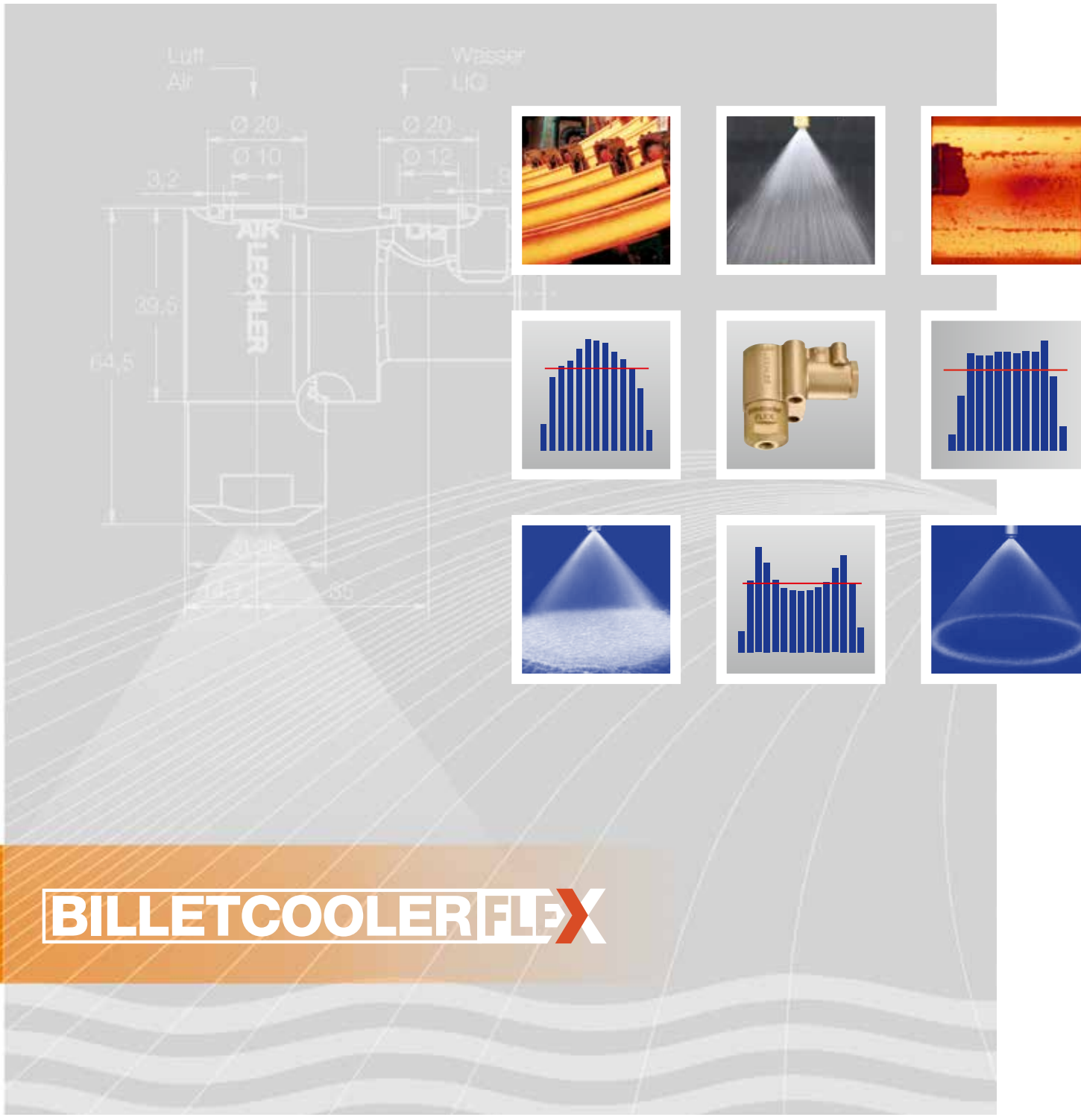
ENGINEERING
YOUR SPRAY SOLUTION

FLEX your cooling.
Improved strand quality through optimized cooling.



BILLETCOOLER FLEX

BILLETCOOLER FLEX

New challenges in continuous casting

In 2002, Lechler introduced the first generation of Billetcooler nozzles for secondary cooling in continuous casting applications. Since then, we have equipped more billet and bloom casters with air mist nozzles than any other supplier.

However, new steel grades as well as an extended range of billet and bloom formats mean new challenges for secondary cooling. That is why we are continuously further developing our nozzles.

One example of this is the new **Billetcooler FLEX®** air mist nozzle.

GOOD COOLING IS A QUESTION OF QUALITY

With today's standard diameters of up to 1,000 mm, bloom casters place significantly higher demands on cooling compared to smaller formats.

