SPECIAL FEATURES

Glass manufacturing stress precision distinguishes VIDROMECANICA annealing solutions

Any serious examination of the complexities of annealing in glass manufacturing must emphasise the importance of precise temperature control in the management of permanent and temporary stresses. Here VIDROMECANICA provides adaptable solutions as it incorporates knowledge of optimal glass production from renowned scientists in the industry.

IMPROVED ANNEALING LEHRS CYCLE

Glass is described as a mineral product obtained by a melting process that cools down without crystallisation and finally takes a solid state - a definition which provides an apt basis of the annealing process. Here every glass type (soda lime, borosilicate, etc.) is characterised by a different batch composition and consequently, a different temperature-dependent viscosity and expansion coefficient. During melting, the batch passes continuously from a solid to a liquid state. At forming it is brought back to a solid, passing the various 'plastic' stages while being characterised by different viscosities. These define the peculiar points of glass annealing, such as working, softening, annealing and strain points as well as annealing range (the temperatures between softening, annealing and strain points). Through knowledge of the annealing range, temperature limits for each stage have been established.

PERMANENT STRESSES

There are two types of residual stress, namely permanent and temporary. Annealing is in fact a cooling process. Glass has poor temperature conductivity and although this property can be advantageous in some instances, it is an inconvenience in annealing.

To explain the origins of stress, consider that glass is made up of a series of distinct layers lying parallel to the surface. Heat loss from the glass depends upon the transfer of heat from layers in the body of the glass to those at the surface. These layers are interdependent and in different states of expansion. As the external surface cools faster, it reaches its final shape while the centre is still in expansion. All the molecules are intimately bound together and their reciprocal action will create compression stresses once the inner layers have cooled and contracted.

There is a necessary balance to maintain between compressive and tensile stresses. Imbalances create varying degrees of destruction in the glass thickness but if cooling is achieved sufficiently slowly, the layers will not be submitted to disturbance and stress generation will be avoided. All stresses created at this point remain permanent. Indeed annealing is important because mechanical and thermal resistance are conditioned by it.

TEMPORARY STRESSES

When being cooled below strain point, glass can still be submitted to thermal influences - creating temporary stresses and distortions that disappear slowly. However, unless cooling is controlled, unbalanced stress levels could lead to breakages. Of course, controlled and strong cooling to generate high stresses makes toughening desirable in some instances. Increasing the compression stress on the surface gives the glass high mechanical and thermal resistance.

ANNEALING CURVE

Passing through the tunnel of a continuous annealing lehr, glass follows a fixed temperature gradient that is necessary to produce the desired level of stress. Glass must be reheated or cooled to assure homogeneity above the annealing point. The amount of time glass is maintained at this temperature is determined by time-thickness calculations.

Precisely-controlled cooling is required during the annealing phase until the strain point is reached. The cooling gradient is given by calculations depending on glass thickness and type. Finally controlled, fast cooling is necessary to bring the glass to ambient temperature. This process must also be maintained within calculated tolerances to avoid breakages resulting from temporary stresses.

CONCLUSIONS

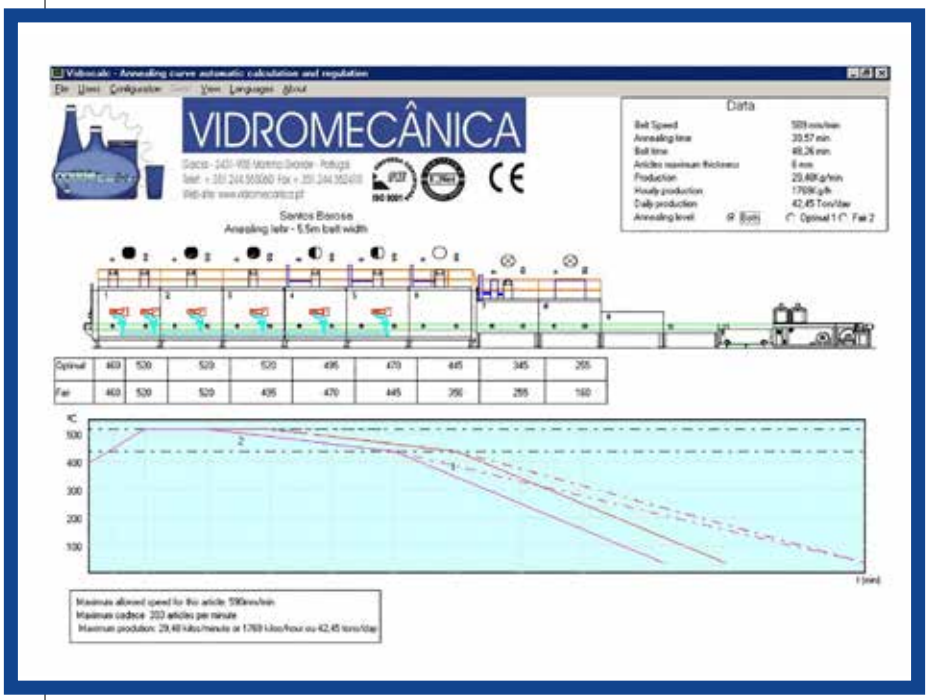
Annealing is an important element of the glass-making process and can be more complex than it may first appear. Consequently, thorough knowledge of the process is becoming increasingly necessary. A number of scientists have developed theories and established rules that are relatively easy to use, including Adams and Williams (widely-applied), Shand (Corning Glass); Owens (the most widely-applied and easy-to-use curves); and Redstone and Stanworth (mainly used for optical glass).

Neutral annealing, which avoids the creation of stresses, is not necessarily the ultimate goal to attain. In certain instances, the introduction of controlled stresses to the glass can be advantageous. Design flexibility has certainly been an important requirement for lehr builders such as Vidromecanica over the last three decades - providing customers with readily adjustable heating and cooling equipment.

Vidromecanica manufactures thermal equipment (for annealing, decorating and toughening); equipment for coating treatment (hot and cold end coating) and cullet recycling equipment.

Development, design and manufacture of machinery, development of control systems, control panel construction and software provision for the production lines are all handled by the company's in-house specialists.

With glass machinery solutions for many applications of the glass industry, equipment and systems from Vidromecanica are used worldwide in the glass container, tableware and technical glass sectors. ■



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