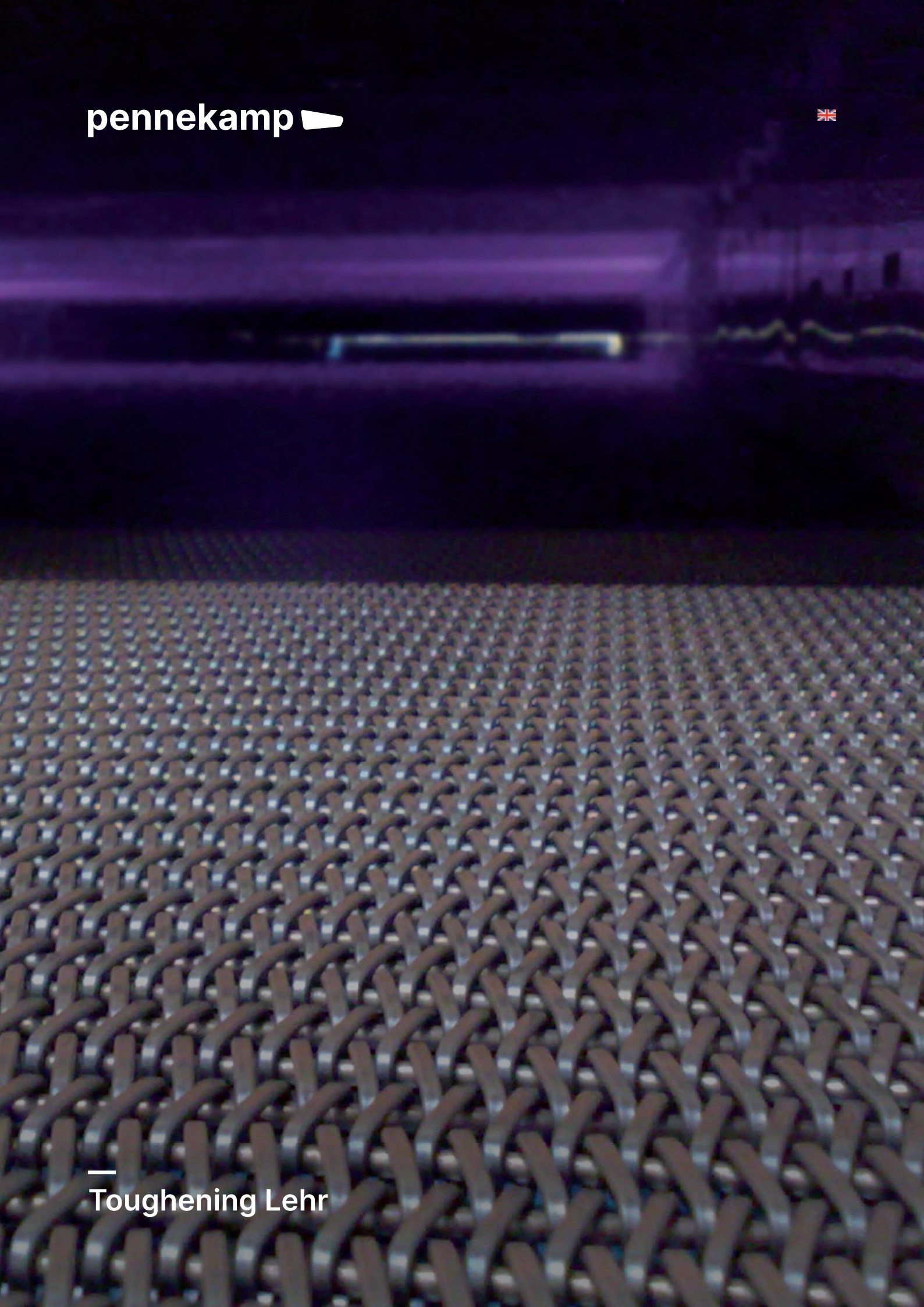


—
Toughening Lehr

pennekamp

Tradition, Innovation, Future. Discover our strength.

