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**DONGGUAN QUNAN PLASTIC INDUSTRIAL CO.,LTD**

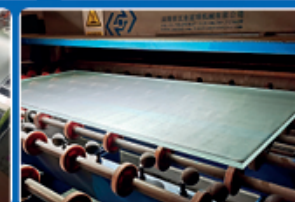
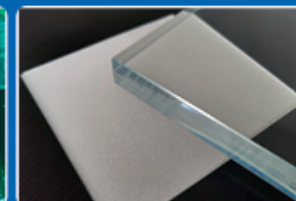
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**DONGGUAN QUNAN  
PLASTIC INDUSTRIAL CO.,LTD**



**(QUNAN SGP®) IONIC INTERMEDIATE  
INTERLAYER PROCESSING GUIDE**

PROFESSIONAL MANUFACTURER OF  
IONIC INTERMEDIATE MEMBRANE PRODUCTS

## (Qunan SGP®) Ionic Intermediate Interlayer Processing Guide

This processing guide provides glass factories with the correct method and process conditions for Qunan SGP® ionic intermediate interlayer material. Traditional equipment for PVB process are suitable for Qunan SGP® interlayer processing. According to different glass producing manufacturers' ability, this guidance may not cover all changes of technological data and equipment.

### Preparing

1. Check the work sheet, process card, operation record, film usage record, temperature and humidity record and prepressing data are prepared; Check the power supply and ammeter are normal and turn on the main power supply. Check water, electricity and air pressure suit for operation requirements. Check the water in the autoclave, cold drying machine and autoclave is drained; Check the glass contains acid or not, alkali compounds (such as colored glass, etc.); Discarded glass could be used to test machines before operation to check whether all the equipment are normal.

2. **Equipment tools/inspection tools:** steel tape measure, utility knife, high-temperature tape, tin face instrument, infrared thermometer;

3. **Environmental control:** clean before and after operation, and can meet the standard of dust-free production, keep the environment and equipment clean; Things are arranged neatly;

4. **Employee protective equipment:** protective sleeves, gloves, wrist guards, safety helmet must be worn when the height of glass is over 1500mm; employee must change their clothes and shoes when entering and leaving the film chamber.

### 1. Production Package

Now, roll shape package SGP® interlayer material was supported by Dongguan Qunan Plastic Industrial Co., Ltd at present, in order to keep out moisture and pollution. The material of the package is sealed into an aluminum foil sealed bag. The outer wood package could prevent possible damage during delivery. The inner and outer packing is as shown below (please make sure the packing is to ensure a vacuumed and sealed state when the goods arrive.)



### 2. Storage

Qunan SGP® interlayer is different from PVB interlayer, SGP® will not adhere each other together, therefore SGP® interlayer does not need intermediate isolating film and unopened SGP® interlayer does not control temperature. Qunan SGP® interlayer could keep stable ability and unchange quality if in store many years under a moistureproof environment. After the SGP® interlayer absorbs moisture, abhesive force with glass may decrease with time.

We suggest that if our productions had been stored **over more than two years since the interlayer produced**, manufacturers need to test Qunan SGP® interlayer moisture content and laminated glass's adhesion property when package unopened. Qunan SGP® interlayer will absorb moisture from the surrounding environment when the package is opened. Comparison with PVB, Qunan SGP® interlayer absorption was slower, but after absorb moisture still decreases adhesion and moisture can not released from dry condition.

We do not suggest using if the moisture content test's result was over more than 0.2%(The Carl-Fischer titration method was used). Our company accepts customized sizes and quantities for improve the utilization rate of film , so basically avoid the trouble from interlayer's storage. However, after each opening and using unspent interlayer need to take the suitable measure to reseal the package. The best condition is reseal factory vacuum packing( as shown above) to ensure stable production quality.

### Suggestion Way of Store and Operate Roll Qunan SGP® Interlayer:

1. Keep it horizontal rather than vertical during the process of use and storing.
2. Please do not pile roll SGP® material one above another.
3. using a traditional PVB way of changing the volume and taking care of the aluminum foil bag.
4. A horizontal roller lifting device or other similar equipment can be used to lift the reel to a certain height to release it from the basket. Then carefully open the outer packing waterproof aluminum foil bag. (Choose one of the following methods)
  - A: Cut one end of the foil bag with A blade and slide the whole aluminum foil bag out of the end of the roll. Take out the complete package.
  - B: Cut the package along the inside of the original sealing line with a knife, and then open the whole package.
5. Reserve an aluminum foil bag for later use.
6. Transfer the rolled SGP® interlayer to the recycle device.
7. After cutting, if the roll is not completely used up, the original aluminum foil bag should be repacked to remove the residual air in the bag as far as possible, and all openings should be sealed with strong tape. If conditions permit, it is recommended to re-vacuum and seal the roll with an aluminum foil bag.
8. Insert the excess aluminum foil bag at both ends into the roll shape film in the middle, and insert the end cover and end plug.

