Precision Nozzles and Systems for Roll Cooling Solutions in Rolling Mills
Lechler nozzles have been setting standards in quality, performance and design for over 135 years.

A wide range of specially developed and proven nozzles of many different designs and in a range of materials is available for applications throughout the processes of metal smelting, refining, casting, rolling and processing. You can also select from over 20,000 other Lechler nozzles for a very wide range of other applications — with new ones being added to the range daily!

A dynamic market with high expectations

Global steel production will increase dramatically in the years ahead. The globalisation of the steel industry is not yet complete.

Every year, new steel-making companies are being newly formed, with production plants on every continent. The trend is similar in the case of the aluminium industry and the producers of non-ferrous metals.

The metallurgical industry places stringent demands on its suppliers

Most metallurgical plant and machine builders are already organised and active globally. Process optimisations, along with new technologies, enable production capacities to be permanently increased and the product quality of the metals produced to be further improved. Nozzles and nozzle systems play an important role here in all production stages.

The following basic requirements must be met for a successful partnership:

- **Great innovative strength** in order to realise new technologies.
- **High problem-solving competence** for ensuring plant availability.
- **Global organisation** as a guarantee of customer proximity and worldwide service.
- **Wherever you are in the world, Lechler is close by and employs over 680 people**

With production facilities in Germany, the USA, England, Hungary, India and China, sales offices in France, Spain, the BENELUX countries, Sweden and Finland, and representatives in over 25 countries, Lechler has a global network of service stations. This guarantees technical support for plant operators, a supply of spare parts and ongoing training of maintenance staff throughout the world.
In the process of rolling the most significant aspect is the generation of heat through friction and deformation in the roll bite. The most important aspects are:

- Maintaining uniform, stable roll temperatures, circumferentially around the roll and transversely across the roll width.
- Creating optimum thermal crowns and minimum differential in temperature in the upper and lower work rolls with optimum heat extraction.

Because of the current demands on mills to process much lighter exit gages from increased incoming hot strip thickness, much larger reductions are necessary on individual mill stands, such high reductions at a nominal width result in a larger area of contact with corresponding higher rolling force, friction and heat generation.

These high reduction schedules combined with the requirement to produce widening range of material cross-sections with a more diverse range of softer and harder materials also result in increasingly greater challenges in the control of roll temperature and the effective transfer/extraction of heat. Establishing a uniform homogeneous cooling across the rolling width with a uniform and acceptable thermal distribution (no gradients) is the ultimate goal as regards cooling and assures that the universal problem of post cooled shape after recoil is minimized. A well designed, cooling system in good operating condition will achieve several important objectives:

- Maximum heat extraction at minimal coolant consumption
- Symmetrical thermal profiles on the work rolls (minimum gradient in temperature)
- Controlled thermal crowns
- “Normal” steady state roll temperatures
- No differentials in the thermal conditions between the top and bottom work roll
- Ensure that the roll bending system is kept within range by maintaining the appropriate thermal crown height and symmetry
Over the life span of a rolling mill the requirements in terms of product quality and the range of steel grades may change significantly. In particular the capability of the installed roll cooling systems needs to be investigated as one of the key technology areas when it comes to process modifications aiming for a higher productivity.

Having engineered and installed more than 350 selective cooling systems in steel, aluminium and non-ferrous rolling mills and having revamped a large number of conventional roll cooling systems in hot and cold rolling mills Lechler has the competence and experience to also help you to optimize your roll cooling system performance.

Where the capability of Lechler was limited to the investigation of the coolant volume distribution characteristic Lechler can now also simulate the thermal cooling effect of the existing work roll sprays with a computer model.

Thermal roll cooling studies help to:
- Improve product quality
- Increase mill speed and productivity
- Experience of 350 Roll cooling systems installed
- Optimized roll cooling headers and nozzles from one source

Optimum strip flatness thanks to simulation of the nozzle arrangement

Circumferential work roll temperature profile before (blue) and after (red) optimization
A roll cooling study is a systematic and structured approach and delivers a wide range of benefits by determining the improvements that can be obtained by an upgraded cooling system with improved operation and maintenance practices. The thoroughly documented final report, containing collected and analysed data and a proposal for future improvements through a system upgrade, forms a comprehensive and indispensable tool for decision making.

A study also identifies problems and causes which were previously not recognised. The time, efforts and cost of such work are insignificant in comparison with the potential benefits of a properly executed study which results in an optimised roll cooling system and the subsequent improvements in product quality, productivity and reduced operation costs.

