Influence of Biomass Pellet Composition on the Pulverised Pellet Flame Propagation and Minimum Explosion Concentration

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Abstract

Partial or complete substitution of coal with renewable biomass like wood is a sustainable and effective solution to reduce the CO_2 emissions in the atmosphere. Utilization of these woods in the form of compact pellets results in the enhancement of energy density, ease of handling and transportation. However, for electric power generation the pellets are broken up into their constituent milled finer particles for burning as a pulverised biomass flame. In the present work four commercial pellets from UK suppliers were investigated and they were broken up into a powder using coarse milling. In addition to the use of the pellets in powder form for power generation, there is an additional hazard of the dust in the process handling of the pellets in stores and in conveyor belt transport to hoppers and mills for transport to the burners. The flame propagation characteristics including minimum explosion concentration, MEC and most reactive concentration for each pulverised pellet were determined. The effect of particle size on the sensitivity of dust explosion was also investigated. Modified Hartmann explosion tube equipment using a vertical array of 3 exposed bead mineral insulated thermocouples and a pressure transducer was used.

Each Pellet sample was split into three size ranges <63µm, 63-500µm and <500µm. It was found that the enhancement in the fraction of fine particles intensifies the explosibility behaviour of the dust. Finer fraction (<63µm) showed a leaner MEC and a faster flame than for the coarser fraction (63-500µm) whereas the mixture of fine and coarse particles (<500µm) was found to have MEC and flame speeds between those of finer and coarser fractions. These results show coarse particles with no fine fraction could still explode and were a hazard. This would not occur for liquid aerosols which will not propagate an explosion for sizes above ~ 150µm.

Results of these wood pellet samples showed a good correlation of % ash+moisture contents against minimum explosive concentration and compared with MEC from agricultural crop residues. It was found that the ash + moisture content had a stronger effect on wood samples than on agricultural residue's samples. Comparison was also made between particle size distribution (PSD) of the finer fractions (<63µm) of wood samples in comparison to crop residue samples that showed a higher particle size range for wood samples. This was also confirmed by Scanning Electron Microscope (SEM). The results showed that the explosibility characteristics of the pellets industry's feed-stocks was variable and depended on the pellet composition and this needs to be taken into account in explosion protection and in utilising the pellets in the main pulverised biomass combustion.

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