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Properties

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Expanded Styropor and its impact on the environment

This Technical Information Bulletin has been compiled in response to a number of ecological queries that have arisen in connection with the production, processing, and application of expanded Styropor.

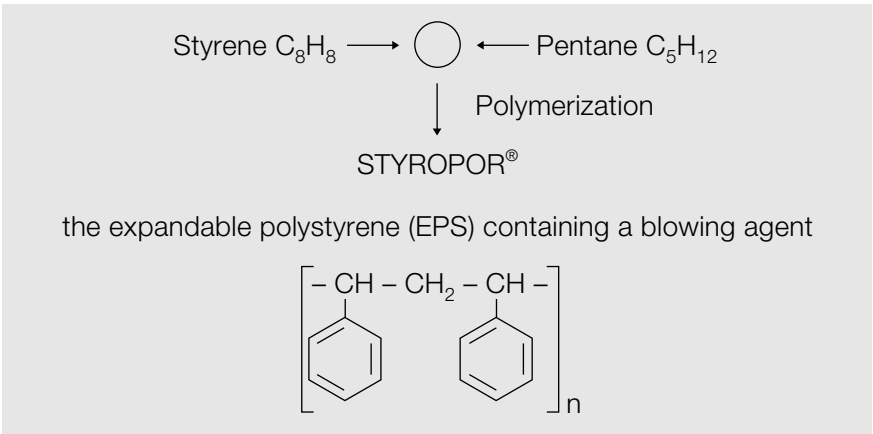
Raw materials and production

Expandable polystyrene (EPS) is obtained by polymerizing styrene and introducing small amounts of a blowing agent, viz. pentane.

Both pentane, which is contained in petroleum, and styrene, which is a petroleum derivative, are pure hydrocarbons, i.e. they consist solely of carbon and hydrogen.

Components

Styropor is manufactured in general-purpose and in special grades. The general-purpose grades of the P series do not contain any special additives. Those of the F series contain small amounts of a flame retardant containing bromine (in numerous European countries, cellular materials for applications in the building trade must be difficultly flammable). Special grades, e.g. for coloured expanded plastics, contain pigments.



Styropor is BASF Aktiengesellschaft's registered trademark for expandable polystyrene and is also the registered trademark of *Industrieverband Hartschaum e.V.* for thermal insulation produced from it.

Styropor is supplied in the form of small spherical beads or cylindrical pellets. The expanded material is formed by fusion of the individual particles.

Blowing agents

Pentane, the pneumatogen used in Styropor, is a member of the alkane group; for example, like methane, ethane, propane, and butane.

It is present in petroleum and is also continuously formed in nature. For instance, it is a product of anaerobic biochemical degradation in human and animal organisms and finds its way into the atmosphere by expiration.

Alkanes are not regarded as pollutants, because they are decomposed in nature just as continuously as they are formed from natural sources. Pentane itself is decom-

posed more rapidly than lower alkanes.

In the atmosphere, pentane is rapidly degraded in a photochemical reaction, particularly by hydroxyl radicals. The half-life, i.e. the time during which its concentration falls to half the original value, is between 10 and 15 hours. Various factors are responsible for this difference in time, one of them being the intensity of solar radiation. Consequently, pentane is decomposed more rapidly in summer than in winter and more quickly in daylight than at night.

The products of decomposition are absorbed by water and the soil. They are converted into products of metabolism or into carbon dioxide and water by plants, bacteria, and microorganisms.

Fluorocarbons are not released to the environment during the production, processing, and application of Styropor and cellular materials obtained from it, simply because they are not contained in Styropor.

Emission

Factories and installations concerned with the transportation, storage and processing of Styropor and cellular material obtained from it are not subject direct to the provisions of the West German Clean Air Act. In other words, these factories and installations may be erected and operated without official authorization in the sense of West German legislation on the prevention of air pollution. However, it has been laid down that they must be designed and operated to prevent any harmful effects on the environment that could be avoided in the light of the current state of the art.

Handling the raw materials

Information on the safe handling of Styropor is given in the Safety Data Sheet.

Production of cellular material

Styropor is processed in three stages, i.e.

preexpansion

intermediate ageing of the preexpanded particles

expansion and moulding.

During these three stages, pentane and traces of styrene are liberated. Their concentrations depend on the technical facilities available and on the desired product properties. Thus technical advice is essential in obtaining accurate data.

