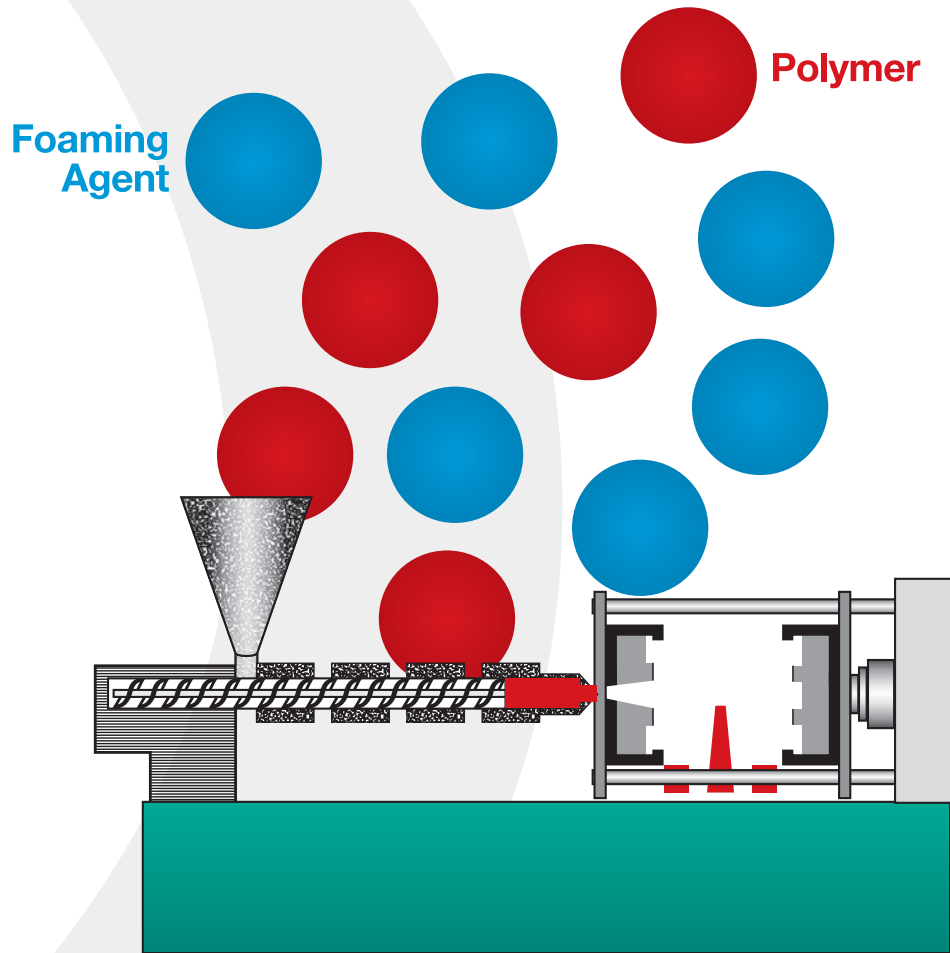


FOAMAZOL™

Chemical Foaming Agents

INJECTION MOLDING PROCESSING GUIDE



INJECTION MOLDING WITH CHEMICAL FOAMING AGENTS

Introduction

The injection molding of structural foam molded parts in a well-established process in the plastics industry. There are a number of processes used for the production of rigid, lightweight structural foam moldings. These parts typically have a higher density skin with a lower density cellular foam core and are produced by introducing a foaming agent to the molten polymer.

Basically, there are two types of foaming agents: physical and chemical foaming agents.

Physical foaming agents are gases (nitrogen, carbon dioxide), to name a few that are injected under high pressure directly into the polymer melt.

Chemical foaming agents are chemical substances that decompose during heating and the gaseous decomposition products are dispersed through the polymer melt.

To obtain a uniform cell structure, the gas is either injected or evolved by heat and must be thoroughly dispersed in the polymer melt. Some of the essential factors influencing this process are the particle size of the foaming agent, the dispersive properties of the machine, decomposition rate of the foaming agent as well as the melt viscosity of the thermoplastic resin being processed.

Bergen International has developed a full line of chemical foaming agents under the trade name of Foamazol™ based on endothermic, exothermic, and blends of endo/exo depending upon application.

