Productioncycle

Production of Building-Elements made from EPS

EPS

EPS is an expandable polystyrol containing the neccesary propellant.

FOAM MADE FROM EPS

The production of EPS foam takes place in 3 stages:

- Pre - expanding
- Intermediate storage
- Moulding

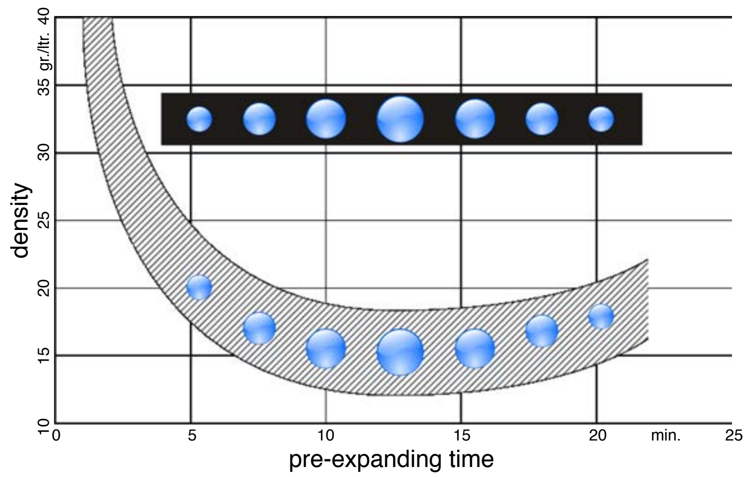
Firstly the granulate is expanded by means of heating. The propellant expands the particles to fifty times their original volume while retaining the cellform. It is followed by an intermediate storage period during which time air can enter and propellant can escape from the particles.

Finaly the pre-expanded particles are filled into moulds, and expanded once more to form a solid mass of the desired form. A compact foam with a larger air content is this produced - the reason for the good and lasting heat retaining ability
The special process allows variation of the desity of the EPS foam. As the foam characteristics are largely determined by the density of the raw material it is possible to produce foam suitable for a large variety ot items, from insulation board to light construction elements.

PRE - EXPANDING

By pre-expanding the volume of the EPS beads is enlarged that means, the density is altered for example: Original 600 gr./ltr. to 20 gr./ltr. if the density of the foam should be 20 kg/m3. The density of the expanded beads and the density of the produced blocks or mouldings made from the same material are relatively identical, before final expansion the mould is completely filled up with beads. The enlargement depends on temerature and time of the heat influence. Fig. 1 shows the relation for boiling water as a heat carrier, saturated steam shows the same curves. Too long pre-expanding or overheated steam cuases deformed beads; the density as show in the graph. In addition to that there is too litle propellant for the final expansion.
Wet steam has to litle warmth content, can cause a false beads. The exact density should be controlled at short intervals, as variation in the steam supply can never be ruled out completely.

Fig. 1: Characteristics of EPS when expanding in boiling water



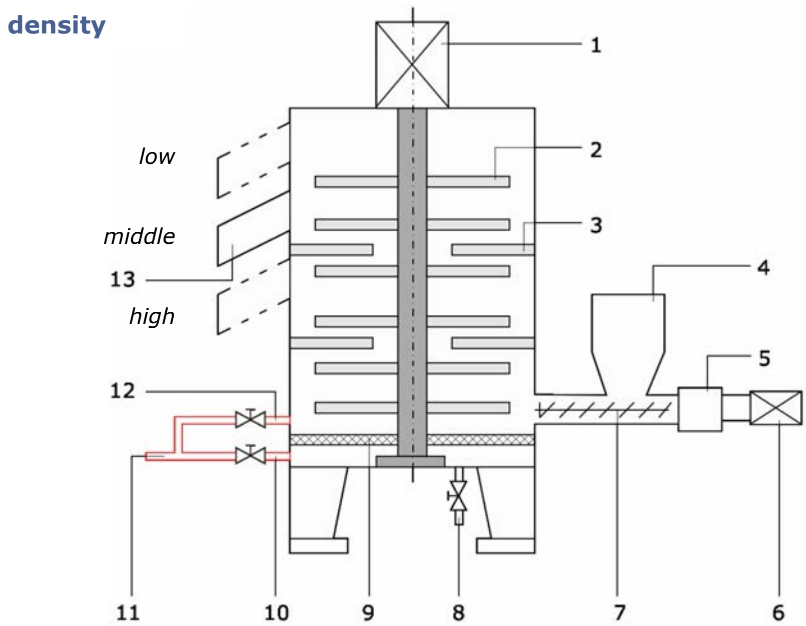
Productioncycle

EXPANDING OF EPS

During normal production the steam pipe contains steam of 100˚C to 150˚C and pressure between 1 and 4,5 bar in front of the regulating valve. The last 3 to 5 meters between the regulating valve and the pre-expander should not be insulated steam reaches the pre - expander. The steam enters the pre-expander with light pressure (1,2 bar - 1,9 bar) and it condensates when giving off heat to the EPS beads and the surrounding area. This happens in both, the continous and discontinuous. pre-expanders.

