

## Heat Tolerances

As long as the differential between the oven and the glass when it is first entered into it is not greater than 84 degrees Celsius there should be no issue taking the glass up to around 600° degrees.

It's the thermal shock that's the issue. Once the glass is in the oven will heat gradually and so will the glass.

It wouldn't be wise to put ambient glass (10 - 15 degrees C currently) into an oven already operating at 200c

### **Temperatures for Glass**

Glass can be heated up to temperatures in excess of 600° degrees without issue, however at this temperature the glass would need to be reannealed (cooled in the correctly controlled manner to remove stress).

Similarly, glass can be frozen, however the issue here is as the content of the glass freezes expansion of the content can result in failure of the container.

When glass is cooled it is put under tensile stress, when it is heated it is put under compressive stress.

The issue for glass is not an ability to withstand extremes of temperature, the issue is the rate of change. Sudden and/or rapid temperature change can result in thermal shock failure of the glass.

Thermal shock is caused as a result of changes in temperature, it does not require an instant increase or instant drop to occur, the speed of transfer results in the issue, The failure is either as a result of the outside of the glass being cooled too quickly whilst the inside is still hot as a result of the product temperature, or the outside of the glass being heated too rapidly whilst the content is still cold. The differing opposing stresses overcome the strength of the glass resulting in failure.

During manufacture we test the glass for thermal shock resistance working to a 42 degree drop in temperature, however, the testing standard requires a delay in transfer from hot to cold to prevent false rejects from occurring detailing that the transfer should not be less than 16 seconds and should not exceed one minute. With the above in mind we would recommend some simple activities which would reduce the risk of thermal shock-

For hot filled product we would recommend that the containers are not filled straight out of a cold warehouse, bringing the glass into the processing area, removing the shroud and allowing the temperature to settle to ambient would greatly reduce risk of thermal failure.

Heating or Freezing.

Heating and cooling should be gradual, slowly taking the glass up to the required temperature and slowly cooling back down.

Freezing should be slow ensuring sufficient headspace to allow the product to expand without unduly stressing the container. Thawing should be natural and not under assist from a heat source.

**We would always recommend that in any doubt regarding the suitability of a container to perform under extreme conditions extensive testing under a controlled environment is undertaken on the container and the particular application before exposing a consumer to any risk.**