made in Germany

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

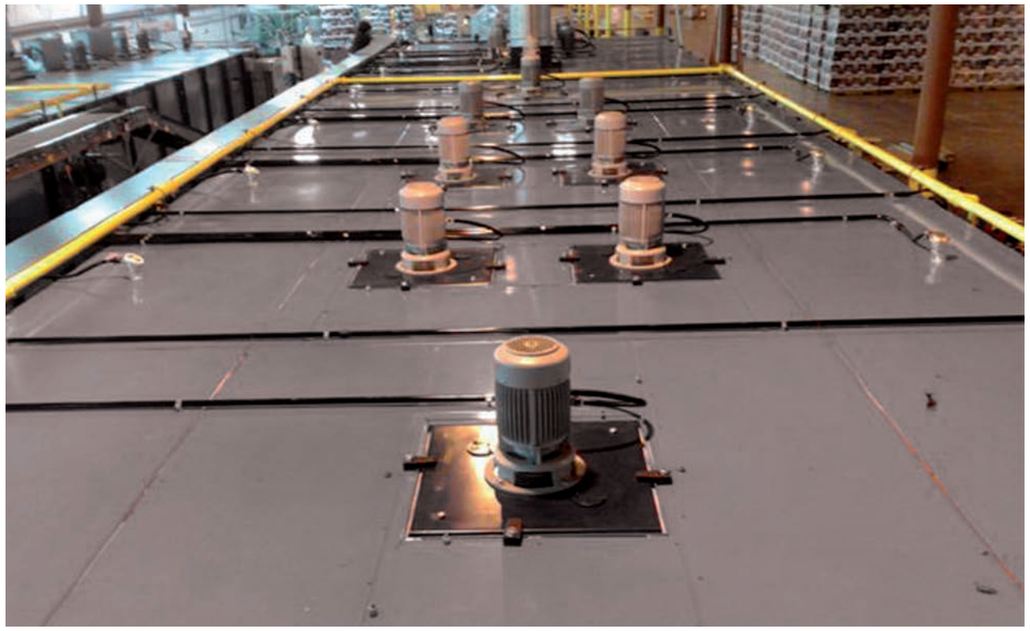
Decoration:
- Container Glass & Table Ware

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

Toughening Lehr



Toughening Lehr

The toughening lehr is one of the important equipment within the glass manufacturing line and is used to create specific tensions within in the glass. According to shapes and glass thickness various toughening results are achievable. The energetic performance of such lehr is most essential for the cost effectiveness and success of the final product, as cold ware enters and has to be heated up.

Today, special attention is directed towards energy consumption. Pennekamp has addressed this issue and ope- rates an internal heat recovery system, called “draft system”. It balances the heating area of the lehr for an energy reduction. The components are equipped with communication links among each other. The toughening 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. Or they are made from polished stainless steel plates in order to demonstrate cleanness and efficiency. The roofs are mechanically pre-bent in order to compensate the weight during operation.

Inner hood (air circulation chamber)
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 anchor supports from the inner hood’s roof towards the outer casing increase strength and durability.

Lehr belt support (standalone unit)
The lehr belt support is a standalone unit, manufactured from stainless steel and allows the free thermal expansion in long and cross direction. Its supports (five cross bars) along the width of the zone, are designed to carry the load (weight and thermal) for lifetime. Those beams are in addition pre-bent to compensate the weight and thermal load according to the zone they are installed in. The stainless steel wear strips attached to it, are the ones in contact to the lehr mesh belt and therefore designed thicker. They are in general 8mm thick and allow life times of up to two furnace campaigns.

Thermal insulation
The thermal insulation is one of the components that require to last very long. According to the temperatures involved mineral wools or a combination of ceramic fiber/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.

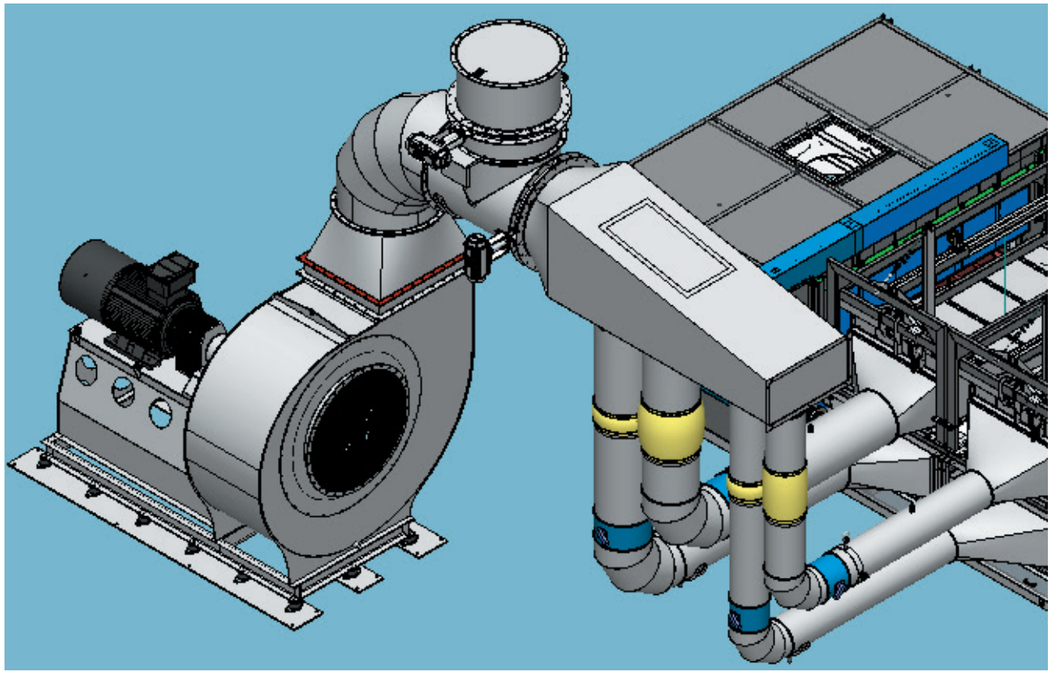
Heating systems
The gas heating systems are designed to minimize energy consumption. According to needs, on/off mode or proportional burners are installed. All burner systems have the availability to heat/cool for highest temperature control into + and – range (higher accuracy) All internal components such as burner tubes, etc. are in high heat resistant stainless steel.

