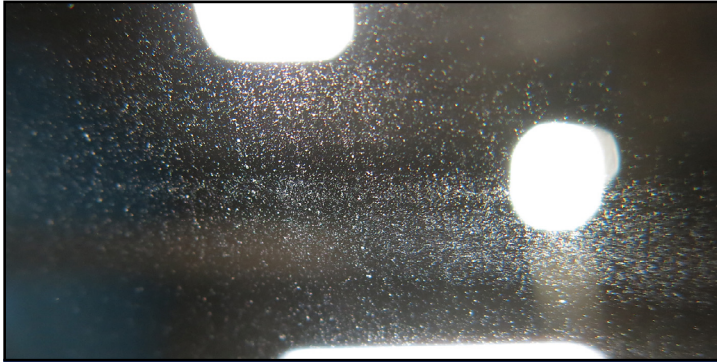


Introduction

Heat Stain, also referred to as ghosting, heat rash or "skunk mark" is a tempering defect usually resulting from either dirty ceramic rollers in the tempering furnace, excessive heat in the tempering furnace or a combination of both. Heat Stain can happen in any type of modern tempering furnace but tends to be more prevalent in smaller oscillation (batch) furnaces where the glass oscillates forward and backwards before transferring as a batch to the quench.



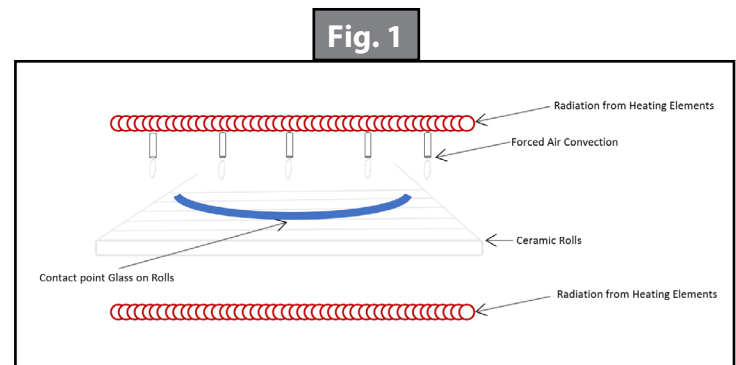
Magnified photo of Heat Staining on Clear Glass



Magnified photo of Heat Staining on Clear Glass

How Heat Stain Occurs

Most often heat stain appears in the center of the glass running parallel to the long edge as glass is most commonly loaded through the tempering furnace in portrait orientation. The long edges of the glass are likely curling upwards in the furnace or "taco-ing" (Fig. 1) creating a central contact area between the bottom of the glass and the ceramic rollers. Even with extremely clean, dust free rolls heat staining may still occur. Should the ceramic rolls be dirty or dusty, the effect worsens.



Mitigating Heat Stain

Eliminating heat staining is fairly easy to accomplish but may take time. Clean ceramic rolls are the singular most important step in combating this issue.

1. Removal of all ceramic rolls and vacuuming of the furnace bottom is the first step. Dust that falls to the bottom of the furnace can be stirred up by convection systems and embedded onto the ceramic rolls.
2. A clean manufacturing environment, free of dust and debris is also important. Airborne dust particles may settle on the glass surface prior to tempering and wind up inside the furnace.
3. Cleaning the rolls with a small amount of warm water and material such as pantyhose will clean off any embedded particles
4. Keeping the infeed roll section covered over the weekends or during longer periods of shutdown will prevent dust from building up on the infeed rolls and prevent glass from transporting dust into the furnace.
5. Adjusting the heat profile in the furnace to eliminate the "taco-ing" will also combat this defect. Typically lowering the heat on the bottom of the furnace and increasing the convection on the top of the furnace will flatten the glass inside the heating chamber
6. Lastly, in an oscillation furnace, increasing the roll oscillation speed may improve the friction on the center of the glass.