



Spraying Systems Co.[®]
Experts in Spray Technology



Spray
Nozzles



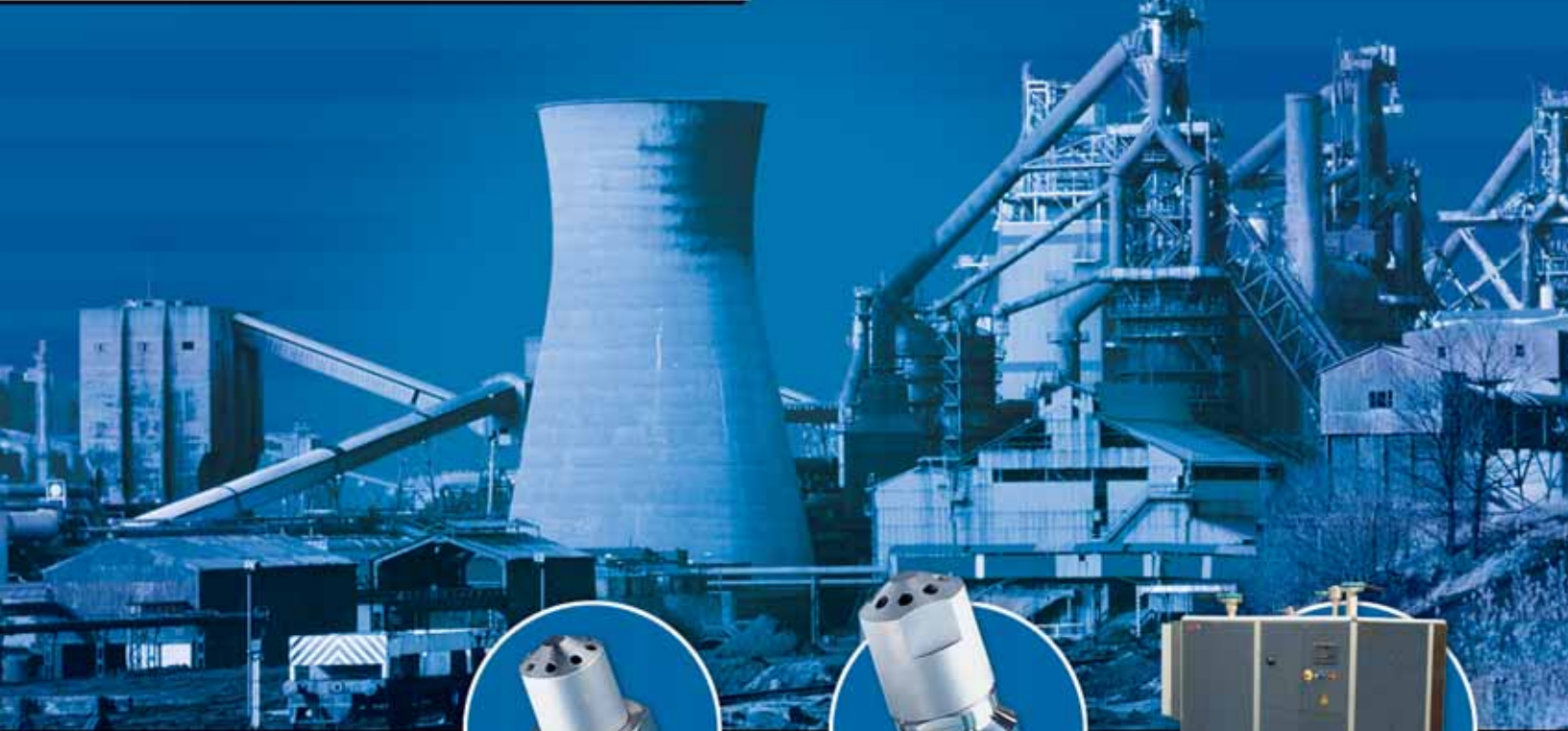
Spray
Control



Spray
Analysis



Spray
Fabrication



Gas Cooling and Conditioning in Primary Metals

A Guide to Improving Efficiency, Increasing Throughput, Reducing Downtime and Lowering Costs

Spray Technology:

better than ever for solving gas conditioning problems

Steel mill customers all have the same basic need — the quick and efficient cooling of gases to lower temperature and reduce volume. Increasing production, minimizing maintenance outages and reducing energy costs are top priorities for users of both wet and dry processes. The use of alternative and low-grade fuels makes effective gas cooling even more complicated.