9. Carefully observe whether there are any pores or tear holes in the package.
10. Return to proper storage.

### 3.Cutting and Deflashing



The most direct and financial way is a sharp knife. The recommended steps to use this approach are detailed below:

1. Using the complete cut could get the right size. If curved or irregular surface shapes are required (such as side Windows), the better solution is using a flat glass as template. Use a sharp knife to scratch along the outline of the template, or a tool such as a scraper to make a shallow scratch.
2. fold the interlayer along the scratch outline.
3. tear or quick snap the interlayer along the scratch outline.
4. using a lint free cloth or Teknek roll adhering to clean surface fragment.

### 4.Clean

SGP® interlayer is very clean before delivery. But material surface adhere to static electricity, it may adhere pollution if interlayer did not clean before laminating. The final clean step is recommended before laminating, especially after cutting or deflashing the interlayer. There are some clean methods as follows:

1. roll adhering ( such as: Teknek) -as the following picture shows



(Reference pictures can be purchased from any relative shop)。

2. Ionized air wash.
3. Wipe with a lint free cloth.



## 5. Glass Preparing

1. In the process of handling glass, the glass tin surface and air surface can be determined by the knife edge surface of float glass. Usually the air surface is knife edge surface of float glass. The different glass surfaces need to be arranged during the process of handling glass. make the air surface or tin surface marking for avoid that the glass tin surface and not-tin surface can not be distinguished by simply way after edge grinding.

2. Note the direction of the glass rotation during the process of edge grinding in order to avoid the appearance of diagonal overlap. Note that glass can not turn over on the rack at will when grinding edge.

3. glass toughening process, the tin surface rubber matching is toughened and the toughening is fed into the furnace, one piece of glass tin faces up and one piece of tin faces down. (If conditions permit, it is recommended to use tin surface meter for supporting verification before toughening.) At the same time, attention

should be paid to the placement of the below glass direction.

Please make sure which side of glass face is the Tin face. **The request of glass laminating is :Tin face+SGP® FILM+Tin face**

## 6. Glass Cleaning

Check whether the water temperature and quality are within the control range before operation; The water tank of cleaning machine must be kept run. The water tank must be cleaned once for a consecutive week of production and once every 10 days for intermittent production. Wash glass with tap water, rinse glass with deionized softening water.

### Process requirement

Water quality requirements for washing glass:  $< 30\mu\text{s}/\text{cm}$  , electrical conductivity less than  $0.3\Omega$ .

The water temperature of cleaning glass is  $40-60\text{ }^{\circ}\text{C}$ .

The air pressure is  $0.6-0.7\text{ mpa}$

It is recommended that you use a glass cleanser to clean and end rinse with demineralized or deionized water. After cleaning with this kind of cleanser, adhesive property between glass and interlayer is better than cleaning with soft water or tap water. Many commercial grade cleansers could get great effect, e.g. Basic H. But there is no relative adhesive property data on the influence of different cleanser. Each kind of cleanser needs to be evaluated for adhesive property ability before daily used. Sometimes water without cleanser also gets a great adhesive property, but water temperature should be over  $55^{\circ}\text{C}$  to ensure the best effect.

## 7. Laminating

Recommended temperature and humidity range of the laminating chamber:

temperature:  $22^{\circ}\text{C} - 28^{\circ}\text{C}$

relative humidity: 18% - 28%



**Work requirements:**

employees protective equipment wear: white coat, white hat, non-hair removal white gauze gloves, cloth shoes, masks; Before operation, ensure that the temperature and humidity have reached the control range.



Before laminating the piece must strictly check whether each piece of glass cleaned qualified; (If the cleanliness of cleaning does not reach the standard, wear gloves with dust-free cloth or medical cotton sand stained with purity of more than 99% alcohol (pure analysis) to wipe hard until clean); When laminating the glass, pay attention to the position of the label, ensure that it can not in the middle of the glass.

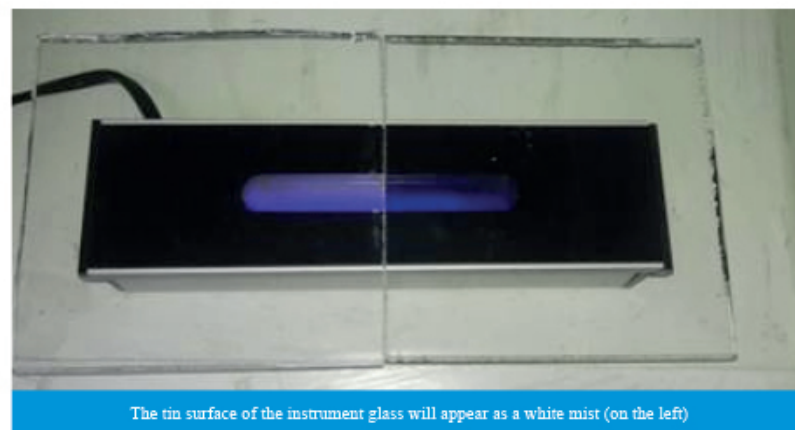
Make sure the glass is dry before laminating. SGP® interlayer must be laminated in the following way: if it is a single layer laminated ATTA, the way of closing the piece needs to be mandatory. In order to ensure the smooth closing process of ATTA tin facing rubber, please refer to point 5 of this guide for the glass opening, edging and toughening process(glass preparation suggestions)

1. SGP® interlayer directly adheres to tin surface, using the direction of ATTA: glass air surface/glass tin surface/SGP® interlayer/glass tin surface/glass air surface, also known as glass tin surface + SGP®+glass tin surface.

