Simulation of Foam Polyurethane Thermal Destruction in Leak Proof Objects

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For the past year, SNL and VNIIA made an investigation on the thermal decomposition process of polymeric materials in order to provide a reliable prediction of «shielding container- dangerous cargo» system behavior in a fire environment. Commonly, shielding container contains polymeric structural materials (FPU, epoxies etc), for example, as damper. The job consists of:

- definition of mechanism and chemical reactions kinetics which governed thermal decomposition of polymeric materials;
- development of thermal decomposition model.

VNIIA in collaboration with Mendeleev University developed thermal decomposition mathematical model of polymeric material based on kinetic equation of reaction and evaporation process of liquid decomposition products based on Arrhenius equations for activation energy [1].

The aim of current work is to implement thermal decomposition model of FPU in Ansys®Fluent environment in order to computing shielding container behavior in fire taking into account all mechanisms of heat-and-mass transfer accompanied decomposition process. Particularly it allows the prediction of pressure of gaseous decomposition products estimated in experiments with scale model of shielding container in SNL [2].

In current work, the first step of solving the problem is presented.

At the initial stage of Ansys Fluent learning the providing of destructed material boundary movement is formulated as primary task. In order to simplify the problem a number of suggestion are presented:

- Instantaneous decomposition with three gases (nitrogen, carbon dioxide, ethane) release when FPU sample temperature go to 300 C;
- All gaseous products release in gaseous phase;
- The density of destructed material is by an order of magnitude greater than FPU in initial state due to similarly melting process

Taking into account above-stated assumption and radiation heat transfer between heated end plate and FPU material it was obtained the pressure increase in air gap presented in Fig. 1

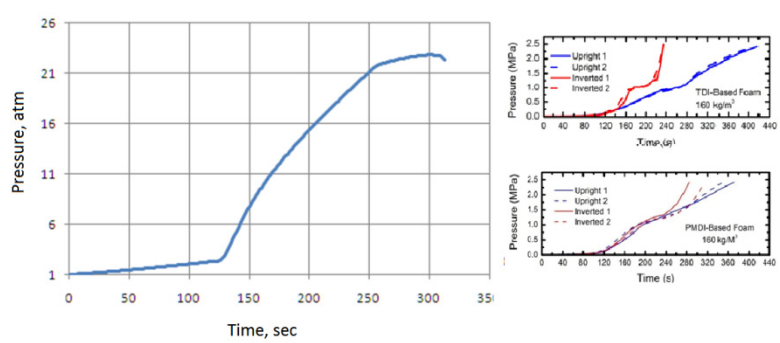

Figure 1. Pressure - time dependence in comparison with SNL experiments

The obtained result of pressure increase trend is in a good agreement with SNL experiments that were evaluated under the same conditions.

References

[1] Report of contract № 264333 “Thermal decomposition of polymeric material,” VNIIA (in Russian), (2006).

[2] K. L. Erickson, A. B. Dodd, and E. C. Quintana, “Physical Behavior and Container Pressurization During Thermal Decomposition of Polyurethane Foams,” *2011BCC Conference on Recent Advances in Flame Retardancy of Polymeric Materials*, Stamford, CT, (23-25 May 2011).