

GLASSTEM[®]
Engineering, Technology & Equipment

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杭州聚能玻璃技术有限公司

有2种不同类型的设备可用来生产钢化玻璃，它们虽然类型不同，但其工艺原理是一致的。

The tempering can be done using two different types of systems and the same principle.

2种不同类型的设备是 The two different types of furnaces are:

A) 辐射加热钢化炉

Radiation Furnace

B) 对流加热钢化炉

Forced Convection Furnace

Radiation Furnace: – They are the first generation machines that are used to temper most of the glasses. The principle is very simple. In this kind of machine the glass is heated directly using through heating elements due to which the heating is slow and as a result the glass spends more time on the rollers in its soften state and hence has a high degree of optical distortion.

Forced Convection furnace: – They are the latest generation machines in which the heating is done by a forced convection technique. By this technique the heating is more even and is nearly 25 % faster. As a result the glass spends less time on the rollers in its soften state and has significantly less optical distortion. In this type of furnace the glass is indirectly heated, the elements first heat the plates and then a turbulence of air is created which transfers the heat to the glass in a uniform way. This furnace is designed to temper all kinds of glasses whether it be clear, tinted, reflective or Low e. As a result, the glass that comes out is of relatively superior quality and is tempered in accordance to the standards.

Glasstem's tempering furnaces:

• ERF: Economical Radiation Furnaces

Flat tempering ranging from 1,000mm (40") x 2,400mm (96") to 1,500mm (60") x 3,600mm (144"), specially designed for shower door and bath enclosure capability. Glass thickness of 5–19mm (3/16" to 3/4")

• SRF Standard Radiation Furnaces

Flat tempering from 300mm x 400mm to 3000mm x 6,000mm , featuring many sophisticated designs that allows more flexibility. Superior optical quality is readily achieved even on soft low-e coated glass by adding ECHS (Enhanced Convection Heating System).

• BFT Bent & Flat Tempering

Mouldless cylindrical bending, from 300 x 200 mm to 3500 x 2500 mm.

• Glasstem's HST Heat Soak Test Oven

Spontaneous broken of tempered glass can be avoided by submitting the tempered glass to a heat treatment cycle based on European Standard En14179.

• ECHS convection technology

The Enhanced Convection Heat System is the result of recent developments of convection technology, and greatly enhances the performance of Glasstem's furnaces

辐射电加热玻璃钢化炉

Conventional Radiation Furnace

传统型辐射电加热玻璃钢化炉分成两大类：ERF低加热功率的普通型与SRF高加热功率的高档型。

普通型采用较低的装机加热功率，目前大多数中国公司生产的钢化炉均属此类。其优点在于总装机功率低，用户可在变电设备上节约不小一次性投资，钢化炉的成本也较低。缺点是玻璃加热慢，生产效率低；温度波动大，控温困难。另一方面，由于玻璃与辊道接触时间长，对玻璃表面质量影响较大。

高档型装机加热功率很大，可对玻璃进行快速加热，生产效率高，温度波动小，玻璃在高温下的停留时间短，从而获得高质量的钢化玻璃。西方公司一般只生产此类钢化炉。

钢化玻璃的单位能耗主要与炉内传热效率和炉子保温好坏有关，单位能耗与装机加热功率无关。一般来说，加热越快速，保温越好，炉体散热就越少，相应单位能耗就越低。

杭州聚能玻璃技术有限公司生产的ERF型属低加热功率的普通型钢化炉，SRF型属高功率的高档钢化炉。



ERF经济型钢化炉 Economical Radiation Furnace

Features:

- Specially Designed for Small to Medium Glazers
- Minimum Capital Investment
- Minimum Operation Costs
- Minimum Maintenance
- Low Power Heating Installation
- Easy---Touch Screen Operation with Fully Automatic PLC Control
- Software in English or other Language
- Oscillation & Blower Driven by Frequency Inverters
- Convection Heat Balance Systems Installed