2. the adhesion promoting agent need to be used for glass structures unable to laminate tin face (such as non-float glass, multilayer laminated glass, etc.); Two or more layers of glass, if you can't do tin face+SGP®+ tin face, adhesion promoting agent must be evenly used in the glass air face (if you can't distinguish the tin and air face, both side of glass need to be used).

3. After laminating glass, the glass need to be checked the qualified (whether there is hair or other stuff in the middle of the glass, whether the film is cut diagonately, shrink the edge, etc.); During production, the equipment and ground in the chamber must be dust-free.

The Tin face and Air face could be defined by tin face equipment, observe glass through tin face equipment as follows picture show. Tin face will showing white mist appears through tin face equipment(as follow photograph show)

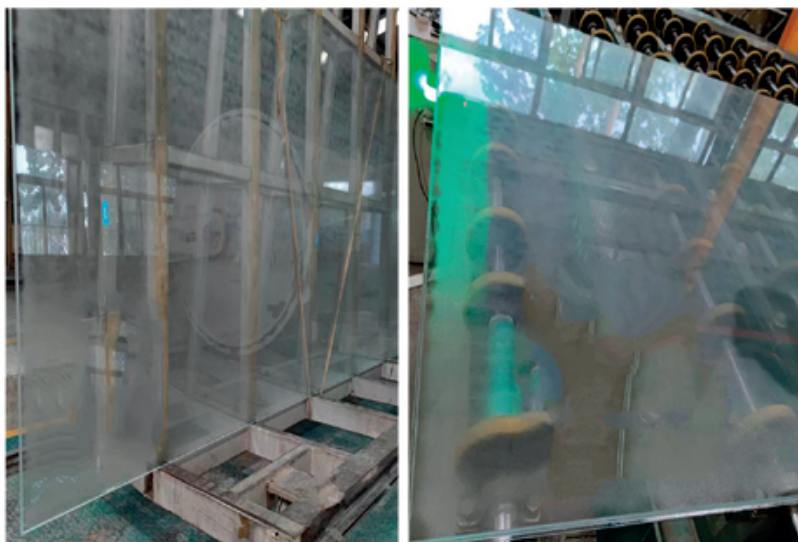
**8.Pressing Processing Technology**

Heat up before work. (General conventional prepress summer about 30 minutes; About 50 minutes in winter).

Temperature rise in strict accordance with the process requirements control; In the mass production of glass, It must first prepress a set of similar products to see the effect of the sample, in line with the standard to mass production, in the production process at any time to check the quality of prepressure. (After the pre pressure: transparency, edge brightness, overall uniformity, tail effect). The adjustment of the height of the rolling shaft shall be carried out in strict accordance with the technical requirements (the premise is: zero error of the

height of the two groups of rolling shafts); Operation and maintenance should be carried out in accordance with the requirements of operation.

Glass specifications must follow the loading method from large to small, from toughened to general glass loading; Glass in the car stacking process must be two or more people together with hand; The glass into the autoclave must be tied up with special ropes. When entering the autoclave, check whether there are any other stuff on the trolley.

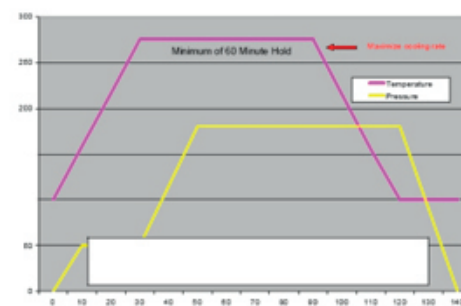


SGP® interlayer requires an exhausting step to eliminate air between the glass and the interlayer, a good exhaust effect could be obtained by rolling and vacuuming. The texture of SGP® interlayer surface could help better exhaust before adhering to the glass. For rolled SGP® film, it is possible to produce some wavy phenomena when it is laid flat on glass during the lamination process, as follows left side photography show. the wavy phenomena likely to worsen if roll SGP® multilayers stacking. However, this phenomenon should not influence the quality of final product if the pressing process recommendations are followed.



### Texture fo Laminated Glass Material

Due to different equipment conditions, the best temperature and the set of pressing speed are differentiation. For each laminating glass industry, lines speed are depend on the temperature roll process and the appearance of glass



after coming out of the roll furnace. Many factors will affect of the temperature of press process, such as, glass thickness, glass coating, different furnace, data setting and line conditions for example, output power and wavelength are different to infrared heating furnace and convection heating furnace. This is due to the higher absorption rate of SGP® film than glass in the infrared wavelength range (see above).



The recommendation of SGP® interlayer glass first data setting shows below. In order to obtain a better quality, those data may be required to appropriate adjustment in practice.

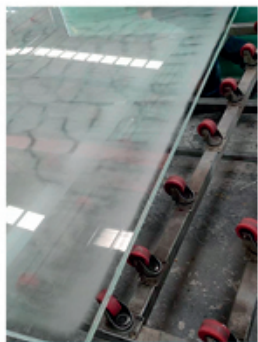
### Reference Conditions :

1. The temperature of the glass surface after press is in the range of 60 to 65°C, The roller speed is set by the temperature of the glass edge at the press machine, and the effect of prepressing is observed. The best prepressing effect is the complete edge sealing around the glass (along the glass perimeter).

