolls Royce as topic manager to understand in deepness the prediction of soot in very high by-pass ratio aero-engines. ESTiMatE follows an integral and multidisciplinary approach that comprises all the stages and elements required to understand the process of soot formation and particle transport. In this sense, it includes the generation of the chemical mechanism for a jet-A1 surrogate including aromatics, task performed by the Universität Stuttgart (IVLR), the production of experimental data for laminar and turbulent flames by the Karlsruher Institut für Technologie (KIT) and the Technische Universität Berlin (TUB), the implementation and application of soot models coupled to advanced turbulent combustion models performed by the Technische Universiteit Eindhoven (TUE), the Technische Universität Darmstadt (TUD) and the Barcelona Supercomputing Centre (BSC), and finally, the understanding of the break-up process of the injected liquid fuel and elaboration of an atomization model by the Universitat Politècnica de València (UPV).

Many of the objectives planned in the project have been already covered being the most outstanding ones till the date the elaboration of a chemical mechanism with soot precursors predictions in the state of the art and the implementation and validation of the soot models for the CFD (Computational Fluid Dynamics) simulations, namely, the Discrete Sectional Method (DSM) and the EQMOM (Extended Quadrature Method of Moments) integrated with the Flamelet Generated Manifold (FGM) and the Conditional Moment Closure (CMC) turbulent combustion models. Moreover, a very extensive experimental database for laminar flames has been created which constitutes a very rich source of information to make up chemical mechanisms and validate the soot models. Therefore, the project is found in a consolidated stage with very strong interaction and synergies between the partners.

The consortium is applying the advancements developed during the previous two years of the project to simulate a turbulent counterflow diffusion flame and a swirl stabilized combustor, both experiments measured at TUB. Such simulations, developed in the frame of High Performance Computing (HPC) by using Large Eddy Simulations (LES), are cutting edge numerical investigations that require a very intensive use of computational resources and, together with the experiments, will provide very valuable information for the scientific community in terms of soot formation and prediction capabilities. To carry out this investigation the consortium was granted with the PRACE project “Soot-AERO - Numerical investigation of soot formation from oxidation to particle size distributions in aero-engine combustors” ID2021240106 with a total of 72 million CPU hours in the supercomputer HAWK from the High-Performance Computing Center of the University of Stuttgart (HLRS).

The wide spectrum of models used for such LES simulations are expected to lead to the understanding of soot formation, fulfill the objectives targeted in the ESTiMatE project and develop new computational models that can be used for the decarbonization of current aeroengine technologies.