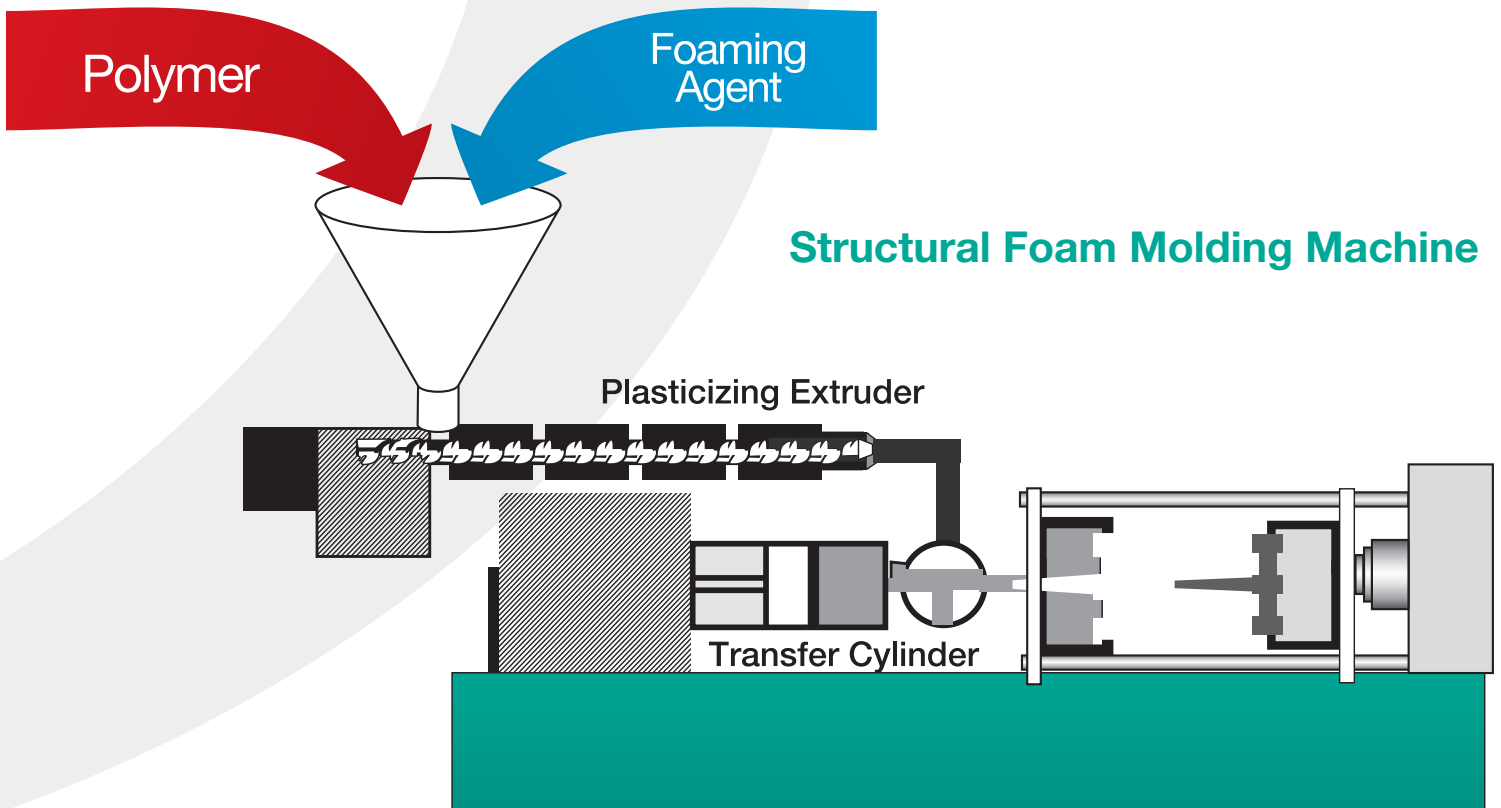
Foamazol™ CFA products offer the following advantages:

- Faster Cycle Times
- Smoother Surfaces
- Very Fine Cell Structure
- No Degassing (In Line Decorating)
- No Discoloration
- Safe Handling
- Food Approval

Machine Parameters

In principle chemical foaming agents can be processed on all injection molding machines. The use of a shut-off nozzle has proven to be advantageous to prevent or eliminate drool. If a shut-off nozzle is not available, working with the nozzle adjacent to the mold can help.