2. Edge width (transparent area along four sides) is at least 2cm. After prepressing, the four sides of the glass should be transparent, and the whole glass should be haze and translucent inside (the left picture below). The best prepressing temperature should be near the lower of the recommended temperature range.

3. Regarding the surface temperature of the glass, the convective heating furnace tends to adjust the temperature from the median temperature to the higher temperature, (the right picture below) the overall effect should be almost transparent. The infrared furnace is adjusted from the median temperature to the lower temperature range.

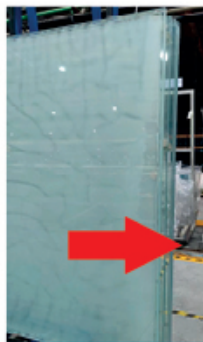
4. If a line of trapped air bubbles can be seen on the edge after prepressing, it is likely that the prepressing temperature is too high and too early edge sealing



Appropriate edge sealing and appearance of infrared furnace



Appearance of optimum preloading for convection furnace



Edge air bubble closure

(FIG. 11).

5. 3mm less than the nominal thickness of laminated glass (for annealed glass) . For tempered glass with serious deformation, it is sometimes necessary to reduce the distance between press rollers, and the pressure of press rollers should be 0.6-0.7mpa or larger. If glass slippage occurs, the first press machine should be separated from operation.

The following parameters are only applicable to the general prepress heated by quartz heating tube (take Handong equipment as an example)

The actual temperature of the first furnace chamber is 80-100°C;

The actual temperature of the second furnace chamber is 140-180°C;

The actual temperature of the third furnace chamber is 160-200°C;

The clearance of the first roller shaft is: about 10% less than the thickness of glass +SGP;

The clearance of the second roller shaft is: about 20% less than the thickness of glass +SGP;

After the first press machine out of the glass surface temperature is about: 35-45°C;

After the second press machine out of the glass surface temperature is about: 60-65°C;

The glass spacing on the autoclave trolley must be greater than 30mm;

The working pressure is 0.6-0.7mpa.

The following laminated glass is recommended to use vacuum bag;

Glass with length and width exceeding 2000mm,

Total thickness exceeding 26.28mm (general prepress),

Total thickness exceeding 32.28mm (only for convective prepress),

Bending and tempering glass, hot bending glass, different shape of tempering glass, and drilling glass;



## 9. Vacuum Bag Molding Process

If under current operating, more than two layers of SGP® interlayer can very great be laminated together by vacuum bag process and will not appearance undesirable defects e.g. bubble. The following key steps should also be paid attention when using vacuum bag process to laminate thicker or more number of layers of SGP® interlayer:

1. As the number of laminating layers increases, the cooling time should be increased accordingly. Usually the cold drawing time will be adjusted according to some conditions (such as vacuum degree, vacuum pump volume and laminate glass size, etc.), often need to be determined according to actual experience.
2. Usually, with the increase of the thickness of SGP® interlayer and the size of glass, the heat preservation and pressure preservation time of autoclave should be increased appropriately.
3. In order to minimize the fog of finished glass, it is necessary to ensure that the glass surface temperature is less than 38 °C before closing the autoclave fan and opening the autoclave door, and use cooling water to force cooling.

The methods of making vacuum bags and rings with vacuum film are as follows:

**Produce requirements:** employee's protective equipments wear: gloves, wrist guards. (with a safety hat and protective sleeve when using a suction cup to lift the glass), check whether the vacuum pump oil level is in the range of use before operation; cut the vacuum film (the size of the vacuum film should be about 150mm larger than the glass edge); the PET film or vacuum film of the same thickness is wrapped around the glass edge (high temperature resistant tape is best used to fix the PET film); the glass is placed on the vacuum film, and the silicone tube is used to draw out the suction hole at the glass edge, and then the vacuum film is made into a tight and airtight vacuum bag with a tube or plastic sealing machine. (the suction part can be wrapped with tube) connect the suction

hole of the vacuum pump, check and deal with the leakage phenomenon; the silicone tube is blocked for more than 10 minutes to check whether there is a leakage phenomenon; (another set can be made during placement); after the initial pumping is finished, the glass is carefully moved to the autoclave car by some employees vertically placed; To prevent damage and air leakage of the vacuum bag during transportation or hoisting, place the vacuum bag on the autoclave rack for large or heavy glass, lift the glass onto the vacuum bag by suction cup or truck, and seal the edge with the air nozzle; more than 30mm between glass and glass; after all required glasses are initially pumped and pushed into the autoclave, immediately insert all silicone tubes into the suction hole of the autoclave, then vacuum and check whether there is air leakage.

**Equipment operation:** Each glass processing manufacturers shall operate according to its own standards and requirements.

**Process requirements:** vacuum degree between -0.08 and -0.1; glass must be tied with special ropes (e.g., high temperature resistant square rope).

