Fire and Smoke

Fire is a serious problem for building and industrial applications. Every year, it causes several thousand deaths, and damages are estimated at several billion dollars in the U.S. and at a similar level in Europe. Just because an insulation material is noncombustible, it doesn't mean that it's safe. The ability of an insulation to "wick" flammable liquids presents a much bigger problem, as does its production of smoke and toxic gases if burned.

We can summarize the conditions needed to start a fire. Three elements should be available at the same place and in adequate quantities: a combustible material, an oxidizer (or supporter of combustion) and, finally, a source of ignition. This is the so-called "fire triangle."

Insulation materials can play a major role in the development and propagation of fire through the development of flames, flammable gases and burning droplets.

Certain insulation materials are inherently combustible and will contribute to the intensity of industrial fires. Other insulation materials may be noncombustible in themselves, but they may absorb combustible liquids. Such absorbed liquids will readily convert a noncombustible material into a highly combustible insulation system. Therefore, for maximum fire safety, it is desirable to choose an insulation material that combines noncombustibility **and** nonabsorptivity.

The insulation material that should be specified anywhere that fire and smoke are possible will be fire-safe in itself and provide fire protection for the insulated structures and equipment. The insulation material will also minimize the heat transfer to the protected structure which, in turn, will help to minimize damage resulting from an external fire.

PROBLEMS

- *Confusion*

  Contributing to this danger is a frequent misunderstanding of tests, classifications, terminology and the protection provided by specific materials. References to "self-extinguishing" and "fire retarding," for example, are often interpreted as the equivalent of "noncombustible." Further, in most instances, it's generally not flames, but smoke and toxic fumes that cause injury or death. In fact, of the numerous ways by which fire can kill, flames are the least likely cause. Three factors are necessary to start and maintain any fire: a combustible material, an ignition source and a combustion supporter. Eliminate any one of these components, and an ongoing fire is not possible.

- *Testing*

  Fire testing often gives varying, ambiguous or even nontransferable data. For example, the results of a widely used U.S. test (ASTM E 84—Standard Test for Surface Burning Characteristics of Building Materials) can be significantly altered by fire-retardant additives. While these additives can reduce polyurethane flame spread ratings under test conditions, they have little retardant effect under many actual fire situations.

  Other conditions that can significantly affect actual vs. tested fire behavior are the particular materials on which an insulation is applied and the rapidity with which maximum temperatures are attained in chemical or petroleum fires compared with structural or building fires. While individual tests confronting these cases are being developed, none has national, uniform recognition.

- *Plastic Foams*

  Generally, inorganic insulation materials do not contribute to fire, but the same cannot be said for organics—especially plastic foams. In fact, polyurethane, polystyrene, isocyanurates and phenolics can introduce serious fire hazards: rapid flame spread and attainment of extreme temperatures, high levels of dense smoke, and generation of toxic or flammable gases or chemicals. Manufacturers' literature for these products includes various warnings and precautions. The potential danger is compounded by the fact that state building codes lack consistent standards in requiring plastic toxicity testing before a product goes on the market.

- *Retardants*

  Fire retardants do slow flame spread, but in many cases, they can actually contribute to the problem with their own toxic fumes. And beyond this, even months after a fire, corrosive retardants can attack metallic structures, as well as reinforced concrete and electronics, creating a secondary disaster.

Combustion Products of Common Insulations

		Parts per million	Safe levels
Std. Polystyrene	Carbon Monoxide	1,000	50
	Styrene	400	420
	Benzene	30	200
S.E. Polystyrene	Carbon Monoxide	1,000	50
	Styrene	100	420
	Benzene	20	200
	Chlorine	15	10
Wood Fiber Board	Carbon Monoxide	69,000	50
	Benzene	1,000	50
Polyurethane	Carbon Monoxide	1,000	50
	Cyanide	200	10
	Nitrogen Oxides	200	25
Polyurethane S.E.	Carbon Monoxide	800	50
	Cyanide	100	10
	Nitrogen Oxides	350	25
	Hydrochloric Acid	120	10
	Chlorine	50	10
P.V.C.	Carbon Monoxide	11,000	50
	Hydrogen Chloride	18,000	10
	Chlorine	1,000	10
Polyethylene	Carbon Monoxide	12,000	50
Cellular Glass*	Produces no toxic gases or airborne materials	0	N/A

** Data supplied by Pittsburgh Corning® Corporation based on testing of their brand of cellular glass insulation*

The FOAMGLAS® Cellular Glass Insulation Solution

FOAMGLAS® insulation is 100% glass, without binders or fillers; so it simply cannot burn. Consequently, it can actually serve to protect piping and equipment from fire damage, retard fire spread and help safeguard personnel. It is nontoxic and produces no smoke or noxious fumes.

