Chapter 1

Introduction

Motivation

During the prolonged storage of glass containers or flat glass, a surface defect called "soda bloom" occurs. The surface may be coated with a film or show crystalline deposits, which often cannot be wiped off. This defect deteriorates glass quality.

The problem of bloom formation is attributed to the reaction between air humidity and the freshly produced glass surface. It is less commonly found on glass which is in use already. The reaction is presumably promoted by

- high air humidity in combination with an expressed day-night temperature amplitude;
- the presence of acid gases like CO_2 or SO_2;
- the kind and acid content of packing materials.

Besides this, alkali migration in the glassware due to thermal gradients as well as overall chemical durability must be considered as factors which render the ware prone to bloom formation.

Concerning the production, this surface defect leads to an increased number of rejects and burdens the production route with an additional step, hence, increases the overall production costs.

Objective and Scope

It is the objective of the proposed work to trace the predominant causes of bloom formation in glass industry, and to elaborate suggestions which help to avoid or reduce the problem.

The durability of glass surfaces exposed to air is not easy to evaluate, requiring much time for a conclusion. However, there are some successful ways for measuring the chemical durability. The methods used in this work are compiled to the following strategy:

1. Assessment of production conditions

Bloom occurrence will be checked versus

- the size and shape of the respective articles;
- the forming method (press-press or press-blow);
- type of annealing furnace (electrical, open gas, or muffled gas);
- the local values of relative humidity in the warehouse during a day-night cycle;
- the influence of packing materials.

2. Morphology of the damaged surfaces and if possible, characterization of existing bloom.

3. Surface analysis of freshly produced glass surfaces

The surface analysis is performed on samples taken right after the individual key steps of production, i.e., forming, annealing, decoration, etc. Methods employed are consecutive etching with hydrofluoric acid, soda extraction in water (98 °C), supported by wet chemical, photometric and electrochemical analysis methods.

4. Data analysis

The chemical durability of the glass is calculated from its oxide composition by using thermodynamic and kinetic theories. Results are compared to the experimental findings of 1. to 4.

5. Elaboration of a problem solution strategy

It will be elaborated in detail, by which measures the present situation can be improved. Measures may comprise the glass formula itself, any details of the forming, annealing procedure, or certain aspects of the storage conditions. The introduction of a preventive surface treatment may have to be taken into consideration.

Literature survey

The literature documentation on "soda bloom" is scant. Some systematic studies are mainly found in earlier papers. Ford (1922) determined the nature of weathering products and drew certain conclusions related to the effects of the storage conditions, glass composition, and the nature of the glass surfaces. Turner and his colleagues (1939) have conducted more recent weathering experiments with storage at room temperature at relative humidities of 0 and 76 % in special chambers, and by using the 5-hour water boiling test of the Society of Glass Technology (1937) to determine the chemical durability of the bottles after storage.

The term "soda bloom" is misleading. Although alkali may play an essential role in its formation, the defect itself is likely to consist of carbonates, sulfates, aluminates, and silicate hydrates of the alkali earth elements. Owen and Emmanuel (1942) illustrate the appearance of many of the glass products by considering the relative humidity of the storage, one of the most important factors. The crystallites

found were calcite and aragonite. Matson (1949) studied the visible weathering products after hygroscopic test, and came to similar conclusions.