Collage of Engineering

Materials Department

Third Class

Lecture (5-b)

GLASS

Asst. Lect. Shireen Hasan

4-2-2 Formation of liquid phase

Liquid phases are formed by the direct melting of batch components, by melting of decomposition products, and by melting of eutectic mixture formed from the batch components.

As the temperature increase, the rates of dissolution of refractory particles such as **sand**, **alumina** and **feldspars** increase. The increase in concentration of these components causes a rapid increase in viscosity, and the release of additional gases as the solubility of CO, and other gases decrease with increasing silica concentration in the melt.

Since the viscosity increase rapidly as the silica content of the liquid increases, the temperature must be increased even further to keep the melt fluid enough for thorough mixing between liquid and remaining solid.

The **final stage** of the melting process, in which the remaining silica and other refractory components are completely dissolved and the melt becomes homogeneous, occurs much more slowly due to the high viscosity of the melt.

The time required to completely dissolve the original batch is known as **the batch –free time**. Although the definition of the batch –free time is straightforward, determination of the exact time for melting all of the batch component is difficult. Other factors include overall **glass composition**, **specific batch components** used to obtain that composition, batch homogeneity, grain size of batch components, and the **grain size** and amount of cullet added to the batch.

The use of **cullet** or **scrap** glass, not only reduces waste, but also aids in reducing batch free time by both reducing the amount or refractory material in the batch , and by providing additional liquid throughout the melting process.

The choice of batch component is also important in controlling batch- free time. Many batch components can be supplied from a variety of raw materials. Changes in particle size can seriously affect the batch free time for melts. While fine particles melt more rapidly, they can also agglomerate to form large, porous particles, which effectively prevent penetration of the viscous liquid to the particle surface.

Since these **agglomerations** have a low bulk density, they can float to the surface of the melt, which significantly slows the

dissolution process. Escape of gasses is inhibited when very fine particles are used, since the channels between the particles are reduced in size. Use of very fine particles can result in the blockage of these channels in the early stages of the melting process, which can suppress decomposition reaction.

4-2-3 Melting accelerants

The most important methods for accelerating the melting process are based on changes in the batch raw materials. Replacement of a small portion of sodium carbonate by sodium sulfate, for example, speedsthe dissolution of sand by forming additional lower melting eutectic mixtures. The release of SO_3 creates a vigorous stirring effect which aids in homogenization of the melt, and improves the contact between silica particles and the surrounding liquid. Other melting accelerants are also based on replacement of some of the sodium carbonate by more easily melted compounds such as NaOH, NaF, or NACl, all of which form very fluid liquids upon melting. The use of the halide will still result in a shorter batch –free time.

4-2-4 volatilization of component from melts

A large number of the components of glasses are quite volatile at elevated temperatures. Loss of these components can significantly alter the composition of the glass obtained after prolonged melting, as compared to that obtained for short melting times.

Volatilization losses are particularly significant for alkali oxides, lead, boron, phosphorus, halides and other components which have high vapor pressures at high temperatures. A simple weight loss method can be used to determine if the yield of glass is equal to that predicted in the batch calculation. If the yield differs from the expected value by more than a few tenths of a percent, the sample composition is certainly suspect.