Expanded Polystyrene (EPS) Packaging

EPS Packaging

Expanded Polystyrene (EPS) is a relatively modern material (developed in the 50´s) but is one of our companions in our everyday life and easily identified among the various plastics materials. The conversion process into the foam structure is quite simple and it is called steam molding. This process goes through three stages:

Pre-expansion:

In this stage tiny spherical EPS beads are expanded to 40 times their original size using steam as heating agent.

Stabilization:

The pre-expanded beads are stabilized in ventilated silos where just air is diffused into the beads.

Moulding:

The beads from the silos are conducted to a moulding machine where the beads bond together, by means of steam and pressure and the final shape is achieved.

This process results on moulds with extraordinary qualities for the fulfilment of all packaging needs: Protective: the outstanding shock absorbency and compression resistance provides excellent protection properties.

Insulation capacity:

The thermal insulating properties of EPS keep food fresh and prevent condensation - guaranteeing that fish, fruit and vegetables can all be safely distributed to retain their freshness and their shape.

Durability:

EPS remains unaffected by damp, moisture or heat and its soft surface protects against any damage. Ligtweight: EPS is 98% air and it is one of the lightest packaging materials in existence.

Versatilility:

Packaging is customized to fit the smallest component or the largest fridge-freezer. The latest computer design techniques ensure that packaging is kept to a minimum yet is 100% fit-for-purpose. These outstanding qualities make EPS a magic material not only used for packaging of the most variety of products but also for other applications from a bicycle helmet to a surfing board.

And once the EPS packaging has been used then it can be recycled for various applications.

EPS Packaging Environmental Facts

In recent years environmental awareness has increased in all sectors of industry. If we consider the behaviour patterns of modern consumer society, there are those who consider that packaging in general has a negative effect on the environment. Sometimes plastics are targeted as the direct cause of certain perceived problems. The facts, however, lead us to very different conclusions.

EPS is completely recyclable and it is being recycled throughout Europe and other areas around the world.

EPS is composed almost entirely of air (98%). Thus reducing the resources usage.

EPS uses pentane, a natural gas, as blowing agent. CFCs, HFCs, and other chlorine derivates have never been used.

As a completely inert material EPS is safe for food contact as well as for waste disposal.

A recent Life Cycle Analysis study demonstrated that in a case study of a TV packaging, EPS was not the most significant contributor to environmental impact. Additionally, developments in recycling have ensured that impacts are constantly being reduced.

Recycling Possibilities:

Once the EPS packaging material has ended its primary function, there are various possibilities for new uses such as:

New EPS products: It is ground and blended with virgin EPS foam beads to make new EPS blocks and shapes.

EPS foam bead: EPS waste is ground to individual beads that are used for lightweight concrete, insulating renderings and porous bricks. These EPS beads can also be used for soil improvement and soil aeration.

Wood substitute: EPS can be extruded and made into hardwood replacement, can be used to make products such as garden f u r n i t u r e , window and picture frames.

New plastic products: EPS waste can be returned to PS (polystyrene) pellets and used for video and CD cases, coat hangers, regulars, plant pots and even for disposable cameras. PS can also be extruded and regassed to make loose bead to aid drainage or “loose fill” packaging.

International Packaging Regulations

EPS AROUND THE WORLD

The healthy and growing market for EPS products in the United States is matched by the

international market's demand for EPS packaging. EPS is a popular choice around the world and is relied upon by its customers in virtually all countries.

International EPS Recycling Agreement

To keep up with the global market expansion, the international EPS community has come together to assist one another, especially to help EPS customers meet the regulatory and environmental requirements that vary from one country to the next. More than 20 countries worldwide are pledged to participate in the International EPS Recycling Agreement.