Although the vacuum bag process is slower and costs more employees, compared with the traditional pressing process, it can get better product yield, especially the yield of defects related to bubbles. For large area of toughened laminated glass or laminated glass of multilayer structure, it is recommended to use the method of vacuum processing. Vacuum bags can be used in a disposable or reusable system. The disposable vacuum bag is handmade according to the size of laminated glass (as shown below). It is necessary to use a breathable tape around the edge of laminated glass inside the plastic bag so that the air of laminated glass can be completely eliminated. For some laminated glass with open edge design requirements, since it is necessary to ensure smooth glass edges without rough edges,



breathable tape can be evenly coated around the laminated glass, so that it is located in the middle of the middle layer material and the breathable wrap tape. If the SGP film is found to adhere to the breathable material, a breathable separation film may be laminated between the two. It should be noted that all materials used in autoclaves need to be resistant to high temperatures(150°C).

#### Attention of vacuum bag use



It is highly recommended that in the production of large thick and toughened glass and laminated glass with multilayer structure or porous structure, the vacuum bag process can greatly improve the yield. The vacuum bag process for porous glass is very similar to that for non-porous glass, only a limited number of steps need to be added.

For the vacuum bag process of holes glass, it is recommended to use tetrafluoride rod or silica gel rod (or other similar things can be used instead) to plug the hole tightly (as shown in the figure below), which can effectively prevent the vacuum bag from being sucked and leaking during the whole operation of the autoclave. Other steps are the same as the vacuum bag process of laminated glass without holes. After the autoclave is completed, knock out the stopper with a wooden rod, iron rod, or PVC or PPR tube slightly smaller than the diameter of the hole.

#### Precautions for vacuum extraction:

The cold draw time should be at least 10 minutes longer. The hot suction temperature should be set based on the pre-pressed appearance of the laminated glass. In order to ensure the laminated glass have a better exhaust effect, we suggest that according to the different configuration and prepressing appearance set heat suction temperature and time (autoclave temperature up to a certain temperature, about 80 °C, and then vacuum for a certain time under the condition of constant temperature and no pressuring). However, if need be, laminated glass can not by prepressing operation, but in the process of high pressure directly using the vacuum, This reduces operation and runtime.

#### Vacuum Bag Process Summary:

1. ATTA structure must always be used to laminating glass. For the multilayer structure glass, try to use the most tin surface and SGP interlayer contact consistent structure.
2. For projects with abnormal or holes structures, it is necessary to consider the direction of glass, and ATTA structure must be considered in the laminating process during drilling, cutting and tempering.
3. If you have to use an air surface to clip the SGP film, you must use an adhesion promoter on the air surface of the glass.
4. According to the size of the laminated glass, the curvature of the glass and the thickness of the SGP film, when employee cutting the SGP interlayer, consider leaving an extra 5mm edge extending out of the long and short sides of the glass, which will reduce the film inflow in the autoclave stage and lead to the possible defect of "plastic deficiency".
5. To the best effect of air extraction, the permeable material needs to be used throughout the edge and the area that completely covers the hole. It is also highly recommended that the breathable material be completely secured to the glass with high temperature tape. Avoid the breathable material being pumped into the glass laminate during vacuuming.



6. For large size glass, it is necessary to use more air extraction taps to improve the pumping effect.

7. In order to achieve a good vacuum effect, it is necessary to improve the vacuum degree. The recommended vacuum degree is -0.08 to -0.1.

8. For large laminated glass structures, the hot pumping time in front of the autoclave should be maintained for at least 60 minutes.

9. For large multilayer laminated glass structures, the insulation temperature of the autoclave stage shall be 135 °C and shall be maintained for a minimum of 150 minutes or an appropriate extension of the insulation time depending on the thickness of the total laminated glass. A laminated glass autoclave with a total thickness greater than 30mm should be held for more than 210 minutes.

10. After drilling with a hollow bit, a sharp blade or hot knife can be used to trim the edge. It is not recommended to use fire baking to soften the SGP film.

## 10. Autoclave Technology



### Autoclave (air circulating autoclave below)

**Operation requirements:** Check whether the rope is loose when pushing the trolley in and out of the autoclave. Adjust the parameters as required before starting the operation, and check whether the fan bearing is filled with high temperature lubricating oil as required; Check the water level of the fan bearing cooling water tank before starting and during operation; In the process of operation, there must be a special employee, can not leave the post, and make corresponding records; Each piece of glass must be inspected and the results recorded in the inspection record sheet when unloading the autoclave. The glass on each trolley must be tied with ropes when it is pushed into storage.

**Equipment operation:** Each company shall operate according to its standards and requirements, and person who only after the learning of the

job training and operation instructions and gain the certificate then can be taken on the job; Autoclave operators must be trained in pressure vessel special equipment and hold the Pressure Vessel Operation Certificate issued by the Special Supervision Office of the local Bureau of Quality and Technical Supervision before operating the equipment. During maintenance, they must hang warning signals on the equipment and check whether there are combustible substances in the autoclave before closing the autoclave.

