# Expanded foam molding

## Description

**Process schematic**

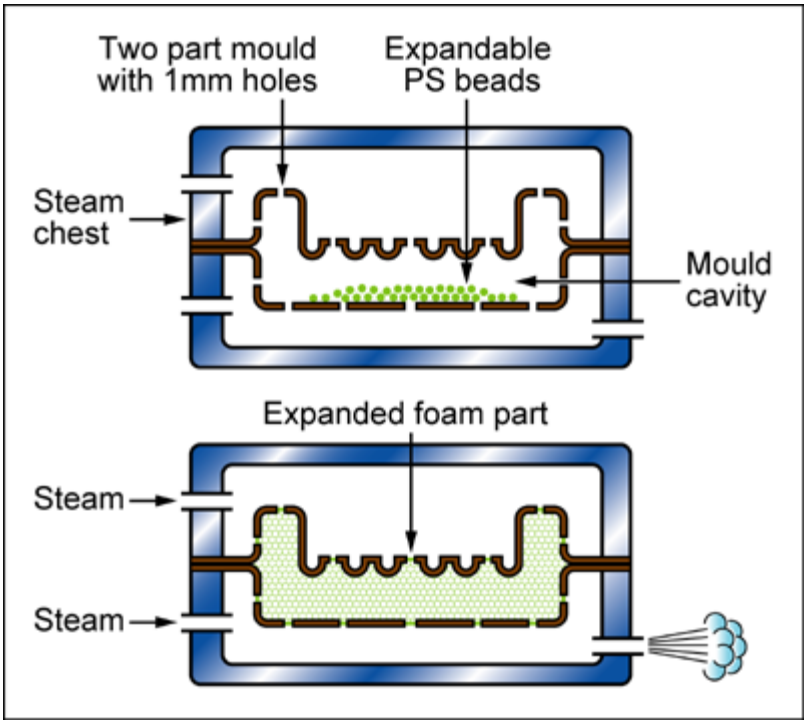



**Figure caption**

Expanded bead molding.

**The process**

The snow-white, crisp, light protective packaging in which your computer arrived, and which you discarded, oblivious of its visual aesthetics, was made by EXPANDED FOAM MOLDING of polystyrene. It is a low temperature, low pressure, process using cheap mold materials, with uses far beyond those of throwaway packaging. There are two stages in its operation. Solid polymer granules, colored, if desired, containing a foaming agent that releases CO2 on heating (a commodity product, widely available) are first softened and expanded by steam-heating under a small pressure. The softened particles are transferred to aluminum molds (to give good heat transfer) and steam-heated at 3 atmospheres, causing them to expand to 20 or more times their original volume and fuse together, filling the mold and taking up its shape.

## Material compatibility

| | |
|---|---|
| Foams | ✓ |

## Shape

| | |
|---|---|
| Circular prismatic | ✓ |
| Non-circular prismatic | ✓ |
| Solid 3-D | ✓ |

## Economic compatibility

| | |
|---|---|
| Relative tooling cost | low |
| Relative equipment cost | medium |

| | | | | |
|---|---|---|---|---|
| Labor intensity | low | | | |
| Economic batch size (units) | 2e3 | - | 2e7 | |

## Physical and quality attributes

| | | | | |
|---|---|---|---|---|
| Mass range | 0.022 | - | 22 | lb |
| Range of section thickness | 197 | - | 3.94e3 | mil |
| Tolerance | 19.7 | - | 78.7 | mil |
| Roughness | 0.394 | - | 3.94 | mil |
| Surface roughness (A=v. smooth) | C | | | |