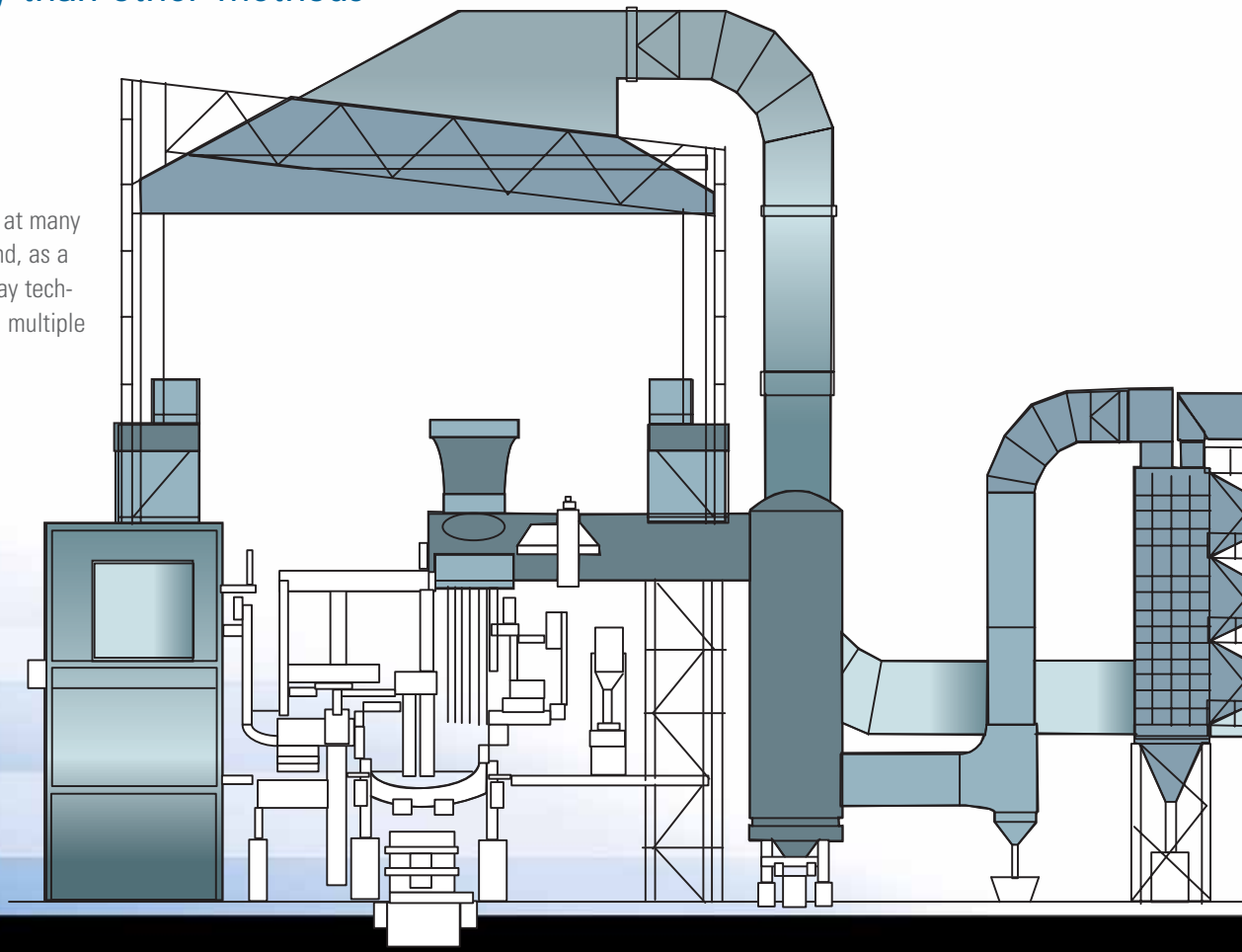
Effective gas temperature control, gas volume reduction and humidification are best achieved by evaporative spray cooling. There are other options, but they are not as efficient or as effective as spray cooling. In fact, the recent introduction of high-efficiency air atomizing nozzles and turnkey systems has made spray technology an even better solution than it was before.

