Modelling of Fire Behaviour of an Aeronautical Composite

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The airframes are dimensioned according to specific fire scenarios and they have to meet the requirements of certification Authorities. The aircraft manufacturers have to demonstrate the respect of safety requirements mainly through experimental certification tests. In the other hand, the amount of composite in aircraft structure has increased and is reached more than 50% in the coming aircraft generation Airbus A350 XWB and Boeing 787. So there is a need to explore more in details the behaviour of composites under fire conditions.

To support future aircrafts certification and to reduce the number of test, simulation tools are under-development to predict the thermo-mechanical behaviour of composite submitted to fire. In this ambitious project, our work is dedicated to the material characterisation and modelling of the thermo-degradation. To achieve this objective, two activities are performed concurrently. On the one hand, a homemade fire test bench is design to mimic certification burnthrough test and to investigate rapidly the composite behaviour. On the other hand, a numerical simulation method is developed to predict the thermal degradation of the composite sample.

Many complex physical phenomena like thermal degradation, gasification, combustion of pyrolysis gases, erosion appear and must be taken into account for good behavioural assessment. A model is developed for predicting the thermal behaviour of the composite exposed to fire. This model is compared with experimental results of the cone calorimeter tests. Numerical and experimental results show good agreement.

Concurrently, a small-scale burner test is developed with a complete set of instrumentation to simultaneously measure the sample temperature profile, the mass loss and the quantitative analysis of pyrolysis gases released during the tests. The experimental data are compared with model predictions to assess the validity of the model, and a sensitivity study is carried out to find the most influent parameters.

In fine, modelling and experimental approaches are coupled to obtain an appropriate prediction tool for certification tests. This work is very promising and will enable risk mitigation, cost saving and prevent from late re-design during future aircraft developments.