38189 March 1995

Properties

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The aging of expanded materials

Intermediate ageing of an expanded plastic is taken to mean the change in its properties in the course of time. Its cause may lie in the plastic itself, i.e. internal stresses, crystallization, etc. However, it can also be ascribed to the external influences to which the plastic is subjected during use. Whether and how the various effects act on the intermediate ageing of expanded Styropor will be discussed below.

Effect of temperature

Expanded Styropor of normal density consists of 1–5%, in terms of volume, of polystyrene, a thermoplastic. Below its softening point, which is 90–100 °C, it is amorphous. Even at extremely low temperatures, it does not undergo any changes in structure, e.g. crystallization. For this reason, there are no lower limits to the application of expanded Styropor unless it is required for design reasons connected with the contraction in volume (linear coefficient of expansion 6 x 10^{-5}/K) associated with cooling.

If expanded Styropor is subjected to a higher temperature, the upper limit for application depends on the duration of exposure and on the mechanical load on the expanded plastic. When there is no mechanical load, expanded Styropor can be exposed to a temperature of approximately 90 °C. In the course of time, a slight shrinkage may thus occur; linearly, this may be of the order of up to 0.5%. When the expanded plastic is exposed to temperatures above 100 °C, pronounced shrinkage would be observed. If the temperature rises above 300 °C, the polystyrene melt depolymerizes again to yield styrene. Long-term tests on difficultly inflammable Styropor F expanded panels have revealed that the risk of a change in properties does not exist, even for the flame-retardant, under normal conditions of temperature. This observation was made on specimens of $7^1/_2$ years of age; an official test certificate exists to prove that they are correct.

Effect of water and steam

The basic substance of expanded Styropor i.e. the polystyrene, absorbs only 0.05%, in terms of the weight of water. Since polystyrene is a pure hydrocarbon, water can effect no change, e.g. hydrolysis or swelling. Styropor also does not contain substances that can be extracted by water and whose extraction would affect the properties of the expanded plastic.

Very small amounts of water, practically negligible in flotation, are absorbed by expanded Styropor, if the beads have been well fused together, in the immersion test. The amounts of water normally absorbed by expanded Styropor of various densities in the course of time are presented in Fig. 1.

Suppose that the vapour pressure gradient persists in the one direction and that the temperature in the expanded plastic falls below the dew point; this could occur if the placement were wrong or if there were floating expanded plastic bodies on the surface of the water. In this case, the steam could condense and the water would become concentrated within the expanded plastic until it reaches up to 30%. In cases of this nature, the thermal conductivity of the expanded plastic would increase. The rule of thumb applies, i.e. 1% of water content in terms of volume impairs the thermal conductivity by 3.8%. However, the original heat insulation effect of the expanded plastic would be regained after it has dried.

The effect of light

Owing to the high proportion of ultraviolet radiation, exposure to direct sunshine leads to a yellowing of the expanded plastic's surface

