

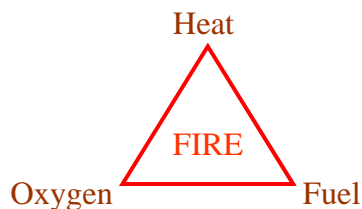
QUASH* Flame Retardant Mechanisms

QUASH Sound Management Foam products are not only a breakthrough in acoustic performance but also incorporate significant technological advances in polyolefin foam fire and smoke test-response characteristics.

Over the years, various laboratory and large-scale fire tests have been developed. Various regulating agencies require various fire-test-response characteristics for particular applications. Dow's extensive product design work has identified patent-pending formulations and processes for the manufacture of QUASH FR foams from proprietary blends of custom designed polyolefin resins and flame retardant additives. These formulations are designed to meet the fire-test-response characteristics required for various applications while maintaining the acoustical performance and other unique attributes of QUASH foams.

Fire performance has always been an important consideration in many markets and applications for polyolefins foams. Specific formulations have been developed to minimize the risk of fire hazard. To inhibit the combustion process, flame retardant additives can act chemically or physically in the solid, liquid or gas phase. Selecting the appropriate flame retardant system is done after studying the mechanism of polymer combustion and its suppression.

A) Combustion process



The Fire Triangle Principle

The basic ingredients for sustained combustion are fuel, oxygen, and heat. Three stages are necessary to initiate the combustion process: heating, decomposition and ignition of the polymer.

During the initial stage of heating, the plastic softens and melts. If sufficient energy is provided to disrupt the bonding between atoms, the polymers will decompose. The decomposition range for polyolefins is 320-400 °C.

In most cases, decomposition occurs via free radical chain reaction, which involves oxygen in the presence of highly reactive species such as $H\Sigma$ and $OH\Sigma$ radicals. The final stage of the combustion process is ignition of the polymer. At this stage, the flammable gases formed by pyrolysis in the presence of atmospheric oxygen, reach



the lower ignition limit. These gases are ignited by external flame or, if the temperature is sufficiently high, the gases self-ignite.

B) Combustion suppression

The basic ingredients for sustained combustion are fuel, oxygen, and heat. Disruption of this classic “fire triangle” is the key to fire suppression. In plastics, this is achieved by incorporating flame retardant additives into the polymer formulation.

Foams behave differently than solid polymers during the combustion process. One of the main reasons for this difference is the difference in surface area per unit mass between foams and solid polymers. The choice of the flame retardant additive system is dependent on the polymers used. Each polymer has its own range of decomposition temperatures. The FR system must be effective below the decomposition temperature as well as over the entire temperature range encountered during the decomposition process. Chemically, flame retardant additives interrupt the radical mechanism in the gas phase. Flame retardant additives also help to interrupt the combustion mechanism by promoting polymer flow away from the flame source by interaction in the solid phase and by forming a layer of carbon “char” on the surface of the polymer. Common flame retardant additives used in polyolefin foams include inorganic substances, halogenated organic compounds, and organophosphorous compounds.

QUASH FR formulations utilize a highly effective brominated flame retardant additive that works by interfering with the radical chain mechanism in the gas phase.

The addition of a unique inorganic synergist enables QUASH FR foam products to achieve superior fire-test-response characteristics while maintaining their acoustical properties and other unique performance attributes.

Fire-test-response characteristic examples:

QUASH* FR 2000 sound management foam achieves B1 according to DIN 4102 test.

QUASH* HT FR sound management foam achieves M1 according to NF P 92501 test.

While laboratory fire-test-response characteristics are not intended to reflect hazards under actual fire conditions, these ratings demonstrate that these products meet the flammability requirements of the various regulating agencies.

QUASH*
Sound Management Foams

Form nr. 172-01668



C) Smoke opacity and toxicity

Smoke opacity and toxic gas formation can be as much of a hazard to life as polymer burning. Therefore, smoke opacity is a criterion in several industry-standard fire tests such as ASTM E-162 and ASTM E-662. Typical pyrolysis gases (CO, CO₂, halogen acids, HCN, SO₂) can be analyzed and quantified during thermal degradation of the product.

As seen in the examples below, QUASH FR foams have very good test-response characteristics with regards to both smoke opacity and toxicity of emitted gas.

Examples:

QUASH* FR 2000 sound management foam achieves SR2, ST2 according to DIN 54837.

QUASH* HT FR sound management foam achieves F1 according to NF F 16-101.

While laboratory smoke-test-response characteristics are not intended to reflect hazards under actual fire conditions, these ratings demonstrate that these products meet the flammability requirements of the various regulating agencies.

Note: All certificates for QUASH products are available on request. Please refer to the detailed list given in the technical data sheets for each product for more detailed information on the various tests and ratings.

References:

- 1) Dr. Jürgen Troitzsch, International Plastics Flammability Handbook, Hanser Gardner Publications, Munich, 1990
- 2) Arnold Factor, The Chemistry of Polymer Burning and Flame Retardance, Journal of Chemical Education, volume 51, 1974