FOAMGLAS® insulation has been exposed to a number of model fire tests; some of these test conditions and results follow.

- **ASTM E 119—STANDARD METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS**

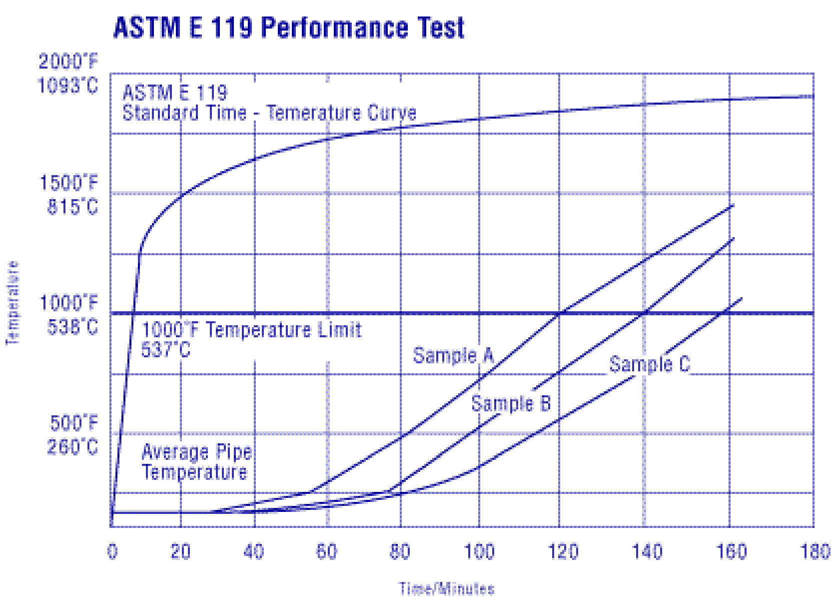
  This test examines the performance of the integral materials of a building under fire exposure conditions within a furnace until failure occurs or when steel temperatures reach 1000°F (538°C). When the average temperature of the members exceeds this level, the test is terminated—piping and equipment would have to be replaced.

  Specifications for FOAMGLAS® insulation pipe test specimens:

  - 3.5" (90mm) NPS pipe, 4" (102mm) OD
  - Double layers of FOAMGLAS® insulation, each with stainless steel bands, having tightly butted joints, HYDROCAL B-11 bore-coated inner layers, and outer layer joints staggered and sealed with PITTSEAL® 444N sealant.
  - Galvanized 0.012" (.305mm) steel jacketing secured with stainless steel bands on 12" (30.5mm) centers.

Performance:

Sample	Inner Layer	Outer Layer	Protection Time
A	2" (50.8 mm) Thick	2" (50.8 mm) Thick	120 min
B	3" (76.2 mm) Thick	2" (50.8 mm) Thick	138 min
C	3" (76.2 mm) Thick	3" (76.2 mm) Thick	158 min