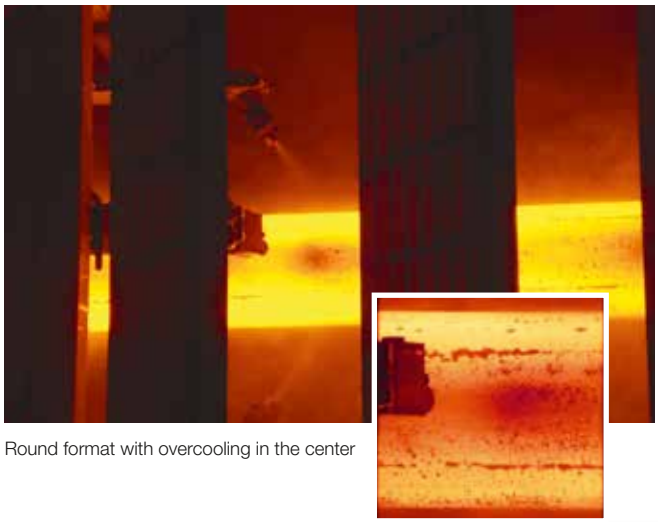
New steel grades and increasing format sizes are significantly more susceptible to cracking and demand much more homogeneous cooling with reduced water flow rates.

Secondary cooling in continuous casting machines for long products normally consists of several cooling zones. The nozzle arrangement is usually defined for a specific format range. In order to permit casting of different steel grades under these conditions, the nozzles themselves must have a wide operating window.

Optimally cooled strands

Sectional view of crack-free bloom format

Sectional view of crack-free billet



Round format with overcooling in the center

Conventional air mist nozzles quickly reach their limits here. The degree of cooling is determined above all by the flow rate of the cooling water, which is adjusted by means of the water pressure. In the past, however, the spray geometry usually also changed with the water pressure.

A changed spray angle led to a change in the liquid distribution – and thus to non-uniform cooling.

On newer bloom formats with larger cross section in particular, this can result in surface stresses and even cracks in the finished product.

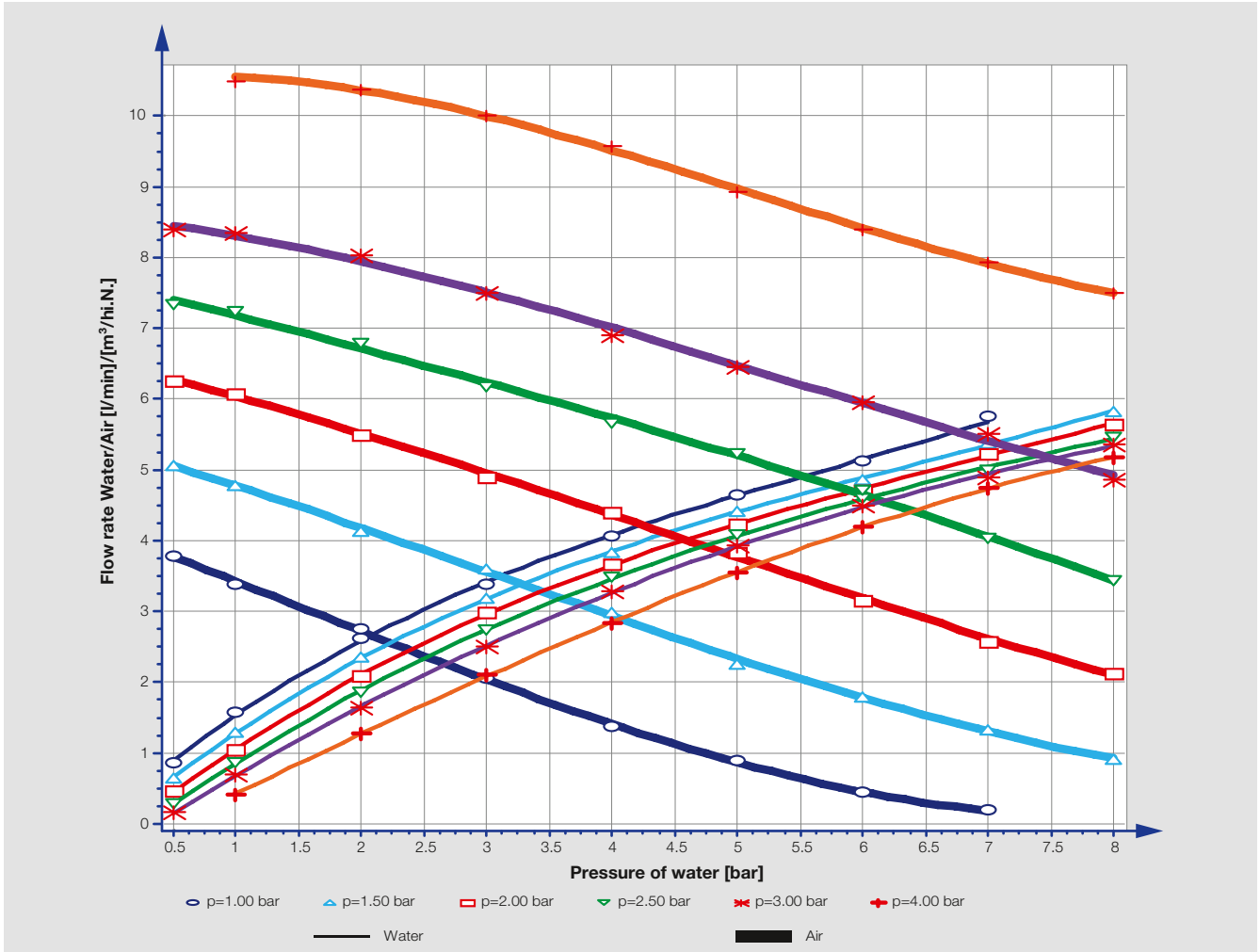
Our goal was therefore to develop a nozzle that guarantees a stable spray angle over the entire turn-down ratio, thereby ensuring optimum cooling.