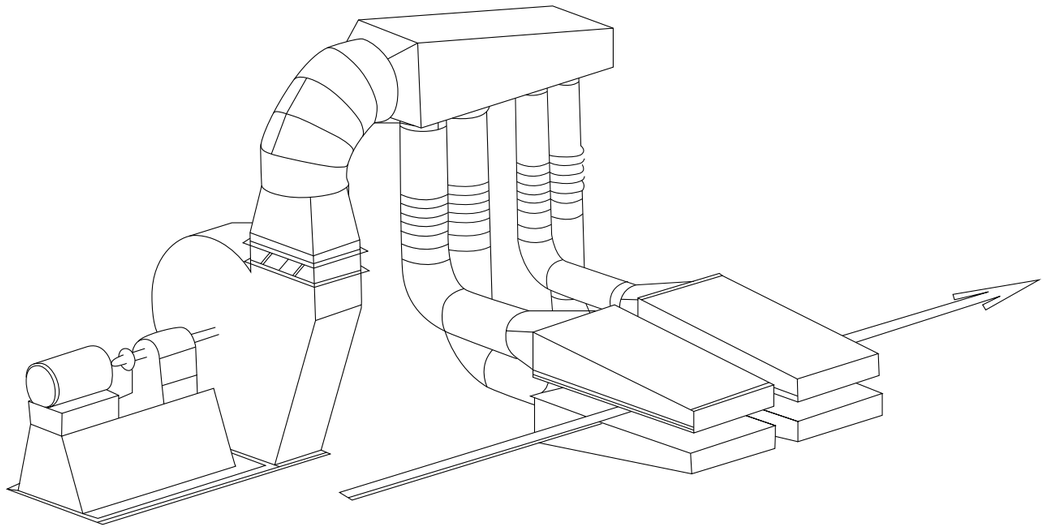
Electric heaters are designed at various outputs, according to requirements. Units are made from stainless steel and installed from top. Control is executed by thyristor and special temperature controllers or the optional PLC.

Fume extraction system
The fume extraction is an area of specific need but at the same time critical to energy consumption. A specially designed extraction system allows the removal of such fumes and solvents with minimizing heat energy losses.

Accessories and chiller bank(s)
As accessories parts and components such as automated air inlet and exhaust dampers must be mentioned. Design is based on energy recovery and energy usage reduction. The toughening unit consists of the fan blower, the air flow control dampers and the actual chiller boxes. The boxes are arranged above and below the lehr mesh belt and are designed to provide the cooling air for the toughening process (increase of heat shock resistance).

The upper unit may be a djusted according to the ware dimensions in height by a manual lifter system.





Open discharge table and belt drive

This area is usually manufactured from mild steel, whereas the wear strips may be from stainless steel, according to buyer's needs and requirements. The discharge table may also accommodate additional equipments such as post cooling fan banks, belt brushes or others. One of the integral parts is the automated belt tensioning zone with its weight roller(s) distributing an even load onto the lehr belt, to compensate thermal stretch. The lehr belt drive is equipped with the main drive gear/motor assembly and a single chain providing the torque to the rubberized drive roller. Easy belt tracking adjustment is performed with the drive unit itself.

Classical Controller or PLC System

The main controls, consisting of power supply/ distribution panel and control panel are scope of the Pennekamp concept. According to customers demands and requests, the controls are equipped with individual controllers and/or PLC systems for the easy operation of the lehrs.

