



— Pattern- and Solar Glass Annealing Lehr



# pennekamp



## 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 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.

## „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:

### Annealing:

- Container Glass & Table Ware
- Pattern & Solar Glass
- Float & Display Glass

### Decoration:

- Container Glass & Table Ware

### Bending & Toughening:

- Automotive Glass
- Specialty Glass

### Automation:

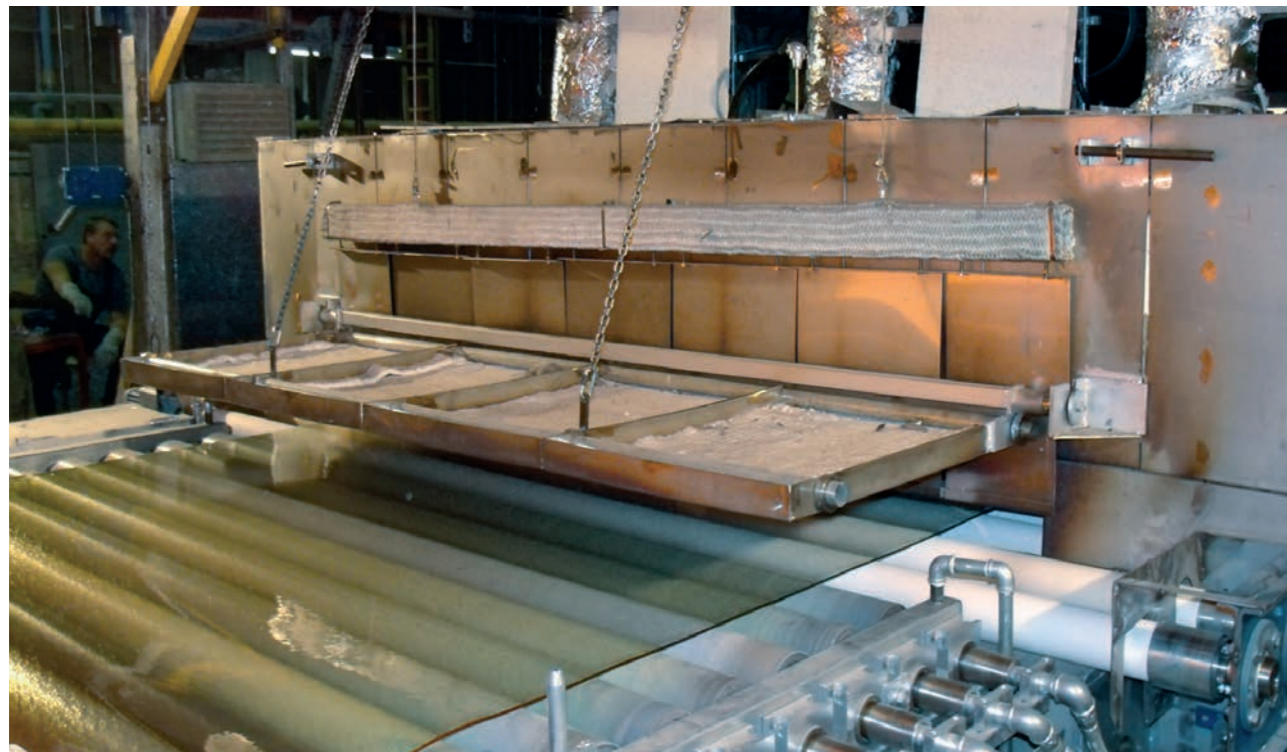
- Container Glass & Table Ware & Glass Decoration
- Ware Transfers
- Lehr stackers
- Cross Conveyors

### Glass Coating:

- Container Glass
- Cold End Sprays (Top & Under Belt)
- Material Dosing Units



# Annealing Lehr



## Pattern- and Solar Glass Annealing Lehr

The pattern & solar glass annealing Lehr is one of the important equipment within the glass manufacturing line to anneal (strain minimization) of the glass. 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 buyer's choice. Additional, secondary side walls from polished stainless steel plates are supplied to prevent interference with factory air. The roofs are mechanically 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 hood's roof towards the outer casing increase strength and durability. Zones A to C designed with support structure for heaters and semi indirect cooler banks.

### 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.

### Thermal insulation

The thermal insulation is one of the components that require to last very long. According to the temperatures involved ceramic fibers & mineral wool are used in a thickness of 350mm. This ensures minimal thermal losses and side wall temperatures of ~20 to 25°C above ambient.

