Improving the impact resistance of container glass through combined fire polishing and chemical strengthening

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Abstract

The mechanical and optical properties of glasses are determined in particular by surface defects. The defects already occur during production, e.g. through contact with metallic moulds. But defects are also introduced by the transport and use of glass products, which can trigger breakage when subjected to stress.
Two processes in particular are suitable for increasing the strength of flat glass. On the one hand, the technologically simple and inexpensive thermal tempering and, on the other hand, chemical tempering, in which sodium ions near the surface are exchanged for potassium ions at temperatures between 400 and 550∘C in salt baths. The possibilities and limitations of the different methods for strengthening have been well summarised by Karlsson, for example (1).

However, the comparably high treatment costs for chemical strengthening of glass are associated with the investment, long process times, exhaust gas cleaning and wastewater treatment. Therefore, the process is considered uneconomical for container glass till now (2), although the increase in strength enables the possibility to significantly reduce the bottle weight. A reduced bottle weight would also reduce the raw material and energy demand. Two aspects which will be increasingly important in the future. In addition, the period of use of reusable bottles can be extended, and lightweight glass containers could increase the acceptance of glass bottles over plastic containers.

Another possibility for increasing strength, but also for improving optical properties, is flame polishing; a process that has been established for decades, especially in crystal glass manufacturing. In this process, the glass surface is briefly melted by a burner in order to heal surface defects by surface tension.

In Bogart's patent from 1971, it is described how a combination of chemical strengthening and flame polishing can further increase the strength of glass (3).

In the paper, we present how this combination can be applied to achieve high strengths at acceptable process times for bottles made of conventional soda-lime glass, and which process combination could enable economical production.

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