In order to obtain a uniform foam structure, it is imperative that the gas expand after it has been injected into the mold. Therefore, it is important to run the injection speed as fast as possible. In some injection machines, the injection rate can be increased by means of a gas pressure accumulator. Typically, low-pressure structural foam molding machines designed for foam molding, are equipped with a plasticizing extruder and a separate accumulator cylinder for quicker injection.



Structural Foam Molding Machine

Some of the basic considerations for building molds designed for structural foam molding are:

- The gates and runners should be located in a way to achieve quick and uniform filling with relatively short flow lengths.
- The gates and runners should be relatively large to help ensure that the injection pressure is relatively low
- It is important that the vents be situated at the end of the flow lengths and large enough to vent the trapped gases.

Due to much lower mold pressure, molds for structured foam molding do not need to be made of high strength steel. The mold cooling, on the other hand, needs to be more intense to overcome the insulating effect that the foam has on cooling. This is especially important in very thick wall sections to help prevent or reduce post expansion. Due to the lower pressures associated with structural foam molding, many applications can use aluminum as the mold material. In cases where steel is the mold material choice, a high alloy steel containing approximately 13% Cr. is recommended.

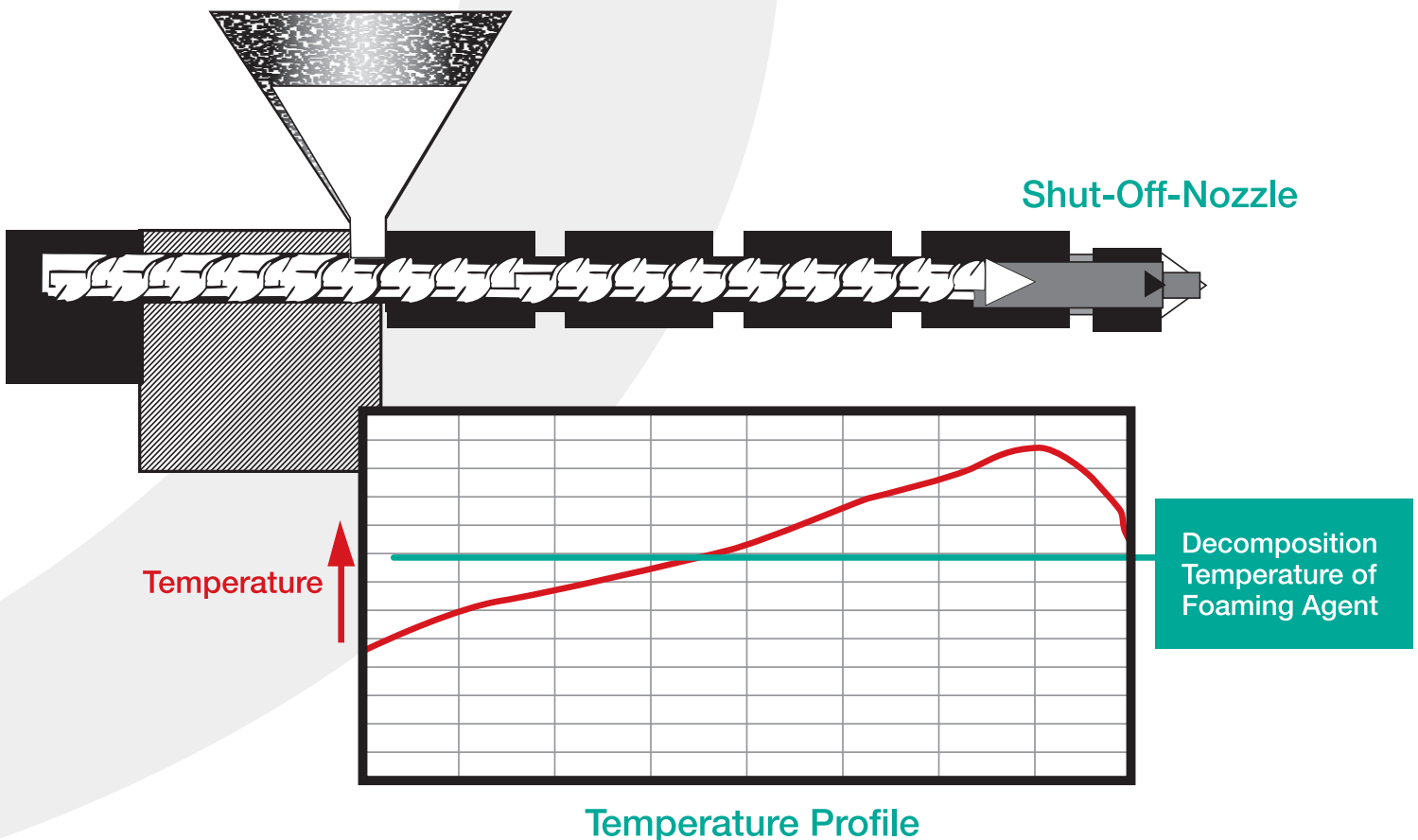
RECOMMENDATIONS FOR PROCESSING

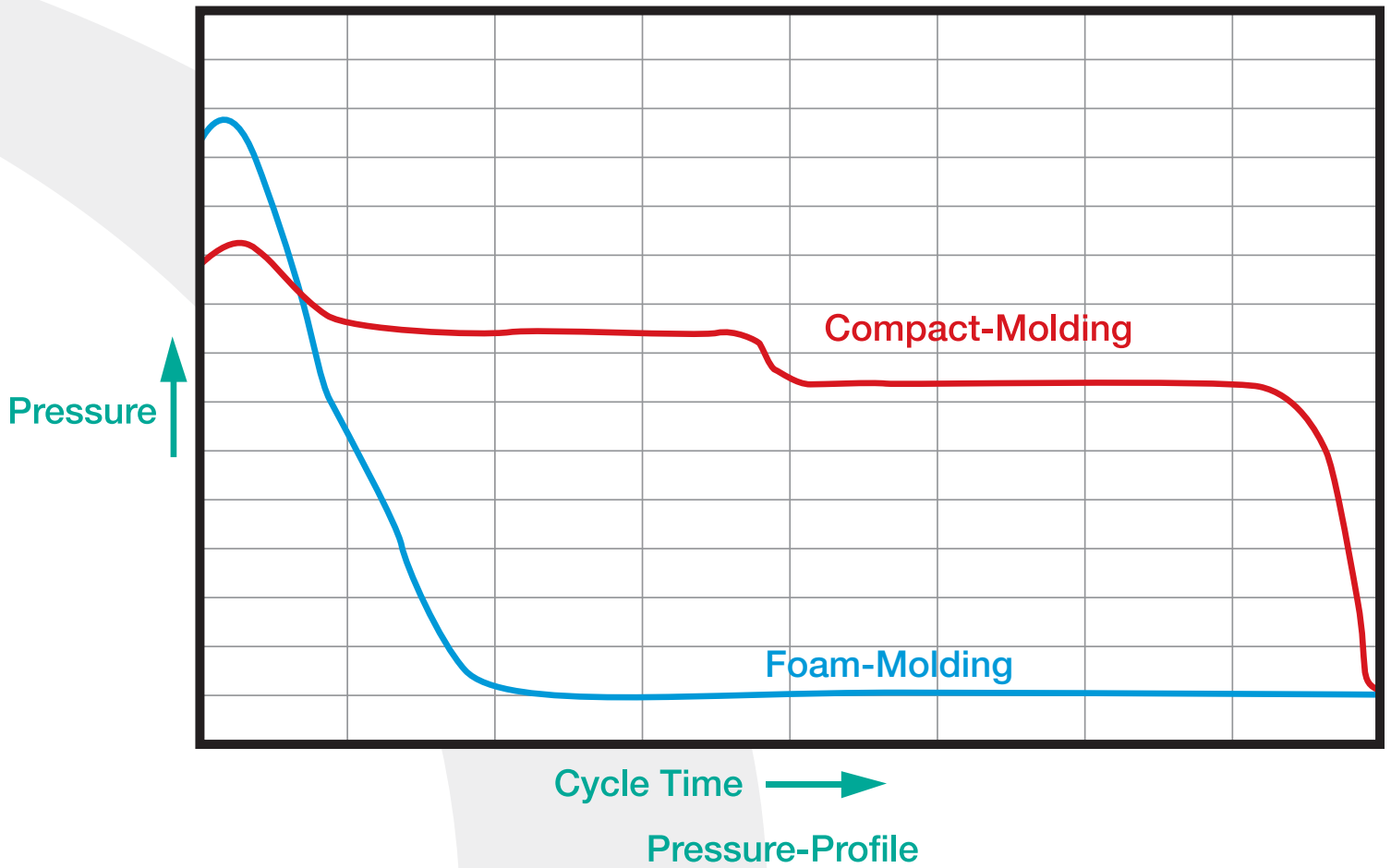
Addition of Foaming Agents

Chemical foaming agents are typically added to the injection molding machine just like colorants or other additives, together with the plastic material to be processed. Mixing with the plastic granules can be carried out lot by lot in separate mixers or in an automatic blending unit directly on top of the injection molding machine. Gravimetric feeders are always preferred, but any feeding method that ensures accurate and consistent dosing of the CFA will be suitable. When processing powder products, it is recommendable to add approx. 0.1% adhesive (calculated on the plastic granules) to avoid later separation.

Temperature Profile

The cylinder temperature for foam molding should be low enough in the feeding section to prevent premature decomposition of the foaming agent in order to avoid gas losses through the feeding hopper. In the **compression zone** the melt temperature should be high enough for the whole reaction of the foaming agent so that the total gas yield can be achieved. At the nozzle, the temperature can be reduced again by 10 – 20% in order to increase the back pressure and improve melt strength.





Injection Rate

The mold cavity should be filled to allow the dispersed gas bubbles to expand completely only after termination of the injection process. The internal expansion pressure forces the melt against the cold mold wall. This leads to a cellular core with a solid skin.

