Other Gases			
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EFFECT OF OBSTACLES ON FLAME ACCELERATION AND EXPLOSION DEVELOPMENT

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Summary

This Discipline Information Note summarises recent research by HSL[(1)], which looked at the effect of obstacles on flame acceleration and explosion development in a rectangular vented enclosure.

Background

HSE require this data for future use in the evaluation and validation of computational fluid dynamics (CFD) explosion models. At present the calibration or 'tuning' of a model to predict pressures in reasonable agreement with experiment is possible, even though the physical basis for the model is incorrect. If a model can predict the correct flame shapes, flame speeds, times and gas flow velocities as well, it is a good indication that the physical basis of the model is also sound.

Objectives

The objectives of the work were:

- measurement of explosion pressures generated with different sizes and shapes of obstacle;
- visualisation, using high speed video, of the flame propagation around the obstacles;
- quantification of the turbulence levels ahead of the flame front.

The Work

The experiments:

- looked at three different gases, methane, propane, ethylene;
- looked at different concentrations of gases;
- used four different obstacles, round, square, triangular, diamond;
- used two sizes of obstacle with blockage ratios of 33% and 50 %;
- used two different orientations for the triangular obstacles, either the apex or one of the sides facing the ignition point;
- looked at the effect of rounding off the edges of the square, triangular and diamond obstacles.

The obstacles were placed in a vertical orientation, extending from the enclosure floor to the roof, along the centre line of the enclosure.
The ignition point was at the centre of the wall furthest from the open end.

The explosion pressure measurements showed two pressure peaks. The first occurred during the initial stages of the explosion. The second occurred during the rapid explosion development induced by the obstacles. The increased turbulence increases the burning rate, which leads to flame acceleration and higher explosion pressures. The high speed video record provides evidence to back this up.

Video of the flame propagation round the obstacles was obtained. The report of the work includes stills taken from the video. Ionisation probes used to measure flame arrival times did not trigger in the order expected. The high speed video provided an explanation for this. In some instances it was due to the probe triggering late, in others it related to the way the flame propagates.

Results

The experiments produced limited flow velocity results because the wires on the probes frequently being broken by the explosion.

(1) Effect of obstacles on flame acceleration and explosion development; D K Pritchard, D Hedley and N K Webber. HSL Report GE/97/02