BILLETCOOLER FLEX®
A REVOLUTION IN FLEXIBILITY

Optimum cooling requires suitable liquid distribution. The key to success is primarily a stable spray angle that is independent of the current pressure.

With the **Billetcooler FLEX®**, we have developed a nozzle family that does exactly that. Thanks to the stable spray angle, the water distribution can now be adjusted to the individual format. The defining variables are water and air pressure.

Both these variables can be adapted dynamically during operation. This means that a single **Billetcooler FLEX®** nozzle is able to cover an enormous operating range.



Typical pressure-flow rate diagram of a **Billetcooler FLEX®** nozzle. The large turn-down ratio of 1:10 (0.5 to 5 l/min) can be clearly seen in the lower curves for water.

FLEXIBLE WATER FLOW RATE – STABLE SPRAY ANGLE

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

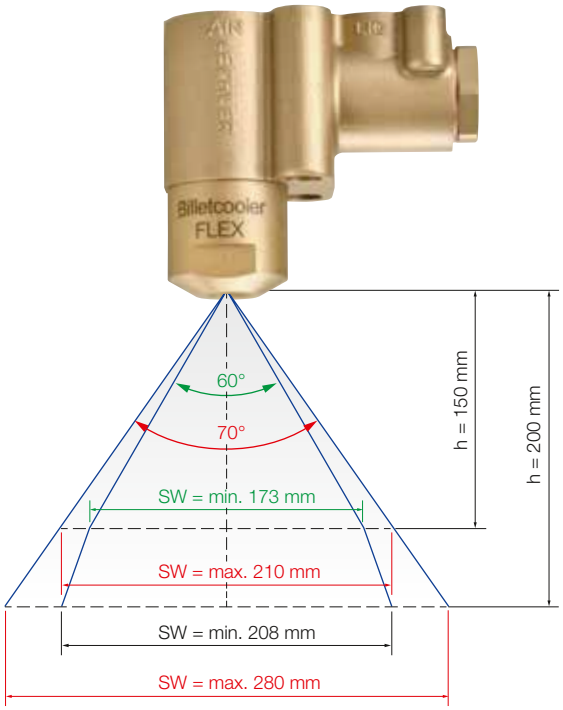
We offer three different nozzle sizes, each with a turn-down ratio (min./max. water flow rate) of 1:10.

Lechler therefore covers the requirements of most bloom and billet casters with just three standard nozzles.

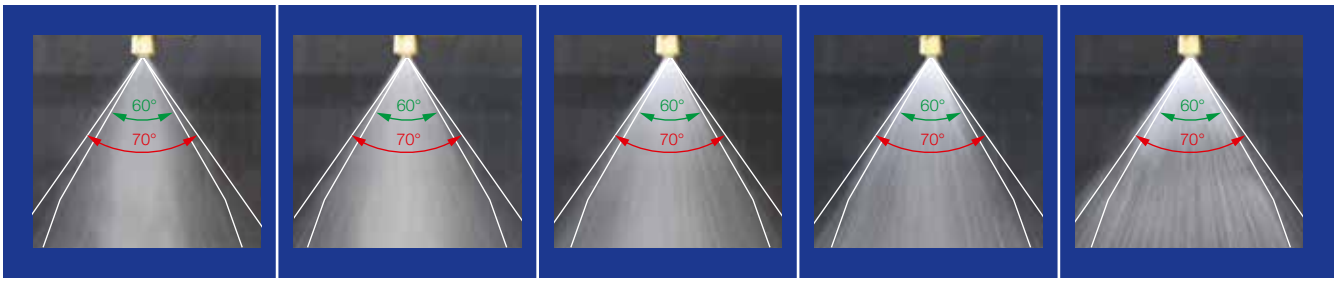
This minimizes the number of different nozzles, reduces logistics costs and helps to avoid maintenance mistakes.