Pressure

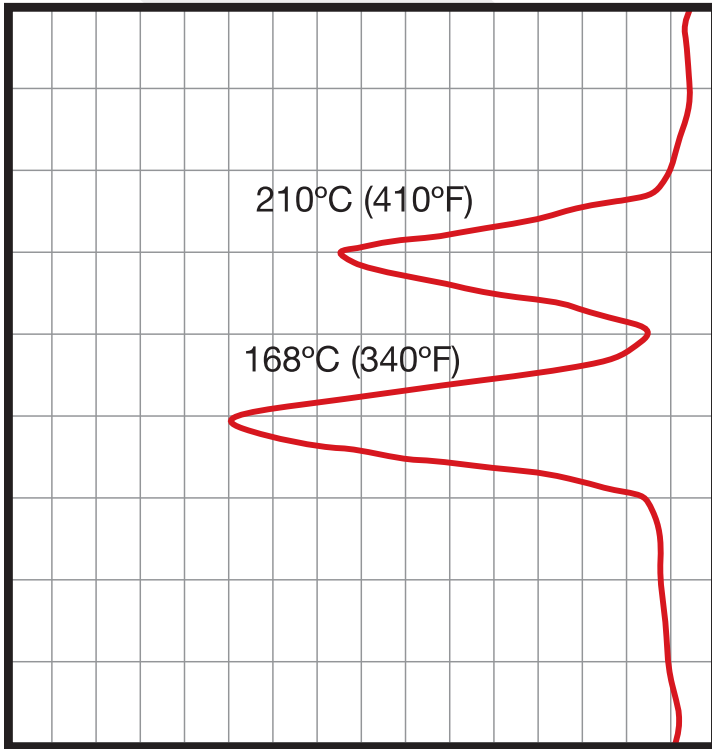
The injection pressure must be high enough to guarantee a high injection rate. In some cases it is recommendable to work with a pressure accumulator.

Normally, post-pressure is not used for foam injection molding in order not to suppress expansion of the foaming agent foam. A certain post-pressure is only required in exceptional cases for the achievement of a thicker solid skin.

TYPES OF FOAMING AGENTS

Due to their energy requirements during the decomposition reaction, chemical foaming agents are principally divided into two groups: foaming agents either with exothermic or endothermic decomposition.

DTA-Decomposition Curve of Foamazol™ (Endothermic)



Exothermic foaming agents release more energy during decomposition than needed for this reaction. Once decomposition has started it continues spontaneously and even goes on for some time when the energy supply has been stopped. For this reason, parts, which have been foamed with such agents, must be cooled intensely for a longer period of time to avoid post-expansion. Important products of the group are hydrazides and azo compounds. Because of possible skin irritations, it is recommendable to take precautionary measures when handling such substance. Furthermore, azo compounds are characterized by a yellow color, which lead to undesired changes in color of the molded parts produced.

