

MASTERCooler HARD HARD COOLING®

Hard Hard® Cooling

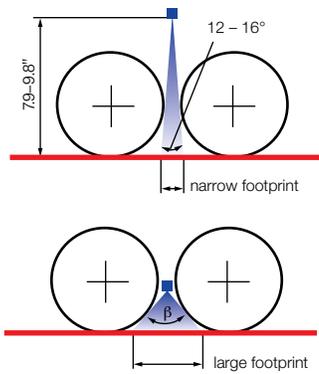
The ability to cast low carbon steels at ever increasing casting speeds, while still being able to cast the more critical steel grades, requires a wider control and performance of the secondary cooling as well as flexibility in nozzle turndown. Maintaining slab bulging at increased casting speeds requires 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.

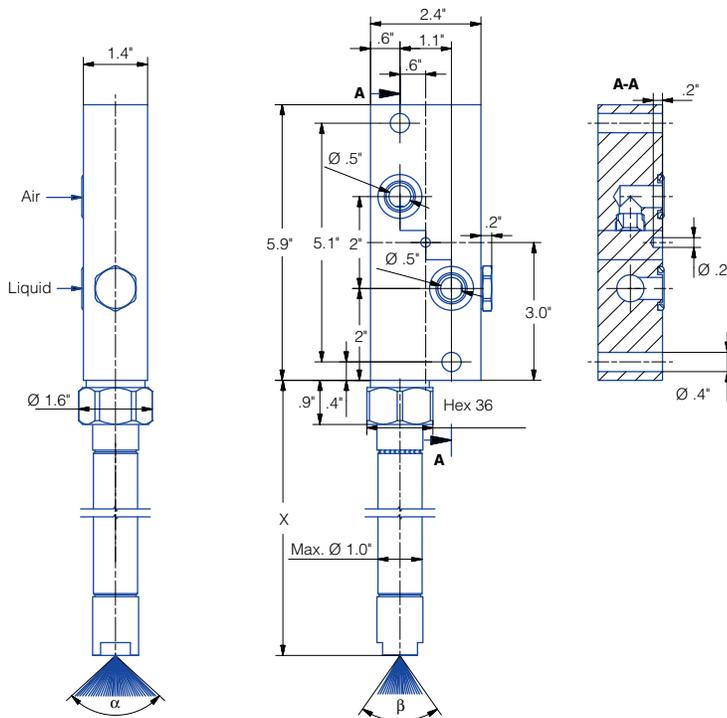


Nozzle type	Max. water flow rate	Operating water pressure	Air flow rates	Operating air Pressure	Spray angle
Mastercooler HHC	13 gpm	73 – 145 psi	0 – 26 SCFM	14.5 – 58 psi	90-125° wide 20-75° deep

Benchmark data only, individual nozzle data to be specified



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



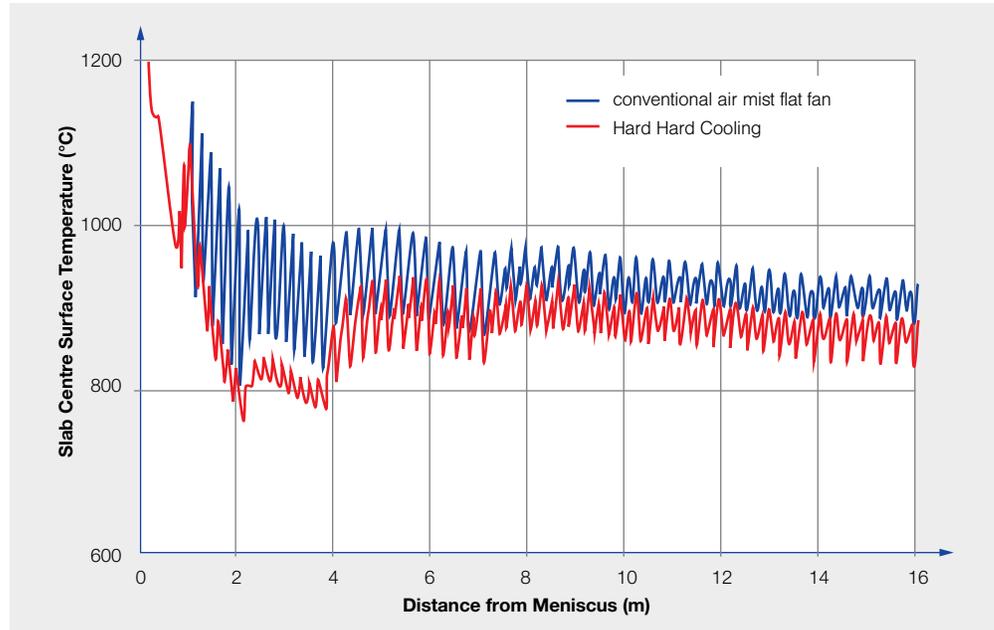
The minor spray angle of conventional nozzles, also referred to as the spray thickness angle, range between 12° and 16° for typical major spray angles of 60° to 120° (wide axis). With spray heights of 6.3" to 11.8" in the upper cooling zones, the slab surface between roll contact and spray water remains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