Consider these issues — many of which you may be facing:

- Unexpected downtime caused by ESP overload.
- Reduced production due to gas volumes straining the capacity of downstream equipment.
- Excessive maintenance time as a result of wetting and sludge build-up.
- Excess emissions.
- High energy costs.
- Additional maintenance time to repair equipment damaged by breakaway build-up from wet walls and bottoms.

From ductwork to dryers and coolers to kilns, spray technology can cool and condition gases more efficiently than other methods

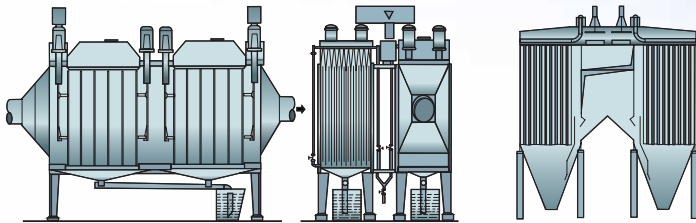
Air pollutants are generated at many points during steelmaking and, as a result, gas cooling using spray technology can often be found in multiple plant locations.



Gas cooling using spray technology can help.

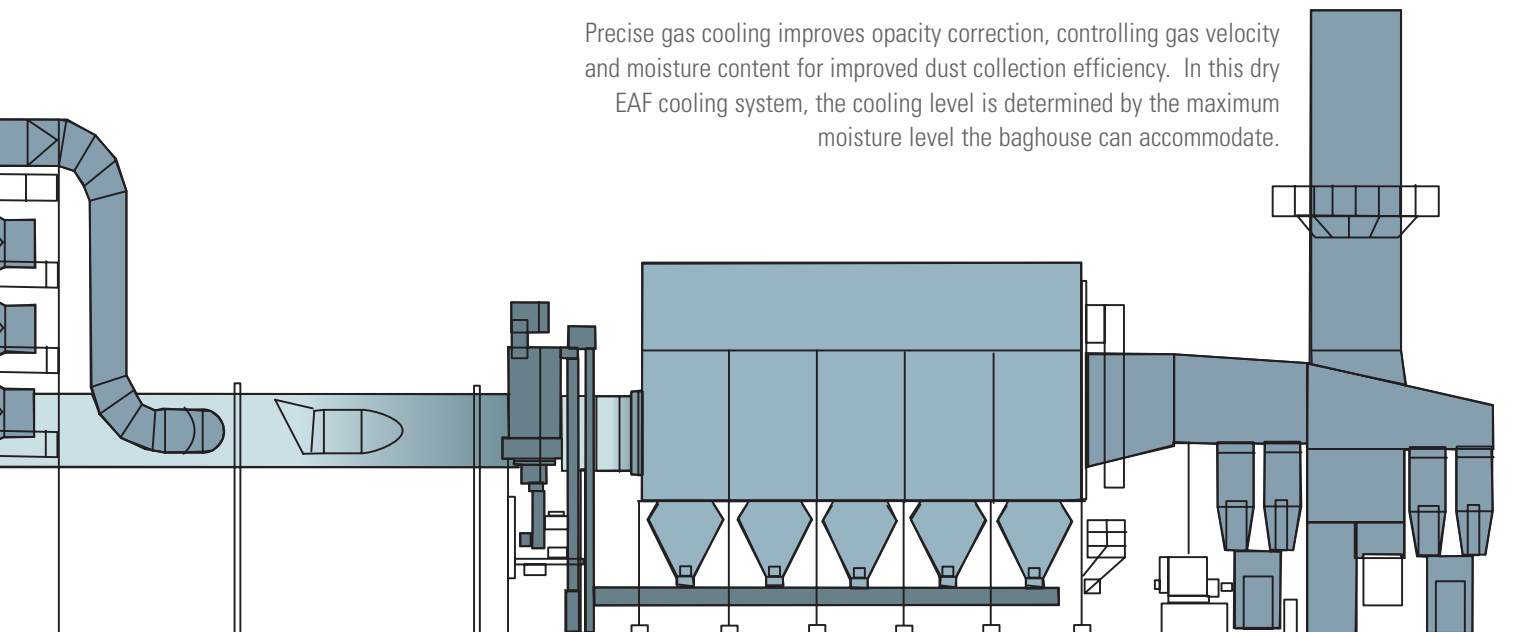
By efficiently reducing gas temperature and volume, you'll experience:

- Precise control of temperature and humidity to maximize dust collection and ESP performance.
- Reduced maintenance time to clean ducts, kiln feed hoods and tower walls/bottoms and to monitor, repair and restart equipment.
- Significant reductions in the creation and release of toxic dioxins and furans and lower costs associated with government compliance.
- Lower energy costs due to optimized ESP performance.



Evaporative cooling prior to ESPs (left) or baghouses (right) optimizes equipment efficiency, lowers energy costs and enables higher production rates without any increase in equipment size.

Precise gas cooling improves opacity correction, controlling gas velocity and moisture content for improved dust collection efficiency. In this dry EAF cooling system, the cooling level is determined by the maximum moisture level the baghouse can accommodate.



AutoJet® Gas Conditioning Systems:

a completely automated solution that results in even greater efficiencies

Many mills are looking for a totally automated solution to ensure optimal performance and savings on labor and downtime. Our AutoJet Gas Conditioning System features a proprietary control system designed to maximize the performance of FloMax® nozzles and provides total system automation.

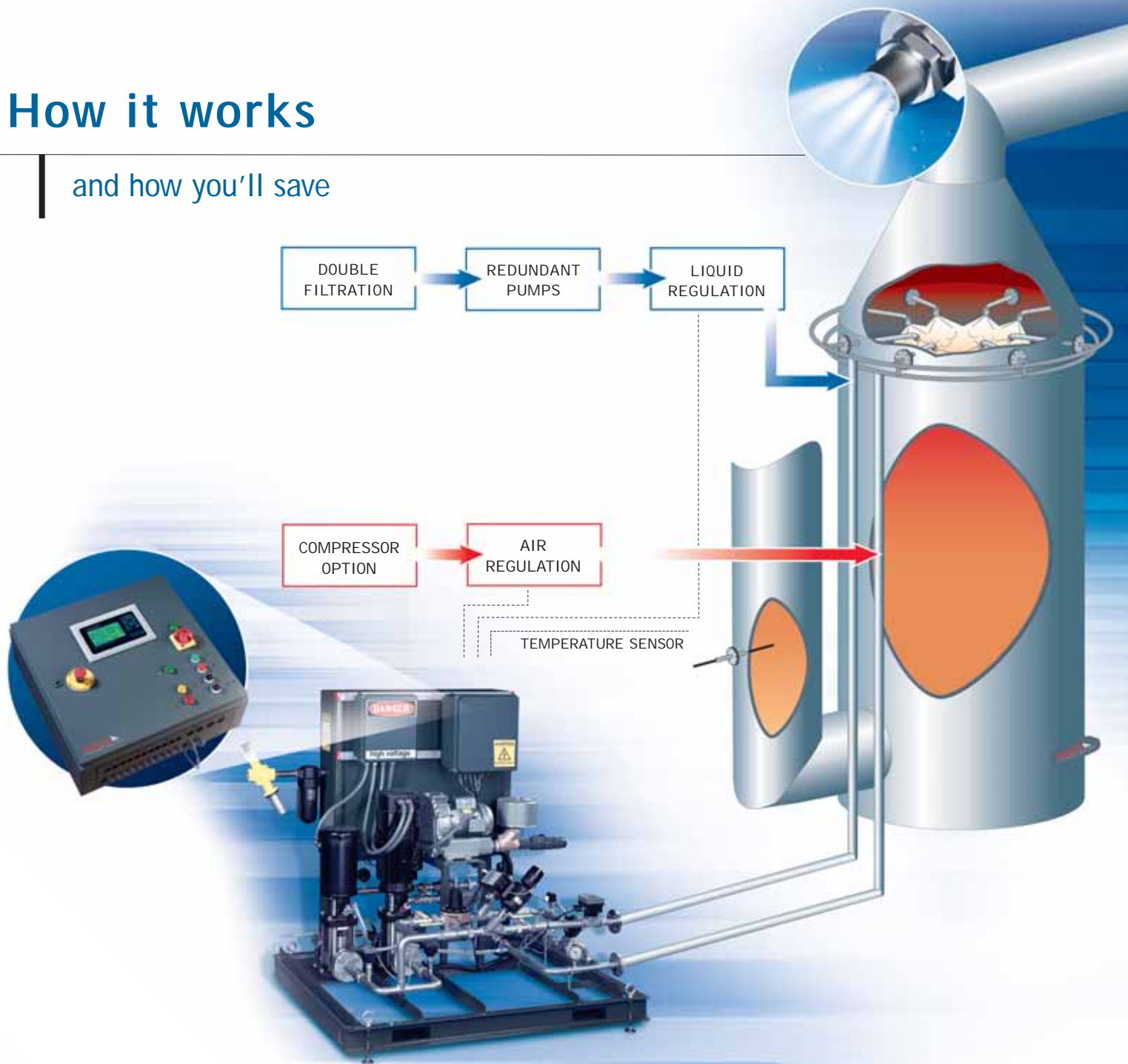
Nine benefits the AutoJet System can bring to your gas cooling application