Properties, Performance and Design Fundamentals of Expanded Polystyrene Packaging

Expanded Polystyrene Expanded polystyrene (EPS) is a generic term for polystyrene and styrene copolymers that are expanded into a variety of useful products. EPS is supplied to molders in the form of a polystyrene bead; EPS beads are loaded with a blowing agent, usually pentane, and other chemical agents and additives that give the beads expansion vibrancy and allow them to be processed and molded into low-density foam articles; EPS is comprised of 90 percent air. The shock absorbing properties and other qualities of EPS foam, combined with its low-cost, high insulating properties, custom moldability and ease of processing make it a popular packaging material.

End-Use Applications:

For more than 50 years, the effectiveness of EPS has been proven in numerous packaging applications used by a wide variety of industries, consumer product manufacturers and catalogue andshipping companies. Lightweight EPS is ideal for these packaging applications due to its physical properties, in particular its cushioning characteristics, dimensional stability and its thermal and moisture resistance. Custom-molded EPS interior packaging has been highly effective in protecting sensitive electronic components, consumer goods and office equipment; its moldability allows interior packaging components to hold products snugly in place. High insulating properties and moisture resistance have made EPS a popular choice in the food packaging, medical and pharmaceutical industries. EPS is also used to protect a myriad of other products used for component assembly, during internal distribution and storage and delivery to the end user.

Because EPS can be molded into virtually any shape or size, it is well suited to automated production lines. End caps, rails and other interior EPS packaging pieces can be customized to accommodate the needs of automated integrated production systems; EPS interior packaging pieces can be quickly and efficiently put into place via automated procedures during the packaging assembly process. A key benefit of EPS is that it is recyclable. EPS materials can be reprocessed and molded into new packaging products or durable goods; Formal EPS recycling programs have been established in several countries throughout the world. Engineered for Optimal Performance Regional EPS molders utilize a multistage production process to expand and mold the beads into EPS products. They use one of two different processes to expand EPS beads: continuous preexpansion and batch pre-expansion.

Physical Properties Mechanical Properties

The mechanical properties of EPS foam depend primarily on density, Generally, strength characteristics increase with density, however the cushioning characteristics of EPS foam packaging are affected by the geometry of the molded part and, to a lesser extent, by bead size and processing conditions, as well as density. This unique characteristic allows a packaging engineer to fine-tune cushioning performance by simple processing changes, without the need to redesign or retool. For shock cushioning, the EPS packaging industry has developed typical cushioning curves for use by designers of EPS transport packaging. Shock cushioning properties of EPS are not significantly affected by change in temperature. Recent studies conducted at San Jose University, Packaging Program, have shown that the optimum performance characteristics of EPS are not affected by changes between –17 C and 43 C. Packaging engineers should regard the following data as an accurate representation of the performance of EPS foam.

Table 1. *Typical Properties of EPS Molded Packaging (70F Test Temperature)*

Density (pcf)	Stress @ 10% Compression (psi)	Flexural Strength (psi)	Tensile Strength (psi)	Shear Strength (psi)
1.0	13	29	31	31
1.5	24	43	51	53
2.0	30	58	62	70
2.5	42	75	74	92
3.0	64	88	88	118
3.3	67	105	98	140
4.0	80	125	108	175

Note: Values based on ASTM short-term, laboratory-load conditions. Both temperature and time period of loading may affect end-point values.

Density:

Packaging density must be considered when choosing the correct level of cushioning needed for the job. In the preliminary design stages, cushion curves developed from dynamic drop testing are used to determine the correct package configuration—foam thickness and density—to adequately protect the product. By varying the density, thickness and shape of the EPS foam, the designer can meet the protection requirements of a wide range of delicate products. Dimensional

Stability:

Dimensional stability is another important characteristic of EPS foam. It represents the ability of a material to retain its original shape or size in varying environmental conditions. Different

plastic polymers vary in their reaction to the conditions of use and exposure to changes in temperature and/or relative humidity. Some shrink, some expand and some are unaffected. EPS offers exceptional dimensional stability, remaining virtually unaffected within a wide range of ambient factors. The maximum dimensional change of EPS foam can be expected to be less than 2%, which puts EPS in accordance with ASTM Test Method D2126.

