Nozzles for Hydromechanical Descaling
Lechler has the leading experience:

- of being the leading supplier for descaling nozzles to rolling mill builders globally
- of supplying SCALEMASTER nozzles to over 500 rolling mills worldwide
- of having re-engineered and optimized more than 200 descaling systems
- of having been the pioneer in descaling in thin slab rolling plants

The unique coreless stabilizer eliminates turbulences.

Single part stabilizer – filter unit completely made from stainless steel reduces pressure losses.

Nozzle tip with tungsten carbide insert.
ROLLED SURFACE QUALITY AND ENERGY SAVINGS

- SCALEMASTER HPS is fully compatible with all other SCALEMASTER nozzles (check overall length). No header modifications necessary.
- Optimized stabilizer design reduces the spray footprint area (A) resulting in a higher impact.
- An increased spray impact can lead to an improvement of the surface quality at no additional energy input.
- A nozzle family providing higher impacts allows the use of a smaller nozzle size so that the impact can be maintained at a lower water flow and reduced energy consumption.

CFD turbulence simulation of the SCALEMASTER HPS showing optimal turbulence free inner flow conditions (dark blue area) right to the tip.

Impact evolution of Lechler SCALEMASTER descaling nozzles against nozzle sizes.

IMPROVE SURFACE QUALITY
Objectives: Clear focus on maximizing the spray impact at given system water pressure and flow.

Analyze
- Check water pressure at header (Lechler Descaling Pressure Gauge)
- Check nozzle types installed
- Check nozzle arrangement (spray overlaps, inclination angle etc.)

Change to SCALEMASTER HPS
- Maximize Impact
- Keep water pressure
- Keep nozzle size

Additional option
- Reduce vertical spray height and increase impact even further
- Contact Lechler for DESCALE simulation and re-engineering of header.

SAVE ENERGY
Objectives: Clear focus on reducing the descaling water flow.

Analyze
- Check water pressure at header (Lechler Descaling Pressure Gauge)
- Check nozzle types installed
- Check nozzle arrangement (spray overlaps, inclination angle etc.)

Change to SCALEMASTER HPS
- Maintain impact values
- Install smaller nozzle size and reduce water flow
- Keep nozzle size and reduce water pressure

Additional option
- Reduce vertical spray height allowing to further reduce the water flow
- Contact Lechler for DESCALE simulation and re-engineering of header.
When a descaling system is being designed the following nozzle performance parameters must be known:

- The water flow rate at a given pressure
- The spray width at a given vertical spray height (this defines the spray angle)
- The spray impact and its distribution across the spray width

The impact (also called impact pressure) is the momentum or force distribution over the spray foot print area. Therefore the impact can be defined as

\[ I = \frac{F}{A} \]

\[ I = \text{Impact} \ [\text{N/mm}^2] \]
\[ F = \text{Force} \ [\text{N}] \]
\[ A = \text{Area} \ [\text{mm}^2] \]

When turbulent free descaling nozzles such as the Lechler SCALEMASTER HPS and lower spray heights are being combined, spray foot print thicknesses of only 3 mm become a challenge for the impact measurement facilities. Spray overlaps below 10 mm also require a much higher precision of the spray width data. Only the new Lechler 3D impact measurement technology utilizing a sensor with only 1.0 mm diameter provides the resolution required for the design of an optimal nozzle arrangement. The impact distribution is measured and documented 3-dimensionally throughout the entire spray in one sensor scan.

The principle of impact measurement

A pressure sensor passes through the spray jet at a defined speed and with defined movement. As it does so, the computer records the pulses in the jet and converts them into a three-dimensional impact representation (see below).

SCALEMASTER® high pressure spray lab

Impact measurements under real installation conditions in terms of nozzle inclination and offset angles can now be performed with the new Lechler high pressure spray lab. Additionally the well proven sensor technology (1 mm diameter) has been integrated into a plate, allowing the measurement of two adjacent sprays. With such a descaling nozzle arrangement Lechler can now investigate the effect on various spray overlap situations in order to fight surface striping especially on rolled plates. Impact measurements up to 500 bars water pressure can be performed.
System Study

A descaling system study with the Lechler DESCALE software is a systematic and structured procedure for defining how an existing nozzle and header arrangement performs regarding the surface quality of the rolled product. Since 1992 the Lechler DESCALE software has made crucial contributions towards increasing of surface quality and plant efficiency.

The new Lechler DESCALE 7X software

The perfect tool to benchmark the performance parameters of the existing situation and to quickly design a new or optimized nozzle arrangement, no matter if billets, blooms, slabs or strips have to be descaled. For the first time and exclusively from Lechler the DESCALE 7X can generate a nozzle arrangement for round billets and blooms.

