EPS Geofoamblocks

Material properties and production processes

Production manager

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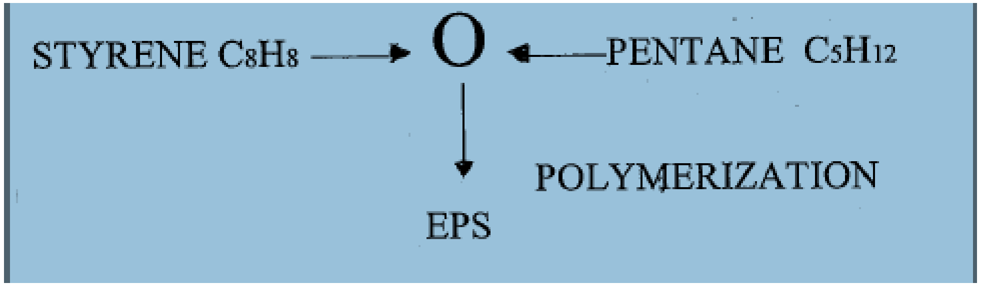
GENERAL

Fig 1

EPS is the standard abbreviation for **E**xpanded **P**oly **S**tyrene. Low levels of styrene occur naturally in plants as well as a variety of foods such as fruits, vegetables, nuts, beverages and meats. However, styrene is produced in industrial quantities from ethyl benzene. Industrial production of polystyrene was invented by BASF, Ludwigshafen in 1929. It took 20years before Dr.-Ing. Fritz Stastny invented EPS in 1949 and it was brought in to the marked at a plastics trade fair in Düsseldorf in 1952 under the trade name of STYROPOR.

EPS is obtained by polymerizing styrene and introducing small amounts of blowing agent as pentane . Both pentane and styrene are pure hydrocarbons. That means EPS consist only of carbon and hydrogen.



EPS raw material (Fig.1) is supplied to the marked in the form of small round, glass-like beads or cylindrical pellets. The expanded material is made using a steam process. EPS foam has been produced worldwide for over 50 years and is mainly used in the construction and packaging industries. EPS raw material is manufactured in general-purpose and in modified grades. The general-purpose grades do not contain any special additives. The modified grades contain small amounts of flame retardant containing bromine. In the Scandinavian countries we are only using the general-purpose grade.

PROCESSING

Pre-expansion

In the first processing stage the beads of EPS are expanded at a temperature of about 100 - 110 °C in a machine called a pre-expander (Fig.2), into which steam is fed. The high temperature softens the beads and the blowing agent they contain causes them to expand up to 50 times their original size. The final bulk density of the beads depends on temperature and steaming time. The bulk density at this stage will determine the density of the foam. The blowing agent within the beads is pentane. Pre-expansion can be done batch wise or continuously.

Fig 2

Batch pre-expanders

Fig. 3 illustrates a typical batch pre-expander. The vessel is charged with an appropriate mass of EPS raw material beads and purged with steam to remove most of the air. While the beads are agitated by a stirrer, further steam is admitted until the pressure reaches the desired value. Since the level of the material in the vessel rises as the beads expand, the beads can be discharged shortly after the required degree of expansion has been attained. The density of the pre-expanded beads can be adjusted automatically in different ways. The pressure in a batch pre-expander can exceed atmospheric pressure, so that steam temperatures can be appreciably greater than 100 °C.

