HVEV: A nonlinear viscoelastic model applied to energetic materials

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In the context of the design of solid propellant, it has been noted that there were significant discrepancies between the predictions of the calculation and the experimental results on models and real objects.

These discrepancies are harmful during the design phases because they prevent from imagining and accessing the most complex geometries with high loading rates.

In order to overcome this issue, a new material model has been built: HVEV.

This model is based on two main elements, on the one hand, the generalized Maxwell's viscoelasticity allowing to mimic the behaviour of our materials at different loading regimes and on the other hand, a damage kinetic based on the principle of equivalent stress [1].

An example taken to verify the relevance of this approach concerns one of the most critical phases of life, the thermal shrinkage and shows a good adequacy of the model with the experimental results as much on the temperatures of appearance as on the position of the cracks in the propellant load.

This behaviour law has been extend to composite explosive with dynamic simulation software (LSDYNA) throw user material law. This implementation allow to predict damage of these materials under vulnerability test.

Tests with drop hammer and split hopkinson pressure bar, shows à dependency of the burn rate with the speed of the hammer and the pressure of the shock wave for non-initiated materials. This increased burn rate is the consequence of damage in the material [2].
Damage variable, micro-fracture and burn rate are linked with empirical experiment in manometric bomb on post-mortem samples.

This progress allow the possibility to simulate coupled simulation, mechanics and combustion, to take into account damage in the reaction speed of the combustion.

References

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