

CONTAINER GLASS

TABLE WARE

GLASS DECORATION

SPECIALITY GLASS

FLOAT GLASS

PATTERN GLASS

Pattern- and Wired Glass Annealing Lehr



**made
in
Germany**

technologies. Therefore Pennekamp is the lehr manufacturer to still use the quality term: “Made in Germany”.

Outlook

A German expression says:

“It is easier to become the leading manufacturer, than to remain the No. 1 for a long time“.

That this expression is correct has proven itself many times. The company has demonstrated that it is possible to remain the leading manufacturer by increasing the know-how, innovation and maintaining high quality standards while all employees are focused on the customer’s satisfaction. Any completion of a development is the beginning of the next one. It is necessary to develop new technologies and innovations in close cooperation with our customers. Those efforts are also directly linked to the quality and performance improvements of our products.

Scope of Products

“Lehrs and More“

Pennekamp is a supplier of complete solutions and manufactures equipment for thermal processes (lehrs) as well as machinery from other product areas within the glass industry:

- | | |
|---|---|
| <p>Annealing:</p> <ul style="list-style-type: none"> - Container Glass & Table Ware - Pattern & Solar Glass - Float & Display Glass | <p>Automation:</p> <ul style="list-style-type: none"> Container Glass & Table Ware & Glass Decoration - Ware Transfers - Lehr stackers - Cross Conveyors |
| <p>Decoration:</p> <ul style="list-style-type: none"> - Container Glass & Table Ware | <p>Glass Coating:</p> <ul style="list-style-type: none"> Container Glass - Cold End Sprays (Top & Under Belt) - Material Dosing Units |
| <p>Bending & Toughening:</p> <ul style="list-style-type: none"> - Automotive Glass - Specialty Glass | |

**Tradition, Innovation, Future.
Discover our strength.**

History

The company Pennekamp was founded in 1945 and dedicated to the glass industry, specializing in annealing (heat treatment) and handling of glass products. The young company developed its products in the area of annealing flat and formed glass as well as for glass decoration. Over the years, new products and machinery required in the industry had to be developed, addressing the speed and performance increases in manufacturing. A constant growth and sustainable developments were required to always meet such market demands.

Today

It hasn’t stopped since. Today demands may be different. Looking at lehrs, innovations related to productivity, efficiency, performance and energy recovery are required. For the automation and handling, “smoothness”, reliability and overall performance are the key factors for success. Pennekamp therefore built a complete new facility in Ennepetal, specially designed to suit the manufacture of lehrs, automation and machinery. With moving into the new facility in 2003, the company managed to control the cost structure and optimize the manufacturing by using latest fabrication





Pattern- and Wired Glass Annealing Lehr

The pattern and wired glass annealing lehr is one of the important equipment within the glass manufacturing line to remove the strain. The energetic performance of such lehr is most essential for the cost effectiveness and success of the final product.

Today, special attention is directed towards energy consumption.

Pennekamp has addressed this issue and operates an internal heat recovery system, called "draft system". It balances heating (annealing) and cooling area of the lehr.

A centralized air cooling damper and air exhaust system monitors and maintains such balance for energy usage reduction, whereas the components are equipped with communication links among each other.

The pattern solar glass annealing lehrs are designed in modules (zones), all at a length of 2,25m each, in order to suit the standard truck or container loading.

The lehr structure consists of the following main components:

Outer casing (tunnel zone housing)

The outer casing is manufactured from mild steels and provides the strength to support the internal components as well as the lehr accessories. The side walls may be from mild steel as well and in this case primer and paint coated to the buyers choice. Additional, secondary side walls from polished stainless steel plates are supplied to prevent interference with factory air. The roofs are generally pre-bend in order to compensate the weight and thermal load from operation.

Inner hood

The inner hoods of the heated zones are generally manufactured from stainless steel, whereas the material thickness varies in relation to the use. Material thickness is in the range of 2 to 4mm. Additional anchors supports from the inner hoods roof towards the outer casing increase strength and durability. Zones A to C designed with support structure for heating and semi cooling.

Lehr Roller

The lehr rollers are preferably from fused silica ceramic, in order to meet highest product quality demands. With its advantages towards stainless steel rollers, such as mechanical strength, lower bending, improved hardness and almost zero heat conductivity make it the best choice.