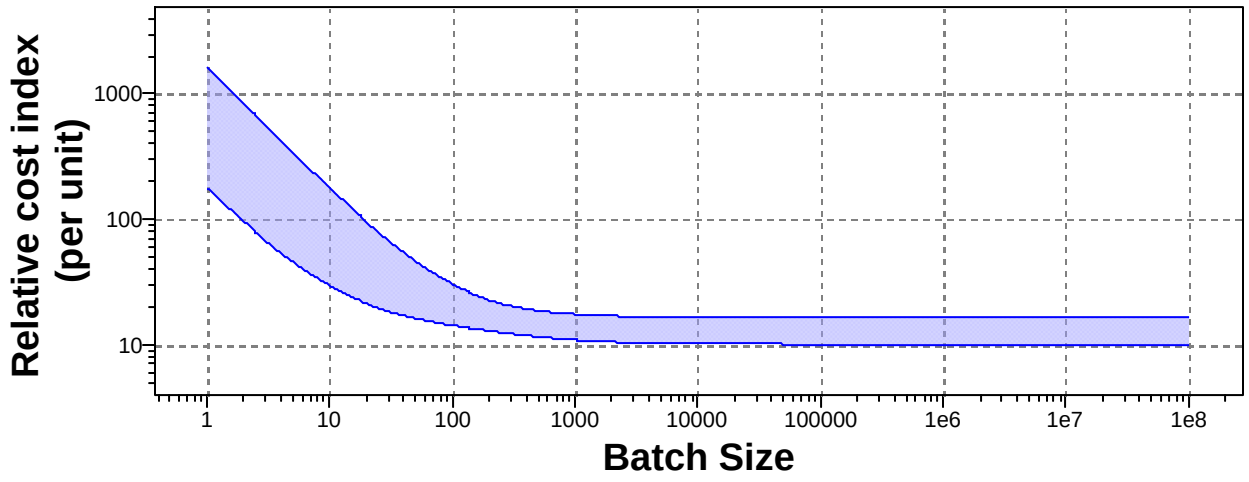
## Process characteristics

| | |
|---|---|
| Primary shaping processes | ✓ |
| Discrete | ✓ |

## Cost model and defaults

| | | | | |
|---|---|---|---|---|
| Relative cost index (per unit) | * 10.9 | - | 17.5 | |

Parameters: Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5




Material Cost=3.63USD/lb, Component Mass=2.2lb, Overhead Rate=150USD/hr, Capital Write-off Time=5yrs, Load Factor=0.5, Discount Rate=5%

| | | | | |
|---|---|---|---|---|
| Capital cost | * 1.64e3 | - | 1.64e4 | USD |
| Material utilization fraction | * 0.85 | - | 0.97 | |
| Production rate (units) | * 20 | - | 120 | /hr |
| Tooling cost | * 164 | - | 1.64e3 | USD |
| Tool life (units) | * 1e4 | - | 1e5 | |

## Supporting information

**Design guidelines**

Expanded foam molding acquires a smooth skin where it contacts the mold surface, and accepts detail provided the radii are greater than 2mm. The product is very cheap, gives good impact protection and can be recycled - so as packaging goes it is very attractive. It is exceptionally good as a thermal insulator - hence its use in disposable cups and cooler bags and walls for kitchen fridges, refrigerated trucks and storage buildings. Increasingly, designers see other possibilities: expanded bead moldings have interesting acoustic properties, complex profiles can be molded, the material is very light, and has visual and tactile properties that are interesting. But the components are very easily damaged.

### Technical notes

Thermoplastics are easy to mold, polystyrene particularly so. Expanded foam molding gives a closed cell foam with a porosity of 80-95%. The high porosity and closed cells make it a good thermal insulator; the low density (about 10% that of water) gives it outstanding buoyancy.

### Typical uses

Disposable packaging for drinks and food (McDonalds has been held to ransom for this), lifesaving equipment, water-sport products like surfboards and life vests; thermal insulation in coolers, containers and carriers, core materials for sandwich structures (window and door frames, floor panels), protection of valuable products such as electronic, computer or audio systems.

### The economics

The low molding pressure and temperature makes this a particularly cheap process - hence its wide use in disposable, apparently valueless, objects.

### The environment

At one time, CFC blowing agents were used for polystyrene expansion. These have now been replaced by gases that - in the volume in which they are used - do not damage the environment.

## Links

MaterialUniverse

Reference