CONTINOUS EXPANDING OF EPS

Continuous working pre-expanders consist of a cylindrical vessel with an agigator, Fig. 2. The steam enters at a tangent at the bottom. The feed screw transports the EPS beads to the bottom of the vessel and the expanded beads leave via an adjustable overflow in the pre-expander.
Fig. 2: Continuous working pre-expander with steam entering from the side and bottom.



1. Agigator motor
2. Agigator arm
3. Crow bars
4. Funnel
5. Infinitely variable speed gearbox
6. Screw motor
7. Feed screw
8. Condensation valve
9. Sieve buttom
10. Steampipe buttom
11. Main Steampipe
12. Steampipe wall
13. Adjustable overflow for the controlling of the density

The following steps affect the density of EPS beads

- altering the speed of the feed screw
- altering the steam entering the pre-expander
- altering the height of the overflow

These steps affect the time the EPS beads are in the pre-expander. The time can be from 2 - 10 minutes. Densities down to 14 gr./ltr. are possible in one stage. For lower densities two stages are necessary, with an intermediate storage time of 3 - 6hours.

PROPELLANT LOSS

The propellant in the EPS beads is activated during the pre-expansion and partially escapes. The escaping propellant depends a loss of propellant during storage afterwards.
EPS beads with a density of 15 g/l - 25 g/l show a loss of propellant within 24 hours of 2%, approximately 30% of the original propellant in the beads.

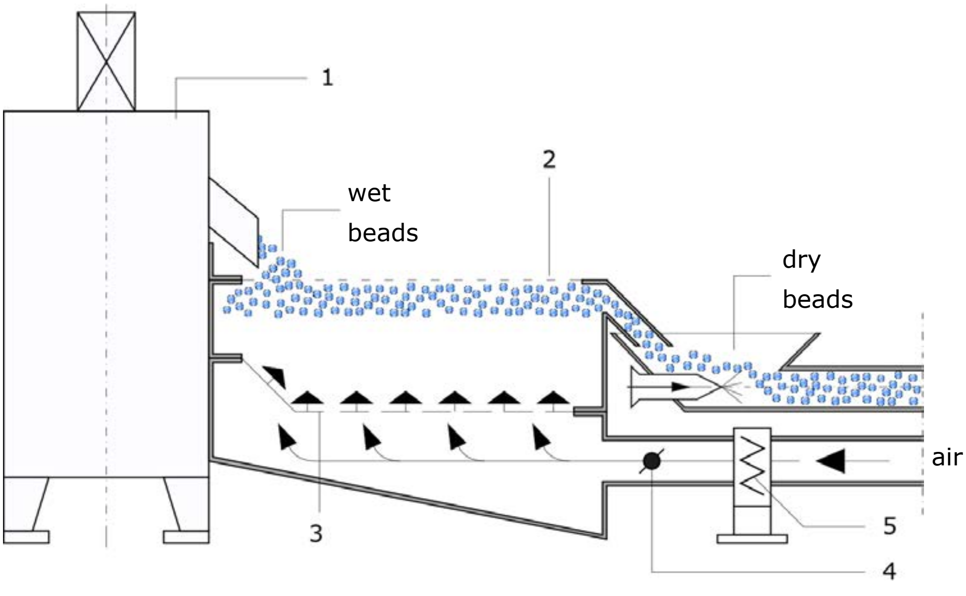
DRYING

It is possible that up to 10% of the weight of beads, expanded with steam is water. These wet beads stick together which means that they have to be dryed immediately after the expansion or be transported on warm air (appr. 40˚C) to the intermediate storage silos. There, they can be dryed with warm air. Where there is a very low humidity they should not be dryed completely, because of the electrostatic effect.

TRANSPORTATION OF EXPANDED EPS-BEADS

Fresh expanded EPS beads are very sensitive and have to be transported very carefully to the intermediate storage containers. The best method of doing this is to place the pre-expander above the container an let the beads drop down; the beads can be dryed by pumping in air (warm air of 35˚C).
If this is not possible, the best way of stabilising the beads is to dry them on a drying bed (Fig. 3) The beads are transported to the silos afterwards on warm air (40˚C) from an injector blower (Fig. 4a). This transport system avoids damage to the fragile beads which would be a problem when using ventilator rotors (Fig. 4b). Damage to the beads would raise the density and the final expansion in the mould would be difficult. Bends in the transport pipes should have a diameter 5 times that of the straight pipe to prevent beads bouncing hard against the pipe walls.

