BILLETCOOLER FLEX® — advantages and benefits

Stable spray angle

The **Billetcooler FLEX®** is characterized by its constant spray angle over the entire turn-down range.

➡ **No strand overcooling or undercooling**

Flexible cooling

With **Billetcooler FLEX®**, the water distribution can be individually adjusted for different formats.

➡ **Optimum cooling guaranteed at all times**

Large free cross-sections

Clog-resistant and maintenance-friendly, thanks to very large free cross-sections for air and water.

➡ **High operating reliability**

New design

All nozzle variants of the **Billetcooler FLEX®** have a forged, space- and weight-saving nozzle body.

➡ **Maintenance-friendly design**

Lower air consumption

Thanks to the new nozzle design, the **Billetcooler FLEX®** requires less compressed air than basic air mist nozzle designs and therefore helps to improve the energy efficiency of the overall installation.

➡ **Reduces operating costs**

Low noise emissions

Compared with conventional nozzles for secondary cooling, the **Billetcooler FLEX®** reduces noise emissions by up to 15 dB.

➡ **Improved work safety**

Billetcooler Oval Spray

BilletCooler air mist nozzles

With this type of nozzle, it is possible to utilize air mist cooling in billet and bloom casters very effectively. The compact block design allows mounting either on horizontal spray rings as well as on vertical nozzle headers. A turn down ratio as wide as 1 : 10 is standard at water pressures between 7.3 and 102 psi at 29 psi constant air pressure, provides a wide range of cooling intensities.
The oval cone spray footprint provides the option to cool a larger area of the strand with one nozzle spray only, which increases the cooling efficiency. Various angles for spray width and spray depth are available to compensate for different spray heights, which meet the requirements of the individual machine types. Large free passages compared to hydraulic and competitor air-mist nozzles result in reducing nozzle clogging. Billetcooler oval cone nozzles cover a flow rate range from .11 to 3.28 gpm.

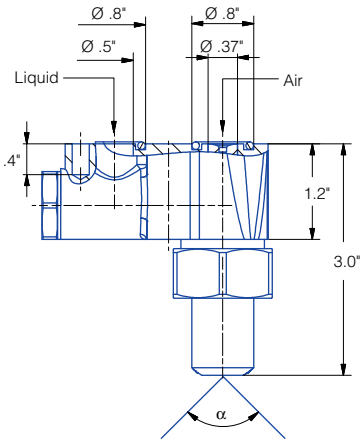
The benefits

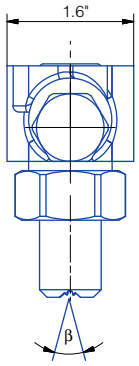
- High turn-down ratio (min./ max. flow rate) 10:1 (max. 14:1) for high flexibility and extended product (steel grade) mix, reduces the number of different nozzle types in the machine
- Compressed air consumption reduced by appr. 40% for lowering operation costs

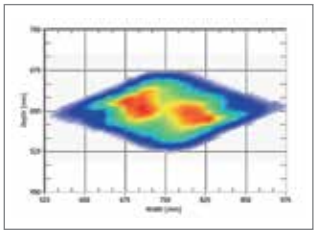
Nozzle type	Max. water flow rate	Operating water pressure	Max. air flow rate	Operating air pressure	Spray angle
Billetcooler oval	3.54 gpm	7.3 – 102 psi	7 SCFM	14.5 – 58 psi	60/90° (wide) 30/45° (deep)

Benchmark data only, individual nozzle data to be specified

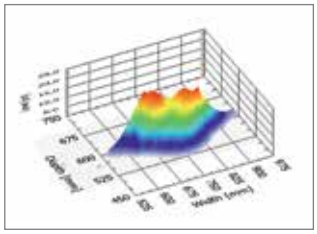
- High Heat Transfer Coefficient (HTC) for high casting speeds
- Compact design ideal for spray rings and vertical headers
- Plate connection for easy and maintenance friendly mounting
- Large free passages prevent clogging for high operation safety with improved plant availability
- Successfully installed in most long product air-mist cooling systems worldwide
- Reduced maintenance costs

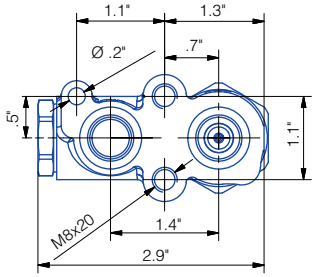


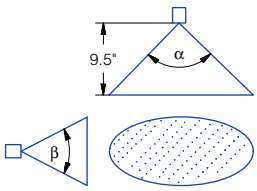




Liquid distribution Billetcooler Oval







Billetcooler Cone Spray

BilletCooler air mist nozzles

With this type of nozzle it is possible to utilize air mist cooling in **billet** and **bloom** casters for **rounds** very effectively. The compact block design allows mounting either on horizontal spray rings as well as on vertical nozzle headers. A turn down ratio as wide as 1 : 10 is standard at water pressures between 7.3 and 102 psi at 29 psi constant air pressure provides a wide range of cooling intensities.