Thermal Insulation:

For construction insulation applications the polystyrene foam industry has developed test data as reported in ASTM C 578 Standard Specification for Rigid Cellular Polystyrene Thermal Insulation. This standard addresses the physical properties and performance characteristics of EPS foam as it relates to thermal insulation in construction applications. There has been no need to develop such a formal document for the packaging industry. EPS is an effective, economical packaging material for produce, pharmaceuticals and other perishables, when these items must be shipped and stored in temperaturecontrolled environments. The uniform, closed cellular structure of EPS is highly resistant to heat flow. The thermal conductivity (k factor) of EPS packaging varies with density and exposure temperature resistance is the ability of a packaging material to prevent water from entering its structure and eroding its mechanical properties. The cellular structure of EPS is essentially water resistant and provides zero capillarity. However, EPS may absorb moisture when it is completely immersed, due to the fine interstitial channels between the molded beads. While molded EPS is nearly impervious to liquid water, it is moderately permeable to water vapor under pressure differentials. Vapor permeability is determined by both density and thickness. Generally, neither water nor water vapors affect the mechanical properties of EPS.

Table 2. ***Typical Thermal Conductivity (k factor)***

Density (pcf)	*Mean Test Temperature (F)*	*K factor (BTU-In./Ft.2Hr F)*
1.0	0	0.22
	40	0.24
	75	0.26
	100	0.28
2.0	0	0.20
	40	0.21
	75	0.23
	100	0.25

Table 3. *Water Absorption and Vapor Transmission*

Mean temperature (F)	Type I 0.90 pcf	Type VIII 1.15 pcf	Type II 1.35 pcf	Type I 1.80 pcf
Maximum water vapor transmission (WVT)[g]	2.0–5.0 perms	1.5–3.5 perms	1.0–3.5 perms	0.6–2.0 perms
Maximum absorption % by volume[h]	<4.0%	<3.0%	<3.0%	< 2 . 0 %
Capillary action	None	None	None	None

Chemical Resistance:

Water and aqueous solutions of salts and alkalis do not affect expanded polystyrene. Most organic solvents are not compatible with EPS. This should be taken into consideration when selecting adhesives, labels and coatings for direct application to the product. All substances of unknown composition should be tested for compatibility. Accelerated testing may be carried out by exposing molded polystyrene to the substance at 120 – 140 F. UV radiation has a slight effect on molded polystyrene. It causes superficial yellowing and friability, but does not otherwise effect its physical properties.

Electrical Properties:

The volume resistively of molded polystyrene within the 1.25 – 2.5 pcf density range, conditioned at 73 F and 50% r.h. is 4 x 1013 ohm-cm. The dielectric strength is approximately 2KV/mm.At frequencies up to 400 MHz, the permittivity is 1.02 – 1.04 with a loss factor less than 5 x 10–4 and less than 3 x 10–5 at 400 MHz. Molded EPS can be treated with anti-static agents to comply with electronic industry and military packagingspecifications.

When Properly Engineered, There is No Substitute for EPS The fundamental objectives of transport packaging materials are to preserve and protect a product from damage, through the manufacturing process all the way to delivery to the consumer. Choosing the right packaging material requires a balance of many factors, including ease of handing and storage, weight, cushioning characteristics, manufacturing efficiency, ease of identification, customer requirements, cost and more. EPS protective packaging offers a broad range of physical properties to allow packaging designers to meet the many challenges of protection and distribution. These properties, in combination with appropriate engineering design considerations, provide the design flexibility required to create truly cost effective protective packaging.