ERF经济型钢化炉规格性能表 Specifications

型号 Model	玻璃厚度 (mm) Glass Thk	装载面积 (Inches) Load Area	加热功率 Heating & driving kw	急冷 kw Quench	总功率 Total kw	40" Containers	Site (m)
ERF4096	5 – 19	40 × 96	165	45	210	2	10.7 × 8.1
ERF40120	5 – 19	40 × 120	195	55	260	2	10.7 × 8.7
ERF40144	5 – 19	40 × 144	238	75	313	3	10.7 × 9.0
ERF4896	5 – 19	48 × 96	196	55	251	2	14.7 × 8.1
ERF48120	5 – 19	48 × 120	245	75	320	2	14.7 × 8.7
ERF48144	5 – 19	48 × 144	292	90	382	3	14.7 × 9.0
ERF60120	5 – 19	60 × 120	305	75	380	3	16.5 × 8.7
ERF60144	5 – 19	60 × 144	350	90	440	4	16.5 × 9.0

SRF型钢化炉 Standard Radiation Furnace

All Glasstem's SRF plants have the following features:

Load & unload 入片台具有点动步进功能

- Stepping according to the length of glass sheets
- 较大炉型装备有侧向装片及气动升降台
- Pop-up table for large syst
- 并有自动测长功能，根据玻璃装载长度自动调节炉内往复行程
- Automatic loading length recognition
- 可选装载玻璃形状记忆功能，配合炉内优化加热防止玻璃边部过热
- Optional dynamic loading pattern recognition

Heating Furnace 模块化设计，一般炉可方便地改造成对流炉

- Easy to add Enhanced Convection Heating System (ECHS)
- 普通玻璃产量高50%，低辐射Low-E玻璃产量增幅达100%
- ECHS Increasing capacity by 50% with clear glass, and 100% with Low-E glass
- 基本消除特厚玻璃、压花玻璃及Low-e玻璃在高温炉内的炸裂问题
- Preventing in-furnace-crack for thick,/patterned/and low-E glass
- 极大改善玻璃平整度，对Low-e玻璃特别显著
- Best flatness for low-E glass
- 高加热功率配置能利用夜间低电价时段高强度生产，降低生产成本
- 采用开放式分区面阵加热器，控制灵敏反应迅速、元件寿命长
- Fast responding open coil matrix heating system, long life, easy maintenance
- 热量回收型对流热平衡系统，节能、加热均匀性好
- Optional ECHS convection heating
- 摩擦传动，往复同步性好，结构简单可靠
- Tensioned friction driving system ensuring no dead time during conveyor reversal
- 独有的辊面温度调节技术，玻璃进炉时避免下表面从辊面过度传热，玻璃表面质量好
- Roll temperature control (RTC) technology avoiding excess heat conduction to low surface of glass
 - Cap temperature control (CTC) technology means lower roll replacement cost by reducing end-cap loose risks
- 分体式轴头密封技术，辊端密封能长期保持良好，提高炉体保温性能
- Easy-to-replace roll seals maintain energy conservation and to protect the roller end caps
- 可选智能优化加热控制技术，根据玻璃形状自动调节分区温度，玻璃平整度好。

Quench

- Automatic independent quench top/bottom blowing distance adjustment
- 独到的上下淬冷风栅开度独立自动控制技术，可分别精确调节上下风栅与玻璃的距离，保证玻璃上下均衡冷却
- Optional pass-through quench for thin glass tempering
- 可选用“过流”淬冷风栅与固定冷却风栅相结合的方案，降低风机功率



