

The Process of Making Glass Bottles

In recent decades, the scientific and technological revolution in all fields has led to enormous changes in the science of glass and glass-making technology. Glass and its layers are used for thermal, acoustic and electrical insulation. Great prospects are opened up for new materials called fiberglasses, in which glass fiber and glass layers are combined with various binders of organic matter. Structures of boats, ships, car bodies, cisterns and others are made of fiberglass. The main disadvantage of glass is its fragility. However, nowadays, remarkable success in improving of the strength of glass is being achieved. By methods of thermochemical toughening, it is possible to increase the glass resistance to static bending. Now, there is widespread production of glass containers for the food industry. In particular, the mass production of glass relates to the manufacturing of bottles (fig.1).



Figure 1. Manufacturing of bottles

In order to produce glass goods, which could meet all the requirements of the most demanding customers, the presence of quartz sand only is not enough. Therefore, the technical department of an enterprise, which makes glass, intervenes. Professionals in this field make up the recipe of the mixture of materials, which are used for the melting of glass. In the case of properly selected proportions of the ingredients, the high quality glass mass is obtained.

The technology of glass production from the beginning to the getting of the final product consists of large investments and a thorough knowledge of the chemical formulae of the manufacture. For large companies, these are the basic requirements. It is possible to obtain this material by using of two methods: the Fourcault process and the float glass process. The technology of the Fourcault process is based on rolling of hot glass mass

through specially designed rollers. Then, the mixture is transported into a cooling chamber. Here, its dividing into sheets is carried out. The technology of glass manufacturing by the float process implies a flow of glass mass in the form of a tape into a cooling melt with tin. The lower surface of this material becomes perfectly smooth, and the surface tension makes the top surface flat. Then the glass mass passes the cooling stage. There are tensions, due to the fact that at this stage the glass is cooled unevenly. They significantly reduce the mechanical strength of the material. In order to eliminate this, the glass is subjected to thermal annealing. The float process technology is the basis of all modern glass production, it also widely used for the production of glass bottles.

The technology of producing of bottle glass consists of two production cycles: the cycle of glass mass technology and the technology cycle, which produces the final glass products. The cycle of glass mass technology includes the following operations:

- Preparation of raw materials.
- Mixing in certain proportions according to a predetermined chemical composition of glass, into a homogeneous mixture.
- Melting of this mixture in special glass-melting furnaces, in order to obtain homogeneous liquid glass.

The technology cycle of the producing of the final glass products consists of the following operations:

- Bringing of the glass mass to necessary temperature.
- Molding of the products.
- Gradual cooling of the products in order to eliminate the tensions, which arise in the process of molding;
- Thermal, mechanical or chemical processing of the molded products in order to give them the desired properties (Stokes).

The basic raw materials for bottle glass are quartz sand, sodium sulfate or soda, chalk or limestone, dolomite and pegmatite (Vogel). In addition to these materials, the composition of glass mixture, depending on the used technology, may include acid and glass forming oxides, as well as other binders, which can give the glass certain features.

The glass melting is conducted at temperatures of 1400° - 1600° C. There are three stages in it:

- The first stage is melting, when there is a chemical reaction and formation of a viscous mass. Melting of glass is produced in special furnaces (fig.2). The type of applied fuel, the range of manufactured products, size of production determines the choice of furnace type. Control of modern glass furnace is strictly monitored and is largely automated. The monitoring is brought up to a high degree of accuracy. The following parameters are controlled automatically: the pressure; the ratio of gaseous or liquid fuel and air; amount of fuel, which is supplied to the furnace; the level of molten glass in the bath, and some other parameters. For the purpose of obtaining colored material, metal oxides are added into glass mass. For example, copper and chromium oxide together give green, chromium oxide alone - yellow-green, and cobalt - deep blue. This explains the variety of bottle glass colors (Pfaender). Another way of producing of such glass is melting quartz powder in a flame of oxygen-hydrogen burner. Opaque quartz glass is obtained by melting of quartz sand on a coal or graphite rod, which is heated by electric current up to 1800° .



Figure 2. The glass melting furnace.

- The second stage is the clarification. The removal of bubbles is occurred, as well as the dissolution of still undissolved grains of sand; in this stage, the glass is maintained in the furnace for several hours at the highest temperature.
- The third stage is the cooling. The glass is cooled to a temperature, at which it is possible to produce from it the desired product most conveniently.

The molding of particular glass products carried out in several ways. The main methods of all are the blowing method and a continuous rolling method.