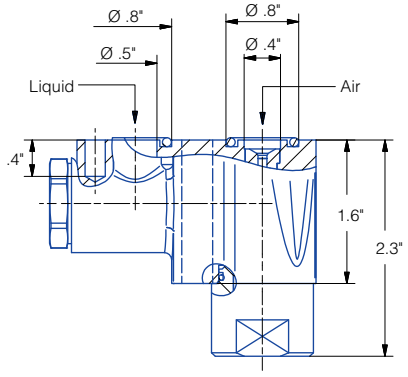
The cone spray footprint distributes the liquid closer towards the edges; avoiding overcooling of the area beneath the nozzle position. The characteristic is often utilized with round product casters. Various angles are available to compensate for different spray heights, and meet the requirements of the individual machine types. Large free passages compared to hydraulic and competitor air-mist nozzles result in reducing nozzle clogging tendency. Billetcooler cone spray nozzles cover a flow rate range from .11 to 2.1 gpm.

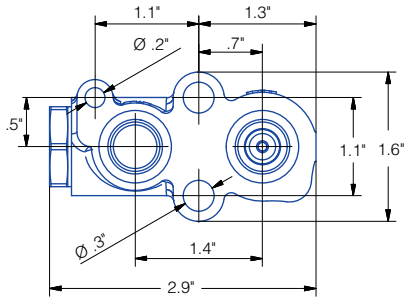
Nozzle type	Max. water flow rate	Operating water pressure	Max. air flow rate	Operating air pressure	Spray angle
Billetcooler cone spray	2.1 gpm	7.3 –102 psi	5 SCFM	14.5 – 58 psi	45°/60°/90°

Benchmark data only, individual nozzle data to be specified

The benefits

- High turn-down ratio (min./max. flow rate) 10:1 (max. 14:1) for high flexibility and extended product (steel grade) mix, reduces the number of different nozzle types in the machine
- Compressed air consumption reduced by appr. 40% for lowering operation costs
- High Heat Transfer Coefficient (HTC) for high casting speeds
- Compact design ideal for spray rings and vertical headers
- Plate connection for easy and maintenance friendly mounting
- Large free passages prevent clogging for high operation safety with improved plant availability
- Successfully installed in most long product air-mist cooling systems worldwide
- Reduced maintenance costs





Billetcooler Special Flat Gasket and Filter Inserts

Special Flat Gasket

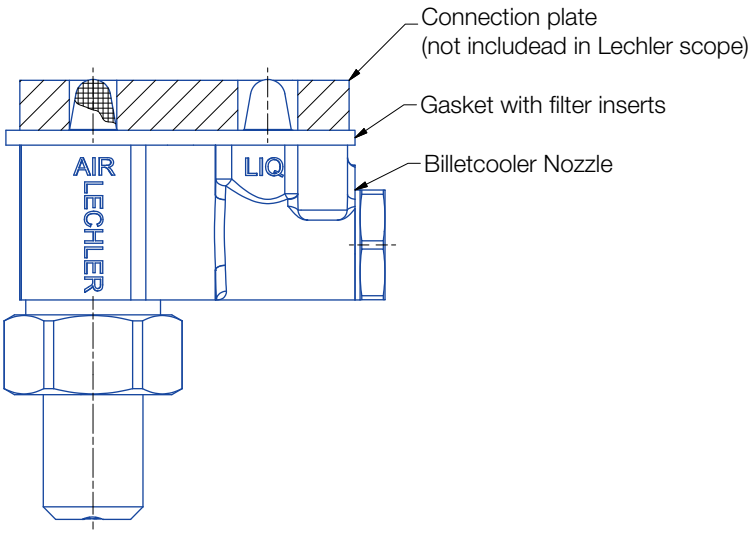
The entire air mist nozzles for secondary cooling in billet and bloom casters can be exposed to high temperatures, unlike slab casters, because of the close mounting proximity to the strand.
A special gasket should be used in combination with the Billetcooler nozzles if longer periods without any secondary cooling spray water do not occur. In this case, the high temperature resistant special flat gasket replaces the standard Viton O-Rings.