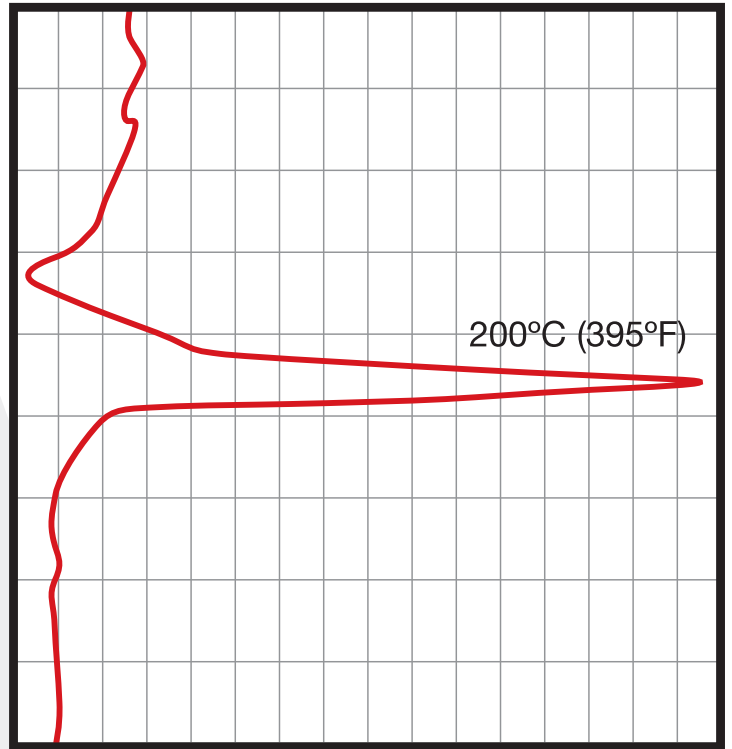
Endothermic foaming agents need energy for decomposition. For this reason, gas release quickly stops after termination of heat supply. In comparison to exothermic agents, shorter cooling periods are required, i.e. cycle times are shorter.

Base material for the most frequently used endothermic foaming agents are biocarbonate and citric acid. These substances are also used as food additives. So handling causes no problems at all.

PROPERTIES OF FOAMED INJECTION MOLDED PARTS

The application of foaming agents in injection molding mainly aims at a weight reduction of the injection molded parts and thus saving of material. The weight reduction

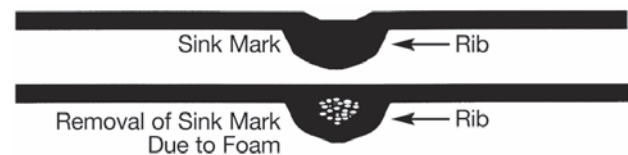
DTA-Decomposition Curve of Azcodicarbonamide (Exothermic)



which can ultimately be achieved greatly depends on the individual mold shape. It is obvious that thicker walls favor the formation of foam. A reduction of 10 – 25% is usually achieved in mold with a wall thickness of more than 4 mm and short flow paths. If circumstances are favorable, reduction of more than 30% can also be possible.

Technical housings are mainly foamed to increase wall stiffness with the same quantity of material used.

Sink marks caused by material shrinkage during cooling often appear in mold with thin wall in places where material has been accumulated on the back of the part (e.g. ribs and bosses). This effect can be avoided by the application of small amounts of foaming agents.

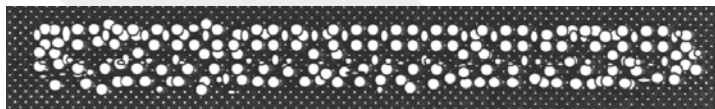


Injection molded parts which have been produced with chemical foaming agents are characterized by a mat surface. Glossy surfaces can only be achieved in special cases with small amounts of foaming agents. Bergen International has developed a special grade, Foamazol™ 62 that allows molds to eliminate sink marks without the swirled surfaces associated with foam-molded parts.