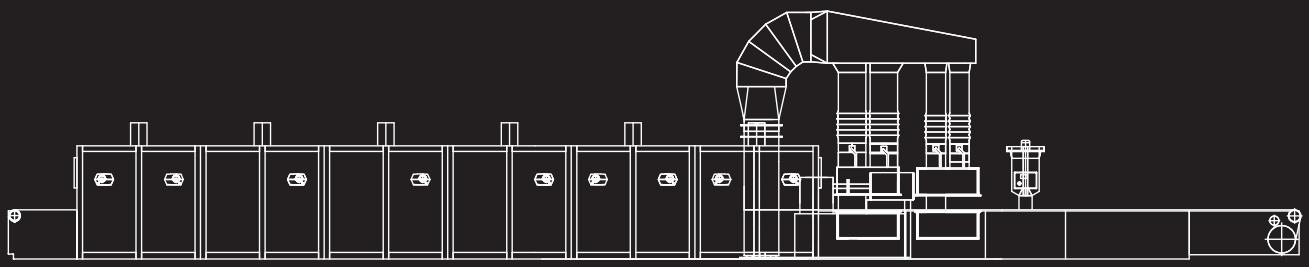
Features

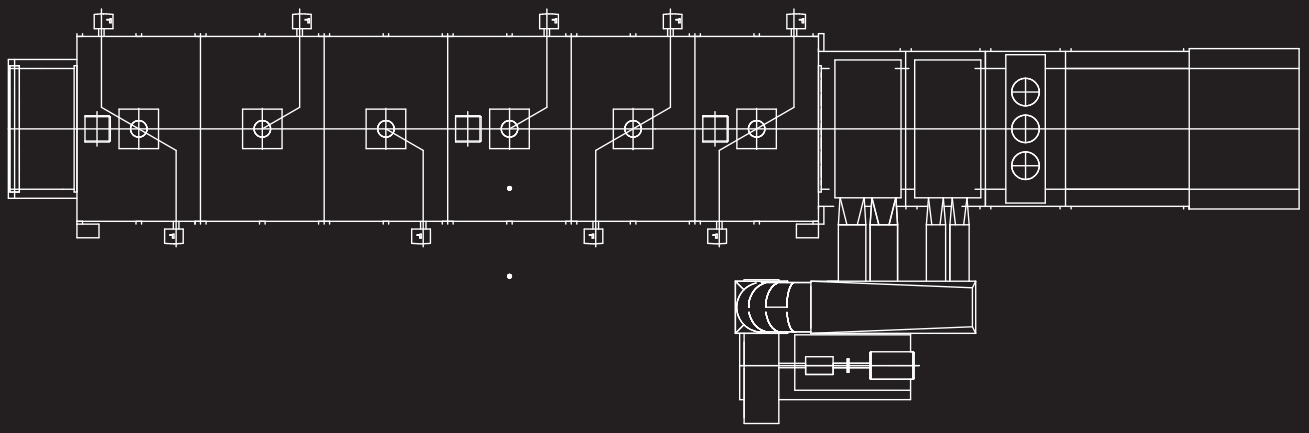
- Belt width of up to 3,6m (12')
- Gas or electrical heating
- Electrical heating system operated by thyristor controls
- Gas burner heat/cool function & system with all required safety devices
- Heated zones manufactured from stainless steels, incl. inner hoods, belt supports, fan wheels and burner tubes/heating elements
- Front door manufactured from stainless steel
- Fume exhaust system on entry zone
- Fully insulated lehr (all tunnel zones) with approx. 300mm (12") mineral wool or combination of ceramic fiber/mineral wool
- Air circulating fan with direct shaft (maintenance free)
- Fully automatic air inlet damper systems for temperature curve control (maintaining of set temperature curve)
- Chiller assembly and required fan blowers
- Automated belt tensioning system by weight rollers
- Easy belt tracking system by drive unit
- Centralized belt drive motor gear assembly with single chain
- Automatic process control for the control and monitoring of temperatures, by individual temperature controllers per zone or optional PLC and backup system
- According to belt width, first zone(s) with individual right/ left control
- In case of PLC, optional communication processor (Ethernet or others) for link to plant process control
- Electronic control of the internal air movements (drift system) to minimize energy consumption
- Optimal temperature distribution across lehr width
- Optional cooling system on discharge table
- Communication link to lehr loading system
- Belt return on inside of lehr with cleaning function
- Optional stainless steel belts for cleanness & life time
- Optional belt brush or belt surface polish device

Options

- Cross Conveyors
- Stackers
- Lehr Belt Brushes

v Blast Cooling Fan Units





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