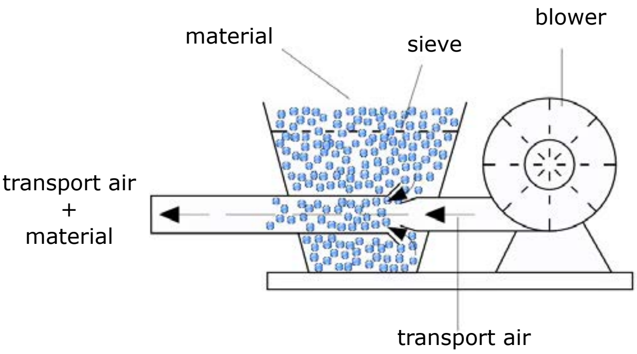
Fig. 3: Drying bed

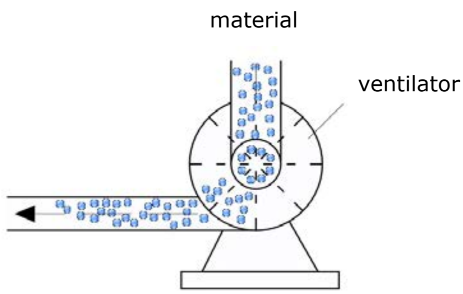


1. Pre expander
2. Mashwire cover # 0,3 - 0,4 mm
3. Mashwire # 0,2 mm
4. Throttel valve
5. Heating

Fig. 4a: Transport of EPS foam beads via injector blower

Fig. 4b: via transportblower (unsatisfactory as a number of the beads are squashed be the rotor blades of the ventilator)





INTERMEDIATE STORAGE

Propellant and steam condens from the freshly expanded beads as they cool down. This causes a vacuum for a short time inside the beads making them very sensitive until air can enter into them and stabilise them. This can last up to 24 hours, depending of the density and size of the beads. It will be shorter with a higher density, because there is more propellant in the beads.
If the intermediate storage time was too short, it is possible that the finished EPS block will strink or become misshapen when removing from the block mould. The minimum storagetime depens on the pre-expansion conditions, humidity, air pressure and storage temperature.
During the intermediate storage the propellant leaves the beads and shortens the pressure reducing time during the final expansion in the mould. If the intermediate storage is too long, the propellant will leave the beads completly and the beads will not weld together very well. The optium quantity of propellant remaining in the beads depens on the steaming during the final expansion, the dimension of the moulding and the desired density.

SILOS FOR INTERMEDIATE STORAGE

The silos for the production of mouldings hold from 10 m3 to 100 m3 of expanded EPS foam beads. A light wooden or steel frame covered in an antistatic material permeable to air and light should be used. The covering should be resistant to ultraviolet light.
Silos permeable to air do not need ventilation but they should not be in a production hall with very high humidity. Effective drying can also be done by means of pneumatic transportation from one silo to an other.

FINAL EXPANSION TO PRODUCE MOULDINGS

For the production of EPS foam buildings elements them mould is filled with EPS beads from the intermediate storage silos and steamed. The reheating cause the beads to expand again (Temperature 100°C to 120°C), but being tightly packed in the mould they can only fill the small gaps between the beads (so called wedge). The polyeder shaped beads now weld together at the connenting cell walls. After a relatively short cooling period the moulding is ready, holds its shape and can be removed from the mould.

Productioncycle

MACHINES FOR THE PRODUCTIONOF EPS FOAM BUILDING ELEMENTS

The machine built by various machine builders mostly working horizontally. That means, the mould opens horizontally and the mouldings are dropped out of the machine.
This not very satisfactory for the EPS building elements, because they can be damaged; „MBS Maschinenfabrik Beaufort GmbH" has developed a vertically working machine espacelly for the production of building elements.
The mould opens up vertically and the finished mouldings are placed on a take - off - table.
Further advantages are:

- very easy further handling
- because the moulding are always in the same possition
- filling from aboce enables more even filling of the mould
- the density is spread out better

easy putting in of steel paths
These machines are excellent for the production of many other very exact, high standard mouldings, to which damage must be avoided.

CONTROLLING THE MACHINE

The working cycle:

- closing of the mould
- preheating and blowing out of the mould
- filling in of the beads
- steaming
- cooling
- opening of the mould and the ejection of the moulding is fully automatic. All steps of one cycle are controlled by electronic modules. Many adjustments possibilities to the steaming and cooling make it possible to program the shortest cycle for a paticular job. To ensure that the working conditions are optimal, both parts of the mould have to be controlled separately.