Roll Cooling Study Phase 1

A typical roll cooling study would be carried out in two phases:

In Phase 1 a site visit could be the start during which data would be collected.

Benchmarking

Also included in Phase 1 would be the benchmarking of the cooling effect of the existing header and nozzle arrangement. Based on the cooling effect and the heat input data the top and bottom work roll temperature can be calculated. Spray cooling asymmetries and any other problematic areas would be highlighted in the final report for phase 1. Speed and work roll diameter differences are being considered.

Roll Cooling Study Phase 2

There can be a number of reasons for conducting a study. The most common are:
- Identify strip shape defects and to eliminate them
- Extend work roll life time
- Increase rolling speed and productivity
- Improve maintenance friendliness and reduce costs
- Optimize coolant flow and hence save energy and coolant treatment costs
- Change of product formats and steel grades (product mix)

Objectives

In most cases it is a combination of all six reasons that determines the objectives for a revamp of the roll cooling system. It is important that these objectives are clearly defined so as to provide the study with a clear focus when preparing the final study report.

Based on the result of the benchmarking and the objectives the required cooling effect and the new heat input into the work rolls would be calculated. With these as an input a recommendation for an optimized nozzle and header arrangement would be worked out for every stand.

Mill Types

Roll cooling studies can be performed for the following flat rolling mills:
- Steel hot strip mills
- Tandem steel cold rolling mills
- Reversing steel cold rolling mills
- Steel plate rolling mills
- Every type of aluminum hot, cold and foil rolling mill
- Every type of NF-rolling mill (copper, brass etc.)

Please contact Lechler for a first discussion regarding the optimization of your roll cooling system.

Lechler scope of supply

Phase 1 - Existing

- Performance of the entire site survey including the roll temperature measurements
- Presentation of the final report of Phase 1 (benchmarking)

Phase 2 - Optimization

- Calculation of the newly set cooling parameters which includes total coolant flow rates and pressures
- Complete basic and detailed engineering for new nozzle and header arrangement
- Manufacturing and supply of the new set of nozzles and accessories
- Fabrication and supply of the new set of roll cooling headers

Optimized spray header designed and fabricated by Lechler
The correct alignment of the roll cooling nozzles on the spray header is essential for optimal roll cooling. Flat jets are the preferred spray pattern for roll cooling, therefore only a self aligning nozzle design provides the operation safety required in a modern rolling mill. All flat jet nozzles of the Lechler series 6E4 and 6E5 come with an automatic self aligning feature which ensures that every nozzle will always be installed under the correct spray offset angle towards the roll center line.

No welding nipple is required for the 6E nozzle series because the tip geometry can be machined directly into a front plate of a box type spray header. A hollow nozzle nut holds the nozzle tip in place. This simple but innovative design does make all the welding nipples and the intermediate nozzle plate obsolete resulting in significant cost savings. Another positive aspect is the reduction of the overall weight and outer dimensions of box type headers. The correct offset angle is machined directly into the header front plate and does not depend on the nozzle tip. The two keys on the nozzle tip are always in line with the flat jet spray axis.

The Spray has a parabolic liquid distribution which is ideal for a multi nozzle header arrangement.

- Parabolic liquid distribution
- Automatic nozzle alignment
- High operation safety
- No welding nipples required
- Simplifies the design of box type headers because:
  - No welding nipples required
  - Reduces header weight
  - Reduces outer header dimension
  - Reduces header costs significantly
Nozzle series 6E4/6E5
Weight: 28 g

Hollow-core screw
Weight: 41 g

Ordering-no. 06E.490.1Y
Blind tip for pressure testing

Spray width [B] at p=3 bar

Spray width [B] at p=3 bar

<table>
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<tr>
<th>Ordering no.</th>
<th>E [mm]</th>
<th>V [l/min]</th>
<th>p [bar]</th>
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Example: Type + Material-no. = Ordering no.
for Ordering: 6E4.721 + 17 = 6E4.721.17

Conversional formula for the above series: 

\[ V_2 = V_1 \cdot \sqrt{\frac{p_2}{p_1}} \]
The correct alignment of the roll cooling nozzles on the spray header is essential for optimal roll cooling. Flat jets are the preferred spray pattern for roll cooling, therefore only a self aligning nozzle design provides the operation safety required in a modern rolling mill. All flat jet nozzles of the Lechler series 6F4 and 6F5 come with an automatic self aligning feature which ensures that every nozzle will always be installed under the correct spray offset angle towards the roll center line. The nozzle tip has two locating lugs for self alignment and seals metallically with a circular surface against the welding nipple when the nut is tightened. No torque is applied on the lugs themselves preventing mechanical damage due to over tightening of the nut. The 6F nozzle series are ideal for mounting when space is limited.

