High technology of in-line continuous Heat Soak Test to avoid spontaneous breakage

Chihiro Sakai1*

¹ NIPPON SHEET GLASS CO., LTD., Hyogo 664-0081, Japan *Corresponding author, e-mail: Chihiro.sakai@nsg.com

Heat Soak Test is one of useful solutions to avoid dangerous spontaneous breakage of the tempered (and heatstrengthened) sheet glass products caused by beta-phase transformation of Nickel Sulfide. In 2017, different two types of the Heat Soak Test processes have been standardized in ISO-20657. The former is conventional off-line Heat Soak Test which repeats heating and cooling every time. It is applied in many glass-manufacturing companies in the world. The latter is new advanced technology of in-line continuous Heat Soak Test which is directly linked to the tempering-quenching process. The new advanced technology has many benefits (time shortening, efficient and effective productions) for the manufacturing of the tempered (and heat-strengthened) sheet glass with high reliability and safety. The standardization of the in-line continuous Heat Soak Test has been achieved based on several experimental and analytical investigations.

Based on Nickel-Sulfur binary phase diagram ^{[1], [2]}, the beta-phase transformation of Nickel Sulfide after tempering-quenching process can be completed during the continuous cooling process. In order to clarify the processing conditions (thermal history) of the in-line continuous Heat Soak Test, the following analysis investigations have been done. 1) High-temperatures microscope observation, 2) Differential Thermal Analysis, 3) High-temperatures X-Ray Diffractometry, and 4) micro-Raman spectrometry.

Figure 1 shows the results of experimental and analytical investigations, for the thermal histories of in-line continuous Heat Soak Test. Based on the high-temperatures microscope observations, the Nickel Sulfide included in glass product is transformed into beta-phase after rapid cooling (quenching) after 12 minutes at constant temperature of 220C. Similar phenomena for beta-phase transformation have been also confirmed in the experimental investigations (such as high-temperatures XRD and DTA measurement).



Figure 1. Results of experimental investigations

Figure 2 shows the relationships between phasetransformation of Nickel Sulfide and in-line Heat Soak Test equipment. It is clear that the Nickel Sulfide inclusion is transformed into the beta-phase after Heat Soak Test processing (220C+/-20C and 12min keeping). There are many benefits for the in-line continuous Heat Soak Test [3].



Figure 2. Beta-phase transformation of Nickel Sulfide

- 1) Improvements of both productivity and reliability
- 2) Automatic producing (a series of processes from tempering to Heat Soak Test)
- 3) Improvements of productive performance (many kinds products, heteromorphic products, and mass production)
- 4) Better adapted to in-line volume manufacturing offering improved consistency and simplification of process flow

References

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