2010 Insensitive Munitions and Energetic Materials Technology Symposium,
October 011-14, 2013, Münich, Germany.

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INSENSITIVE MUNITIONS EUROPEAN MANUFACTURER GROUP (IMEMG)

Modelling of intumescent coatings growth: simulations from lab-scale to the large one.

Best Poster Award

In military applications intumescent paints have been commonly used as an IM technology to protect munitions against fires by increasing their reaction delay. Up to now many experimental tests have been made to assess how efficient such thermal coatings are to provide optimal protection to the munitions. However, few numerical studies have been carried out to calculate heat transfer in the intumescent coated munitions and to accurately predict their reaction delay when they are faced with thermal aggressions such as fuel fires.

That is why in the present work numerical efforts have been made to compute heat transfer both in the reactive coating and the substrate and to account for the swelling process. Based on several existing mathematical models of material ablation due to pyrolysis, and of non-steady decomposition of intumescent coatings, a set of nonlinear partial differential equations describing the evolution of the system (intumescent coating and substrate) during an aggression has been developed. The model is solved using the finite differences method, in a one-dimensional geometry and describes several moving boundaries. A 45kW solar furnace was used to validate it by applying radiative heat flux up to 250kW/mÂ² to the instrumented samples.

The final step of the study consists in testing the validated model within a three-dimensional CFD code, typically used to simulate munitionsâ€™ heating when engulfed into large scale fuel fires. Reaction delays of some intumescent coated munitions (Solid Rocket Motor, bomb, etc) have been directly compared to the experimental ones, obtained by using a large scale test setup in conformity with the STANAG 4240 edition 2. Such a comparison is promising and provides us strong elements to predict how efficient intumescent coating is against fuel fires, whatever munition it is applied to.