Blowing and Foaming

Blowing is the liberation of gas which may create pores. Pores can only be obtained if the structure of the product wherein the gas is developed is strong enough to keep at least a part of the gas inside. To obtain porous products the gas creates pores in the blowing process. The gas is mostly liberated in the polymer during solidification to a film, coating or impregnation. Gas can be generated by adding a blowing agent like azoisobutyric acid dinitrile or azodicarbonamide (see Chap. 2.1) to the polymer(solution) prior to the solidifying step. By raising the temperature, the blowing agent liberates nitrogen gas [3]. Another product that liberates gas by raising the temperature is ammonium bicarbonate, which liberates carbon dioxide [8].

Another method is to add small sized polymer particles to a polymer solution or dispersion. The particles contain a swelling agent, which after liberation by a thermal shock is a gas, i.e. a blowing agent. An example is a vinylidene chloride-acrylonitrile-divinylbenzene copolymer containing isobutane or pentane [9].

Another method exists in the manufacturing of polyurethane-foams: A molar excess of isocyanate, compared to the hydroxyl functional polyether or polyester also present, and added water, liberates carbon dioxide [4] (see Eq. 8.1) which - during the polyaddition reaction and solidification of the polyurethane - blows up the foam.

In the conventional methods blowing was achieved by the evaporation of fluorochlorohydrocarbons to develop small closed pores with excellent thermal insulation properties. Today, volatile alkanes of a low boiling point are used together with the carbon dioxide liberation of the isocyanate/water reaction [11].

Fluorochlorohydrocarbons seemed to be suited very well due to their non-inflammability. They were used worldwide in the production of insulating foams or foams for mattresses, etc. Due to the impact on ozone destruction in the stratosphere, their use today is banned.

Polyurethane foam (Fig. 11-1), rubber sponge [7] (Fig. 11-2), or a man-made PVC-leather [5] (Fig. 11-3) show different pore structures. All these materials are produced by a blowing reaction.

Materials with a foamed polymer layer between a water vapor permeable top layer and an adhesive coat are, for example, suited for the production of bags [13].

Another method to produce foams is to whip air in a polymer dispersion [2]. In this case the foam is produced by mechanical means. This process is, however, described in more detail in Chap. 11.1.
Fig. 11-1. Pore structure of a polyurethane foam. The rigid polyurethane foams are used mostly for insulating products, like in refrigerators. The best insulation property of the foam is achieved if the foam contains a gas of low thermal conductivity. Therefore the pores must be closed to keep the insulating gas inside.

Fig. 11-2. Pore structure of a rubber sponge.