Handling cellular material

Residual blowing agent and traces of styrene can still be emitted from freshly prepared blockware and mouldings. A study made on Styropor insulating board installed in rooms has demonstrated that the emission of styrene into the atmosphere can no longer be detected after an adequately long storage period. Likewise, the emission of residual blowing agents practically ceases after this period.

Cutting cellular material with heated wires

Vapours and gases are given off if expanded Styropor is cut with heated wires. They are formed by degradation and cleavage of the polymer chains into segments that become progressively smaller until the starting material, i.e. styrene monomer, is obtained.

The heat of the wire evaporates the degraded and cleaned segments, together with the blowing agent, with the result that the vapours emitted consist essentially of low-molecular-weight segments, styrene and pentane. Traces of hydrogen bromide may also be emitted from flame-retardant cellular materials (cf. “Industrial health”).

Radioactivity

Neither alpha, beta, or gamma radiation nor radon emanations were detected in studies on expanded Styropor.
(Expertise signed on 07.03.1987 by R. Reiter, Garmisch-Partenkirchen).

Fire behaviour and combustion

Styropor and cellular material produced from it are 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 predominantly of carbon dioxide and water. Other constituents, the concentrations of which depend on the conditions under which the fire occurs, are carbon monoxide and soot. Traces of hydrogen bromide are also given off during the combustion of flame-retardant cellular Styropor.

Styropor and cellular material produced from it, including that containing a flame-retardant, may be burned at temperatures of ca. 1000 °C in incinerators, if adequate air is supplied.

In the event of a fire, no risk of hazard to the environment by toxic fumes nor a risk of contaminating water may generally be expected. The gaseous products of combustion are comparable to those that are given off by wood-based materials. Slight traces of hydrogen bromide, which is precipitated by the water used for extinguishing and thus finds its way into natural water courses, can be regarded as harmless. (See TI 0/1/2-810 and TI 0/1-130).

Brominated dioxins were not detected either in the gas phase or in the fire residues in the experiments described in DIN 53436 with Styropor F. All that was detected were negligible amounts of brominated furans, all of which, however, do not fall under the German chemical prohibition ordinance of 1994.

Industrial hygiene

Styropor and cellular Styropor have been produced and processed for decades. Over this period, no reports have ever been received on any harmful effects on health that could have been brought into causal relationship with these materials.

Styropor and expanded material produced from it are chemically neutral, insoluble in water and do not give off any water-soluble substances that could lead to contamination of the ground water. They are not decomposed by microorganisms and are not nutritive substrata for moulds and bacteria. Likewise, Styropor and expanded Styropor do not allow their use as nutrients or substitute nutrients for human beings and animals.

Even external influences, e.g. manure, earth that has been fertilized with phosphates, acid rain, etc., do not have any significant effect. The expanded material does not rot.

Styropor or expanded Styropor that has been accidentally ingested by persons or animals passes through the stomach and digestive track and is eliminated again chemically unchanged.

Queries concerning food

Styropor is used in the production of articles for food-contact applications as defined in the German *Lebensmittel- und Bedarfsgegenständegesetz.* In the light of the current state of the art, the West German Ministry of Health has published recommendations that stipulate the conditions under which plastic articles intended for food-contact applications conform to the pertinent paragraphs in the above act.

In addition, international legal requirements and provisions must be adhered to and observed.

Styropor packaging for food-contact applications may not affect the taste or odour of the food, and must be suitable for the application in question. The test to determine whether the taste or odour is affected must be performed by the user or packer in the case concerned. It has been demonstrated in practice that this condition can be fulfilled if the packaging has undergone a sufficiently long period of intermediate ageing. The only cases when difficulties may occur arise if the foods have a delicate aroma or contain fats, e.g. chocolate, margarine, and cream tarts. In cases of this nature, resort may be taken to wrappers produced from parchment paper, plastics film, or metal foil.

Styrocolor® G packaging may not be used for food-contact applications unless it has been ensured that no traces of the colorant may migrate onto the food. Evidence to this effect also must be supplied by the user or packer.

Food legislation

The monomer used in the production of Styropor conforms to the EEC Guideline 90/128/EEC dated 23.02.1990 and the German Ordinance on articles that come into contact with foods dated 10.04.1992.

Furthermore, the processing and production aids used in the manufacture of Styropor are listed in corresponding recommendations issued by the German Health Authorities on polymers that contain polystyrene, colorants, and/or those listed in EEC Synoptic Documents.

The composition of Styropor grades satisfy all requirements in the corresponding recommendations of the German Health Authorities.