Some other useful advantage for the production are :

- control of filling time and pressure reducing time depending on process
- automatic interuption of work process when there is a loss of steam or irregularity in the air supply
- switching over to semi control or manually controlled
- each step of the machine (production) can be run separately to test the machine
- possibility of filling the mould with or without a ventilation gap

LOCKING MECHANISOM

With clamping areas over 1m* there is a pressure in all directions of more than 10.000kg. This means that in addition to the standard locking system, an additional locking system is required.

Productioncycle

STEAM CHAMBERS

The steam chambers are standard on the machine and designed so that the mould can be changed quickly and easily. The depht of the steam chamber should be 50 - 100 mm. If the steam chamber is not deep enough the steaming of the beads is not equal everywhere. If it is too deep the cycletime will be longer, espacally the steaming periods and the steam, cooling water and the air consumption are too high.
The steam chambers have fittings for the supply and the lead off for air, water and steam, also jets, deflector flaps and guid flaps for all the mediums. There are also connections for temperature and the pressure controls which control the expansion process.
A fixed and a moving steam chamber are clearly distinguished.

FILLING DEVICE

The EPS beads are filled into the closed mould by means of an injector; the air escapes again through jets or special ventilation valves. On very simple moulds there is only one injector needed in a central position, but on large and difficult mouldings more injectors are required. It is also possible to suck the expanded beads with the help of the crack into the mould.

STEAMING

In order to have as little water (condensation) as possible in the mouldings, only saturated steam should be used to expand the beads. This is nit possible if working with cool moulds where the steam condensates. To prevent this, the condensation valves have to be left open, when beginn steaming until both sides of the mould have warmed up. After that, with thick wall moulds, one condensation valve is closed and the steam floates from one half of the mould to the other pushing the cold air away and already expanding the beads. The second condensation valve will be closed, controlled by time and pressure. The steam now flows from both sides into the mould (pressure 1,4 - 2,2 bar) for a good expansion and the beads weld together very well.

COOLING

The mould is firstly cooled with water to reduce the expansion pressure quickly. Mouldings with thicker walls need a longer pressure reducing time than those with thin walls. Mouldings with thick walls can be cooled faster by using vacuum and the water content in the moulding is then reduced. To do this there is a vacuum pump and tank.

REMOVAL FROM THE MOULD

Very often only some air pressure is needed, blowing through the steam chamber and jets to eject the moulding. Air is blown alternately into both halves of the mould during opening. In large mould there can be an air pressure up to 11 bar, a considerable force. Complicated and deep mouldings are ejected with mechanical ejectors. This is very safe and there has to be no control afterwards to check that the moulding has been ejected. Both methods of ejection are also used together.

MOULDS FOR THE PRODUCTION OF EPS FOAM MOULDINGS

One mould consists usualy of two halves. The cavety surrounded by the 22 halves of the mould (also called nest) has the size of the moulding which will be produced. Each halves of the mould is fitted on to a steam chamber. Usually steam enters into the cavity via the steam jets, made of special aluminium or brass and slotted. The area covered by the steam jets is critical for the result of the finished moulding. This complete area should be minimum 2% of the complete moulding surface. As a guide the jets should be not more than 25 mm apart in a square from.

Due to the demands on the moulds:

- cheap tool making costs and short tool making time
- high heat conveyance and low heat storage
- high pressure resistance and light weight
- resistance against heat and corrosion
- strong surface

small expansion by heat has proved itselfs to be aluminium. The best material for moulds.
The walls of moulds have to be fairly thick, but there is a good heat conveyance and a low heat storage by using aluminium. Moulds made of aluminium can be casted, so there is no need of further processing afterwards. Fig. 5 shows the physical weight and the attributes of a few mould materials.

Fig. 5: Physical weight and thermals attributes of mould materials

	Densit (g/cm^3)	**Warm conductivity W/cm•K**	**Warm conductivity J/g • K**	**linear coefficient of expansion t K^{-1}**
Aluminium (99,5%)	2,70	2,22	0,92	$23{,}8 \bullet 10^{-6}$
® Duralium	2,80	1,47	0,92	$23{,}0 \bullet 10^{-6}$
® Silium	2,70	1,59	0,90	$22{,}0 \bullet 10^{-6}$
High-grade steel (V2A)	7,88	0,21	0,50	$16{,}0 \bullet 10^{-6}$
Copper	8,90	3,94	0,39	$17{,}0 \bullet 10^{-6}$
Zinc	7,14	1,10	0,38	$29 \bullet 10^{-6}$
Brass	8,40	0,92	0,39	$19{,}0 \bullet 10^{-6}$
Bronze	8,80	0,42	0,38	$17{,}0 \bullet 10^{-6}$

® Duralium: registered trade mark of the Dürener Metallwerke
® Silium: registered trade mark of the Metallgesellschaft Ag