- 1. Optimal performance:** Our AutoJet spray controller, with patent-pending SprayLogic® software, monitors and automatically adjusts the closed loop system. By regulating liquid and air flow to the nozzles based on data gathered from RTD temperature sensors, the controller offers the highest level of reactivity and accuracy for the system.
- 2. Plug and spray convenience:** Pre-programmed with parameters and function screens specific to gas conditioning applications, our controller will save you time and money during installation. Full LabVIEW® simulation and system pre-testing prior to shipping ensure full functionality upon set-up.
- 3. Total automation minimizes labor and downtime:** The AutoJet spray controller controls all system components — nozzles, pumps, sensors and other hydraulic/pneumatic components. If a problem is detected that the controller can't resolve automatically, operator warnings will be displayed or sounded.
- 4. Multiple lance zones:** AutoJet Gas Conditioning Systems can be configured with multiple lance zones to allow greater turndown of flow rate under variable system conditions.
- 5. Built for reliability:** Emergency modes, system redundancy, intelligent fault sensing and patent-pending continuous system integrity checking are just a few of the reasons why you can count on long-term, trouble-free performance.
- 6. Reduced energy costs:** Variable Frequency Drive (VFD) pumps provide proportional liquid regulation and significant electricity savings. In addition, energy-efficient proportional air regulation reduces air consumption and operating costs.
- 7. Easy integration:** You can easily integrate the AutoJet Gas Conditioning System with other systems through direct wiring and current splitters for access to critical data. For full control of all available data, an optional OPC communication link is available.
- 8. Ease of use:** Our controller is easy to use and is equipped with complete spray "knowledge." Just provide information about your operation using the menu system and the controller will essentially configure itself.
- 9. Single source convenience:** Should you have a question about your system, just give us a call. No need to contact multiple suppliers and coordinate their efforts should a problem occur.



How it works

and how you'll save



Potential savings

using an AutoJet® System and FloMax® nozzles

- 5% savings on installation compared to hydraulic systems.
- 30% less in electricity.
- 50% less in replacement parts.
- 75% less in labor/maintenance.