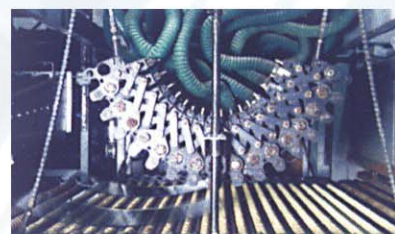
SRF型钢化炉规格性能表 Specifications

型号 Model	玻璃厚度 (mm) Glass Thk	装载面积 (mm) Load Area	加热功率 Heating kw	急冷 kw Quench	驱动 kw Drive	总功率 Total kw	占地面积 Install Site (m)
SRF0304	2.8--19	300 × 400	25	压缩空气			3.4×1.2
SRF0606	2.8--19	650 × 650	45				4.3×1.6
SRF0613	2.8--19	650 × 1300	72	Compressed Air			7.2×1.6
SRF0715	3.0--19	750 × 1500	100	200	5	305	8.6×3.0
SRF1020	3.0--19	1000 × 2000	180	300	5	485	10.7×8.0
SRF1224	4--19	1200 × 2400	220	200	8	428	14.7×8.1
SRF1240	4--19	1200 × 4000	360	225	8	593	20.5×8.1
SRF1525	4--19	1500 × 2500	300	205	8	573	14.5×8.3
SRF1530	4--19	1500 × 3000	360	225	8	593	16.5×8.3
SRF1540	4--19	1500 × 4000	480	230	8	718	20.5×8.3
SRF1735	4--19	1750 × 3500	490	290	9	789	18.4×8.8
SRF1740	4--19	1750 × 4000	560	290	9	859	20.5×8.8
SRF1745	4--19	1750 × 4500	630	290	9	929	22.5×8.8
SRF2130	4--19	2100 × 3000	530	340	9	879	16.6×8.8
SRF2135	4--19	2100 × 3500	660	350	9	919	18.4×8.8
SRF2140	4--19	2100 × 4000	756	360	10	1116	20.6×8.8
SRF2145	4--19	2100 × 4500	850	360	10	1220	22.7×8.8
SRF2445	4--19	2400 × 4500	970	420	10	1400	22.7×9.3
SRF2455	4--19	2400 × 5500	1180	440	10	1630	26.9×9.3
SRF3060	4--19	3000 × 6000	1440	565	15	2220	28.9×9.3

硬轴弯钢机组 BFT Bent & Flat Tempering Features



- Mouldless cylindrical bending
- User friendly interface, automatic forming
- Standard Radiation heating, convection optional
- Synchronous roller opposite pressing ensures Excellent optical quality
- Superior insulation guarantees efficient energy consumption



Specifications of Bent & Flat Tempering Furnace
常用规格硬轴弯钢机组参数表

型号 Model	最大玻璃 Max. Glass (mm)	最小玻璃 Min. Glass (mm)	厚度 Thk. (mm)	半径 Radius (mm)	弓高 Arch height (mm)	功率 Power (kw)	产量 Load/hr
BFT0806	800 X 600	200 X 300	3.2 - 8	350 - 900	120 - 50	200	32
BFT1208	1250 X 850	200 X 350	3.2 - 10	450 - 1000	185 - 115	300	32
BFT1208A	1250 X 850	200 X 350	3.2 - 10	450 - 1000	185 - 115	400	48
BFT2010	2000 X 1000	200 X 350	3.2 - 12	450 - 1000	250 - 120	480	32
BFT2010A	2000 X 1000	200 X 350	3.2 - 12	450 - 1000	250 - 120	580	48
BFT2410	2400 X 1000	200 X 350	3.2 - 19	450 - 1000	250 - 120	580	32
BFT2410A	2400 X 1000	200 X 350	3.2 - 19	450 - 1000	250 - 120	700	48
BFT2015	2000 X 1500	200 X 400	4 - 19	600 - 1500	410 - 180	650	32
BFT2415	2440 X 1500	200 X 400	4 - 19	600 - 1500	410 - 180	700	32
BFT2025	2000 X 2500	200 X 500	4 - 19	950	710	450	15
BFT2420	2440 X 2000	200 X 500	4 - 19	750	570	870	32
BFT2425	2440 X 2500	200 X 500	4 - 19	950	710	500	15
BFT2825	2800 X 2500	250 X 600	5 - 19	1000	680	550	15
BFT3025	3000 X 2500	200 X 600	5 - 19	1000	680	600	15
BFT3525	3500 X 2500	250 X 600	5 - 19	1200	820	800	15