- **FIRE RESISTANCE TEST FOR PETROCHEMICAL FACILITY STRUCTURAL ELEMENTS—UL 1709 (MODIFIED)**

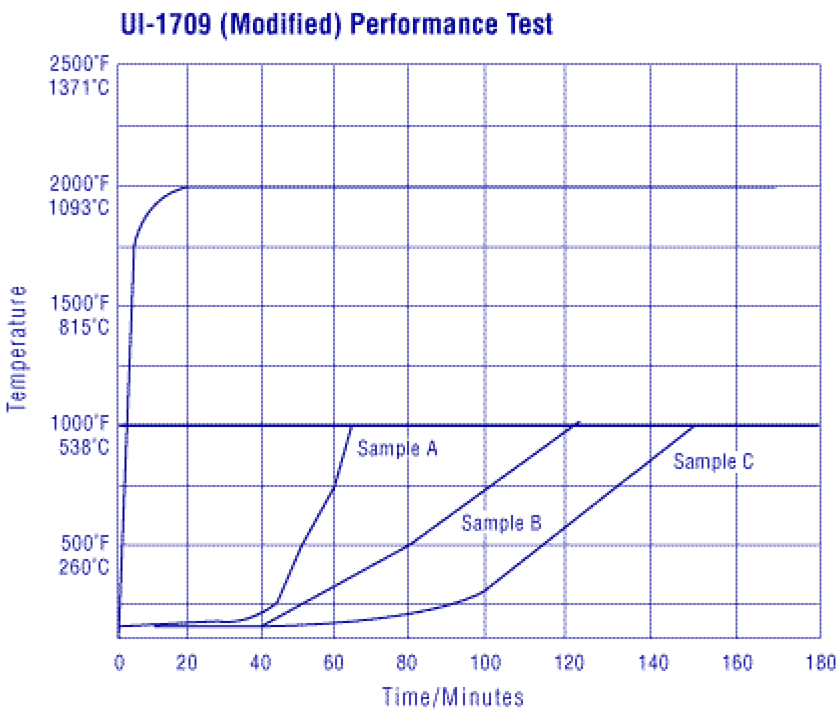
  This test is specifically designed to create unique conditions of a petrochemical plant fire and measures the hourly protection afforded steel during a rapid temperature rise that reaches 2000°F (1093°C) within five minutes. The burning rate and fuel energy potential here are totally unlike those involving typical building materials of construction. As with the previous test, performance is based on a material's ability to limit the temperatures measured on a steel member in a furnace environment to an average value of 1000°F (538°C). FOAMGLAS® insulation has been tested in three formats as jacketed double-layer systems.

Specifications for Specimens:

- Pipe section test—10" (25.4cm) ø , sch 40 steel pipe Small/large column tests—W10x49 steel column
- Double layers of FOAMGLAS® insulation, each with stainless steel bands:
  Pipe test—Bore coating of Hydrocal® B-11 applied to both layers
  Column tests—Layers adhered with PC® 88 adhesive; column voids filled with insulation
- Stainless steel 0.016"-thick (.406mm) jacketing secured with 0.5" (12.7mm) stainless steel bands

Performance:

Sample	**Inner Layer**	**Outer Layer**	**Protection Time**
A. Pipe	3" (76.2 mm) Thick	2" (50.8 mm) Thick	64 min
B. Small Column	2" (50.8 mm)	2" (50.8 mm)	122 min
C. Large Column	3" (76.2 mm)	3" (76.2 mm)	153 min



- **ASTM E 136—BEHAVIOR OF MATERIALS IN A VERTICAL TUBE FURNACE AT 1382°F (750°C)**

  As with ASTM E 119, this test also considers the combustion and heat generating characteristics of building materials. Testing continues until specimen thermocouples reach 1382°F (750°C) or until specimen failure. Visual observations regarding flame and smoke are made throughout the test. A material passes if three or four specimens: (1) do not have thermocouple temperatures more than 54°F (30°C) above the furnace temperature, (2) show no flaming after the first 30 seconds and (3) show no temperature rise or flaming when specimen weight loss exceeds 50%.

Performance:

Material	**Rating**
FOAMGLAS® Insulation Layer	Noncombustible

- **ASTM E 84—SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS**

  This test compares a building material's surface burning regarding flame spread and smoke development with that of red oak and inorganic reinforced cement board. In a horizontal furnace, gas burners direct flames against the sample. At the beginning of a test, base readings are observed, and, during the test, photoelectric cell output is recorded at least every 15 seconds. At the conclusion of the test, chamber conditions are observed, the sample is further examined, and flame spread distance, temperature and changes in the photoelectric cell readings are plotted.

Performance:

Material	**Flame Spread**	**Smoke Developed**
FOAMGLAS® Insulation	5*	0

* This "spread" is due entirely to "bounce" of the flame where is impacts the FOAMGLAS® insulation surface; it is *not spread resulting from the specimen's support of combustion. Consequently, the lowest possible rating is 5*