SPECIAL PROCESSES

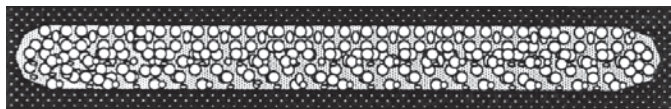
In structural foam molding a number of special processes have been developed to achieve the particular properties of the molded parts. The most important processes are:

Gas Counter Pressure Process



Gas Counter Pressure Part

Co-Injection Molding (Sandwich Method)



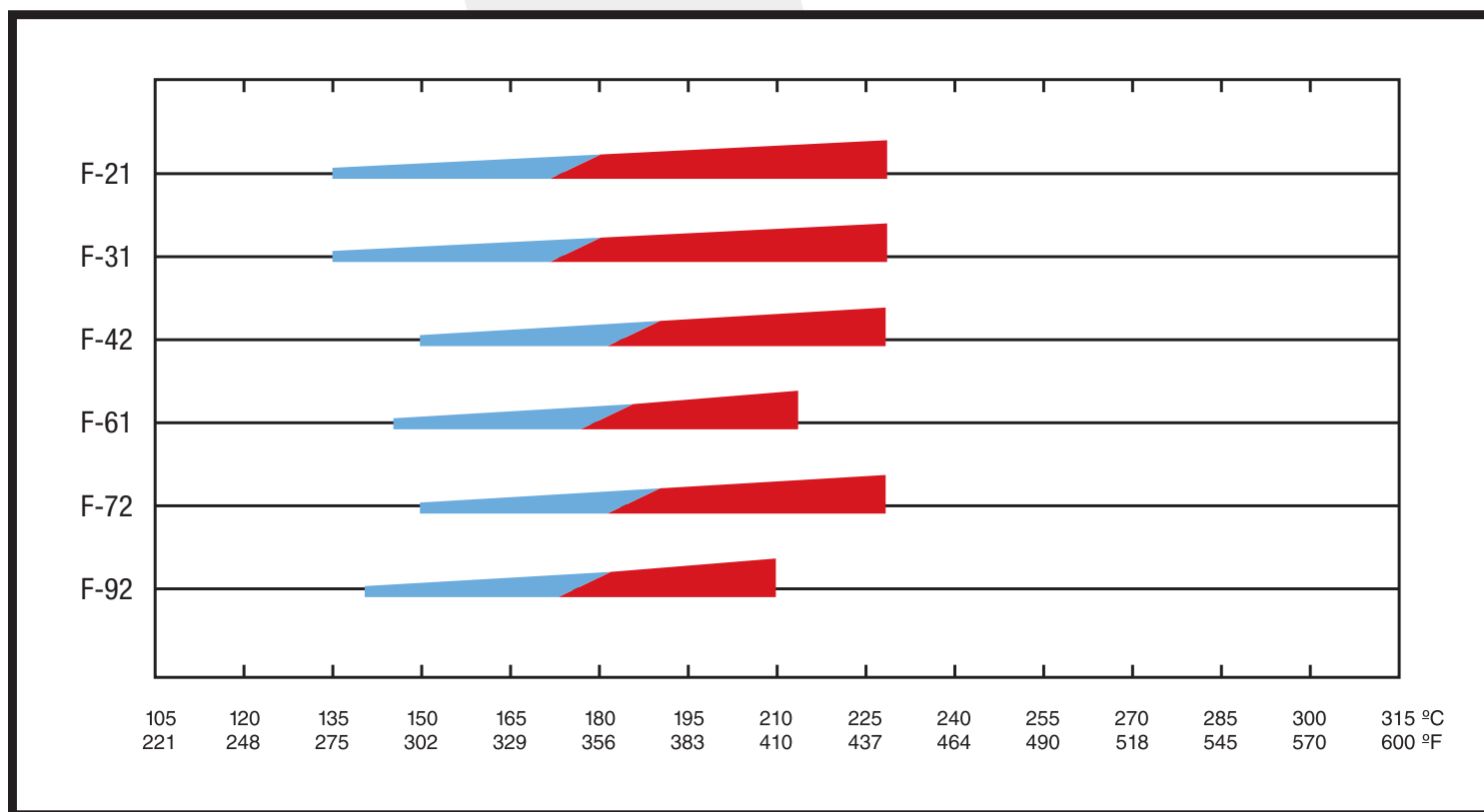
Co-Injected Part

Mold Expansion Process

In all these process, Foamazol™ foaming agents have proven excellent qualities.

START OF DECOMPOSITION/RECOMMENED TEMPERATURES

Foamazol™ Chemical Foaming Agents



Start of Decomposition



Recommended Processing Temperatures

For additional information on chemical foam molding and extrusion, contact:

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