Type	Nozzle size	Spray angle	Min. flow rate [l/min]	Max. flow rate [l/min]
1PM.150.30.33	0.8	45°	0.3	3.0
1PM.150.30.35	1.25		0.5	5.0
1PM.150.30.38	2.0		0.8	8.0
1PM.150.30.03	0.8	60°	0.3	3.0
1PM.150.30.05	1.25		0.5	5.0
1PM.150.30.08	2.0		0.8	8.0
1PM.150.30.93	0.8	90°	0.3	3.0
1PM.150.30.95	1.25		0.5	5.0

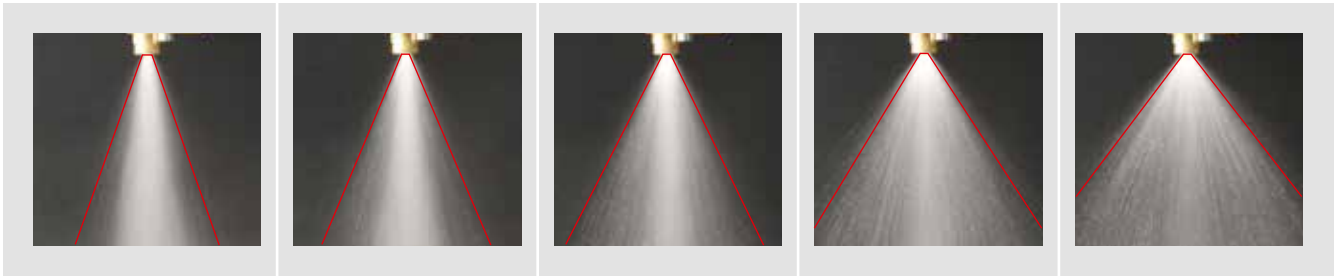
Example **BC FLEX®** 60° spray angle nozzle



BILLETCOOLER FLEX 60° spray angle nozzle



Conventional nozzle



0.5 bar	1 bar	3 bar	5 bar	7 bar

At varying water pressures and with a constant air pressure of 2 bar, the spray coverage of the **Billetcooler FLEX®** (top row) is much more homogeneous than with conventional nozzles (bottom row).

FROM HEAT TRANSFER COEFFICIENT TO RELIABLE COOLING MODEL

The heat transfer coefficient (HTC) is a measure of the cooling performance of a medium. Alongside other parameters, this depends above all on the surface temperature and spray kinetics.

Since it is not always possible to adequately describe the spray kinetics, the simplified assumption that the HTC is a function of the water impact density is often used in the continuous casting process.

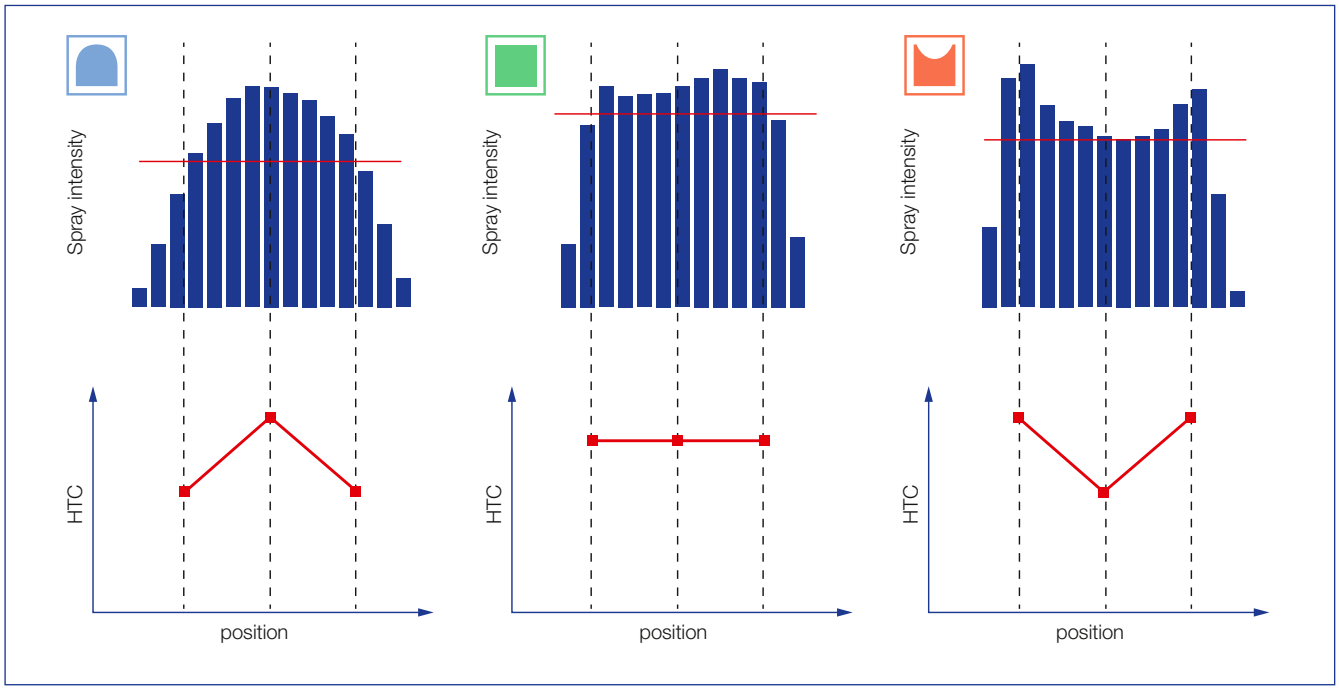
Corresponding empirical equations are used for calculation for air mist nozzles, partially taking into account the air pressure.