Filter inserts for water and compressed air

The identical filter inserts have been designed for the use in combination with the special flat gasket only. The filters protect the Billetcooler inside and the nozzle tip from clogging. Solid particles being carried into the nozzle, by either polluted cooling water or compressed air, will be kept away. Nevertheless, a sufficient filtration of both fluids is still essential for a trouble free cooling operation with good product quality.

Item	Ordering no.	Material	Mesh size
Gasket only	1PM.021.L1.20.09.0	Novaphit SSTC	–
Gasket with 2 filter inserts	1PM.021.L1.20.80.0	Novaphit SSTC/304 L	–
Filter only	095.016.1D.15.46.0	304 L	280 Micron (55 Mesh)

Gasket and filters suitable for all standard Billetcooler nozzle types



MASTERCOOLER SMART

The air mist nozzle for every slab caster

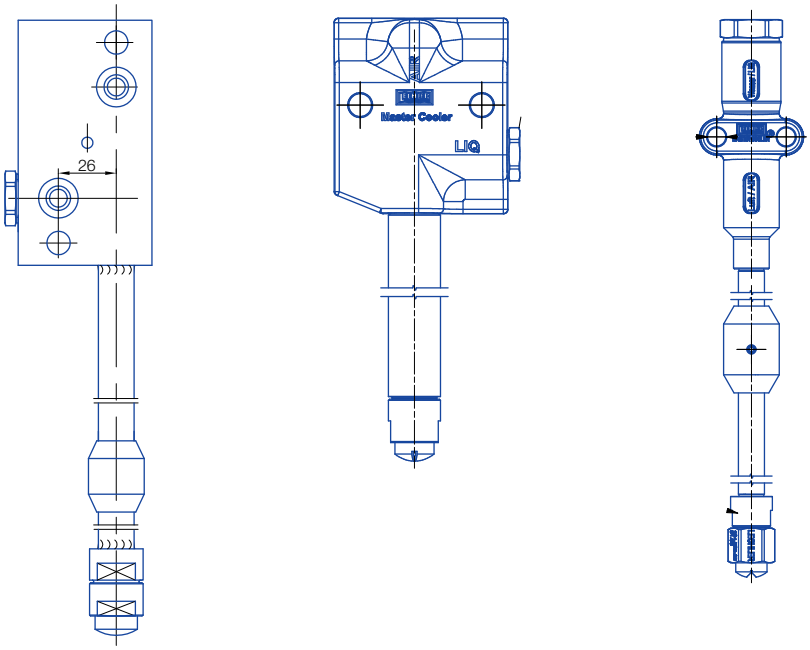
The Mastercooler SMART is the state of the art flat fan air mist nozzle type; combining high cooling efficiency with high flexibility in terms of water turn down ratio, spray angle, nozzle arrangement and connection methods. Mastercooler SMART nozzles cover a flow rate range from .08 to 18.5 gpm.
They are equipped with a plate that is bolted vertically onto adaptor plates. Small diameter fluid feed pipes are no longer necessary. All nozzles are mounted outside of the framework at the rear side of the segment, with only the nozzle pipe carrying the spray tip reaching down to the spray position. A very rigid header pipe and a nozzle self alignment is the result.

