Reliance Innovative
BUILDING SOLUTIONS PVT. LTD.

TECHNICAL BULLETIN

EPS FIRE RATING

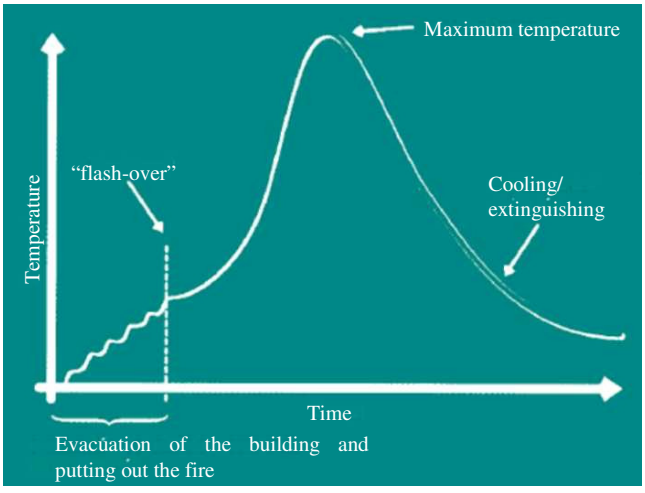
FLAMMABILITY AND TOXICITY

Expanded polystyrene is primarily manufactured from the styrene monomer, and it is expanded to form a basically closed off cellular structure. Considering the performance of any material used in construction, when it is subjected to fire, said evaluation should be made based on how the material performs in its end use conditions. Fire rating will not only depend on the chemical composition of the material, but it will also largely depend on the physical conditions of the material.

As with many other construction materials, EPS is flammable. In all cases, this is only relevant if EPS is evaluated as an exposed insulating material.

How a fire ignites and spreads through the building

When a building functions under normal temperature conditions in its daily use, flammable materials and the atmospheric oxygen are naturally in a state of equilibrium. However, in the first stages of a fire, the ignition energy comes in contact with the flammable material. At temperatures of approximately above 200 ºC, the material will give off flammable gases, which will burn due to the original fire and due to spontaneous ignition. Flammable gases can become the direct sources of combustion, thus directly bursting into flames, however solid materials such as furniture must first catch on fire to thus become sources of incandescent ignition.



In the first stage of a fire, there is a gradual accumulation of heat energy in the form of flammable gases. At this point the temperature is relatively low and the fire is still contained inside the building. Later, the near simultaneous ignition of all combustible material, the "flash-over", will result in significantly increased temperatures, and the fire will rapidly propagate through the whole building. After the "flash-over" any opportunity to rescue people or equipment from the building is greatly reduced.

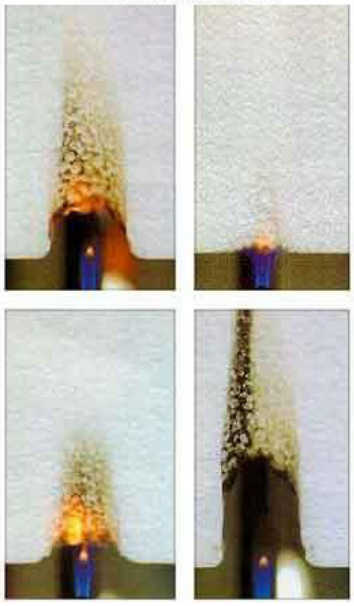
EPS fire rating

To gauge the different risk situations implied by using EPS, all factors derived from its content, shape and environment must be taken into consideration. The fire rating for EPS materials can be modified by covering or coating the materials.

Fire amplitude and the way the fire spreads, will depend on the intensity and duration of the same as well as on the specific properties of the raw materials used in manufacturing the expanded polystyrene.

Styrene monomers containing a mix of low boiling point hydrocarbons (as the expansion agent) are used as the raw materials in expanded polystyrene. All of these are combustible materials. Pentane, the expansion agent, becomes volatile progressively during the transformation process. The residual 10% must be stored for a certain time depending on the product specifications: size, density, etc.

Performance tested with a vertical flame



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The calorific value of Expanded Polystyrene materials (40 MJ/kg) is approximately two times that of wood (18.6 MJ/kg). However, taking the densities of both materials into consideration, the calorific value per unit volume for Expanded Polystyrene is between 540 and 1,250 MJ/m3, where as cellulose, wood fiber or wood products have a calorific value per unit volume of between 7,150 and 10,400 MJ/m3.

EPS has a small quantity of flame retardant in the material (maximum of 0.5%). Hexabromocyclododecane flame retardant (HBCD) is used for this purpose. Thus, one beneficial effect of EPS, when it is exposed to an open flame, is that the foam will quickly draw in pulling away from the source of heat. Thus, it reduces the probability of igniting. The additive's decomposition products extinguish the flame. Thus, when the ignition source is eliminated, EPS does not continue to burn.

A material treated with self-extinguishing agents contracts if the EPS is exposed to an open flame. It will only begin to burn if exposed to a flame for an extended period of time. Speed of propagation is very low and the flame only propagates on the surface of the material.

If there is no ignition source, the thermal decomposition products will not ignite until the products reach temperatures of around 400 - 500 ºC. When exposed to temperatures of greater than 100 ºC, EPS products will slowly begin to get soft and contract, and if the temperature increases they will melt. If they continue to be exposed to such levels of heat for a given time, the melted materials will emit flammable gaseous decomposed products. To that end, a table providing the composition of said gases is attached. The table provides a comparative analysis with other products commonly used in construction.

Carbon monoxide can be fatal if inhaled for between 1 and 3 minutes in concentrations of 10,000 to 15,000 ppm (parts per million). Styrene has a characteristic odor that can be detected in concentrations of between 25 and 50 ppm. These become unbearable at between 200 and 400 ppm. This odor functions as a preventive measure warning those in the building to immediately evacuate. Irritation to the eyes and nausea can occur at 600 ppm and some neural damages can be incurred at 800 ppm. Burning styrene will most likely decompose into carbon monoxide, carbon dioxide and water. In the decomposition of EPS with flame retardant, traces (10-15 ppm) of Hydrogen Bromide (HBr) can be found. The toxicity value of HBr is similar to that of carbon monoxide. Since its concentration is so low in comparison to that of carbon monoxide, its presence in the fumes released during the combustion of flame retardant EPS does not significantly increase health risks.

Taking these factors into consideration, when EPS is correctly installed in recommended applications, it can be concluded that expanded polystyrene products do not represent an excessive risk of fire, and they do not increase the risks related with fumes given off when burning.

MATERIAL	COMBUSTION GAS COMPONENTS	COMPOSITION OF COMBUSTION GAS IN PPM AT SPECIFIC TEMPERATURES OF			
		300 ℃	400 ℃	500 ℃	600 ℃
Self-extinguishing EPS	Carbon Monoxide	10*	50*	500*	1000*
	Styrene monomer	50	100	500	50
	Other aromatic substances	Trace elements	20	20	10
	Hydrobromic acid	10	15	13	11
Spruce wood	Carbon Monoxide	400*	6000**	12000**	15000**
	Aromatic substances	-	-	-	300
Slabs insulated with compressed wood	Carbon Monoxide	14000**	24000**	59000**	69000**
	Aromatic substances	Trace elements	300	300	1000

* Combustion without flame
** Combustion with flame