Precise impact data

For the DESCALE 7X all nozzle types of all SCALEMASTER nozzle families have been impact measured with the new 1 mm diameter sensor technology providing Lechler with the most accurate process data on the market.

Lechler Descaling Pressure Gauge for precise pressure data

With the exact value of the water pressure available at the nozzle a much more accurate simulation of the existing situation and the proposed modification can be made with the Lechler DESCALE software. It is also possible to detect potential pressure losses in the pipe work.

Lechler descaling pressure gauge
Ordering-no. 06PM00
The SCALEMASTER HPS is the ideal nozzle for descaling in conventional hot strip mills when the vertical spray height is not below 150 mm.

The proven SCALEMASTER HP tungsten carbide insert geometry combined with the new coreless stabilizer and the optimized filter design form the next step in the evolution of the SCALEMASTER family of descaling nozzles.

The window design of the new tip in combination with the new stabilizer-filter unit make the SCALEMASTER HPS a nozzle for every modern hot rolling mill which offers the following benefits:

- Remarkable increase of impact for better descaling
- Better product surface quality due to higher impact
- Reduction of descaling water flow rate possible
- Potential of energy savings due to reduced slab/strip cooling
- More durable tip with high mechanical strength due to window design
- Interchangeable with all other SCALEMASTER nozzles (check overall length)

<table>
<thead>
<tr>
<th>No.</th>
<th>Component</th>
<th>Order no.</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Welding nipple</td>
<td>9410.1.C.73</td>
<td>1.08 lb</td>
</tr>
<tr>
<td></td>
<td>Material: AISI 304</td>
<td>L = 2.87 in</td>
<td>1.57 lb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L = 3.94 in</td>
<td>1.83 lb</td>
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<td></td>
<td></td>
<td>L = 4.72 in</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Other length on request.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Filter stabilizer unit</td>
<td>06P350.1.Y0.00.00</td>
<td>0.22 lbs</td>
</tr>
<tr>
<td></td>
<td>Material: Stainless steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>with filter S = 110</td>
<td>06P352.1.Y0.00.00</td>
<td>0.29 lbs</td>
</tr>
<tr>
<td></td>
<td>with filter S = 130</td>
<td>06P353.1.Y0.00.00</td>
<td>0.34 lbs</td>
</tr>
<tr>
<td></td>
<td>with filter S = 150</td>
<td>06P354.1.Y0.00.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Gasket</td>
<td>095.015.34.04.02.0</td>
<td>0.011 lbs</td>
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<tr>
<td></td>
<td>Material: Copper</td>
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<td></td>
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<tr>
<td>4</td>
<td>Nozzle tip</td>
<td>6P4.XXX.XX</td>
<td>0.31 lbs</td>
</tr>
<tr>
<td></td>
<td>see order table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nut (standard)</td>
<td>069.400.11</td>
<td>0.31 lbs</td>
</tr>
<tr>
<td></td>
<td>Material: AISI 430 F</td>
<td>Hex 41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. torque 250 Nm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Max. permissible operating pressure: 6257 psi
**NOZZLE DATA**

**CORRECT NOZZLE ARRANGEMENT**

### Order No. for nozzle tip

<table>
<thead>
<tr>
<th>Type</th>
<th>Material Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>22°</td>
<td>495</td>
</tr>
<tr>
<td>26°</td>
<td>535</td>
</tr>
<tr>
<td>30°</td>
<td>565</td>
</tr>
<tr>
<td>34°</td>
<td>605</td>
</tr>
<tr>
<td>40°</td>
<td>645</td>
</tr>
</tbody>
</table>

### Water flow rate (V)

<table>
<thead>
<tr>
<th>Series</th>
<th>p = 100 bar  (1450 psi)</th>
<th>p = 200 bar  (2900 psi)</th>
<th>p = 400 bar  (5800 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6P4</td>
<td>V1 [l/min]</td>
<td>V1 [US Gall./min]</td>
<td>V1 [US Gall./min]</td>
</tr>
<tr>
<td>6P4</td>
<td>V2 [l/min]</td>
<td>V2 [US Gall./min]</td>
<td>V2 [US Gall./min]</td>
</tr>
<tr>
<td>6P4</td>
<td>V3 [l/min]</td>
<td>V3 [US Gall./min]</td>
<td>V3 [US Gall./min]</td>
</tr>
</tbody>
</table>

**Flow rate conversion for table**

\[
V_2 = \sqrt[p_2]{p_1} \times V_1 [l/min]
\]

\[
p_2 = \left(\frac{V_2}{V_1}\right)^2 \times p_1 [bar]
\]

### Special nut with hexagon socket for very narrow distances between nozzles

Order no.: 069.402.11

### Alignment aid (Fig. 2, Order No. 069.490.01) is also used as a dummy part to shut off nozzle connections or for hydrostatic pressure testing.