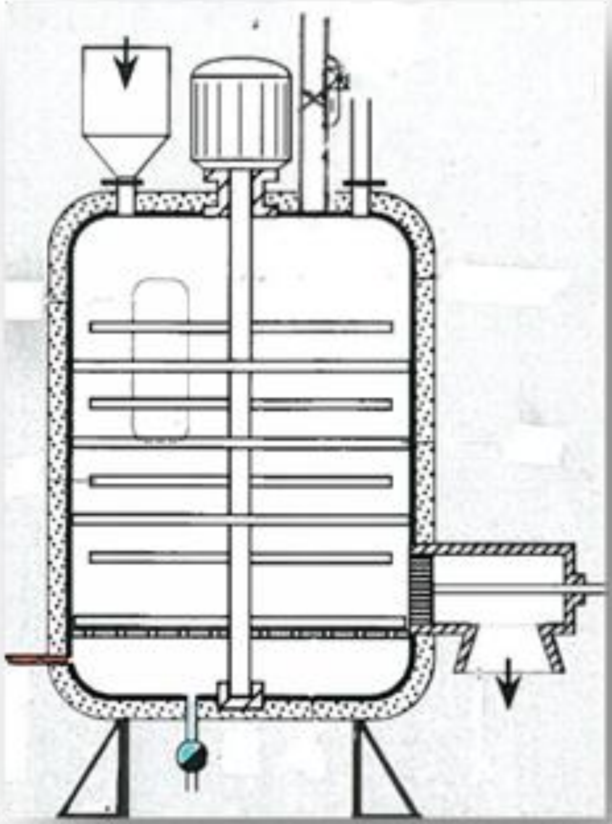


Fig 3

Continuous pre-expanders

A common type of continuous pre-expander is shown in Fig. 4. EPS raw material is introduced continuously at the bottom and expanded beads leave at the top. As in a batch pre-expander, the beads are agitated by a stirrer. Steam is supplied steadily at a fixed rate; the inlet excess pressure is kept as low as possible. As a rule, the expanded beads leave the vessel through an opening at a constant height. The density can be adjusted automatically by varying the feed rate.

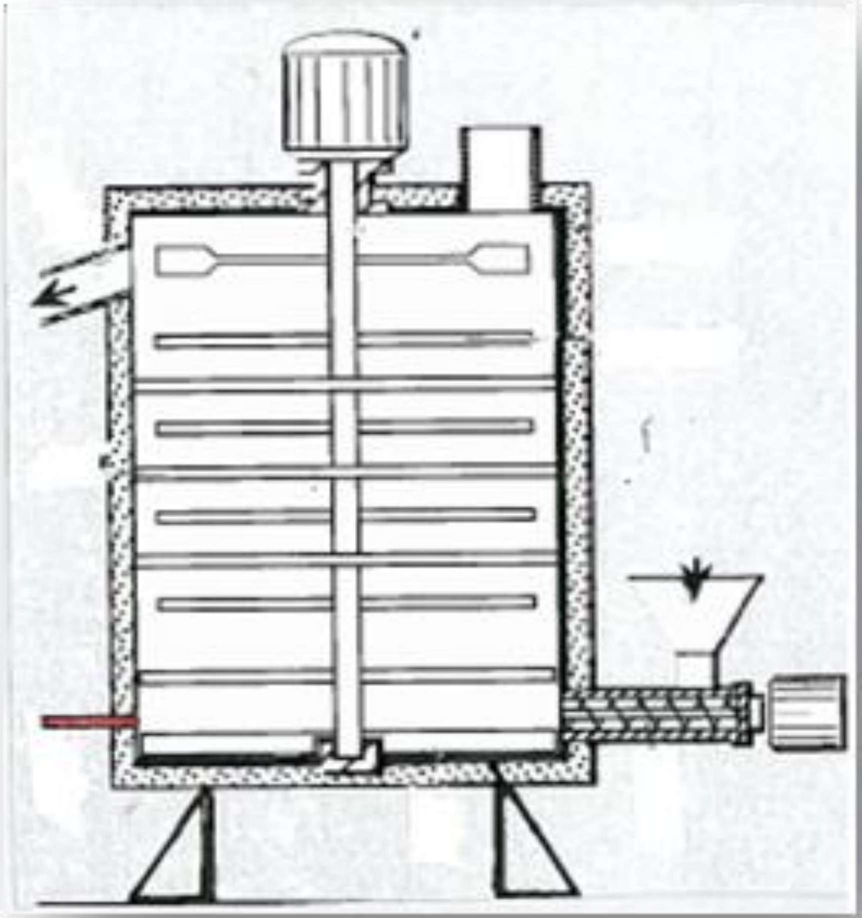


Fig 4

Intermediate ageing

The beads cool down when leaving the pre-expander. A partial vacuum develops within the individual cells caused by condensation of residual blowing agent. The pressure is equalized by storing the beads to allow air to diffuse into the cells, which is a slow process. The intermediate storage in silos (Fig.5) last for about 12 hours and stabilizes the beads and makes them ready for further processing.