Estimated first year savings: **US \$20,000**

Estimated ongoing annual savings: **US \$12,000**

Sophisticated Spray Characterization and Testing Ensure Optimal Spray Performance

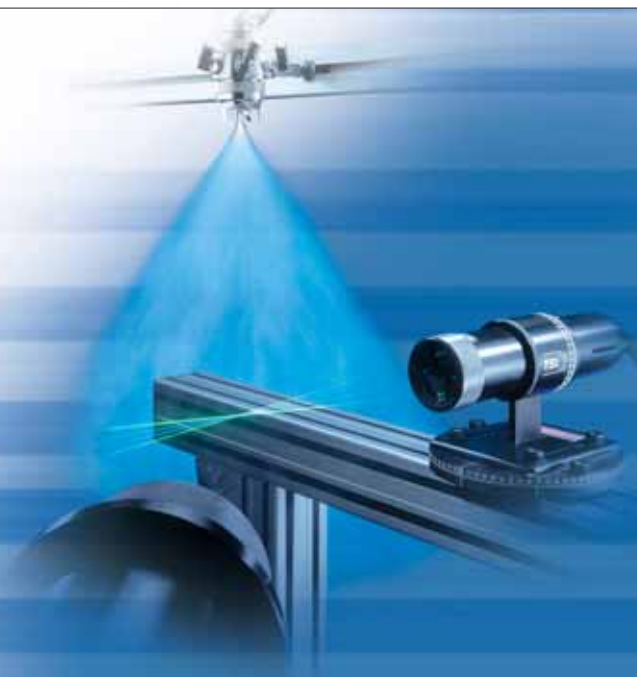
Determining the exact drop size required in gas cooling applications is critical. Many problems result from premature or incomplete evaporation. If drops evaporate too quickly, the desired level of absorption may not occur and upstream/downstream equipment may be less efficient or damaged. If drops don't evaporate quickly enough, wetting will occur, unplanned steam may result and dust can accumulate in the duct or tower and obstruct gas flow.

The most effective way to determine the required dwell time is to conduct spray characterization studies in a fully equipped spray laboratory to simulate actual operating conditions.

Typically these studies include:

- Drop size testing to determine the optimal drop size and drop size distribution.
- Determination of gas velocity and density and the resulting impact on drop size.

Spray Analysis and Research Services, a service of Spraying Systems Co., is home to the most fully equipped spray laboratory in the world. We have several state-of-the-art instruments for drop size measurement including Phase Doppler Particle Analyzers, Laser Imaging, Particle/Image Analyzers and Laser Diffraction Analyzers.



▲ **Phase Doppler Particle Analyzers**
The Phase Doppler method is based on the principles of light scattering interferometry. These flux sampling instruments are most effective in measuring the drop size and velocity of medium to large sprays.

Drop size data:

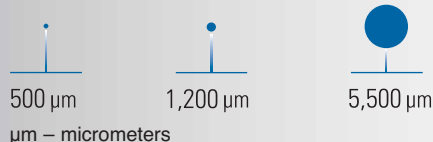
Why it is important in gas conditioning and what you need to know

Drop size is the critical consideration in evaporative cooling. It impacts virtually every aspect of gas cooling and can have a significant impact on cooling effectiveness.

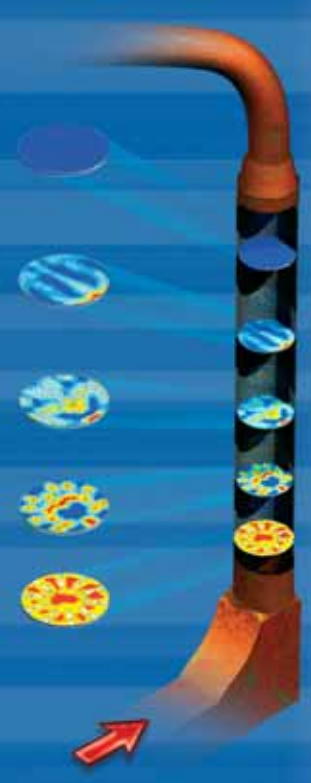
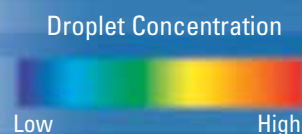
Actual Drop Sizes

One inch = 25,400 μm

One millimeter = 1,000 μm



In some cases, simulating operating conditions in a laboratory environment and modeling of the data is not feasible. That's when we turn to Computational Fluid Dynamics (CFD) and proprietary drop distribution calculations. These tools enable us to accurately predict spray performance in a customer's operating environment.