Fig. 2: Alignment tip / dummy part

Fig. 3: Installation example for welding nipple

### Nozzle spray positions

1. All nozzle jets turned parallel in one direction.

2. Nozzle jets, half of them turned outwards in opposite directions. This directs the spray water to both sides (see Fig. 1).

### Nipple installation

So that the correct alignment of the nozzle mouthpiece (15° offset angle to the header’s longitudinal axis — see Fig. 1) is guaranteed, the welding nipple on the spray header must be positioned so that its flat inner surfaces are parallel to the header’s longitudinal axis. This is best achieved with the alignment aid supplied as an accessory (Fig. 2, Order No. 069.490.01). To do this, it is inserted into the flat nipple opening. A rule (or similar) can now be used to easily bring the nipple into the correct parallel position where it can be welded in place (see Fig. 3).

### Alignment tip

The installation aid (Fig. 2, Order No. 069.490.01) is also used as a dummy part to shut off nozzle connections or for hydrostatic pressure testing.
NEW

WSV SUPERIOR WATER STOP VALVE FOR SERIES 6P4

During thermomechanical rolling of steel plate and when rolling stainless steel strip, descaling is not performed for every roll pass. Nozzle check valves are used here to prevent undesired surface cooling of the rolling stock caused by the system prefilling water, which would otherwise flow unrestricted through the nozzles.

Increasing the impact compared with conventional nozzle check valves was the primary development goal for the WSV Superior water stop valve for the SCALEMASTER HPS series.

This was achieved in two stages of turbulence reduction. In the first stage the turbulences created when the water is passing through the valve seat are being calmed down by the patented needle geometry.

As a result of omission of a valve piston, this is followed by a further calming section in the flow guide tube with a large cross section before the water passes the second turbulence reduction stage, the proven jet stabilizer.

In comparison with conventional valves, the piston and coil spring were replaced in the new WSV Superior by a precisely preloaded metal bellows, which ensures defined opening and closing pressures and prevents leaks. A flow guide tube prevents dirt deposits on functionally relevant components. The metal and thus wear-resistant seal is maintenance-free and therefore reduces servicing costs.

A filter protects the valve and nozzle and increases operating reliability. The nozzle geometry of the SCALEMASTER HPS series ensures optimum descaling results.

Impact increase by WSV superior compared to conventional WSV depending on the nozzle size.
FEATURES AND BENEFITS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALEMASTER HPS (6P4)</td>
<td>06P.460.1Y.00.00.0</td>
<td>203</td>
<td>116</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

**New internal design**
- Increase of impact due to reduction of internal turbulences
- Surface quality improvements and energy savings

**Compatible with SM-HPS nozzle series**
- Can replace SM-HP nozzle with conventional WSV
- No header modifications required, cost savings

**Single component design**
- Maintenance free
- No maintenance costs

**Large free internal cross sections**
- Non clogging design
- High operation safety
MINISCALEMASTER HP SUPERIOR®

The MiniSCALEMASTER HPS is the ideal nozzle for descaling in conventional hot strip mills when the vertical spray height is typically below 150 mm and where the nozzle pitch requires a smaller size nozzle.

The proven SCALEMASTER HP tungsten carbide insert geometry combined with the new coreless stabilizer and the optimized filter design form the next step in the evolution of the MiniSCALEMASTER family of descaling nozzles.

- Spray height reduction
- Improved rolled material surface quality
- Saves on pump energy
- Water flow rate reduced
- Less cooling of rolled product

The window design of the new tip in combination with the new stabilizer-filter unit make the MiniSCALEMASTER HPS an ideal nozzle for every thin slab hot rolling mill, plate mill or any other hot rolling mill and which offers the following benefits:

- Remarkable increase of impact for better descaling
- Better product surface quality due to higher impact
- Reduction of descaling water flow rate possible
- Potential of energy savings due to reduced slab/strip cooling
- More durable tip with high mechanical strength due to window design
- Interchangeable with all other SCALEMASTER nozzles (check overall length)

