Post Doctoral position
Institut Pprime – Poitiers - France
Program ANR « Fire REsistaNce of External Thermal Insulation Composite Systems" - FRENETICS

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Place: Institut Pprime (UPR 3346 CNRS), ISAE-ENSMA, Téléport 2, 1 Avenue Clément Ader, BP 40109, 86961 Futuroscope Chasseneuil cedex, France

Dates: 4th january – 30th june 2020 (6 months). Possibly to continue in CORIA Rouen

Context:
Due to current thermal regulations (RT 2012 and 2020), external thermal insulation (ETI) has been developed extensively (with two types: ventilated cladding and composite systems of external thermal insulation, ETICS). This potentially translates into an increase in the fuel mass and fire propagation on the facades, with regard to the insulation materials used (PE, EPS, PIR, PUR), generally derived from plastic. The consequence is the emergence of strong external flames, for which the spreading can be enhanced by the combustible load on the facade.

In this context, one of our objectives will then be to characterize the ignition as well as the flame propagation processes in the specific case of the facade situation. Considering those different elements, part of the project will be dedicated to the study of ETICS and ventilated systems:

- The experimental characterization of the thermal decomposition of materials used, the development of new and performant models of pyrolysis and their validation at increasing scale.
- The experimental study of the ignition process of the materials used, and for representative conditions of facades, for the development and the validation of representative key parameters and models.
- The experimental investigation of the thermal exchange (radiation and convection) between the flame and the combustible facade, for the development of more realistic radiative models and laws of walls.
- The experimental investigation of thermal exchange and flow characteristics in ventilated system when submitted to a fire. In particular, the amount of pyrolysis gases transported in the air layer and their contribution to fire propagation.

Subject:
The project will involve experimental and numerical investigations on fire reaction properties of fireproofed and fire-retarded materials, actual and new, used for the insulating systems of facades. For this, a reduced number but representative of ETI systems will be scrutinized after an analysis on facade fire accidents which occurred for several years, and by considering their availability in French market. Both ventilated and composite ETICs systems will be considered and analyzed.

Into Pprime Institute, experimental characterization will be realized:
- At the small-scale. The fire reaction properties of materials will be investigated on small samples with analytical methods: Thermogravimetric analysis with coupled Fourier-Transform-Infrared spectrometer (FTIR), Differential scanning calorimetry (DSC), Cone Calorimeter (CC). New materials will be developed with a multi-conceptual approach (e.g. fire retardant in gas phase then relayed with an intumescent material). The properties of current and fire-retarded materials will be then compared. The experimental data will be used to analyze material flammability, ignition and burning behavior and to characterize the kinetics of the decomposition and the pyrolysis models which will be coupled with CFD simulations carried out at larger scales.

- At the intermediate-scale. The tests are performed on panel with 1 m typical size. An original test bench, fully instrumented, will be specifically constructed and developed in order to study the degradation and the flame propagation on ETI samples when they are thermally stressed by a controlled fire source. Two cases will be scrutinized: with the source located against the sample or under the sample.

This specific bench scale has to be developed, instrumented and tested. It will allow:

- To study in details the flame and smokes properties, the heat flux on the vertical burning samples. The test bench will be equipped with exhaustive measurement facilities: thermocouple, IR and visible cameras, laser diagnostics (PIV) and heat flux sensors on the sample. Smoke toxicity will be analyzed using gas analyzers and FTIR spectrometer.
- To look at the interaction flame-panel and at the development of fire through the insulating system, in particular due to cracks or delamination, which induce an internal combustion inside the insulation material. So it will be possible to focus on the behavior of the singularities of the construction solutions, as the edges or part of a window frame when they are stressed by a fire source.
- To build affordable and reliable flux meters and to develop flame-image processing in view of their application to the large-scale tests.
- To obtain detailed experimental data that will be used to validate the numerical simulations of the flame spread on panels (with the CFD codes FDS and OpenFOAM).

The work realized will be associated to the one of a PhD position, notably for the realization of the tests at small scale.