### Heating systems

Electric radiation heaters are designed at various outputs, according to requirements. Units are made from stainless steel and installed from either side above and below the glass ribbon. The six loop control is executed by thyristor via the PLC software.

### Roller Driving

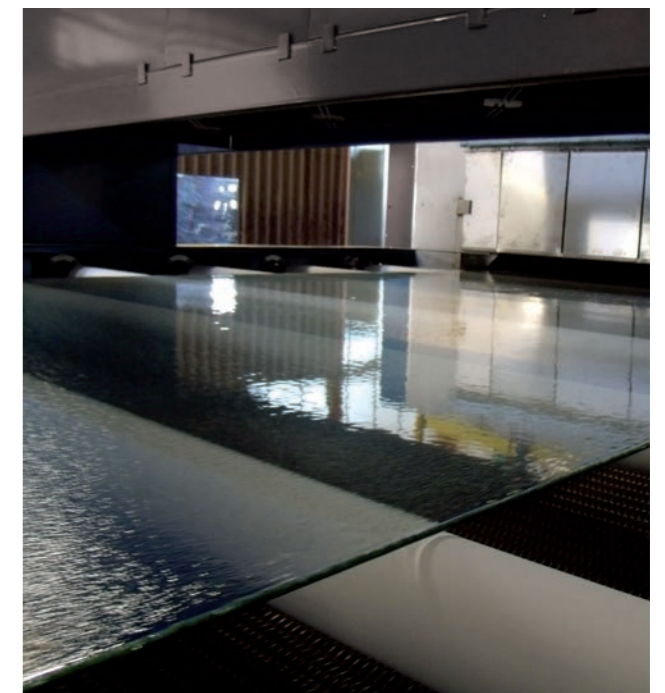
The roller driving is arranged in groups in order to compensate the glass shrinkage in the annealing and cooling process. This minimizes the effect of relative glass movements on the rollers. Its unique design and safety function allow a trouble free operation over life time. The individual drive configuration (one drive per roller) further allows lowering and/or replacement of individual rollers.

### Roller support system

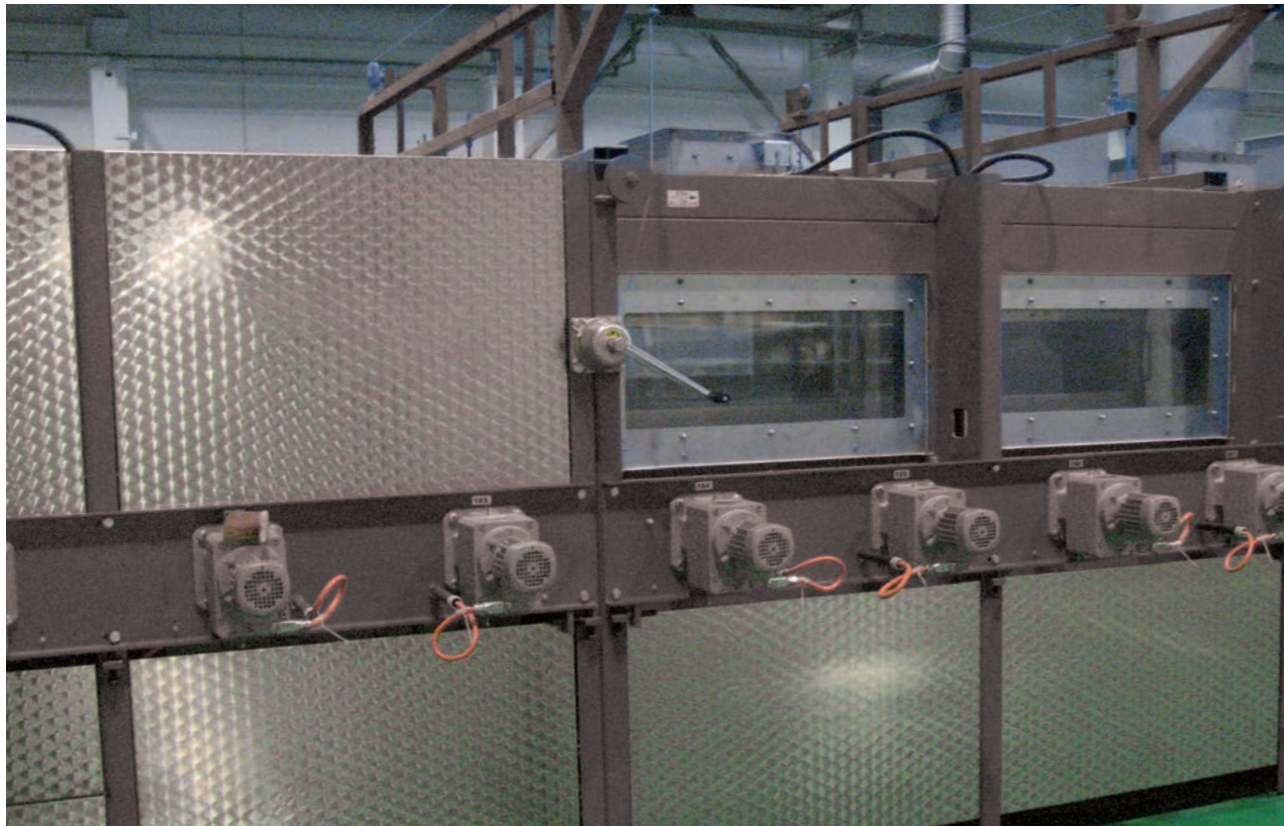
The rollers are generally supported with CNC machined beams, directly attached to the zone housing, each at a length of 2,25m. Adjustable in lateral and horizontal direction they are fixed after installation. Repeatable positioning is no issue any more.

