

Development of Vacuum Glass in China – Both Opportunity and Challenge Coexist

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Abstract: China is currently leading the world in vacuum glazing technology, as well as its industrialization, standardization and project application. The newest technology highlights on vacuum glass in China are metal edge sealing, infrared edge sealing and pillar which can regulate height and shape by itself. Market requirement and government drive give vacuum glass opportunities to further develop. But meanwhile there are also challenges for vacuum glass industry, for example, lack of understanding of the characteristics of tempered vacuum glass, high cost vacuum glass, lack of unified testing standard of product quality, and so on. The next five years will be the key development period for vacuum glass industry.

Key words: Vacuum glass, development, opportunity, challenge.

1. Vacuum Glass in China Leads the Development Trend of the World

The call for green energy-saving building is becoming more and more strong as building energy consumption is one of the major contributors to environment disruption, and there is massive market needs for new building as well as old building renovation. Government is putting in more effort to support research and the development of green building materials including energy-saving glass. China is still leading the world in vacuum glass at the moment, In 1990s, Beijing Synergy Vacuum Glazing Technology Co., Ltd.” (Synergy) was the only company in this field with relatively large investment, whereas now there are at least six companies.

In China, the first industrial standard “Vacuum Glass” JC/T 1079 was introduced in 2008 and then “In-situ Test Method for Degradation Ratio of Vacuum Degree of Vacuum Glazing – Photoelastic Method” GB/T 32062-2015 was launched in 2015. At the same time, vacuum glass was included in several standards such as “Technical Specification for Application of Architectural Glass” JGJ 113. China

leads the world in terms of the number of vacuum glass standards and the coverage of these standards. At present, vacuum glass is used in different kinds of buildings such as office building, building group, exhibition center and showrooms, library, greenhouse, house and apartment, many of which were “world first” or “world greatest”. There are more than 10 passive houses using vacuum glass such as Residential Building at Qinhuangdao City (Fig. 1), Disaster Relief Command Center of Quancheng Park (Fig. 2), Tuanlin Experimental School at Qinhuangdao City, The Great Wall Kindergarten at Baoding City and Favor Nature Passive House at Zhuzhou City, etc.

In 2014, Beijing Science and Technology Committee approved “Research Center of Beijing Synergy Vacuum Glazing Technology Co., Ltd.” as “Beijing Vacuum Glass Engineering Technology Center”, which is the first professional research center on vacuum glass.

2. Newest Technology Highlights on Vacuum Glass in China

2.1 Edge Sealing Technology

Strengthened vacuum glass has already been manufactured in relatively large scale at Synergy and

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Fig. 1 Residential Building at Qinhuangdao City.



Fig. 2 Disaster Relief Command Center of Quancheng Park.

other companies. In order to improve the strength and safeness of vacuum glass, every company is trying to launch “tempered vacuum glass”. The technical route is almost the same in making tempered and strengthened vacuum glass. “First temper and then vacuuming”, that is, first temper the glass sheet which has been cut well according to the size requirement, and then make vacuum glass on the production line. In order to avoid annealing, two edge sealing technology methods are considered.

2.1.1 Metal Edge Sealing

Used “Metal-glass” sealing technology which had been frequently used by electronic industry in the past. First, metalize the four edges of the two pieces of glass, and then seal the two pieces of glass using metal solder such as tin or indium under 300 °C where tempered glass remains, and then extract the air before sealing the extraction opening [1]. “Metal-glass”

sealing technology was used by many companies trying to make vacuum glass since last century [2].

2.1.2 Infrared Edge Sealing

The technology of making tempered vacuum glass in rapid step infrared heating furnace and edge sealing by infrared glass solder was first proposed in Chinese and American patents [3]. In recent years, a Chinese company not only developed low-melting-point and lead-free glass solder which can heat up rapidly by absorbing infrared, but also designed and manufactured step infrared continuous heating furnace with 6 minutes a beat. The edge of glass is sealed at a relatively fast speed where the temperature of glass center is 30-50 °C lower than the edge. The technology not only decreased the anneal extent of tempered glass, but also reduced electricity consumption and production cost [4].

A key breakthrough of the above two technologies is that it can make lead-free vacuum glass. The tempered vacuum glass production line, which adopted these new techniques and breakthroughs, is expected to run for trial in near future.

Synergy has also been researching on new techniques, material and equipment, trying to produce tempered vacuum glass using the exiting furnaces.

2.2 Pillar that Can Self-Regulate Height and Shape

In the process of making tempered vacuum glass, the surface stress of glass sheet is generally required above 110 Mpa, which is higher than the 90 Mpa required in the Chinese standard of “Tempered Glass” GB15763.2. If the flatness of tempered glass is poor, some pillars with fixed height cannot play a good role of supporting the glass even under air pressure, which influences the production rate. Therefore, there are companies researching on pillars made from glass-ceramic frit which can self-regulate its height and shape, so that the vacuum glass can be supported evenly avoiding breakage due to concentrated stress [4]. If this technique can be used for production, then it will be a new technology highlight.

3. Opportunities and Challenges

Increased market needs and government support has given vacuum glass the opportunity to further develop. Yet at the same time, the industry is also facing serious challenges.

3.1 Lack of thorough Understanding of the Characteristics of Tempered Vacuum Glass

Initial theoretical and experimental testing proves that the surface pressure stress of tempered and strengthened vacuum glass is not evenly distributed. This is different from the even surface pressure stress of normal tempered glass. For example, the surface pressure stress of glass before vacuuming is 90 MPa; which after vacuuming, it reduces to 70-90 MPa with periodic wave distribution, and the pressure stress at pillar is reduced to 70 MPa. The strength and fragment status of broken pieces of tempered vacuum glass are significantly different from normal tempered glass. So, we call it “nearly tempered vacuum glass” [5]. We therefore set out testing method on the basis of sound experiments and results in order to confirm what kind of product is safe and qualified before introducing to the market.

3.2 High Cost of Vacuum Glass

The technology of vacuum glass is much more difficult than insulating glass. Currently, the low automation of production and relatively high energy consumption result in high production cost of vacuum glass. In recent years, the technologies of multi-cavity insulating glass, heat mirror glass and aerogel glass are becoming mature which are all in competition to vacuum glass. It is a great challenge for vacuum glass to be cost competitive to these new products.

3.3 Lack of Unified Quality Test

In China, there are a number of companies producing vacuum glass. The quality of products varies as they use different materials, technology, equipment and quality test method. To control the

quality, we need to ensure the key properties of the product such as heat transfer coefficient and mechanical properties (e.g. surface stress, status of broken glass fragment) reach the required standard. We also need to ensure the lifetime of product including thermo lifetime and mechanical lifetime. So, it is necessary to introduce unified test standard. At present, international standard “Vacuum Glass” ISO19916 and Chinese industry standard “Heat transfer coefficient Detection Method of Vacuum Glazing” are in process. At the same time, the relevant test equipment must be made. These work are great challenges but shall be completed in recent years.

4. Conclusions

“Industrialization of Tempered Vacuum Glass” has been chosen as one of the key projects in the “Thirteenth Five-year Plan (2016-2020)” of China. This means both opportunities and challenges. This is the critical five years for the development of vacuum glass technology and its industrialization. Like many new technologies and products, it is inevitable that vacuum glazing still has many challenges to overcome. Nevertheless, it has so far proven its good start in China with many applications on building projects. It is also undoubted that the construction glass industry around the world, particularly in the developed countries and countries that are big consumers of construction glass, need new glass technologies like vacuum glazing to bring in a new way of thinking than simply adding.

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