2D MEASUREMENTS OF SOOT CONCENTRATION BY LASER-INDUCED INCANDESCENCE – APPLICATION TO SOLID MATERIAL COMBUSTION

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For some years, we have witnessed an outbreak of activities concerning solid material combustion. This type of fuel is present in many combustion systems, for example incineration power plants, boilers or, for what interests us, fires. The main difficulties are to understand and to estimate heat emission, which leads to pyrolysis, emission and radiation energies, in particular for conception of numerical models. Heat transfer by radiation is one of the processes which control flame growth on the solid material. Ignition and propagation result from a competition between fuel vapour emission (pyrolysis) and combustion heat emission, processes coupling are realized by flame convection and radiation. In some cases, soot radiation can be responsible for the majority of the transfer between a flame and a solid wall, hence the importance to be able to quantify it.

The first step in the study of flame radiation is to know the concentration of soot particles produced and present in the flame. To do this, Laser-Induced Incandescence (LII) is a very interesting technique because it allows to obtain 2D concentration fields of particles in a flame [1]. This technique can also be applied to the study of fire smoke. Its principle is based on a very rapid temperature increase of particles using a laser pulse. Then these particles radiate by incandescence. The measurement of the incandescence signal emitted by particles is directly linked to particle concentration. Thus, by processing the images obtained, we can obtain particle concentration. An extinction measurement is used to calibrate the LII signal. Implementation of a laser sheet allows to obtain instantaneous 2D concentration fields in a flame (or in smoke).

Before studying the case of a solid material vertical sheet combustion, we chose to apply this to the case of a rectangular burner with a bronze porous [2], fed with gaseous fuel (methane/ethylene). This burner is oriented to obtain a vertical wall fire configuration. Then, we replace the burner with a PMMA sheet [3]. After a presentation of the experimental method, the soot concentration measurement technique by LII will be presented. Then, 2D soot volume fraction fields obtained for a vertical wall flame will be shown, i.e. for the gaseous burner and for the PMMA sheet combustion.

References

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