STUDY ON MINIMUM IGNITION TEMPERATURE FOR AN ORGANIC DUST CLOUD EXPLOSION

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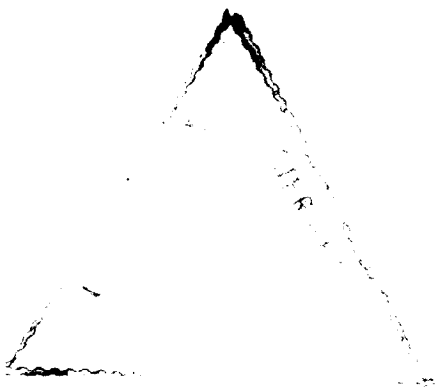

CERTIFICATE

This is to certify that the thesis entitled **Study on Minimum Ignition Temperature for an Organic Dust Cloud Explosion** being submitted by **Ms. Manju Mittal** to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in Chemical Engineering, is a record of bonafide research work carried out by her. She has worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis which, to our knowledge, has reached requisite standard.

The results contained in this dissertation have not been submitted,in part or in full, to any other university or institute for the award of any degree or diploma.

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ABSTRACT

The dust explosion hazard exists in plants and facilities wherever the combustible dusts are handled. Several parameters characterise dust explosion phenomenon and their quantitative evaluation; and interrelationship becomes a major factor for the design of any preventive or protective measures against such incident.

Most of these parameters have to be determined by experimental techniques and their applicability to a wide range of materials and circumstances is quite limited. Mathematical model development for predicting some of these parameters becomes essential to overcome these difficulties.

The most important factors requiring special attention for the design of any preventive measures are: the minimum ignition temperature, minimum ignition energy and the minimum explosible concentration. The present thesis is confined to the study on minimum ignition temperature of an organic dust and the development of a model to predict the same. Low density polyethylene particles have been taken as a representative organic dust sample.The information and data on models for ignition temperature determination and the related aspects have been reviewed. The most general existing model for determination of minimum ignition temperature of dust clouds proposed by Mitsui and Tanaka was analysed. It was found to be quite successful in predicting the minimum ignition temperature for the metal dusts, whereas for organic dusts the predicted values were quite different from the experimental findings, both in absolute value, as well as, trends.

Experimental work was carried out for the determination of minimum explosible concentration of polyethylene dust in Hartmann Vertical Glass Tube apparatus to specify the experimental conditions for the determination of minimum ignition

temperature. This was determined using the Godbert-Greenwald furnace apparatus for different particle sizes and dust concentrations. The experimental results, particularly the variation of minimum ignition temperature with particle size and dust concentration, have been explained on the basis of homogeneous autoignition of polyethylene. It has been shown that a two stage ignition involving devolatilization and combustion of gaseous components was the main controlling factor for the ignition of such dust particles.

The model was developed for determining minimum ignition temperature of polyethylene dust simulating the conditions in the test furnace. The model equations were solved to find variation of this parameter with dust concentration and particle size. The minimum ignition temperature values were also calculated using the model developed by Mitsui and Tanaka. The results of both the computations were compared with the experimental values. The close agreement between the experimental values with the ones predicted by the model developed confirm the proposed homogeneous phase ignition mechanism, i.e., oxidation of votatiles evolved from the dust particles prior to ignition is responsible for autoignition of the dust cloud.

Thus the model can be used for the prediction of minimum ignition temperature of organic dusts, those are having similar autoignition mechanism as that of polyethylene dust in terms of chemical oxidation when exposed to a heated environment.

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