UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ENGINEERING AND APPLIED SCIENCE

ELECTRICAL ENGINEERING DEPARTMENT

Doctor of Philosophy

IGNITION OF SENSITIVE MATERIALS BY LOW ENERGY ELECTRICAL DISCHARGES

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Electrical discharges pose an ignition threat to sensitive materials in manufacturing industry, medical technology, mining and the pyrotechnics and explosives industries. A minimum ignition energy (MIE) is used as a guide to the sensitivity of the material. Observed values of MIE are dependent on the reactive mixtures, ambient conditions, the nature of the discharge and experimental conditions. Researchers to date have used a wide variety of test methods yielding a range of MIE results. It cannot be confirmed that any of these corresponds to an absolute MIE and yet the term implies considerable authority. Careful standardisation of the ignition test is recommended here using carefully chosen discharge characteristics, and material presentation and other conditions. Simple capacitive discharge techniques are probably appropriate in routine ignition sensitivity testing once standard test conditions have been identified. Stored energy for ignition as a function of peak discharge current, breakdown voltage and series resistance are important parameters which have easy application in the field.

In this study high voltage pulse and capacitive discharge apparatus and techniques are described for the generation and measurement of low energy gaseous discharges. Capacitive and pulse discharges could be of unidirectional arc–like, unidirectional glow–like or pulse train forms as a function of discharge current. A capacitive discharge could also take oscillatory form. As the discharge current was reduced through the 10^{-1}A range transition from arc–like to glow–like characteristics was observed, corresponding with an observed decrease in stored energy and optimum time constant for capacitive discharge ignition. A decrease in observed sensitivity corresponded to low discharge currents (10^{-3}A or less) where pulse train discharges could form.