Roller Driving

The roller driving is arranged in groups in order to compensate the glass shrinkage in the annealing and cooling



process. This minimizes the effect of relative glass movements on the rollers. Its unique design and safety function allow a trouble free operation over life time. The individual drive configuration with its chain links allows lowering and/or replacement of individual rollers.

Roller support system

The rollers are generally supported with CNC machined beams, directly attached to the zone housing, each at a length of 2,25m. Adjustable in lateral and horizontal direction they are fixed after installation. Repeatable positioning is no issue any more.

Thermal insulation

The thermal insulation is one of the components that require to last long, very long. According to the temperatures involved ceramic fibers & mineral wool are used in a thickness of 300mm. This ensures minimal thermal losses and side wall temperatures of ~20 to 25°C above ambient.

Heating systems

Gas heating systems are designed to minimize energy consumption. According to needs on/off mode or proportional burners are installed. All burner systems have the availability to heat/cool for highest temperature control in into + and - range (higher accuracy) All internal components such as burner



tubes, etc. in high heat resistant stainless steel. Electric heaters are designed at various outputs, according to requirements. Units are made from stainless steel and installed from top. Control is executed by thyristor and special temperature controllers, optionally PLC.



Air circulation

The air circulation fans are designed with a direct (extended) shaft and directly attached stainless steel fan wheels. Those units more or less maintenance free, with a single lubrication cycle a year. Specially designed double fan wheels in cooling zones for air admission and mixing.

Fast cooling Zones

The fast cooling zones are specially designed to provide the cooling of the glass ribbon according to needs. Banks of three or four individual fan assemblies provide the mass cooling air, whereas the outer ones also maintain certain under ribbon cooling.

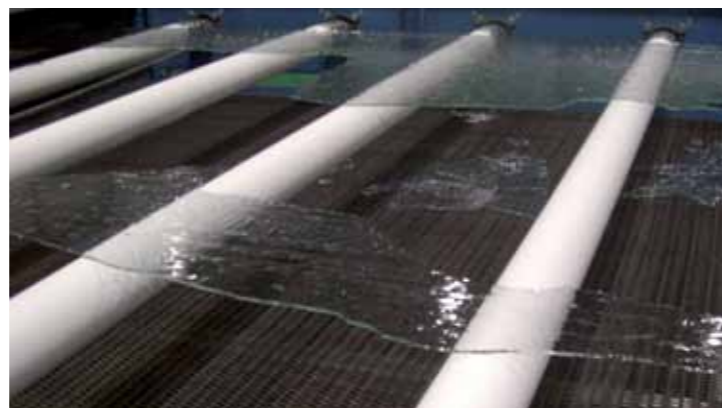
Accessories

As accessories parts and components such as automated air inlet and exhaust dampers must be mentioned. Designs are based on energy recovery and usage reduction. Additional installed IR spot and scanning pyrometers are required for precise monitoring & control.



Optional Cullet Belt

The cullet belt throughout the lehr is one of the high lights. Within the frames of the discharge tables an additional cullet belt drive is installed. Another integral part is under such circumstance the automated cullet belt tensioning zone with its weight roller(s), distributing an even load onto the cullet belt, to compensate thermal expansion. The cullet belt drive is equipped with the main drive gear/motor assembly providing the torque to the rubberized drive roller. Easy belt tracking adjustment is performed with the drive unit itself.



Control System

The main controls, consisting of power supply/distribution panel and control panel are scope of the Pennekamp concept. According to customer's demands and requests, the controls are equipped with a PLC System and the communication link to the plant process control for the easy operation of the lehrs.