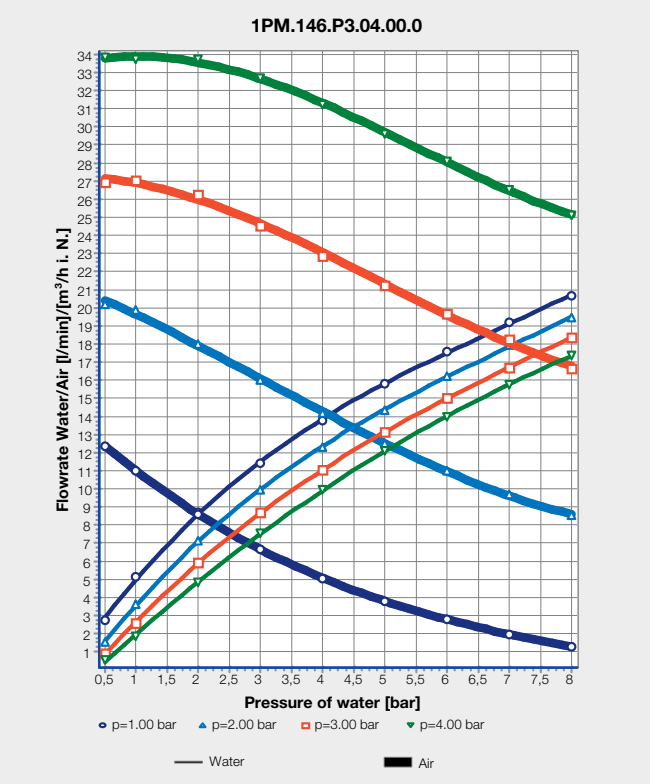
Mastercooler SMART technology is available for all slab casting machine types as the design can be adapted to match the individual requirements in terms of nozzle geometry and connection design. Nozzle parameters, such as water and air flow rates, spray angle, extension pipe length and connection plate details are customized to the requirements of each individual project.

The nozzles are fine tuned to match the spray height and nozzle pitch in each segment to provide an even liquid distribution for the whole slab width in all nozzle operating conditions. Multi nozzle measurements in the Lechler laboratories ensure the highest quality for each individually designed Mastercooler SMART nozzle type.

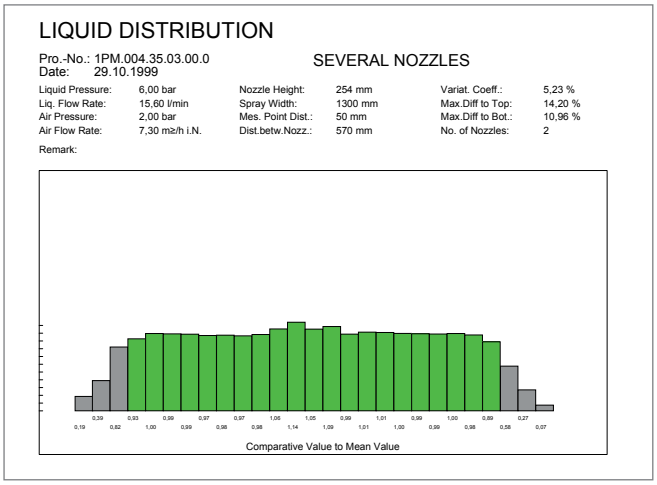
Nozzle type	Max. water flow rate	Operating water pressure	Max. air flow rates	Operating air pressure	Spray angle
Mastercooler SMART	18.5 gpm	7.3 – 145 psi	41 SCFM	14.5 – 58 psi	30 – 130°

Benchmark data only, individual nozzle data to be specified

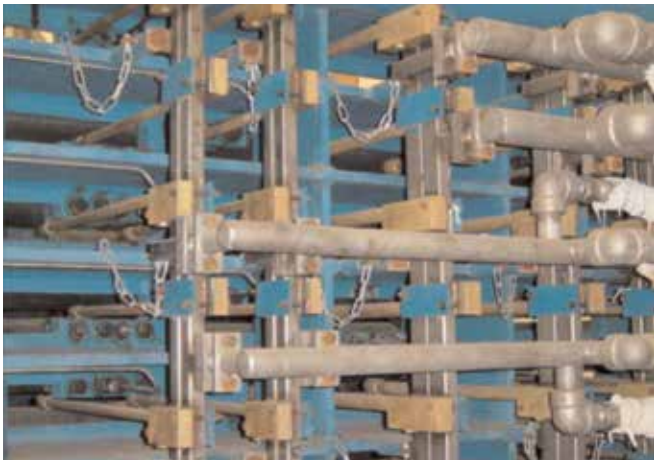




Typical Mastercooler SMART pressure-flow diagram



Typical twin nozzle arrangement liquid distribution measurement documentation



Slab caster segment with Mastercooler SMART nozzles

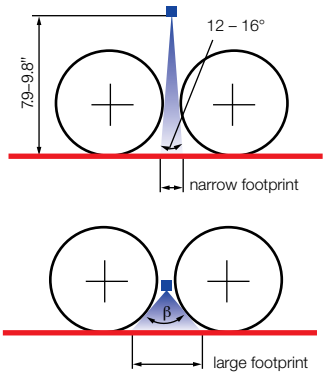
Horizontal segments with Mastercooler SMART nozzles

MASTERCOOLER HARD HARD COOLING®

Hard Hard® Cooling

The ability to cast low carbon steels at ever increasing casting speeds, while still being able to cast the more critical steel grades, requires a wider control and performance of the secondary cooling as well as flexibility in nozzle turndown. Maintaining slab bulging at increased casting speeds requires both reduced roll pitches and increased secondary cooling intensities. The result can lead to unacceptable temperature fluctuation on the slab surface with standard secondary cooling design. Mastercooler HHC nozzles cover a flow rate range from .48 to 18.5 gpm.