### Autoclave requirement

Temperature rise and pressure increase can be carried out at the same time, but the pressure cannot rise too fast;

**Heating speed:** about 2° C/min;

**Boost speed:** 0.4-0.6mpa/cm<sup>2</sup>/ min;

**Holding time:** 150 minutes or over (depending on the amount and thickness of the glass in the autoclave more than 30mm glass need to hold 210 minutes);

**Holding temperature:** 135-138°C (depending on autoclave manufacturer and glass/film thickness);

**Holding pressure:** 1.15-1.25mpa;

**The first stage cooling speed:** 5° C/min; (135-70°C);

**The second stage cooling speed:** 3° C/min; (70° C -35° C)

**The temperature of exhaust air:** as low as possible 35° C; Until the pressure in the autoclave is maintained at the value of the equilibrium pressure before exhaust air;

**The switch time of the vacuum pump:** open when the autoclave is running and close when the autoclave is venting.

### Attention

In the process of operation, condensate water of air compressor, cold drying machine and gas storage tank must be drained every 1 hour.



If it is an air circulating autoclave, fill the fan bearing with high temperature lubricating oil once every two times.

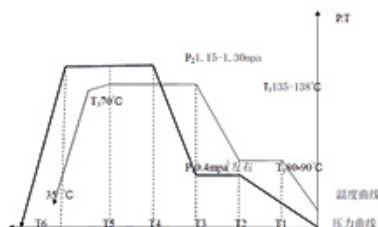
Operate once empty autoclave every 15-20 times. (Due to the high temperature of autoclave required by SGP® film, the autoclave should be opened once as far as possible according to the requirements of our company's parameters before opening the autoclave, otherwise there is a risk of fire)

The safety valve should be checked at least once a year.

Drain the water in the autoclave after each operation.

The main valve of the vacuum pump must be closed after each autoclave operation.

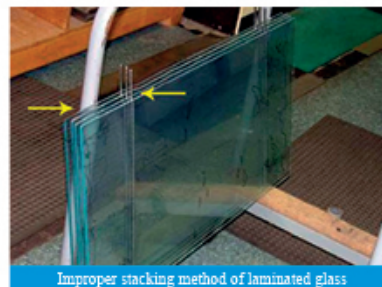
Operation picture of autoclave (The following is the operation picture of conventional air circulation autoclave in the climate of Southwest China)



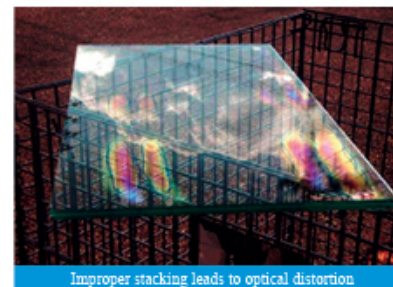
Controlling and tracking the high pressure process is an important factor in producing high quality SGP® laminated glass. Autoclave parameters including prepressing conditions, holding time, holding temperature and cooling speed will affect the optical and physical properties of the final laminated glass. Before prepressing the laminated glass in the autoclave, the distance between the glass on the tray should be at least 30mm (the interval of the laminated glass can be stretched into at least two adult fingers). It is not recommended to use metal bars or wooden spacers, because they will affect the normal air flow between the glasses during the cooling process. The local pressure should be minimized, which can be achieved by spreading the pressure over a large area. Laminated glass

should not be placed directly against a vertical stack. (below left) is a picture of improperly stacked laminated glass.

The metal bars restrict air flow, resulting in uneven heating and cooling of each piece of laminated glass. Uneven compressive place (caused by placing the laminated glass directly on the stack) can lead to uneven thickness of the SGP® film during heating process. The residual stress and light distortion of laminated glass in this area may be caused by different thickness. The photo (below right), taken through a polarizing lens, shows colorful laminated glass with optical distortion, which is directly caused by inappropriate stacking of laminated glass in the autoclave.

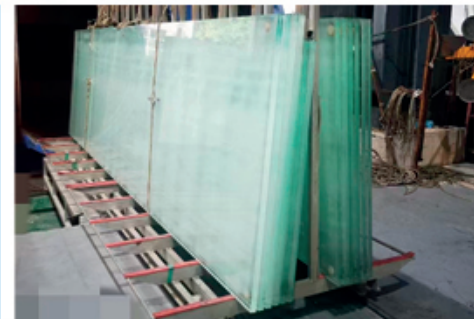


Improper stacking method of laminated glass



Improper stacking leads to optical distortion

The following picture shows the stacking method of laminated glass. The laminated glass intervals are reasonably spaced so as not to influence air flow, and padding is placed at the vertical supports to disperse pressure.



stacking method of laminated glass

Different autoclaves have great differences caused by different sizes of glass, heating, cooling rate and overall processing efficiency. Our recommended

temperature range is between 135°C and 138°C. The autoclave insulation time must be long enough to ensure that the laminated glass reaches the expected temperature and the necessary time, so as to ensure sufficient adhesion. We recommend a minimum holding time of 2.5 hour (The total thickness of laminated glass is greater than 30mm, and the holding time is at least 3.5 hours). If enough heat preservation and pressure preservation time is not guaranteed, although the laminated glass can obtain a better appearance, the adhere strength will be reduced, which is caused by the insufficient binding between the glass and the intermediate film. In order to accurately measure the relationship between holding time and temperature, embedded thermocouple temperature measuring instrument can be placed in laminated glass for measurement.