Unlike the dove tail assemblies the tip is put in in axial direction of the welding nipple. Safe and one-handed nozzle tip mounting is guaranteed because thread engagement does not take place before the two location lugs have been correctly positioned on the opposite nipple side. The 6F nozzle series is available with a wide variety of standard offset angles which simplifies spray header fabrication significantly. It also helps to prevent wrong fabrication of headers.

The spray has a parabolic liquid distribution which is ideal for a multi nozzle header arrangement.

- Parabolic liquid distribution
- Automatic nozzle alignment
- High operation safety
- Secure one-handed axial mounting
- Mechanical damage prevented
- Variety of standard offset angles
- Design and fabrication errors prevented
### Accessories

**Welding nipple**

**Retaining nut**

### Technical data and ordering data for accessories see page 13.

### Conversional formula for the above series:

\[
V_2 = V_1 \times \sqrt{\frac{p_2}{p_1}}
\]

### Technical data and ordering data for accessories see page 13.
The 660 series nozzles come with the conventional, automatic self-aligning dovetail connection which ensures that every nozzle will always be installed under the correct spray offset angle towards the roll center line.

The small tip dimensions make this nozzle series ideal for roll cooling and strip cooling headers when space is limited especially in small rolling mills for non ferrous metals.

All tips have an automatically built in 5° offset angle if the welding nipple is welded in line with the centre line of the spray header. Any other offset angle has to be compensated for by welding the nipple under a different angle (minus the 5° inbuilt offset angle).

The spray has a parabolic liquid distribution which is ideal for a multi nozzle header arrangement.

### Technical Data

**Spray width [B] at p=3 bar**

- H = 250 mm: 70, 125
- H = 500 mm: 90, 175
- H = 100 mm: 100, 200
- H = 150 mm: 135, 260
- H = 150 mm: 150, 300

### Ordering Information

**Ordering no.**

- Type + Material-no. = Ordering no.

### Conversional formula for the above series:

\[ V_2 = V_1 \times \sqrt{\frac{p_2}{p_1}} \]

Subject to technical modifications

### Accessories

- **Welding nipple**
- **Retaining nut**

### Technical data and ordering data for accessories see page 13.
The 664 and 665 series nozzles come with the conventional, automatic self aligning dovetail connection which ensures that every nozzle will always be installed under the correct spray offset angle towards the roll center line.

This nozzle family has become an industrial standard solution for roll cooling applications. All tips have an automatically built in 15° offset angle if the welding nipple is welded in line with the centre line of the spray header. Any other offset angle has to be compensated for by welding the nipple under a different angle (minus the 15° inbuilt offset angle).

The spray has a parabolic liquid distribution which is ideal for a multi nozzle header arrangement.

### Technical data and ordering data for accessories see page 13.

- **E** = Narrowest free cross section. *US gal/min
- Subject to technical modifications
- Conversional formula for the above series: 
  \[ V_2 = V_1 \times \sqrt{\frac{p_2}{p_1}} \]

### Accessories

- **Welding nipple**
- **Retaining nut**

Other offset angles are available on request.
The 669 series nozzles come with the conventional, automatic self aligning dovetail connection which ensures that every nozzle will always be installed under the correct spray offset angle towards the roll center line.

This nozzle family allow very large flow rates for roughing mill, plate mill and strip cooling applications.

All tips have an automatically built in 15° offset angle if the welding nipple is welded in line with the centre line of the spray header. Any other offset angle has to be compensated for by welding the nipple under a different angle (minus the 15° inbuilt offset angle).

The spray has a parabolic liquid distribution which is ideal for a multi nozzle header arrangement.

### Table: Ordering Data

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<th>Mat. no.</th>
<th>E  [mm]</th>
<th>V [l/min]</th>
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<td>Ø 60°</td>
<td>669.044</td>
<td>30</td>
<td>40° psi</td>
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</table>

- **E** = Narrowest free cross section. * US gal/min
- Subject to technical modifications

#### Conversional formula

For the above series:

\[ V_2 = V_1 \times \sqrt{\frac{p_2}{p_1}} \]

### Accessories

- **Welding nipple**
- **Retaining nut**

Other offset angles are available on request.