During development of the **Billetcooler FLEX®**, HTC measurements were carried out with a moving measuring sensor for all operating conditions. The cooling performance was measured and evaluated for all nozzles as a function of the water and air pressures. These measurements produced a precise, positiondependent description of the cooling performance in the spray in each case.

The figure shows a schematic representation of the relationship between the dynamic liquid distribution measurement and the corresponding average HTC values determined at three measurement positions.

The correlation between water distribution and cooling performance of the new **Billetcooler FLEX®** was proven experimentally.

Thanks to these characteristics, the **Billetcooler FLEX®** offers greater flexibility in the continuous casting process, since the local heat extraction on the strand can be specifically increased or reduced for the first time.



Thanks to these characteristics, the **Billetcooler FLEX®** offers greater flexibility in the continuous casting process, since the local heat extraction on the strand can be specifically increased or reduced for the first time.

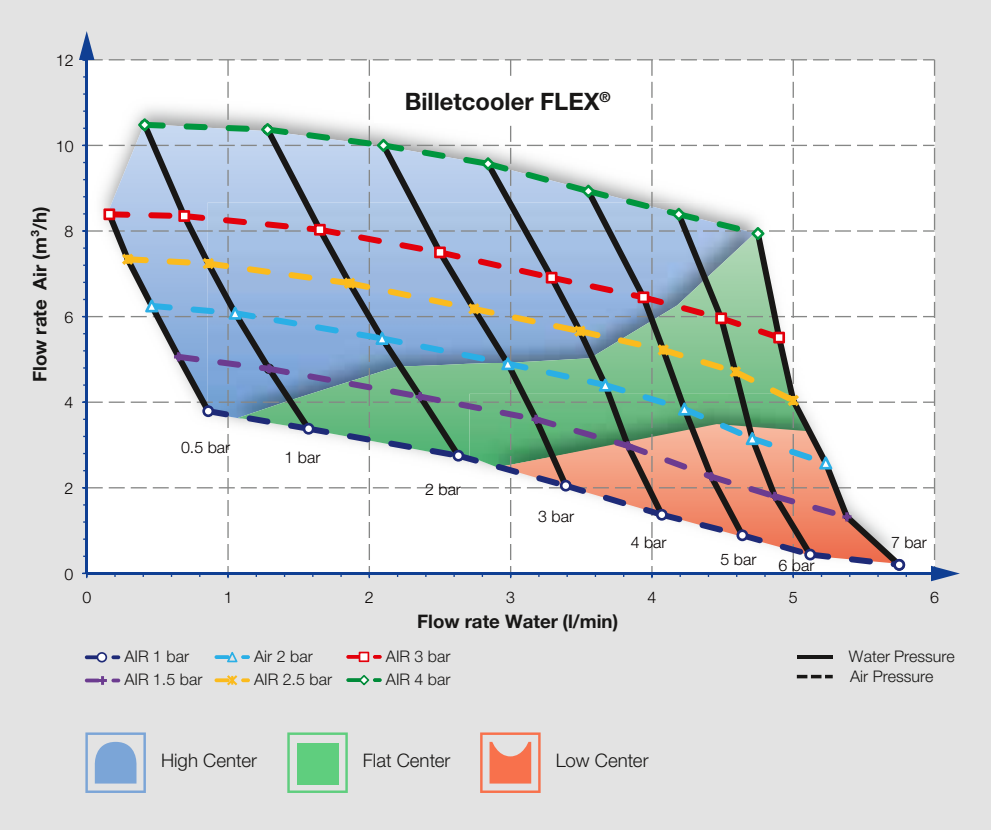
The adjacent figure demonstrates the flexibility of the new **Billetcooler FLEX®** 60° spray angle. For an example nozzle size, the excerpt shows the adjustable liquid distributions as a function of the flow rates with indication of the respective air pressures.

The liquid distribution can be controlled by appropriate selection of the air pressures for comparable water flow rates. As described on the previous page, this allows the local cooling to be adapted to the process-specific requirements.

It is possible to easily see from the diagram how a large operating range can be covered with varying air and water supply pressures.

The colored areas represent the different spray characteristics of the nozzle.

In the blue area (High Center), the liquid distribution is centered and decreases towards the edge of the spray. The green area (Flat Center) is characterized by homogeneous liquid distribution, while the spray characteristic in the red area (Low Center) is similar to a hollow cone nozzle with ring-shaped distribution.

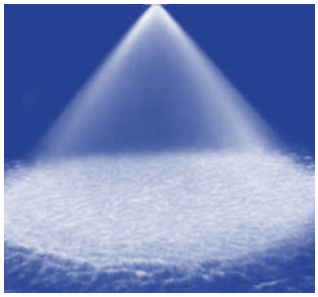


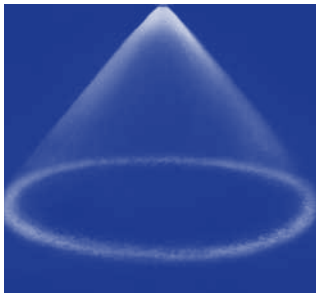
Flow distribution chart of a **Billetcooler FLEX®** 60° spray angle

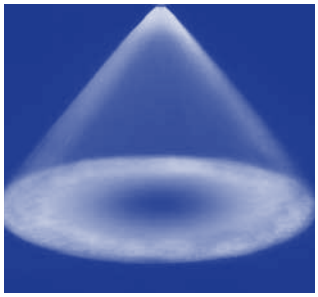
THE RIGHT NOZZLE FOR EVERY FORMAT

Optimum spray characteristics for all formats

The optimum spray profile for every format can be realized with the **Billetcooler FLEX®** by controlling the air pressure.