The haze degree of the final product is directly related to the cooling rate of the autoclave. The faster the cooling speed, the less haze. To ensure a proper cooling rate, the following operations are recommended:

1. Use a proper size fan;
2. Use sufficient cooling water to ensure maximum heat exchange;
3. The cooling circulation pool shall be equipped with a cooling water tower of appropriate capacity;
4. Use radiators with sufficient power in daily operation;
5. Place the glass in the autoclave at the required intervals. If laminated glass with high fog is produced, the fog can be reduced by re-entering the autoclave and cooling it quickly.

The recommended autoclave parameters are as follows:

**Autoclave heat preservation and pressure preservation parameters:**

**Temperature: 275 ° F (135 ° C)      Pressure: 1.15-1.25mpa**

Note: Lower autoclave pressures are also acceptable; however, this increases the risk of bubbles due to reduced pressure.

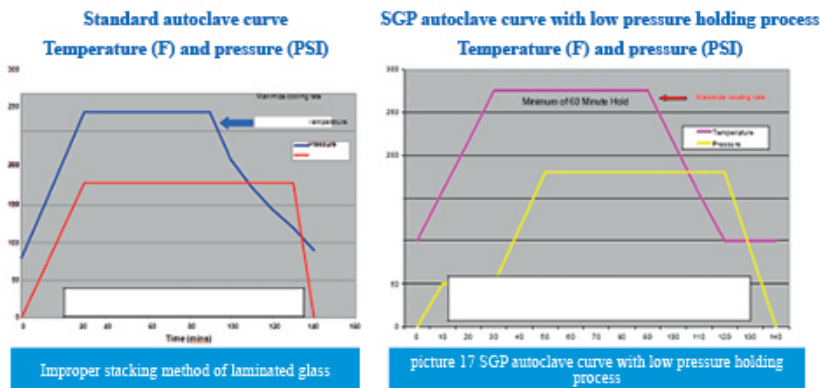
Holding time: 150 minutes(or longer, depending on glass specification and

autoclave size, load and air flow).

Cooling rate: at least 3°C/min, the haze of the final product is directly related to the cooling rate of the autoclave. It is recommended that the laminated glass be cooled to near environment temperature before turning off the cooling fan and cooling water system.

To reduce the possibility of film flow, it is recommended that the autoclave temperature not exceed 137.8°C.

Figure 16 shows the autoclave curve of a typical SGP film material. Figure 17 is the autoclave curve with the low pressure holding process.



## 11. Instruction for Empty Autoclave Operation

Fully open the exhaust valve before operation. The overtemperature is set to 150 degrees, the overpressure pressure is set to 1.3Mpa,

The constant temperature is set to 145 degrees, the constant pressure is set to 1.2Mpa, and the time is set to 45 minutes. When the program is 45 minutes of constant temperature and pressure, manually open the exhaust button and directly enter the exhaust program. After the exhaust air is finished, open the autoclave door and manually open the air circulation equipment to blow out the hot air in the autoclave. 5 minutes later, close all the power supply and finish the process (If the autoclave is heated by radiation: after opening the door, blow into the autoclave

with fan).

Radiator autoclave without wind circulation, constant temperature and pressure up to the limit, other parameters unchanged.

## 12. Multilayer SGP® Interlayer Laminated Sandwich Process

In order to achieve the strength and higher rebound resistance ability, two or more SGP® interlayer should be required laminated together between two glasses. The vacuum bag process is likely to fit any number of interlayer for multilayer laminated glass. The operating range is relatively narrow using the press process.

### Pressing Process:

Two layers of SGP interlayer (0.76mm, 0.89mm and 1.14mm thickness) can be easily prepressed using the standard press method. Each piece of SGP interlayer needs to be cleaned of possible dust and other pollution by a sticky roller before closing. Similarly, the linear speed of the press can be adjusted to ensure good edge sealing effect and no bubble problem at the end.

Laminated glass, usually with more than two pieces of SGP interlayer laminated between two pieces of glass, can also be prepressed by press process, but the total thickness of the laminate material should be controlled to be no more than 5mm. If the total thickness is greater than 5mm, the following consequences may occur:

1. As SGP interlayers cannot get enough heat, they cannot fully adhere to each other in the prepressing process, which leads to bubbles in the autoclave stage due to high pressure air blowing in (as shown below).
2. In order to improve the SGP interlayer fully adhered to each other, if the temperature of prepressing will lead to premature edge sealing between the glass and the outermost layer, and it is possible to produce the problem of falling into bubbles.



## 13. Precautions for the Use of Adhesion Promoter

The adhere grade between SGP film and glass can be improved by using adhesion promoter. In any case where the glass surface in contact with the interlayer material is a non-tin surface, an adhesion promoter must be used. According to the requirements of some users, for the possible problems in this application, the adhesion promoter can be configured by the manufacturers themselves (as follows) or pre-configured solution can be purchased. For details, please contact our technical representative or sales manager.