Technical data and ordering data for accessories see page 13.
Series 6F

- Hex 32
- 3/4 BSPP
- Weight brass 60 g
- Retaining nut: 065.600.11 (AISI 430 F) 065.600.16 (303 SS) 065.600.17 (316 SS) 065.600.30 (brass)

Series 660

- Hex 22
- 3/8 BSPP
- Weight 25 g
- Retaining nut: 065.200.16 (303 SS) 065.200.17 (316 SS) 065.200.30 (brass)

Series 664/665

- Hex 32
- 3/4 BSPP
- Weight brass 60 g
- Retaining nut: 065.600.11 (AISI 430 F) 065.600.16 (303 SS) 065.600.17 (316 SS) 065.600.30 (brass)

Series 669

- Hex 50
- 1 1/4 BSPP
- Weight brass 205 g
- Retaining nut: 066.900.16 (303 SS) 066.900.17 (316 SS) 066.900.30 (Brass)

Series 6F

- Nipple length 20 - 99 mm
  - Basic type number: 06F.410.17
  - Length L1
  - xx = nipple length [mm]
  - Example for nipple length 35 mm: 06F.410.17.35

- Nipple length 100 - 199 mm
  - Basic type number: 06F.411.17
  - Length L1
  - xx = nipple length [mm]
  - Example for nipple length 35 mm: 06F.411.17.35

Other nipple lengths for all nozzle series on request.

Alignment tips

Series 6E: 06E.490.1Y
Series 6F: 06F.490.1Y
Series 660: 066.090.16 offset angle 5°
Series 664/665: 066.490.16 offset angle 15°
Series 669: 066.990.16 offset angle 15°
(other offset angles on request)
The principle

To achieve precise cooling control, the roll barrel is ‘divided’ into zones, each of which has coolant precisely applied to it by MODULAX valve controlled spray nozzles. Each of the zonal sprays can be operated independently of the others either manually, by push button control, semi automatically by a PLC, or automatically in connection with a shape control system.

The SELECTOSPRAY® system can be used in conjunction with any of the shape control systems currently available, the roll zoning being dimensioned to exactly match that of the shape metering roll involved. Zone widths for both automated and manually controlled systems are available, widths in general use being between 25 mm and 100 mm.

The SELECTOSPRAY® system includes complete headers, air hoses and control cabinet.
Lechler competence and expertise

Of paramount importance for any roll cooling application is how the sprays impinge on the roll surface. An effective and precise footprint geometry is the fundamental requirement to establish a uniform cooling from top to bottom work rolls and transversely across the cooling area resulting in an optimal heat extraction across the spray cooling area on the roll.

When designing a spray header Lechler arranges the sprays without interference or creating hot and cool bands in adjacent cooling zones. The nozzle flow rates and spray angles are taken into account besides the positions of the spray headers in the mill for the design of the optimal nozzle offset and impingement angles in order to obtain the best heat transfer.

Lechler SELECTOSPRAY® valves

The proven Modulax valve design is available in three different versions:

- Pneumatically controlled with the solenoid in the control cabinet outside of the mill
- Electro-pneumatically with the solenoid directly attached (DSA)
- Purely electrically controlled (EVA)

All valve versions have very large coolant entry ports, are easily removable from the header front and are protected by the header itself. All valves carry self aligning flat jet nozzles.

Lechler SELECTOSPRAY® valves (MODULAX)

- Liquid to air pressure ratio 2:1
- Very large internal free passages
- Uses standard shop air
- Simple design, only one moving part which is the piston

Electro-pneumatic valve actuation (DSA)

- Each valve has its own dedicated solenoid directly attached
- Shorter response time
- Air for the pilot operation is fed by a single tube directly into the header and instantly available when the electrical solenoid is activated
- Solenoids can be supplied in either normally open or normally closed

Electric valve actuation (EVA)

- Especially in rolling mills where inflammable rolling oil or kerosene is used as a coolant and without the need for compressed air
- Large orifices for a laminar flow and a stable spray
Yes, I want to get detailed information on Lechler products

Please send me the special information:

- Catalogue »Precision Spray Nozzles and Accessories«
- Brochure »Nozzles and Systems for the Metallurgical Industry«
- Brochure »Continuous Casting«
- Brochure »SELECTOSPRAY® Roll Cooling Systems«
- Brochure »SCALEMASTER HPS®«
- Brochure »SCALEMASTER® HP«
- Brochure »MicroSCALEMASTER®«
- Brochure »VarioCool® Gas Conditioning Systems«
- Special interests:

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Company/Department

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Postcode/City

Country

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