Drop size refers to the size of the individual spray drops that comprise a nozzle's spray pattern. Each spray provides a range of drop sizes. This range is the drop size distribution.

Hydraulic vs. air atomizing:

comparing the evaporative cooling options

Evaporative cooling can be achieved two ways: with hydraulic spray nozzles or air atomizing nozzles. Historically, high-pressure hydraulic nozzles have been used primarily because high-efficiency air atomizing nozzles weren't available. However, significant technological advances in atomization have occurred in the last decade and air atomizing nozzles are now the preferred solution. The charts that follow explain why.

PERFORMANCE COMPARISON		
	AIR ATOMIZING NOZZLES 	HYDRAULIC NOZZLES 
OVERALL PERFORMANCE	<ul style="list-style-type: none"> Precise control of both liquid and air. 	<ul style="list-style-type: none"> Fluctuates with pressure changes.
DROP SIZE	<ul style="list-style-type: none"> Small: 200 μm D_{max}* reduces dwell time and risk of wetting. 	<ul style="list-style-type: none"> Large: 290 μm D_{max}* (42% larger than a drop from an atomizing nozzle); more dwell time required, wetting more likely.
PARTICULATE COLLECTION DEVICES	<ul style="list-style-type: none"> Performance improves due to an increase in gas density and a reduction in volume/velocity. 	<ul style="list-style-type: none"> Performance improvements limited; may require expansion if volume increases.
EMISSION CONTROL	<ul style="list-style-type: none"> Better temperature/humidity control enables reductions in toxic dioxins and furans and lowers cost of compliance. 	<ul style="list-style-type: none"> Particulate release more likely because of variations in drop size and less control over temperature/humidity.
ENERGY	<ul style="list-style-type: none"> Low-pressure pumps require less energy. Compressors required but nozzles are air efficient. Faster cooling and more efficient reduction of gas volume requires less energy. 	<ul style="list-style-type: none"> High-pressure pumps are not energy efficient. No compressors required.
EQUIPMENT COST	<ul style="list-style-type: none"> Requires low-pressure pumps and low-pressure piping. High capacity nozzles mean fewer lances required. Smaller cooling tower. 	<ul style="list-style-type: none"> Requires high-pressure pumps and high-pressure piping. Lower capacity limits on nozzles required to ensure drops evaporate effectively. More nozzles mean more lances and larger cooling towers.
MAINTENANCE	<ul style="list-style-type: none"> Low-pressure pumps require little maintenance. Lack of wetting eliminates clean-up of sludge and build-up. Wear-resistant materials require less maintenance. 	<ul style="list-style-type: none"> High-pressure pumps require more maintenance. Wet walls and bottoms require considerable cleaning. Corrosion due to excess humidity possible. High-pressure atomization results in accelerated wear, higher replacement costs and performance problems.
WATER	<ul style="list-style-type: none"> River water, basins and run-off water acceptable due to nozzle large free passage. 	<ul style="list-style-type: none"> Clean water supply (drinking water standard or better) required to ensure nozzle clogging is minimized.