### Adhesion Promoter Preparation

The effective ingredient of the adhesion promoter is 4-aminopropyl triethoxy silane. We offer two formulations, the first as a standard formula and the second as an improved formula (using more readily available ingredients). See the corresponding tables attached for both formulations. Only a very small amount of 4-aminopropyl triethoxy silane is needed to obtain high adhering properties. Note that if the second modified formulation is used, ensure that the purity of the isopropyl alcohol and white vinegar is high and that it contains no other additives. As the solution is flammable, ensure that it is stored in an area isolated from heat and open flame. Before preparing this solution, be sure to understand the recommended use of all silane coupling agents, acetic acid, and isopropanol in the MSDS (Material Safety Data Sheet). After configuration, the promoter should be left for 24 hours before use to ensure adequate hydrolysis of the silane coupling agent. The promoter is recommended to be stored in a plastic or glass closed container with a shelf life of 4 months.



adhere promoter Formula 1		adhere enhancer Formula 2 (modified)		
ingredient	weight%	ingredient	weight%	volume%
isopropyl alcohol	0.92	isopropyl alcohol	0.8992	0.9191
water	0.079	water	0.0847	0.068
acetic acid	0.0001	acetic acid	0.015	0.0119
4-aminopropyl triethoxy silane	0.0009	4-aminopropyl triethoxy silane	0.0011	0.009
total	1	total	1	1

#### Application of Adhesion Promoter:

The adhesion promoter shall be applied to the glass surface, not to the surface of the SGP® film. The following lists a number of methods for applying the promoter to the glass surface, but is not limited to:

1. Spray on the surface with a sprayer, and then wipe well with a dry cloth.
2. The adhesive promoter is first applied to the cloth without flaring, and then the cloth is used to wipe the glass surface.
3. Use commercially available coating equipment to evenly apply the adhesion promoter to the glass.

Coating of the adhesion promoter needs to be carried out in a clean laminating chamber, and the glass needs to be cleaned in advance and spread evenly and thinly. Use a sprayer to spray only on the surface of the glass, and make sure to apply a dry cloth to cover the entire surface of the glass. If too thick, the adhesion promoter may lead to reduced adhesion property. After the adhesion promoter is applied, the glass can be laminating immediately. The adhesion promoter can be used in any standard prepressing process (roll, vacuum bag process, etc.)

#### 14.SGP® Interlayer and Color Glaze and Metal Coated Glass Laminate Compatibility:

Usually, SGP® film and color glaze or metal coating have a very good adhesion. Metal coating materials that have not been tested for adhesive and compatibility properties. Glazes with low-E coats or colored glazes that are not on this list are not recommended.

However, if needed, we recommend a separate evaluation of the adhesive and compatibility properties. Where possible, the ceramic glass material should be adhered to the tin surface of the glass. If the air surface of glaze and glass is laminated and does not reach 100% full coverage. The use of an adhesion promoter may need to be considered. It is necessary to pre-test the adhesive properties and compatibility of the laminate product.

#### 15.Test for Quality Inspection

Routine quality assurance testing is recommended. The test needs to include, at a minimum, tests of hammer grade and optical properties, such as haze and light transmittance. Hammering experiments on SGP interlayers were performed at room temperature (usually 21°C). The picture below shows a series of SGP interlayer laminated glass hammer experiments.

Surface area of the film after high impact /%	Knock value	After tapping, the surface area of the film is painful /%	Knock value
95≤S<100	0	20≤S<40	5
90≤S<95	1	10≤S<20	6
85≤S<90	2	5≤S<10	7
60≤S<85	3	2≤S<5	8
40≤S<60	4	S<2	9

## 16. Problem Solution



Problem	Potential Cause	Solution
Low adhesive property	Incorrect orientation of the glass laminating surface	change direction of Tin face+SGP®+Tin face
Low adhesive property	The moisture content of the SGP® interlayer is too high.	Use film with a moisture content that does not exceed the standard, and check storage and handling methods
Low adhesive property	The intermediate membrane is not getting enough temperature and time.	Check the holding time and temperature of the autoclave. Make sure there is plenty of space between the glasses and good air flow. If necessary, extend the holding time. Thermocouples are placed inside to verify correct operating conditions.
Low adhesive property	Incorrect hammering test.	Make sure the experiment is done at room temperature.
Bubble	Edge sealing too early	Speed up the rod passage or reduce the furnace temperature.
Bubble	A small area of irregular air trapped by excessive speed.	decrease roller speed.( maybe need to reduce the temperature)
Bubble	The roller space is too wide.	The roller clearance should be at least 2.5mm lower than the total thickness of the glass
Bubble	Edge sealing uncompletely and air enter the autoclave	reduce roller speed or improve the furnace temperature.
Bubble	Uneven heating leads to formation on one side of the intermediate membrane.	Adjust the upper and lower heater temperatures in the furnace to make them equal.
Bubble	The air pockets are distributed laterally on the glass plate due to corrugations of the roller or too much bending of the glass.	Check the glass toughening process; Match the curved glass to weaken the curvature.
Rainbow	The local pressure is too high during the autoclave process.	Eliminate the uneven pressure of laminated glass and ensure that the correct glass is used to segment the liner.
High haze	Autoclave cooling speed is too slow or uneven.	Ensure good air flow and cooling rate at least 3.3°C/ min. Increasing glass spacing (at least 3cm)

## 17. Attention



If you have any questions about the production process of SGP® laminated glass that are not covered in this guide. Please contact our technical representative.