

## Use of solid blowing agents in Injection Molding

The use of solid blowing agents may have two purposes. Reduction of density and reduction of sink marks and internal bubbles.

1. **Reduction of density** (weight reduction of the article). The foam obtained is not integral. Since the mold walls are cold and exposure requires a certain temperature, slightly lower than injection temperature, the material in contact with the mold does not expand. The result is a semi-expanded structure comprised of two outer skins having a thickness varying from 1 to 1.5 mm, with a density approaching that of the normal material, and between the skins a foamy structure having a density that may fall to as much as 40 % lower than compact density.
2. **Presses** - Any screw injection press may be used for the production of semi-foamed polypropylene items. The only indispensable expedient consists in fitting the press with a perfectly airtight valve nozzle, so as to keep the molten material under pressure and prevent it from expanding in the plastication chamber. There are presses specially designed for thick-gauge or large-size pieces.
3. **Molds** - A mold for the injection molding of semi-foamed items may be very similar in design to a mold for extrusion-blow molding, granted the low injection pressures and closure forces applied. It may be produced from cast aluminium, kirksite, zinc. The cavity walls do not require any special finishing. The basic point to be borne in mind is the necessity of providing the mold with generous air vents. Runners must be wider than in the molding of solid items, so as to minimize melt flow resistance.
4. **Materials** - The most suitable polypropylene grades are those with a high melt index, since they are more readily filled into the mold cavity. There are special presses, however, that allow the use of the lower melt index grades which yield items with higher impact strength. The semi-foaming technique is also applicable to the polypropylene grades filled with calcium carbonate, talc, glass fiber, etc. The densities obtained are 0.5-0.7 g/cm<sup>3</sup> using unfilled polypropylene and 0.8-1 g/cm<sup>3</sup> using the filled grades.
5. **Blowing agents** - Blowing agents are products that decompose under the effect of heat, evolving gases (N<sub>2</sub>, CO<sub>2</sub>, NH<sub>3</sub>) which lead to the formation of cells in the mass of material. Blowing agents are usually used in combination with nucleating agents, which have the function of distributing the cells as evenly as possible and make them as small as possible. These products may be: calcium stearate, zinc stearate, zinc oxide etc. Blowing agents are used in amounts of 0.3-1% for densities of 0.7-0.5 g/cm<sup>3</sup>, respectively; the nucleating agents are added to the blowing agents in a ratio of at least 1:1. The blowing agents more widely adopted are:
  - azodicarbonamide (trade names: Genitron EP/A, Celogen AZ); NH<sub>2</sub>-CD-N N-CO-NH<sub>2</sub> decomposition temperature: 190-200°C
  - p-p'-oxy-bis (benzenesulphonyl hydrazide) (trade names: Genitron OS, Celogen OT): decomposition temperature: 150°C.

**Operating conditions** - The best semi-foamed items are obtained under the following conditions

- high injection speed
- high injection pressure, which allows a regular rise of the material in the mold
- mold temperature around 40-50°C
- wide runners to allow the obtainment of low densities
- injection backpressure such as will prevent the material from expanding in the plastication chamber
- cooling time is longer than in the molding of solid items. This becomes more evident with thickness increases

### **Reduction of sink marks and internal bubbles**

Materials with a high shrinkage create problems in the production of very thick articles. The contraction of volume during the cooling step gives rise, in fact, to internal bubbles when the outer walls are very cold, or to sink marks if shrinkage occurs from the outside towards the inside. The use of small amounts of blowing agents often solves this trouble. The percentage to be mixed to the thermoplastic material in this case must not exceed 0.02-0.1% the final density of the article remains practically unvaried.