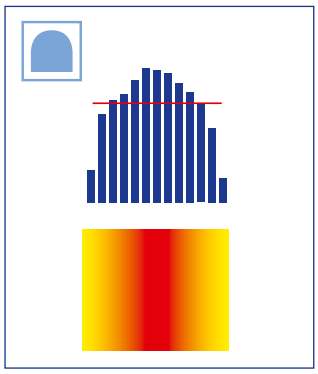






Rectangular long products

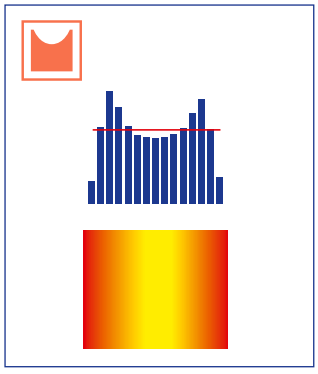
Billets tend to cool down more quickly at the edges. Spray profiles with a liquid distribution that decreases slightly towards the edges („High Center“) have proven themselves to be suitable for ensuring that the edges are not overcooled.



„High Center“ cooling profile

Round formats

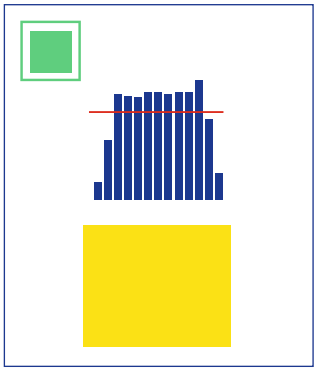
Round formats have a three-dimensional cooling surface. On larger formats in particular, the spray height increases from the center to the edges. A center-reduced „Low Center“ profile is recommended here to ensure that the center area of the blooms is not overcooled.



„Low Center“ cooling profile

Blooms

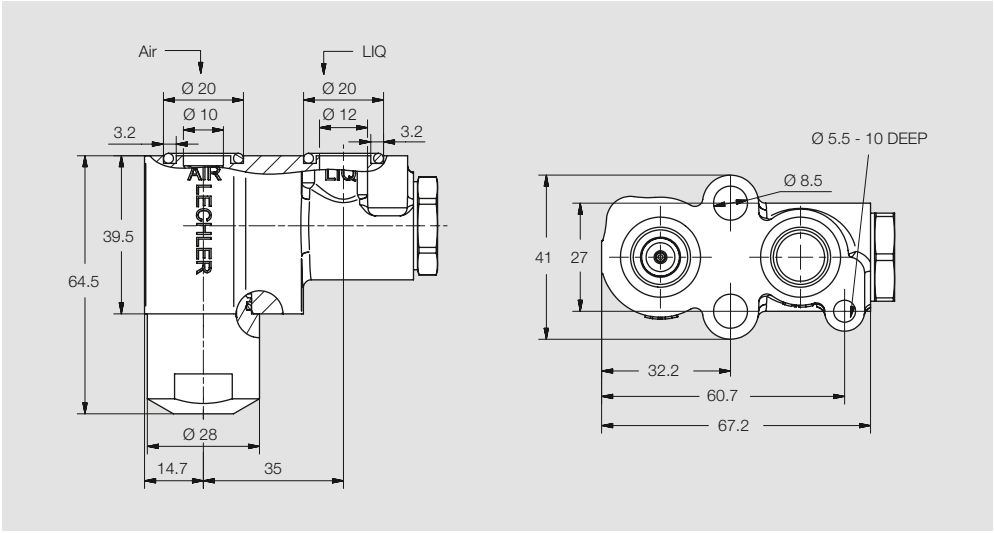
The „Flat Center“ cooling profile is recommended for blooms and larger billet formats.



„Flat Center“ cooling profile

BILLETCOOLER FLEX® – TECHNICAL SPECIFICATIONS

The connection dimensions correspond to the previous Billetcooler nozzles of the series 1PM.021.30.XX. Please request the data sheets for comparison.