Recycled Content in Expandable Polystyrene Foam Protective Packaging

Trends in Manufacturer Specification of Recycled Content

In the early 1990's, a strong environmental movement swept the United States that called for manufacturers and consumers to demand recycled content packaging. Threats of mandatory content legislation forced many manufacturers into a reactive mode of mandating recycled content from their packaging suppliers. More recently, the environmental movement has subsided and there is less legislative threat. More appropriate emphasis has been placed on packaging cost and performance than environmental attributes. However, the lessons learned in the early and mid 1990's have not been forgotten. Although significantly less, some manufacturers (particularly electronics companies) are continuing to feel the pressure of producer responsibility— but now they feel the pressure is to incorporate recycled content into the product itself (not just the packaging).

To economize, some manufacturers are looking to their packaging suppliers to provide recycled content packaging. Most manufacturers have transitioned from a panic, reactive mode to a steady, roactive mode with respect to environmental issues. Where it is not an economic disadvantage, manufacturers are strongly encouraging packaging producers to incorporate recycled content. Cost being equal, a packaging producer may not get the bid if their proposal does not consider recycled content and other environmental issues. Most manufacturers today recognize the importance of building an environmental resume that can be produced when the environmental pendulum swings back to where it was in the early 1990's.

Recycled Content in Expandable Bead Foam Applications:

In order to appreciate recycled content limitations in expanded bead foam materials, it is important to understand industry supply chains and product manufacturing methods. Manufacturers of expanded bead protective packaging purchase the bead material from plastics resin producers—they don't manufacture it themselves. They then expand and mold the purchased beads into protective packaging products using steam, which softens the plastic so that it can be processed. Because protective packaging manufacturers don't melt the plastic beads, they can only incorporate recycled content in two ways: (1) blend in used expanded particles from bead foams they take in and grind down to the bead level; or (2) purchase beads that already contain recycled content.

Since EPS beads have already been fully expanded and no longer contain a blowing agent, they cannot expand to fill interstitial void spaces when reused in a new part. Damage from grinding and the inability to expand results in void spaces in manufactured parts, which may weaken the product. The bottom line is that EPS that is ground and reused as recycled content serves primarily as a "dead" filler material because it lacks blowing agent. The level of recycled content that can be used without sacrificing performance depends on the product that is being produced. Like all plastics, and even other recyclables such as paper, glass and steel, recycled content EPS will exhibit some weakening in its physical properties and appearance. Molded EPS products, particularly those that require relatively thin part cross sections or that require high foam densities (e.g., those used to package heavy computer and electronic equipment) can normally tolerate recycled content levels of five to ten percent.

ARCEL®, due to its composition, will tolerate levels up to 12%. Less demanding applications, such as EPS block manufacturing, can tolerate up to twenty percent recycled content levels.

Other Recycled Content Factors:

In addition to the technical considerationsdiscussed previously, there are other factors that may limit the ability of packaging manufacturers to incorporate significant amounts of recycled content into expanded bead protective packaging, such as constraints on the availability of recovered material.

EPS protective packaging has an average recycling rate of ten percent. This level of recycling is amazing given that virtually no community-based recycling programs collect EPS from consumers for recycling. Most of the EPS that is recycled comes from manufacturing assembly plants that receive components packaged in EPS protective packaging. In most cases, EPS recovery for recycling at these companies is already occurring and there is little opportunity for additional recovery. Because EPS packaging represents such a small portion of the residential solid waste stream, community-based recycling programs are not likely to add EPS to their list of materials for collection. The conclusion to be drawn is that recovered material supply (for recycled content manufacturing) is limited to near current levels. Companies that mold non-foam rigid polystyrene products purchase about one quarter of the EPS packaging that is recycled. EPS molders consume approximately half of the remainder, with an equal amount of material being consumed by polystyrene loosefill manufacturers. Limits on recycled content in EPS protective packaging that are based on lack of supply and competition by other recycled product uses, therefore, result in an average industry-wide post-consumer recycled content percentage of two percent (not including pre-consumer manufacturing scrap).

Expanded polystyrene manufacturers use pentane as its primary blowing agent. EPS transport packaging has never

been made with CFCs (chlorofluorocarbons) or HCFCs.