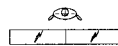
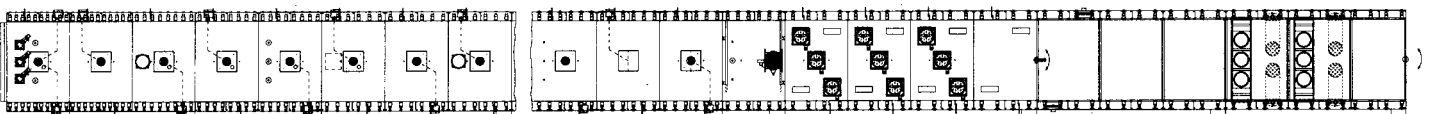
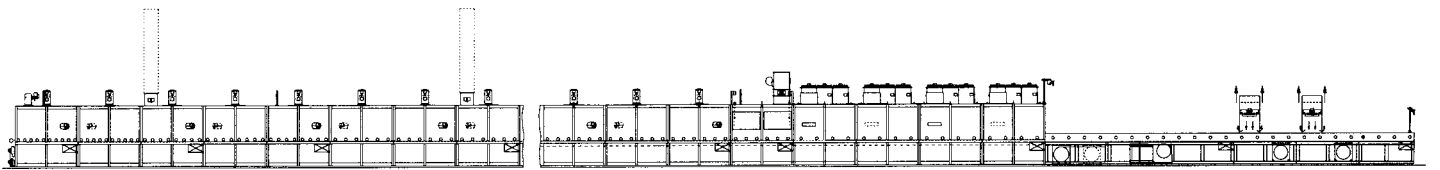
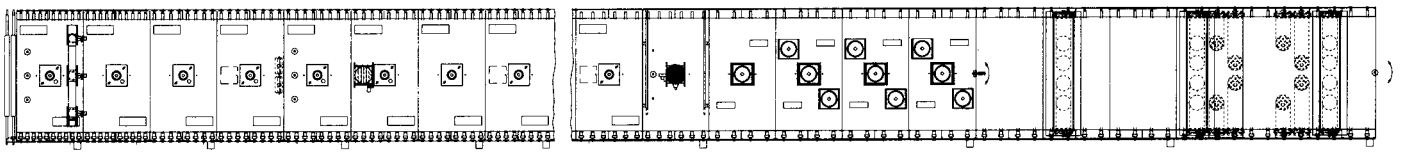
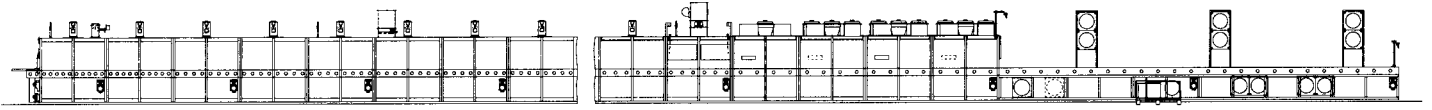
Open discharge & post cooling

This area is manufactured from mild steel, whereas the driving and supports are the same as on the tunnel zones. The discharge table may also accommodate additional equipments such as the cooling fan banks from above and below the glass ribbon. A modern design by inverter driven mass cooling by side arranged blower fan assemblies is used therefore.

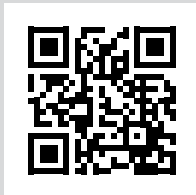


Features

- Glass ribbon width of up to 2,5m (8')
- All tunnels zones with inner linings manufactured from heat & chemical resistant stainless steel incl. inner hoods, fan wheels and burner tubes/heating elements
- Optional, cooling zones manufactured from stainless steels, incl. inner hoods, belt supports and fan wheels
- Gas or electrical heating
- Electrical heating system operated by thyristor controls
- Gas burner heat/cool function and system with all required safety devices
- Air circulating fan with direct shaft (maintenance free)
- Special design of down flow cooling fans in cooling zones to mix the internal air with cooling air
- Use of ceramic rollers for glass transport and scratch minimization
- Individual group drives, chain link
- Drive configuration by inverters, to compensate thermal glass shrinkage on ribbon
- Additional backup inverters for operational roller drive safety
- Roller support arranged by zones, for easier alignment and higher accuracy
- Fully insulated lehr (all tunnel zones) with approx. 300mm (14") ceramic fiber & mineral wool
- Fully automatic air inlet damper systems for automated temperature curve control
- Control of lehr exit temperatures, required for optimal cutting results
- Individual inverter controlled cooling banks (decentralized) in F zones
- Optional automatic internal cullet removal system (patent pending)
- Automatic process control for the control and monitoring of temperatures by PLC and backup system
- Optional communication processor (Ethernet or others) for link to plant process control
- Electronic control of the internal air movements (draft system) to minimization energy consumption
- Full scope supply incl. control & field wiring



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