Spray angle	Type	Nozzle size	Min. flow rate [l/min]	Max. flow rate [l/min]	Narrowest free cross-section [mm]		Material		Weight
					Water	Air	Nozzle	Gasket	
45°	**1PM.150.30.33**	**0.80**	0.3	3.0	1.35	1.35	Brass	Viton	0.9 kg
	1PM.150.30.35	**1.25**	0.5	5.0	1.90	1.90	Brass	Viton	0.9 kg
	1PM.150.30.38	**2.00**	0.8	8.0	2.20	2.15	Brass	Viton	0.9 kg
60°	**1PM.150.30.03**	**0.80**	0.3	3.0	1.35	1.35	Brass	Viton	0.9 kg
	1PM.150.30.05	**1.25**	0.5	5.0	1.90	1.90	Brass	Viton	0.9 kg
	1PM.150.30.08	**2.00**	0.8	8.0	2.20	2.15	Brass	Viton	0.9 kg
90°	**1PM.150.30.93**	**0.80**	0.3	3.0	1.45	1.45	Brass	Viton	0.9 kg
	1PM.150.30.95	**1.25**	0.5	5.0	1.90	1.90	Brass	Viton	0.9 kg

For detailed technical information, please contact us.
We will provide you the complete technical nozzle documentation.

BILLETCOOLER FLEX® – ADVANTAGES AND BENEFITS

Stable spray angle

The **Billetcooler FLEX®** is characterized by its constant spray angle, which is between 60° and 70° 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

Blockage-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 simpler air mist nozzle designs and therefore helps to improve the energy efficiency of the overall installation.

➡ **Saves 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**

Our engineers have extensive know-how in the metallurgical industry. Together with you, they analyze the situation on-the-spot and recommend a suitable nozzle combination and configuration.

Contact us and arrange a consulting appointment without obligation.
Detailed technical documentation is available on request.

As a **process engineer** at Lechler, I frequently encounter problems relating to instable spray angles and inhomogeneous liquid distribution on the strand when optimizing the secondary cooling systems of long-product casters. This is particularly true for casters with a wide product range and different section sizes where the maximum nozzle turn-down range is used. This frequently results in local undercooling and overcooling as well as quality problems in the form of cracking.

The new **Billetcooler FLEX®** is a tool that I will use specifically to solve these problems for our customers in future. The stable spray angle guarantees a constant secondary cooling surface in the entire nozzle operating range and will therefore contribute to improving product quality on these casters.

In my opinion, development of a nozzle type in combination with verification of the local cooling effect is a convincing approach, since the cooling performance is the most meaningful process parameter of a nozzle in the area of secondary cooling.

Precise documentation of the liquid distribution characteristics as a function of flow rates and pressures permits realization of a flexible secondary cooling control which adjusts the required cooling characteristics on a product-specific basis.

Robert Wolff

I am convinced of the quality of the **Billetcooler FLEX®** and its ability to meet increased customer demands. It can be used both for eliminating local overcooling and undercooling in existing casters, since its connection geometry is compatible with its predecessor, and for installation in new casters with the highest requirements for secondary cooling quality and flexibility.

As an **application engineer** at Lechler, customers frequently confront me with issues relating to secondary cooling in modern continuous casting installations.

Overcooling of the edges is always a problem when casting rectangular billets and blooms and can be avoided only with a very stable nozzle spray angle. A stable nozzle spray angle is also required for round formats in order to ensure precise cooling in the overlap areas.

With the new **Billetcooler FLEX®**, I now have a product that allows me to help customers achieve optimum secondary cooling.

More homogeneous cooling can be achieved thanks to the extremely stable spray angle over the entire turn-down range – particularly with low water flow rates for low casting speeds.