Fig 5

Moulding

At this stage the beads are placed into a metal mould (Fig.6). The mould is closed and steam is passed through it. Vacuum is introduced before and after the steaming. The residual blowing agent within the beads causes them to expand again and fuse together into a homogenous block of foam. After a short cooling phase, the foam block is removed from the mould and allowed to stabilize before being processed further.

Fig 6

Cutting blocks

After some hours of ageing, the fresh moulded blocks may be cut into final dimensions with hotwire cutting equipment (Fig.7). Cutting is needed to split the block and to achieve better tolerances and flatness. One standard dimension is 600 mm x 1200 mm x length. Normally dimensions that make use of the total volume of the block are to be preferred.

Fig 7

PROPERTIES

Shrinkage general

Whenever expanded EPS beads are moulded, dimensional changes take place after de-moulding. This behaviour, common to all plastics and moulding techniques, is called *moulding shrinkage* if it takes place within 24 h and *after shrinkage* if it continues for longer than that.

Moulding shrinkage

Moulding shrinkage is defined as the relative difference between a given dimension of the mould, measured from one face of the mould to the diametrically opposite face, and the corresponding dimension of the cooled moulding after 24 h. It should be roughly the same in all directions and no more than about 1%. Higher values or uneven shrinkage indicate unfavourable processing conditions.

After shrinkage

After shrinkage is defined as the relative difference between a given dimensions of the *moulding* 24 h after removal from the mould, measured some time later. After shrinkage is largely the result of loss of residual blowing agent. The after shrinkage is about the same % in any direction. After shrinkage values are affected by the density of the material, storage temperature, duration of the intermediate ageing and ageing of finished blocks (Fig.8). Low-pentane raw material products have less after shrinkage than products with normal pentane content.