Max. permissible operating pressure: 6527 psi

<table>
<thead>
<tr>
<th>No.</th>
<th>Component</th>
<th>Order no.</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Welding nipple</td>
<td>060.020.1C.01</td>
<td>0132 lbs</td>
</tr>
<tr>
<td></td>
<td>Material: AISI 304</td>
<td>060.020.1C.00</td>
<td>0176 kg</td>
</tr>
<tr>
<td></td>
<td>Length: L = 1.26 in</td>
<td>060.020.1C.02</td>
<td>0419 lbs</td>
</tr>
<tr>
<td></td>
<td>L = 1.54 in</td>
<td>06P.350.1Y.00.00.0</td>
<td>0220 lbs</td>
</tr>
<tr>
<td></td>
<td>L = 3.15 in</td>
<td>06P.352.1Y.00.00.0</td>
<td>0287 lbs</td>
</tr>
<tr>
<td></td>
<td>Other length on request</td>
<td>06P.353.1Y.00.00.0</td>
<td>0342 lbs</td>
</tr>
<tr>
<td>2</td>
<td>Filter stabilizer unit</td>
<td>095.015.34.02.07</td>
<td>0002 lbs</td>
</tr>
<tr>
<td></td>
<td>Material: Stainless steel</td>
<td>064.400.11</td>
<td>0087 lbs</td>
</tr>
<tr>
<td>3</td>
<td>Gasket</td>
<td>064.400.11</td>
<td>0309 lbs</td>
</tr>
<tr>
<td>4</td>
<td>Nozzle tip</td>
<td>0309 lbs</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nut (standard)</td>
<td>064.400.11</td>
<td>0187 lbs</td>
</tr>
<tr>
<td></td>
<td>Material: AISI 430 F</td>
<td>see order table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hex 32</td>
<td>Max. torque 200 Nm</td>
<td></td>
</tr>
</tbody>
</table>
### NOZZLE DATA

#### CORRECT NOZZLE ARRANGEMENT

<table>
<thead>
<tr>
<th>Order no. for nozzle tip</th>
<th>Water flow rate (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p = 100 bar (1450 psi)</td>
</tr>
<tr>
<td></td>
<td>[l/min]</td>
</tr>
<tr>
<td><strong>Nominal spray angle</strong></td>
<td><strong>Material code</strong></td>
</tr>
<tr>
<td>6P3</td>
<td>495</td>
</tr>
<tr>
<td>6P3</td>
<td>535</td>
</tr>
<tr>
<td>6P3</td>
<td>565</td>
</tr>
<tr>
<td>6P3</td>
<td>605</td>
</tr>
<tr>
<td>6P3</td>
<td>645</td>
</tr>
<tr>
<td>6P3</td>
<td>685</td>
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<td>6P3</td>
<td>885</td>
</tr>
<tr>
<td>6P3</td>
<td>-</td>
</tr>
<tr>
<td>6P3</td>
<td>-</td>
</tr>
</tbody>
</table>

**Flow rate conversion for table**

\[
V = \sqrt{\frac{p_1}{p_2}} \cdot V_1 \text{ [l/min]}
\]

\[
p = \left(\frac{V}{V_1}\right)^2 \text{ [bar]}
\]

**Ordering example:**

- **Series:** 6P3
- **Code:** 495
- **Mat.Code:** 27
- **Order No.:** 6P3.495.27

**Nozzle spray positions**

1. All nozzle jets turned parallel in one direction.
2. Nozzle jets, half of them turned outwards in opposite directions. This directs the spray water to both sides (see Fig. 1).

**Nipple installation**

So that the correct alignment of the nozzle mouthpiece (15° offset angle to the header’s longitudinal axis — see Fig. 1) is guaranteed, the welding nipple on the spray header must be positioned so that its flat inner surfaces are parallel to the header’s longitudinal axis. This is best achieved with the alignment aid supplied as an accessory (Fig. 2, Order No. 064.490.01). To do this, it is inserted into the flat nipple opening. A rule (or similar) can now be used to easily bring the nipple into the correct parallel position where it can be welded in place. (see Fig. 3)

**Alignment tip**

The installation aid (Fig. 2, Order No. 064.490.01) is also used as a dummy part to shut off nozzle connections or for hydrostatic pressure testing.

