BURNERS, COMBUSTION AND HEAT TRANSFER

(565) - NOVEL FLOW VISUALIZATION TECHNOLOGY FOR INDUSTRIAL FURNACES

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The flow inside furnace chambers influences processes as fuel burn out, NOx formation and buildup of ash deposits. In this study a new technology was developed for large-scale flow visualizations in high temperature environments. The dedicated experimental equipment mainly consists of several water-cooled stainless steel probes, needed to inject seeding particles, for the light source and to acquire video camera recordings, which are inserted into the furnace through inspection ports. Pressurized air is used on the probes' tip to avoid dirt and soot, to protect optics and LEDs from radiation and heat, as well as to inject the seeding.

The underlying idea is to exploit the fact that flames principally emit thermal light in the red part of the visible spectrum, and therefore a strong blue (396 nm) light can filter the flame light away. Blue light beams are generated by several 2W LEDs, arranged on a line on a tailored curved plate, collimated with a cylindrical lens. 1µm aluminum oxides are employed as seeding material, since they are good reflectors of light and follow the flow accurately. The video camera is synchronized with the light source and has a 400/40 nm optical bandpass filter mounted on.

The post-processing of the images is done using PIVlab, a particle image velocimetry (PIV) tool created for Matlab. This allows tracking the aluminum oxides clouds as they move in the furnace and, by cross-correlating pairs of consequent images, to obtain their velocity vectors. The experimental results can then be compared with computational fluid dynamics (CFD) simulations of the same boiler chamber.

The concept has been validated by well-controlled laboratory experiments, at ambient temperature, in an open wind tunnel. The described technology will serve to determine the influence of changes in operation conditions on the flue gas and/or ash flow pattern in the furnace chamber.

Palavras-chave : industrial furnace, flow visualization, novel technology, experimental