Fig 8

Mechanical loads

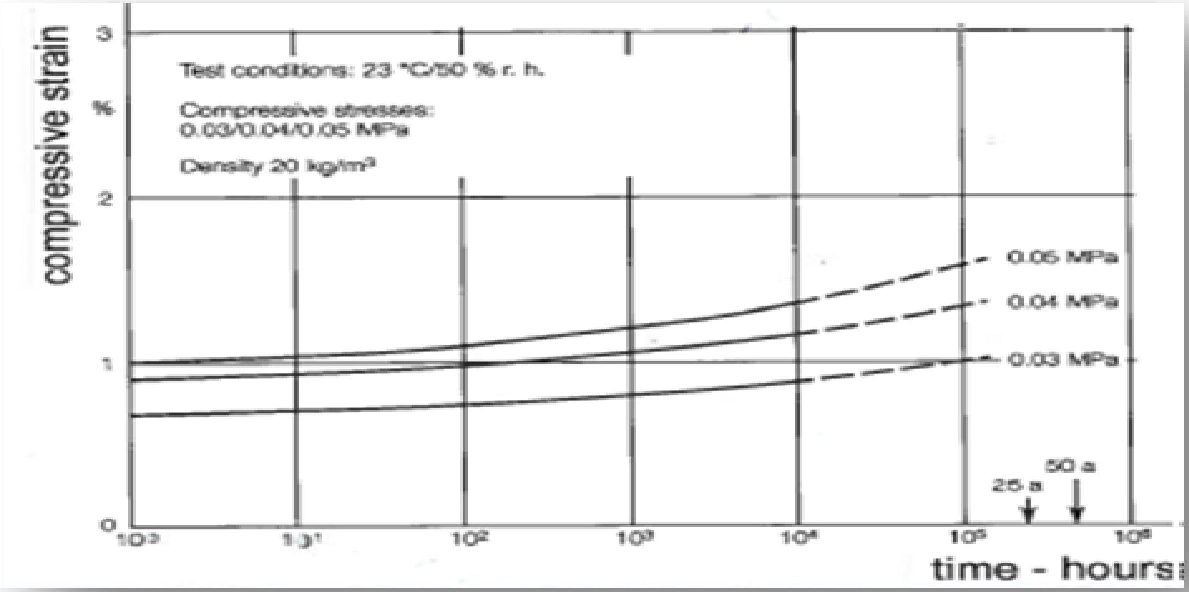


Fig 9

One important property of EPS foam is its mechanical strength when subjected to short-term and sustained loading. EPS foam is classed as rigid foam. For sustained loading, the appropriate values of compressive stress are those corresponding to less than 2% compressive strain (Fig.9). European standard describes a method for determining stress values with respect to creep behaviour when EPS foam is subjected to sustained compressive loads. Other standards describe methods for determining values on shear, flexural and tensile strength. Because mechanical properties are density dependent, comparative assessments are only meaningful if density values are also quoted.

Thermal insulation

One of EPS foam's other outstanding properties is thermal insulation. The foam consists of about 98 % air and 2% polystyrene. It is well known, the air entrapped within the cells (Fig.10) is a very poor heat conductor and so plays a decisive role in providing the foam with its excellent thermal insulation properties. Unlike foams containing other gases, the air stays in the cells so that the insulation effect remains constant. How to measure the thermal insulation properties of EPS are described in “EN 14933”. The thermal conductivity depends on the density of the foam. The mean value can be seen as a result of a large number of data collected in Europe(Fig.11).

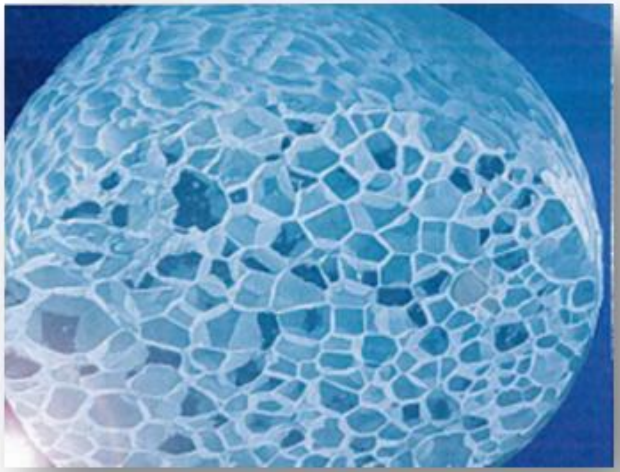


Fig 10

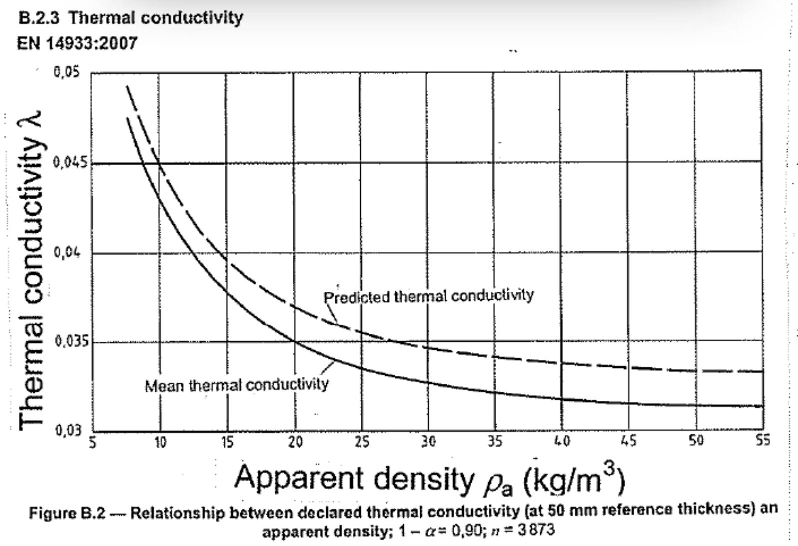


Fig 11

Water absorption

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EPS foam is not hygroscopic unlike many other types of foam. Even when immersed in water it absorbs only a small amount of water. As the cell walls are waterproof, water can only penetrate the foam through the tiny channels between the fused beads. This implies that the amount of water taken up depends on how the EPS raw material behaves when processed and upon the processing conditions . For the testing, it is always preferable to use specimens intended for practical applications. After 28 days in water, the foam absorbs less than 5% of its own volume of water. This is independent of the density