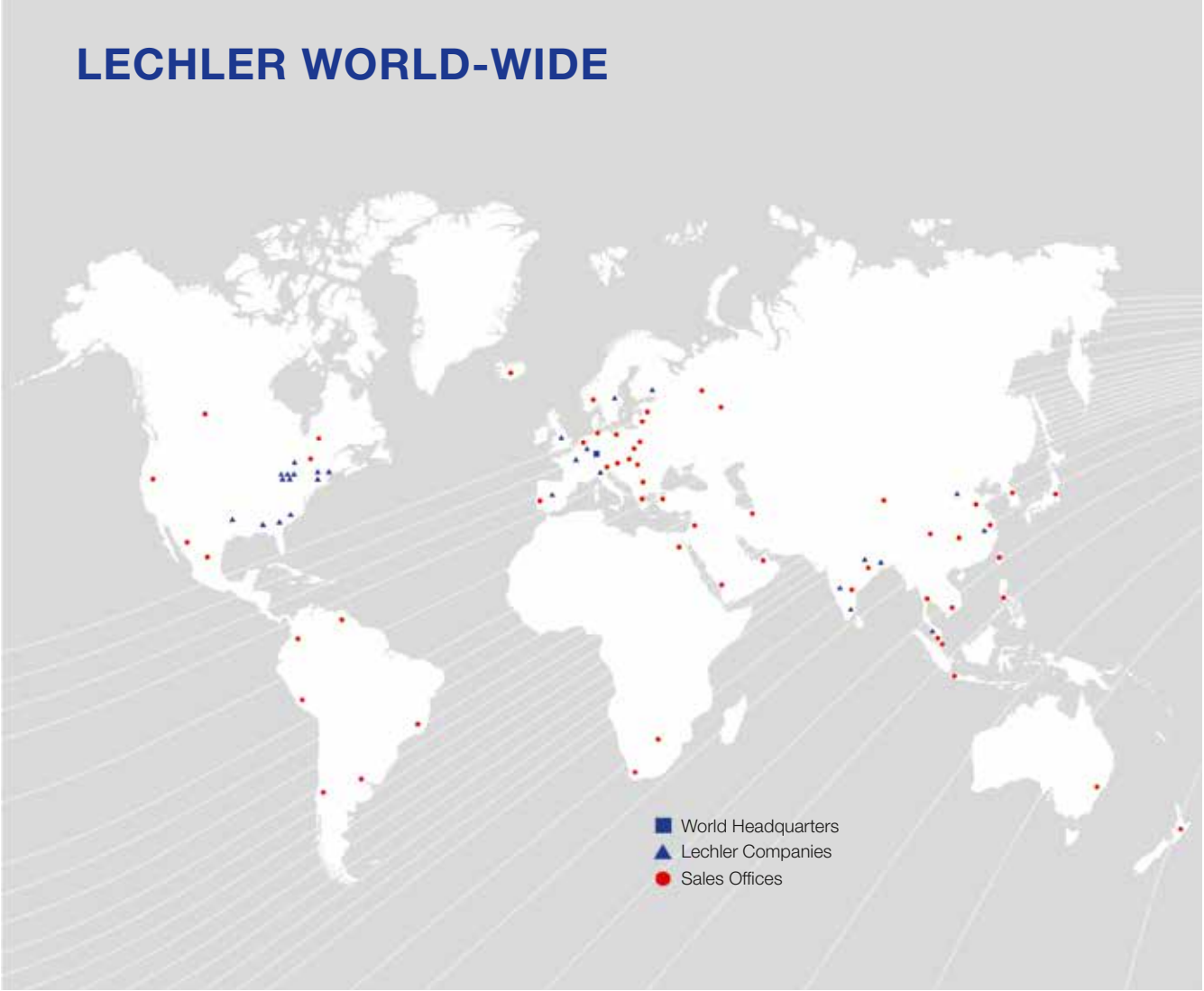
Since today's continuous casters must offer high flexibility as regards formats and steel grades, the nozzles used also have to satisfy higher demands. The versatile adjustment possibilities of the **Billetcooler FLEX®** allow targeted and demand-oriented fine tuning, a feature that is often needed in practical operation to guarantee optimum quality and productivity.

Jochen Munz

I would be delighted if I can contribute with this new nozzle series to enhancing the product quality of our customers together with them.

ENGINEERING
YOUR SPRAY SOLUTION

LECHLER WORLD-WIDE



Lechler GmbH · Precision Nozzles · Nozzle Systems
Ulmer Strasse 128 · 72555 Metzingen, Germany · Phone: +49 7123 962-0 · info@lechler.de · www.lechler.com

ASEAN: Lechler Spray Technology Sdn. Bhd. · No. 23 Jalan, Teknologi 3/3A · Kota Damansara · 47810 PJ, Malaysia · Phone +603 6142 1288 · info@lechler.com.my
Belgium: Lechler S.A./N.V. · Avenue Newton 4 · 1300 Wavre · Phone +32 10 225022 · info@lechler.be
China: Lechler Nozzle Systems (Changzhou) Co., Ltd. · No.99 Decheng Rd, Jintan, Changzhou, JS 213200, P.R.C · Phone +86 519-6822 8088 · info@lechler.com.cn
Finland: Lechler Oy · Ansatie 6 a C 3 krs · 01740 Vantaa · Phone +358 207 856880 · info@lechler.fi
France: Lechler France SAS · Bât. CAP2 · 66–72 Rue Marceau · 93100 Montreuil · Phone +33 1 49882600 · info@lechler.fr
Great Britain: Lechler Ltd. · 1 Fell Street, Newhall · Sheffield, S9 2TP · Phone +44 114 2492020 · info@lechler.com
India: Lechler (India) Pvt. Ltd. · Plot B-2 · Main Road · Wagle Industrial Estate Thane · 400604 Maharashtra · Phone +91 22 40634444 · lechler@lechlerindia.com
Italy: Lechler Spray Technology S.r.l. · Via Don Dossetti, 2 · 20080 Carpiano (Mi) · Phone +39 2 98859027 · info@lechleritalia.com
Russia: Lechler Rus · OOO, 108811, Moscow, Settlement Moskowskiy, Kiewskoe Chaussee km 22 · Object 4, Bld. 2, Block G, Floor 6, Office 601/G · info@lechler-rus.ru
Spain: Lechler, S.A. · C / Isla de Hierro, 7 – Oficina 1.3 · 28703 San Sebastián de los Reyes (Madrid) · Phone +34 91 6586346 · info@lechler.es
Sweden: Lechler AB · Kungsängsvägen 31B · 753 23 Uppsala · Phone +46 18 167030 · info@lechler.se
USA: Lechler Inc. · 445 Kautz Road · St. Charles, IL 60174 · Phone +1 630 3776611 · info@lechlerusa.com

Edition 10/17 · EN · PDF · M-2017-3550-105 · www.dgm-walliser.de · S · Subject to technical modifications.