Industrial health

Pentane and traces of styrene are liberated during the production and processing of expanded Styropor. Thus there is a slight risk in workrooms of exposure to these substances. Since pentane and styrene, in common with ethanol, are classified as industrial chemicals that may be harmful to health or constitute a health hazard if certain regulations are not observed, steps must be taken to protect all personnel involved in handling them. The criterion adopted by industrial hygienists in West Germany for assessing the health hazard inherent in a chemical substance is the maximum allowable concentration in the workplace (MAK value).

A list of MAK values has been compiled for health protection and is taken as a basis in deciding whether or not a given concentration of a given substance is harmful to health*.

MAK values are checked annually by a commission and either confirmed or revised. The commission also arranges for fresh studies on substances that have already been listed and on others that have not. The MAK values for pentane and styrene are as follows:

Pentane		1000	ml/m^3 (ppm vol.)
	≙	2950	mg/m^3
Styrene		20	ml/m^3 (ppm vol.)
	≙	85	mg/m^3

(1987 MAK List)

These values must never be exceeded. Normally, the concentrations in workrooms where Styropor is processed lie far below these limits. We recommend that an exhaust fan be installed in workrooms where Styropor is cut by heated wires (see above) in order to ensure that the workroom concentration remains below the MAK values.

Physiological aspects

A number of studies have been made to determine the effect of expanded Styropor on living organisms.

Experiments on seeds and mealworms

Seeds were allowed to germinate on cellular plastic and wooden (reference) boards. No differences were observed in germinating, in the shape and colour of the embryos, and during further growth. Similar experiments were performed with mealworms on Styropor and wooden board. Again no differences were observed. Holes that were drilled into the cellular plastic boards were also accepted for pupation.

Experiments on microorganisms

Since microorganisms have an exceptionally sensitive reaction towards toxins, even in extremely small amounts, a number of microbiological tests were performed.

Expanded Styropor was placed on a substrate together with ubiquitous moulds. Both these and the reference cultures showed no signs whatever of harm in all phases of growth. Furthermore, no changes were observed in the subsequent generations.

Expanded plastics were placed in a liquid nutrient, which was inoculated with mixed apathogenic species of aerobic and anaerobic bacteria. The cultures were compared with a reference. In a number of experiments of this nature, neither a microbicidal nor a microbiostatic effect was observed. Likewise, no microbicidal or microbiostatic effects were observed in yeast and vegetable cell cultures in liquid nutrients contained in expanded Styropor. There were also no signs of hypertrophy.

In all these experiments, no evidence was obtained of morbid or degenerative mutation.

** The MAK value (maximum concentration in the workplace) is defined as the maximum permissible concentration of an industrial substance present in the air within a working area (in the form of a gas, vapour, or particulate matter) which, in the light of current state of the art, generally does not impair the health of persons employed nor cause undue annoyance. MAK values are based on work schedules involving shifts of 8 hours' duration in a working week of 40 hours. The main factors for which allowance is made in the compilation of MAK values are the characteristics of the airborne pollutants and (whenever possible) practical details on the working process or on the exposure pattern governed by it. What counts are well-founded scientific criteria on health protection and not the technical and scientific means for realization in practice (translation of citation from, "Maximale Arbeitsplatzkonzentration und Biologische Arbeitsstofftoleranzwerte 1987, VCH Verlagsgesellschaft mbH, D-69469 Weinheim, 1987").*

Experiments on algae and lichens

Experiments on colonies of green and blue algae and lichen that had been formed on expanded plastic were found to be exclusively on the surface. They did not penetrate into the cellular material itself. The surface was accepted for colonization, and the colonies grew in the same way as they do on stones, plants, wood, bricks, etc. Over a period of one year, no changes whatsoever were observed in the cultures. The one and only means that could be found for the necessary growth and development was to withhold the algae and lichens from the necessities of life, e.g. light, moisture, etc.

(The experiments were performed by the Institute Bio-Bauforschung K.H. Sirtl, Karlsfeld).

Recycling and waste disposal

Before it is finally dumped or incinerated, expanded Styropor can be recycled in a number of ways. For instance, it can be re-used in the production of cellular material; it can be converted into Styromull® (cellular flakes); it can be melted and pelleted to yield compact polystyrene for injection moulding; or it can be degraded into the original raw materials. These subjects are dealt with in detail in Technical Information Bulletin TI 0/1/2-810 (Recycling and disposal of used expanded Styropor).

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.

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