The blowing process is a specific method of molding. In the production of non-mass products, the manual method of blowing is still used. The main tool of blowing worker is a blowpipe. During the long history of glassmaking, blowing was done by mouth. Nowadays, an automatic blowpipe has been constructed and is used for the mass production of bottles (fig.3).

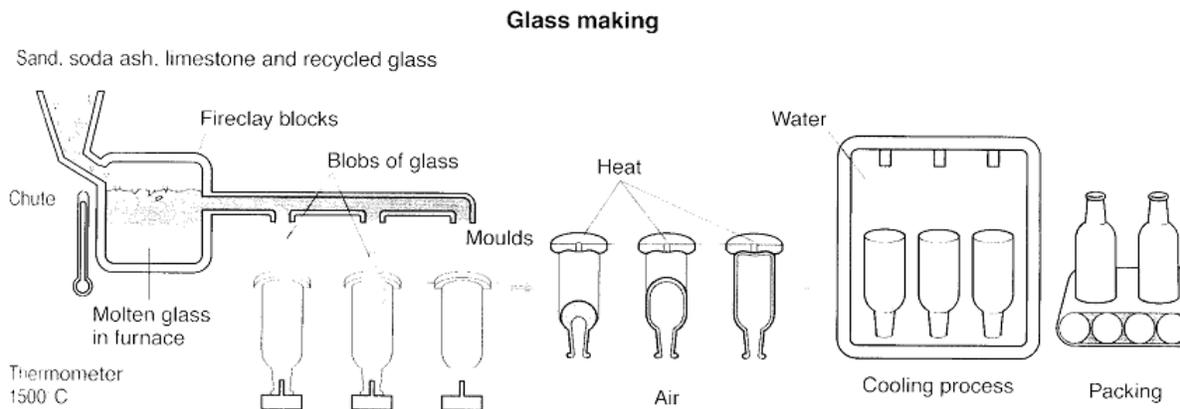


Figure 3. The process of making of bottles.

By the method of continuous rolling, sheet glass is produced. The method consists in the fact that the stream of molten glass from the furnace is continuously fed into the space between the rotating rolls, where it is turned into the tape (fig.4). By this way, sheet glass of different types can be produced (Bralla).

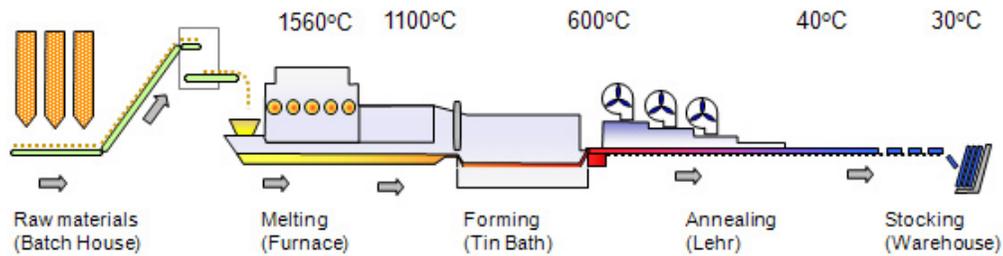


Figure 4. The method of continuous rolling.

The next and final stages are the annealing, toughening of the glass and its hot processing. Annealing of the molded and still hot products is used to prevent the occurrence of uneven internal tensions in it. This has significant importance in the manufacture of glass bottles, since this enhances their strength and allows to avoid the dangers of a split, when they are used. The toughening of the glass is the operation, which is inverse to its annealing. The toughened products are thermally and mechanically much more durable. In the result of toughening, it is possible to obtain shatterproof glass, which is used not only for the production of bottles, but also for glazing of windows of cars and airplanes (Olavi). In order to toughen the glass, it is heated to 600° - 650° C, then it is cooled rapidly. Then hot and cold processing of glass may be conducted, if they are needed.

Many people argue that our century may be called the age of the glass. Glass has been used by human many hundreds of years, but the process of its creation is still attractive and even somewhat mysterious. The glass not only protects our homes from the cold and wind, but also creates significant conveniences, when it is used in everyday life.

Works Cited

- Bralla, James G. Handbook Of Manufacturing Processes. New York: Industrial Press, 2007. Print.
- Olavi, Uusitalo. Float Glass Innovation In The Flat Glass Industry. Cham: Springer International Publishing, 2014. Print.
- Pfaender, H.G. Schott Guide To Glass. [S.l.]: Springer, 2012. Print.
- Stokes, Noel C. The Glass And Glazing Handbook. [Homebush, N.S.W.?]: Standards Australia, 1998. Print.
- Vogel, Werner. Glass Chemistry. Berlin: Springer-Verlag, 1994. Print.