Experimental estimation of laminar burning velocities in hydrogen-air mixtures, with and without water mist

Wulme Puoru Dery & Bjorn J. Arntzen, University of Bergen, Norway

This research project characterizes an experimental set-up with aim to find laminar burning velocities of flammable hydrogen-air mixtures using two different methods. Conducted at the University of Bergen in a laboratory, a 20-litre cubic explosion vessel was used to quantify the outward propagation of spherical flames. The two different techniques employed were a Schlieren imaging technique and a pressure-time history approach. The Schlieren optical set up consisted of among other things circular windows mounted on the chamber and a high-speed camera to capture and later quantify the outward propagation of spherical flames. A regressive analytical technique was developed based on previous studies, linearly and nonlinearly relating the propagation to change in stretch rate. Pressure measurements during the transient dispersion process using pressure traducers where employed to extract the burning velocity, relating the pressure rise to the radius of the flame.

Initial experiments for only hydrogen-air mixtures where performed utilizing both measuring technique for comparison. The results were in qualitative agreement. Limitations associated with explosion experiments performed in closed 20-litre vessel made it difficult to produce quantitative unison with results by other work. A thorough investigation into the source of errors, and an estimate of the influence on the final result were conducted. Among other things, errors associated with the optical set-up, assumptions concerning the pressure measurements and the calculation process were identified.

A nozzle was mounted to the chamber to inject water mist with a Sauter mean diameter of 19.5 microns and a loading mass between 0.1 - 0.3 m^3/kg. This was done to investigate its influence on the laminar burning velocity. Current preliminary experiments with the inclusion of water mist gave burning velocities much larger than the dry results. This is mainly due to the generation of turbulence during the injection of water mist. Measures are therefore being made to ignite the mixture once the mist has had sufficient time to be quiescent after injection.