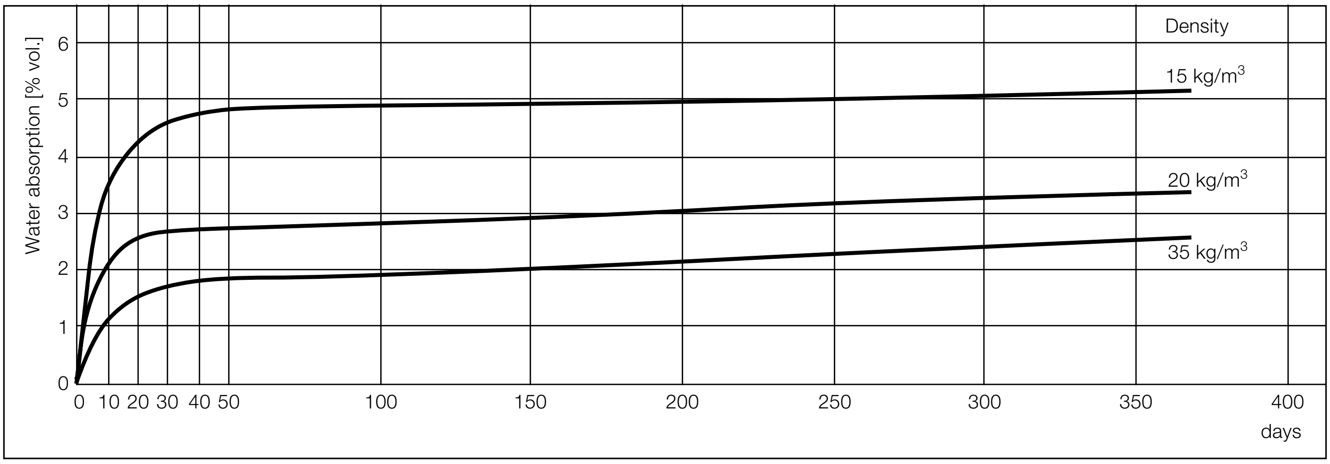

Fig. 1 Water absorbed by expanded Styropor on immersion in water

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.

The effect of radiation

Long-term exposure to high-energy radiation, i.e. short-wave ultraviolet, X-ray, and gamma-rays, are responsible for embrittlement of the expanded plastic structure. The degree of embrittlement depends on the radiation dose and the duration of exposure. The adverse effect of various sources of radiation on the compressive strain and the flexural strength of expanded plastics, expressed as the percentage impairment in terms of the untreated plastic, are shown in the following Table.

Effect of the weather

As opposed to each of these influences, on its own, the joint action of the sun, rain, and wind erodes the expanded plastic. On exposure to direct sunshine, the upper layer of cells becomes brittle. It can thus be easily removed by rain, hail, and wind. The mechanism depends considerably on the density of the expanded plastic. Thus an expanded plastic of 60 kg/m^3 density displayed no signs of erosion after it had been exposed for a period of four years outdoors, whereas the effects of corrosion were visible after only a few months' exposure in the case of a plastic with a density of 15 kg/m^3. The skin formed during the manufacture of mouldings protects the expanded plastic to some extent. It can be observed that the erosion of expanded plastics formed from fine-grained material proceeds more rapidly than that of coarse material.

Microorganisms

Microorganisms exert no effect whatever on expanded Styropor. The material does not offer them a substrate for nutrition; it does not decay, become mouldy, and rot. Even if it is greatly soiled and microorganisms form colonies on its surface under special conditions, it acts solely as a carrier and takes no part in the biological process.

Mechanical effects

Expanded Styropor undergoes strain when subjected to continuous mechanical loading, the extent depending on the amount and nature of the applied stress. In each case, tests should be run to determine if the material is strong enough for the intended application. Results obtained in long-term experiments are available for compressive loads,

Type of expanded plastic	Source of radiation	Radiation dose kGy	Rate of radiation Gy/s	Decrease in strength in %	
				Compressive stress (10% strain)	Flexural strength DIN 53423
Styropor P	Röntgen	340	1.17	10	20
	Co 60	2000	0.55	30	40
	van de Graaf	2000	41.7	30	40
Styropor F	Röntgen	340	1.17	0	30
	Co 60	2000	0.55	30	60
	van de Graaf	2000	41.7	50	70
Styropor FH	Röntgen	340	1.17	0	0
	Co 60	2000	0.55	0	15
	van de Graaf	–	–	–	–

Table 1 Effect of exposure to radiation on the mechanical strength (measured on plastics with densities of 15 to 25 kg/m^3). Unit of energy dose Gray (Gy). 1 Gy = 1 J/kg