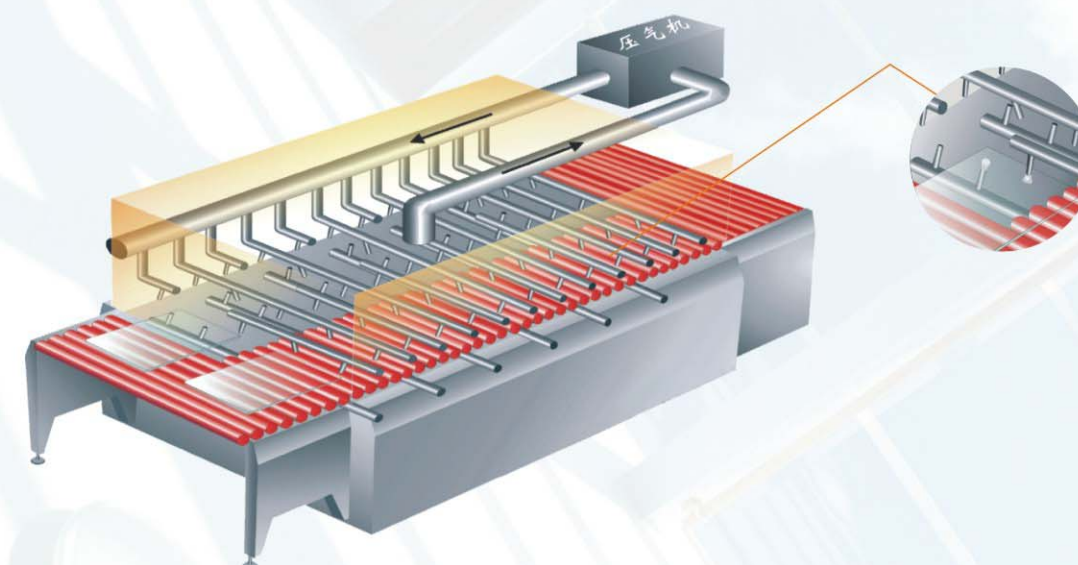
ECHS对流加热系统 Enhanced Convection Heating System

工作原理: 炉内高温气体通过保温管路,经外置压气机加压成高压热空气,回流入炉内,经喷嘴吹向玻璃板的上下表面,实现快速均匀地强对流加热。

适用范围: 特别适合将一般钢化炉改造成对流炉,能很方便地加装在现有的各种不同公司生产的钢化炉上。本技术可按用户需要选配在本公司生产的全新钢化炉上。

ECHS technology employs a special compressor which raises pressure of the hot air from the tempering furnace. Compressed hot air blows directly on glass at high speed. Glass is heated by both radiation & convection, resulting in uniform and faster heating up.

In Addition to construction of new high convection furnaces, ECHS technology can be easily for retrofit of existing furnaces.



技术特点 Features:

- 缩短加热周期, 提高生产效率 Reduce cycle time, and increase productivity
- 与辐射炉比较, 效率提高20%以上 Over 20% efficiency improvement compared to conventional radiation furnaces
- 能钢化各种硬膜和软膜“low-E”玻璃 Tempering hard and soft coated “low-E” glass
- 改善玻璃光学质量 Improvement on glass optical quality
- 可方便地安装在普通钢化炉上 Easily retrofit on conventional radiation furnaces
- 投资回收期很短 Short payback period

钢化玻璃均质炉 Heat Soak Test Oven



钢化玻璃均质处理的目的是使存在自爆倾向的玻璃在出厂前提前爆碎，从而保证供应给用户的玻璃不会自爆。

自爆的内在原因是玻璃制造过程中混入硫与镍杂质，在高温下生成硫化镍。硫化镍有二种结晶，高温时($T > 380^{\circ}\text{C}$)是 α 相、低温时是 β 相。在钢化时由于急速冷却， α 相来不及转变成 β 相。在使用过程中，常温亚稳的 α 相慢慢转变成稳定的 β 相，伴随约4%的体积膨胀，引起钢化玻璃自爆。