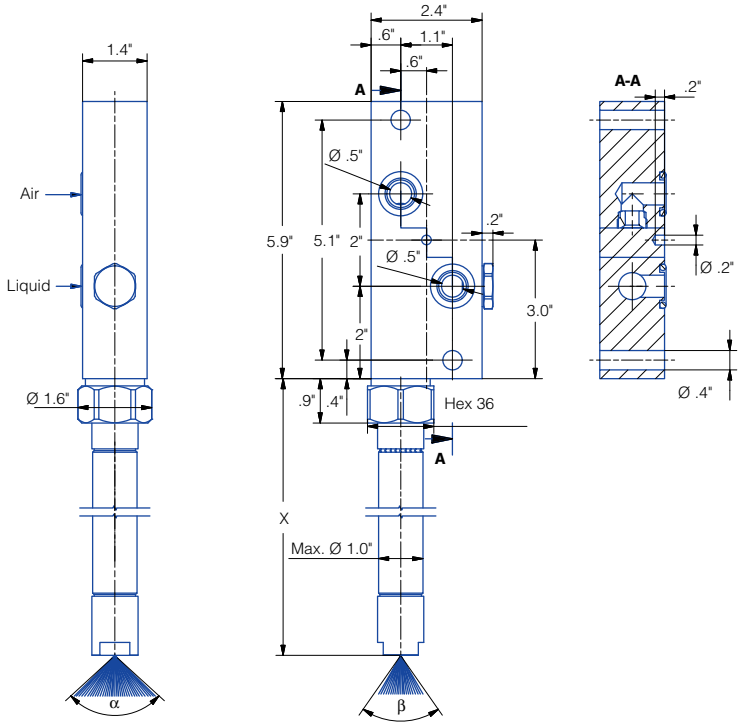
One technology which provides a solution for problems is “Hard-Hard” cooling, which is the ability to apply large amounts of spray water to the slab surface in the upper cooling zones, which reduces the slab surface to below 1292°F while maintaining acceptable surface temperature fluctuations. This practice requires a special nozzle design and arrangement in the top zone of a slab caster.



Spray footprint for conventional air mist nozzle (top) and HHC nozzle (lower)

Nozzle type	Max. water flow rate	Operating water pressure	Air flow rates	Operating air Pressure	Spray angle
Mastercooler HHC	13 gpm	7.3 – 145 psi	0 – 26 SCFM	14.5 – 58 psi	90-125° wide 20-75° deep

Benchmark data only, individual nozzle data to be specified



Mastercooler Hard Hard Cooling® nozzle, SMART® mounting method and slim tip design

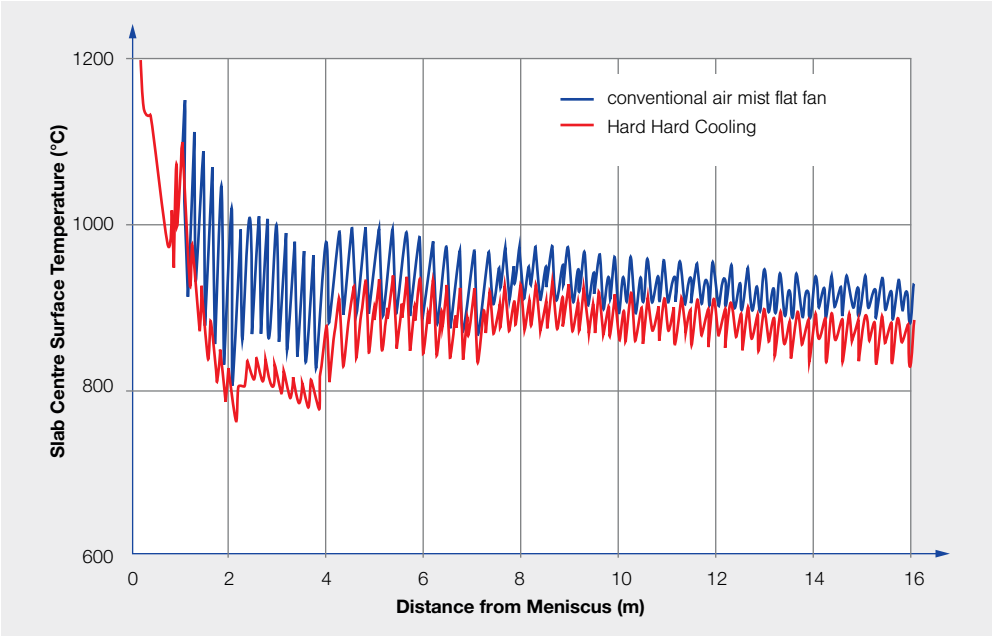
The minor spray angle of conventional nozzles, also referred to as the spray thickness angle, range between 12° and 16° for typical major spray angles of 60° to 120° (wide axis). With spray heights of 6.3" to 11.8" in the upper cooling zones, the slab surface between roll contact and spray water remains uncooled and high temperature fluctuations within the roll gap can occur.