### Indirect & semi indirect Cooling system

Unique banks of indirect & semi-indirect cooler assemblies, variable in positioning are installed for zone A to C. four to six loop control arranged over glass ribbon width monitored and controlled by the PLC.







#### 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 thermocouples, IR spot and scanning pyrometers are required for precise monitoring & control.

#### RET Zones

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



#### Discharge und F Zone 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 (A,B and C) with inner linings manufactured from heat & chemical resistant stainless steel
- Electric radiation heating
- Electrical heating system operated by thyristor controls
- Six heating control loops across glass ribbon width
- Heating elements and semi indirect cooler units manufactured from high temperature resistant stainless steels
- Indirect & semi indirect cooler inserts in annealing zones (A to C)
- Six cooling control loops across glass ribbon width
- Special design of down flow cooling fans in cooling zones (RET) to mix the internal air with cooling air
- Modular zones with side wall inserts, for flexible installation of heating and indirect/semi-indirect cooling units
- Special design for over & under ribbon heaters
- Double lateral wall system with stainless steel surface
- Use of ceramic rollers for glass transport for scratch minimization
- Individual drives, one unit per roller (no open sprockets/oil pans)
- Drive configuration by inverters, to compensate thermal glass shrinkage of 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. 350mm (14") ceramic fiber & mineral wool
- Fully automatic air inlet damper systems for 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) for RET and F zones
- 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 (drift system) to minimization energy consumption
- Optimal temperature distribution across lehr width
- Full scope supply incl. control & field wiring

#### 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.

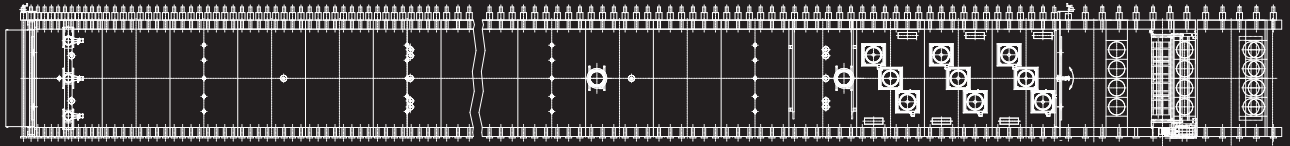
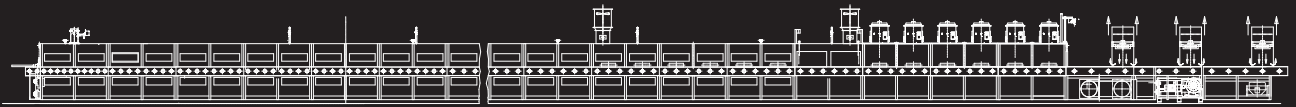
Another integral part is under such circumstance the automated cullet belt tensioning zone with its weight roller(s), distributing an even load onto the cullet belt, to compensate thermal expansion.

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.



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