**Fig. 1:** Alignment tips

- Order no. 064.490.01 (for series 6P3)
- Order no. 064.490.02 (for series 6P3)
- Order no. 064.490.00 (for series 6P3)

**Fig. 2:** Alignment tip / dummy part

**Fig. 3:** Installation example for welding nipple

A ø = equivalent bore diameter

Material code 27: Stainless steel nozzle tip with tungsten carbide insert

Special nut with hexagon socket for very narrow distances between nozzles

Order no.: 064.490.11
### NOZZLE ARRANGEMENT ON THE SPRAY HEADER

The following apply to the arrangement on the spray header:

- \( E = C - D \)
- \( C = \cos \gamma \cdot B \)
- \( \beta = 5^\circ, 10^\circ \) or \( 15^\circ \)

### Parameters

- **A** = Spray length
- **B** = Spray width
- **C** = Spray width in rolling direction
- **D** = Overlap
- **E** = Nozzle distance
- **\( h_2 \)** = Vertical spray height
- **\( \alpha \)** = Nozzle spray angle
- **\( \beta \)** = Angle of inclination
- **\( \gamma \)** = Offset angle of the nozzle against pipe roll axis

### Diagram

The diagram illustrates the arrangement of the spray header, showing the spray length (A), spray width (B, C), overlap (D), nozzle distance (E), vertical spray height (\( h_2 \)), nozzle spray angle (\( \alpha \)), and angle of inclination (\( \beta \)).

### Table

<table>
<thead>
<tr>
<th>Vertical spraying height (in)</th>
<th>Angle of inclination ( \beta = 15^\circ )</th>
<th>Nominal nozzle spray angle ( \alpha ) at ( p = 150 ) bar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \alpha = 22^\circ )</td>
<td>( \alpha = 26^\circ )</td>
</tr>
<tr>
<td>1.97</td>
<td>2.05</td>
<td>1.02</td>
</tr>
<tr>
<td>2.95</td>
<td>3.07</td>
<td>1.42</td>
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<td>3.94</td>
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<tr>
<td>9.84</td>
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<td>4.37</td>
</tr>
</tbody>
</table>

1) only MiniSCALEMASTER HPS with hexagon socket nut
2) only MiniSCALEMASTER HPS
3) only with hexagon socket nut
QUESTIONNAIRE FOR NOZZLE ARRANGEMENT

Questionnaire about existing Descaling Nozzle Arrangement

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Department</th>
</tr>
</thead>
</table>

Location of descaling installation: □ Behind the furnace □ RSB □ FSB □ Interstand descaling

<table>
<thead>
<tr>
<th>Format</th>
<th>Dimensions [in] Nozzle Data</th>
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</thead>
<tbody>
<tr>
<td>Strip</td>
<td>top</td>
</tr>
<tr>
<td>Slab</td>
<td>Number of headers</td>
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<tr>
<td>Plate</td>
<td>Nozzle type</td>
</tr>
<tr>
<td>Bloom</td>
<td>Horizontal distance (E)</td>
</tr>
<tr>
<td>Billet</td>
<td>Number of nozzles</td>
</tr>
<tr>
<td>Rounds</td>
<td>Vertical spray height (h₂)</td>
</tr>
<tr>
<td>Material speed</td>
<td>Spray angle (α)</td>
</tr>
<tr>
<td>Pressure at header</td>
<td>Offset angle (γ)</td>
</tr>
<tr>
<td>Available max. water flow</td>
<td>Impingement angle (β)</td>
</tr>
</tbody>
</table>

Room for sketch:
ACCESSORIES AND SPRAY HEADERS

Disassembly set

The disassembly set is pushed onto the recess on the mouthpiece. The entire nozzle unit can be pulled out when the union nut is unscrewed.

Anti-seize compound

(Ordering No. 9ET.048.29.00.00.0; 80g) The application of the anti-seize compound on the thread of the welding nipples is recommended and ensures easy removal of the nut.

Spray headers

Next to the wide range of descaling nozzles we offer the design and production of complete spray headers or rings.

For SCALEMASTER HPS

1. Disassembly set
   Order no. 069.492.12.00.00.0
2. Tip extractor
   Order no. 069.492.12.00.10.0
3. Extraction tool
   Order no. 095.009.00.12.56.0

For MiniSCALEMASTER HPS

1. Disassembly set
   Order no. 064.492.12.00.00.0
2. Tip extractor
   Order no. 064.492.12.00.10.0
3. Extraction tool
   Order no. 095.009.00.12.56.0
Hand-held pressure reading

With the new Lechler descaling pressure gauge the water pressure can be measured directly at the spray header in front of a descaling nozzle by simply taking one nozzle out and putting the pressure sensor instead.

For detailed information please ask for the special product data sheet.

- Simple and user-friendly key operation
- 2 sensor inputs, automatic sensor recognition

Sensor details

- Measuring range: 0...600 bar
- Burst pressure: 2,000 bar
- Accuracy of sensor: ± 0.25 % of full scale (± 1.5 bar)
- Protection class: IP67

Complete Descaling Pressure Gauge

(Ordering No. 06P.M00.00.00.00.0)
Sensor adaptors for 6P3 (Mini SM-HPS) and 6P4 (SM-HPS) nozzle tips included.