Resistant to chemicals

EPS foam's resistance to chemicals corresponds to that of parts made from polystyrene. However, because EPS's cell structure gives the material a greater surface area, damage occurs quicker, and to a greater extent, than is the case with the compact basic polystyrene material. Similarly, low density EPS is attacked far more easily than higher density EPS. In practice it is very important to know how EPS reacts to chemical substances in order to prevent defects

Resistance of expanded materials to animal and vegetable pests

EPS is a substance of no nutritional value to plants and animals, including microorganisms. However, it offers almost no resistance to rodents and many insects, which may gnaw through it when in search of food. Several kinds of insect also appreciate the thermal insulation provided by EPS.

Resistance to ageing and sunshine

EPS foam does not rot; and it is resistant to ageing. These are facts that have been confirmed by independent experts and scientific institutes in many years of observation in all the feasible applications that arise in the building trade. Owing to the high proportion of ultraviolet radiation, exposure to direct sunshine leads to a yellowing of the expanded plastic's surface within a few weeks. The yellowing may be accompanied by a slight embrittlement of the upper layer of expanded plastic. This yellowing is of no significance for the mechanical strength of insulation, because of the low depth of penetration

Road embarkment

Quality control

Quality and assessment standards for EPS geo foam blocks are: Eurpean Standard 14933

"*Thermal insulation and light weight fill products for civil engineering applications – Factory made products of EPS – Specification EN 14933*".

ECOLOGICAL ASPECTS

Fire behaviour and combustion

EPS foam is combustible. The gaseous products of combustion formed in the event of a fire do not differ very much from the fumes given off by other organic materials. They consist predominately of carbon dioxide and water. They also contain carbon monoxide and soot to an extent dependent on the conditions of burning. In the event of a fire there is no risk or hazard to the environment by toxic fumes or a risk of contaminating water. The gaseous products of combustion are comparable to those that are given off by wood-based materials.

Hygienic aspects

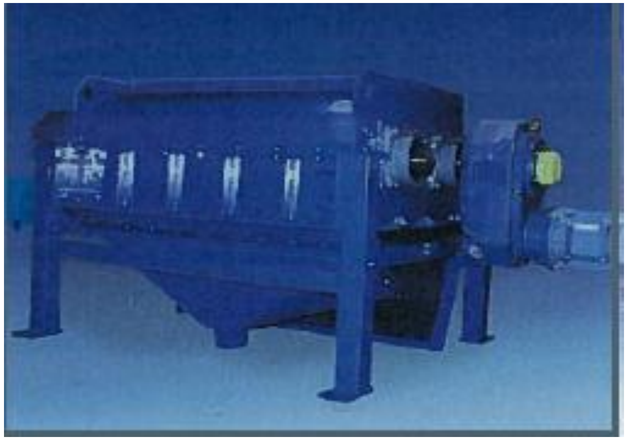
EPS foam have been manufactured and processed for decades. No adverse influences on health have become known in this time.

Biological aspects

A series of various studies have been carried out to determine the behaviour of EPS foam towards biological material. Experiments have failed to reveal any morbid or degenerative mutations in microorganisms, algae, and lichen.

Recycling and waste disposal

After it has been originally used, EPS foam can be often recycled and further recycled.
Before an article is dumped or incinerated, recycling offers a number of possibilities. For instance crossing and used as expanded EPS flocks. You can melt it dawn and granulating to yield compact polystyrene for injection moulded products or regenerated raw material.



CROSSER

EPS Flocks

Note

The information submitted in this publication is based on current knowledge and experience. In view of the many factors that may affect processing and application, these data do not relieve processors of the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose.

References:

BASF Styropor Technical Information
European Standard

Thank you for your attention