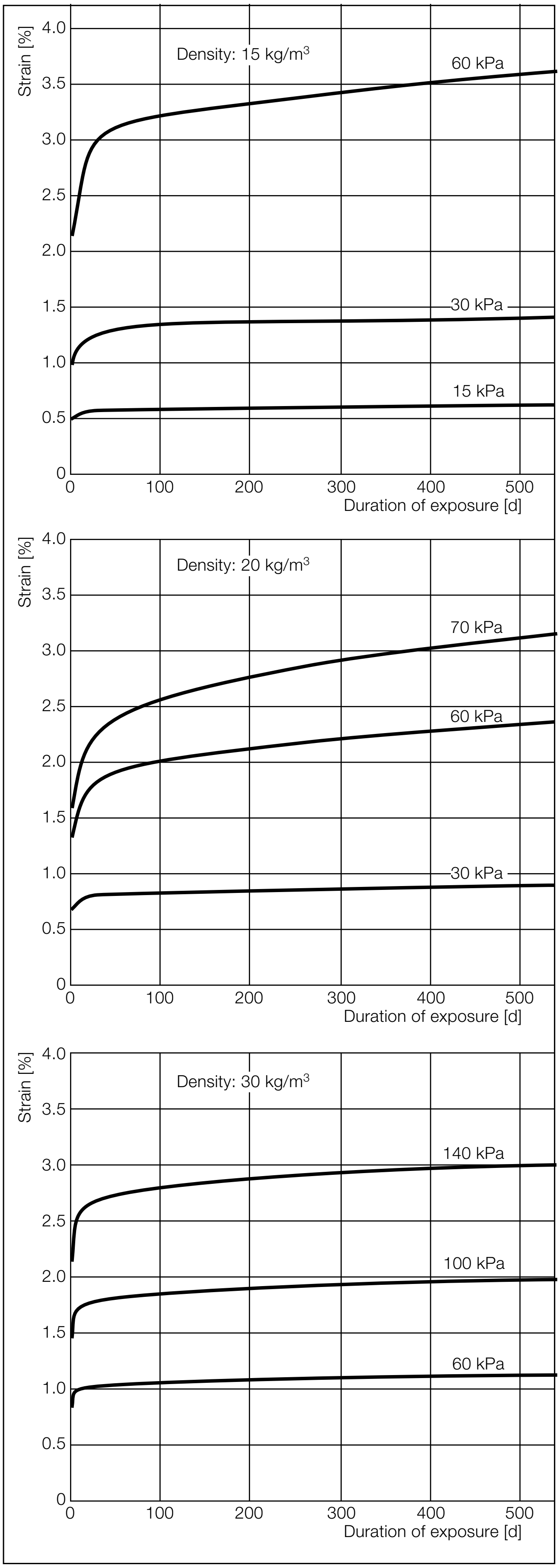

Fig. 2 Creep diagram showing the strain undergone by expanded Styropor with densities of 15, 20 and 30 kg/m^3 under various loads

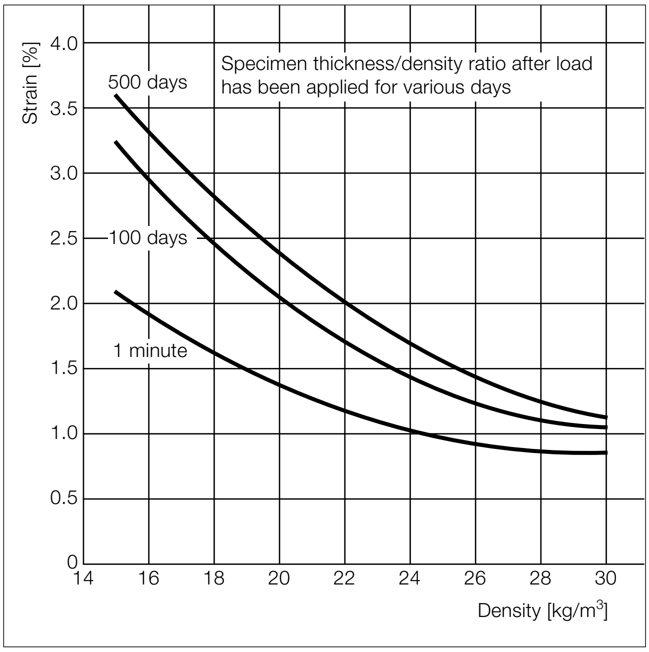

Fig. 3 Density-strain ratio after various days

which constitute the most important form of stress in practice (Fig. 2).

The load per unit area that the cellular material can withstand for longer periods is, of course, lower than that found in short-term compressive tests.

Summary

This list demonstrates that expanded Styropor is resistant to ageing. The only threat is when it has been stored for a long period unprotected or when it is installed uncovered. We therefore recommend that expanded Styropor be stored and installed in such a manner that it is protected from the weather and mechanical damage.

Note

The information submitted in this publication is based on our 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. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.