均质炉的作用是使硫化镍 α 相彻底转变为低温稳定的 β 相，从而防止玻璃在用户手中自爆。

因为硫化镍转变速度与温度关系很大，炉内温度均匀性特别重要。当温度为280度时，转变时间仅为1小

时。而当温度为250度时，需100小时。可见炉内温度均匀性是极其重要的，否则有些玻璃经几小时后仍然没有转变完成，等于没有效果。HS系列均质炉采用国际专利多维立体热风循环方式加热，炉内有精心设计的循环风管道，循环路线经流体力学优化，保证炉内装满玻璃时也能处处均匀加热。

Nickel Sulfide(NiS) has been known to be the cause of Spontaneous burst in tempered glass. During tempering the nickel sulfide is transformed to the high temperature α -phase($T > 380^{\circ}\text{C}$) and has no time to return to the β -phase on quenching. With the passage of time NiS slowly inverts to the low temperature β -phase with an increase in volume of about 4%. This volume expansion may cause glass breakage.

The Heat Soak is a destructive treatment which heats the glass for several hours at about 280°C to speed up the α -NiS to β -NiS transformation and consequently forces the contaminated glasses broken within the oven.

Standard HST requires more than ten hours thermal treatment including 1 to 6 hours to heat large quantities of glass up to 290°C followed by a temperature plateau at these temperatures for 3 to 12 hours before cooling down slowly to ambient temperature. The time necessary for 99.9 % α to β -NiS transformation is less than 1 hour at 280°C . For comparison, more than one hundred hours become necessary to complete the same transformations at 250°C , i.e. only 30 degrees below!

The average temperature difference is about 30 degrees between the hottest and the coldest glass during Heat Soaking within most ovens in use.

Glasstem's heat soak ovens use the most advanced technology. Patented Dual Flow technology optimizes the pattern of hot air circulation insures homogeneous temperature distribution in the oven. Temperature difference is less than 10 degrees within the entire oven.



均质炉主要规格指标如下 Specifications:

型 号Type	最大玻璃尺寸mm Max. Glass Size	外形尺寸L×W×H mm Overall Sizes	加热功率 kW Power
HS-1525	1500×2500	3950×2500×2480	100
HS-1535	1500×3500	4950×2500×2480	120
HS-2135	2100×3500	4950×2500×3080	145
HS-2145	2100×4500	5950×2500×3080	168
HS-2545	2500×4500	5950×2500×3480	200
HS-2555	2500×5500	6950×2500×4480	240

附录：欧洲标准EN14179均质处理的基础知识 Knowledge on En14179 Heat Soak Process System:

The heat soak process system consists of:

- The oven
- Glass support
- Separation system

The Oven

The oven shall be designed and constructed in such a way that it shall allow an unhindered air circulation around each glass pane. Even in the event of glass breakage the airflow shall not be hindered. This will require a careful design of the openings for the air ingress / egress so that fragments of broken glass will not cause blockages.

Glass support

It is very important to lay down exactly the way the glass is put up inside the HST oven. The glass stack shall be aligned with the heating air flow direction.

Separation system

The distance between the single glass panes in the stack combined with the alignment of the glass stack are the most important parameters decisively determining the quality of the test.

The separators shall assure optimised airflow between the glass panes without hindering the airflow themselves. A minimum separation of 20mm is recommended. It goes without saying that glass to glass contact is not allowed! Distances between the glass panes of less than 20mm will not only badly influence the heat exchange but also increase the risk of breakage.

The latter will certainly be the case when the oven is fully loaded as huge temperature differences can occur between 2 points in the same glass pane.

Heat Soak Process System Calibration

The calibration test determines the method of operation of the heat soak process system during manufacture of heat soaked thermally toughened soda lime silicate safety glass. In other words, the calibration shall determine the heating phase of the process, glass separation distance, the positioning, material and shape of separators, the type and positioning of stillage(s) and define the operating conditions for use during manufacture and this for both 100% and 10% load. Thus the calibration test has to be done twice in order to check whether the heat soak process system is capable of meeting the time / temperature regime at both 100% and 10% load.