Slab defects attributed by secondary cooling, can be minimized or avoided by reducing these surface temperature fluctuations. “Hard-Hard” cooling is a technology developed to address this issue as well as inter roll slab bulging.

“Hard-Hard” cooling technology also requires that the strand surface temperature be reduced quickly to be approximately 1292°F or less in the first cooling zone after the mold sprays. This temperature is then maintained throughout the complete solidification length of the strand.

The necessary temperature profile requires high cooling intensities through high water flows. When these water flows are applied through normal flat fan nozzles, large cyclic temperature fluctuations occur on the slab surface.

These cyclic fluctuations in the upper cooling zones of the caster can result in significant thermal stresses in the cast strand, which could lead to generating both internal and surface defects.



Intense cooling profile conventional flat fan air mist vs “Hard-Hard” cooling nozzles

Reducing the surface temperature fluctuations to acceptable levels, while still extracting the necessary heat from the slab surface, requires that the spray thickness in the casting direction is maximized within the roll gap. This is achieved with a new Lechler design concept — “Hard-Hard” cooling nozzle.

The main difference with respect to surface temperature between the conventional flat fan nozzles and the new “Hard-Hard” concept is shown by the reduction of the surface temperature fluctuations in zone 1. The “Hard-Hard” cooling nozzles also require less spray water to achieve the required cooling due to their increased minor spray angle, which produces a larger spray thickness on the slab surface.

With the low surface temperatures associated with “Hard-Hard” cooling, the loss of cooling due to clogged nozzles will result in large localized slab surface reheats. These reheats will produce large localized thermal stresses and possible defects. “Hard-Hard” cooling air mist nozzles benefit from a non-clogging nozzle tip, featuring a single slot principle, giving users the benefits of both the highest operational safety and lower maintenance.

Hard-Hard cooling nozzles are mounted utilizing the proven Lechler MasterCooler SMART method which has become an industry standard.

HHC nozzle tip

Hard Hard Cooling means improved slab quality and higher productivity due to:

- Lower strand temperatures in upper part of machine
- Minimized strand bulging and mould level instability
- Reduced temperature fluctuations on slab surface
- Increased quality and productivity
- Fitted Nozzle tip in roll gap
- Standard Mastercooler SMART mounting method

Slab caster segment piping

Mastercooler SMART Mounting

Because of their internal mixture, air mist nozzles require two separate feed pipes for compressed air and water. Vertical segment piping with square air and water main header pipes became an industry standard design. The air mist nozzles, now equipped with plates, are bolted vertically onto adaptor plates.

In order to maintain an identical nozzle length in one segment, the nozzles are bolted onto adaptor plates of a tailored length to compensate for the in-built bending radius.

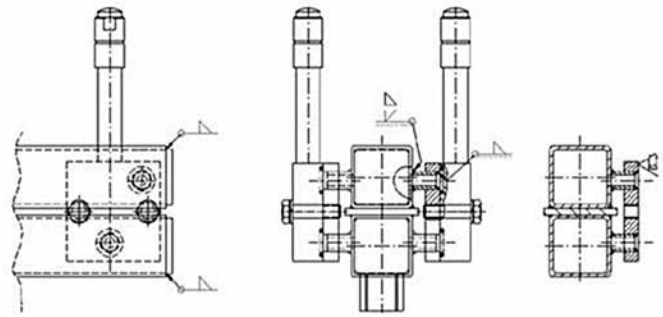
Air mist nozzles fed and installed by means of small and long hydraulic pipes

Nozzle staggering between the roller gaps within one segment can be served from only one header pipe manifold. Nozzle staggering is one method to equalize the water distribution along the strand in the direction of the length with the intention to eliminate surface defects and cracks.

