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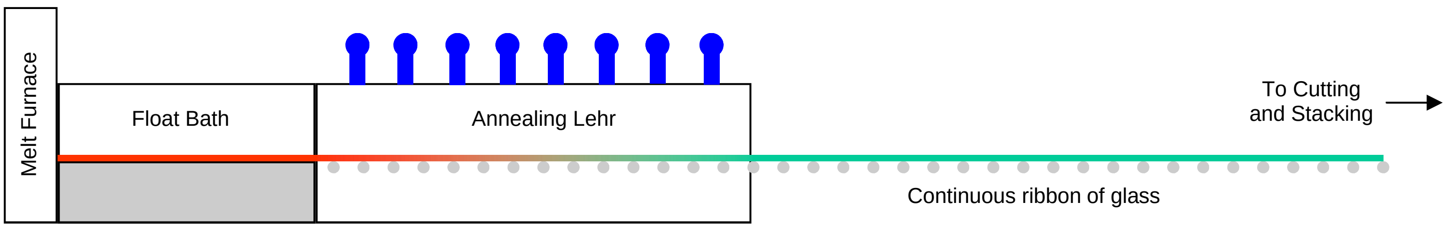
Float Glass Inspection

Float glass inspection offers opportunities to detect tin, stone, and other contamination before glass is cut and shipped to the customer. A portion of a typical float glass line is shown below:



The initial phase of float glass manufacture involves a melting furnace, where proper quantities of raw materials are heated to produce the molten glass mixture. The glass then moves out of the melt furnace to the float bath, which consists of a pool of molten tin upon which the less dense, but much more viscous glass floats. The intersection of glass and tin produces a very flat surface. This process was patented by Pilkington in 1952. Before that, making very flat glass wasn't possible.

The glass ribbon is cooled in the float bath enough so that it can be supported by rollers, and then is moved to the annealing lehr, where the glass is carefully cooled as it moves along the line. Coatings are also applied at this point. The glass then further cools on the exposed rollers before going to cutting and stacking. The total length of the production line can exceed a kilometer when the cutting and stacking areas are included.

Float glass can be subject to imperfections that result from contamination of the batch mixture, improper or incomplete melting, or issues in the float bath. Contamination in the batch mixture can cause imperfections to show up anywhere in the glass as embedded objects. Also, if there is a problem in the melt process, unmelted batch (called "stones") can appear within the glass. In the float bath, it is possible for tin to contaminate the glass, usually on the bottom.

Float glass can also have surface irregularities. There are normally areas which show dimpling at each side of the ribbon from the toothed rollers used to control ribbon thickness in the float bath; these are trimmed off at cutting. Other irregularities can result, and cause the glass to depart from flat topography.

Therefore, there are two types of defects that need to be detected within float glass. Tin and other contaminants can be seen simply by looking through the glass at a light source. Topographical defects usually require some from of reflection to see.

Further complicating matters, float glass is coated for lubrication purposes as the ribbon moves over the hundreds of individual rollers. This coating usually occurs as the glass exists the float bath, and the interaction of the coating and the hot glass produces sulfates. Usually, the sulfates are visible as a light haze on the glass, but can congeal and form particles on the surface. Dust and other debris usually settles on the glass as it moves along the rollers. These sulfates and other particles resting on the glass are not considered defects, so a system must be capable of distinguishing between particles resting on the glass, and actual defects which may be on the glass surface or embedded within it.

Laser systems have proven useful in float glass inspection, as they can distinguish topographical and contamination defects simultaneously. However, their greater cost than cameras is a drawback.

A laser system can inspect the glass for contamination and topographical issues by transmission. In this mode, lasers create an apparent line of light by firing against a rapidly spinning mirrored polygon, which then reflects the light through the glass ribbon (typically from above the glass), and into receivers located under the glass. Contamination will stop the laser light from getting to the receiver, and most topographical defects will refract the laser light away from the receiver. Only continuous topographical streaks that run in the direction of ribbon movement cannot be detected this way. It is necessary to clean the glass of dust and large sulfate particles to achieve good results with this method, however.

Camera inspection can work very well in detecting topographical and contamination defects, but typically, a separate set of cameras and light sources are required for detection of the two types. Reflection is used for topographical defects, which means that cameras are necessary top and bottom.

However, if the main requirement is to detect bottom tin contamination, a camera-based system can perform this at low cost. By utilizing certain light sources and geometry, it is possible to detect the tin on the bottom of then glass and distinguish it from similar-sized sulfate deposits. Since the tin contamination particles can be quite small, it is necessary to ensure that any camera system applied has sufficient resolution to view the particles.

Lasers can also be used in reflection, but in general, cameras can achieve nearly the same results at lower cost.

The inspection system can be located anywhere along the production line after the lehr and before the cutting station, but at the output of the lehr is the preferred location. This location ensures that the least amount of dust and sulfate particles have had a chance to accumulate on the glass.

Proper setup of the inspection will allow best detection of the widest array of defects, as that is usually the requirement. Some inspection systems, such as those supplied by WEBVIEW, include video processing modules which can enhance certain types of defects and make them even easier to detect. WEBVIEW systems, even the low-cost Web-*i*, come with a special video mode called “Small Defect Channel”. Video is sent through a rate-of-change filter to enhance spots where brightness is changing rapidly from pixel to pixel. This video mode can be used to detect even defects which can get to be much smaller than the calibrated pixel size. This can allow resolution requirements to be relaxed and cost of a system to decrease significantly.

For various reasons, it may be necessary to place the inspection system in a high-temperature area. When mounting electronic equipment of any type, one must take into consideration ambient temperatures. As camera operating temperatures increase, noise generated within the camera increases due to the nature of CCD and CMOS devices. As this noise increases, the dynamic signal range of the camera is reduced. To prevent this, some sort of supplementary cooling is suggested when the camera(s) or light source(s) will be placed in areas where ambient air temperatures are at or above 100°F (38° C). This can be provided by plant air (dry air of instrument quality is a must to prevent condensation and other issues), external fans, or self-contained air conditioning units.

Webview offers inspection systems based on both cameras and lasers. We invite you to view our website at:

www.webinspection.com