Small diameter fluid feed pipes are no longer necessary. All nozzles are mounted outside of the framework at the rear side of the segment with only the nozzle pipe, carrying the spray tip, reaching down to the spray position. A very rigid header pipe with self alignment nozzle arrangement is the result. The nozzle spray position is always secured. A “Hoseless” fluid supply system is possible.

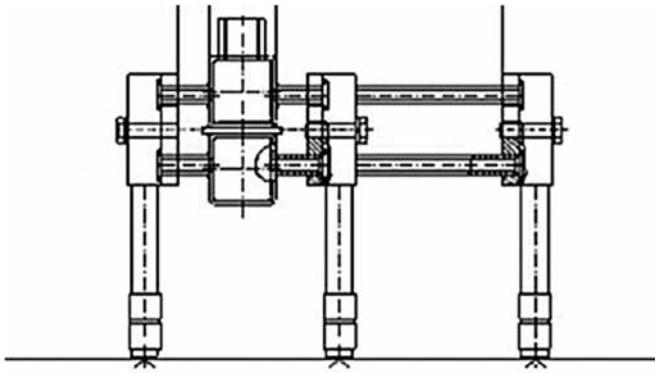
In order to maintain an identical nozzle length in one segment, the nozzles are bolted onto adaptor plates of a tailored length to compensate for the in-built bending radius.

Nozzle staggering between the roller gaps within one segment becomes much easier, since different nozzle positions can be served from only one header pipe manifold. Nozzle staggering is one method to equalize the water distribution along the strand in the direction of the length with the intention to eliminate surface defects and cracks.



Air mist nozzle with vertical plate connection and square pipe header manifold

Air mist nozzle with vertical plate connection and adaptor plate



Nozzle staggering

Example of staggered nozzle positions with Mastercooler SMART piping

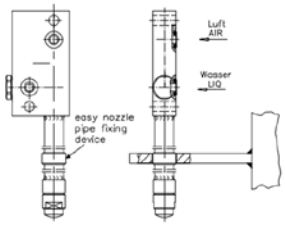
Split pipe design and tip alignment

Nozzle and tip alignment

Lechler nozzle tips are equipped with two standard fixed keys which ensures the correct position of the spray tip providing the correct spray direction and plane. However, there are cases where the tip adapter on the extension pipe of the nozzle has four holes, so that the nozzle tip can be turned by 90° for versatility reasons. For this reason, the correct nozzle tip spray direction has to be checked and ensured during assembly of the nozzles and headers.

Nozzle and pipe alignment

An additional tool for nozzle alignment is a bushing, which is flexibly or permanently mounted on the nozzle pipe. This bushing is a counterpart for a welded plate on the segment, which keeps the nozzle pipe in position to avoid pipe misalignment.



Nozzle alignment with bushing

Nozzle Body Interface

It is important that the nozzle body mounting surface is kept clean and free of marks in order to secure a tight connection. Please make sure that new o-rings are being used whenever the nozzle is removed for a major repair or off-site maintenance. It is also important that the plugs be kept tight with undamaged copper seals.

Split pipe design

For nozzles with extension pipes longer than approximately 11.8" it is recommended to install nozzles with the “Split Pipe” version, allowing to the front part to separate, carrying the nozzle tip and nut only. The nozzle’s vertical plate combined with the remaining part of pipe can be retained. The position of the joint between the two pipe ends can be designed on request. A self- aligning design also secures the correct spray direction at this point. In case of a break out, only the extension pipe with the tip has to be replaced.

Mastercooler nozzle body mounting surface with air and water inlet holes including o-rings, air and water plugs including copper seals

The special features:

- Only extension pipe needs to be replaced after a break out
- Very rigid and durable connection
- Failure proof system due to a variety of the different joint shapes

The benefits:

- Lower maintenance costs
- Improved operation safety
- Reduced complexity of stock logistics due to reduced number of nozzle types for beam-blank casters

Mastercooler split pipe design