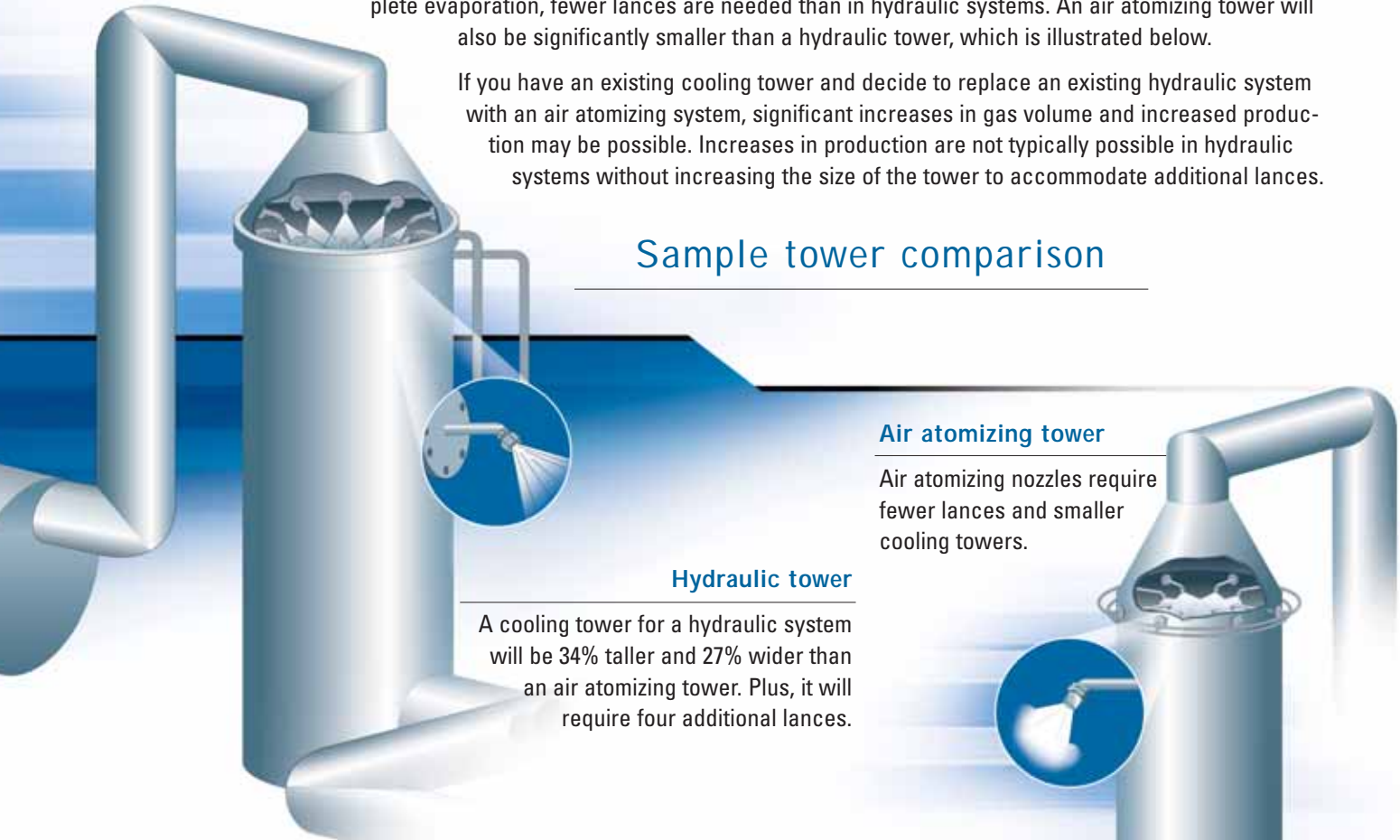
* Based on FloMax® nozzle spraying 10.0 gpm at 50 psig air pressure and the Flowback 7.0 gpm nozzle at 580 psig liquid pressure.

High-efficiency air atomizing nozzles result in more than energy and operational savings — smaller cooling towers are possible

Choosing an air atomizing system can have a significant impact on the design of the cooling tower required. Since air atomizing nozzles produce smaller drop sizes and require shorter dwell times for complete evaporation, fewer lances are needed than in hydraulic systems. An air atomizing tower will also be significantly smaller than a hydraulic tower, which is illustrated below.

If you have an existing cooling tower and decide to replace an existing hydraulic system with an air atomizing system, significant increases in gas volume and increased production may be possible. Increases in production are not typically possible in hydraulic systems without increasing the size of the tower to accommodate additional lances.

Sample tower comparison



Air atomizing tower

Air atomizing nozzles require fewer lances and smaller cooling towers.

Hydraulic tower

A cooling tower for a hydraulic system will be 34% taller and 27% wider than an air atomizing tower. Plus, it will require four additional lances.

SPECIFICATIONS	SAMPLE AIR ATOMIZING TOWER	SAMPLE HYDRAULIC TOWER
DIAMETER	20.6 ft. (6.3 m)	26.2 ft. (8.0 m)
HEIGHT	39.3 ft. (12.0 m)	52.5 ft. (16.0 m)
NUMBER OF LANCES	6	10
LIQUID PRESSURE	59 psig (4.1 barg)	600 psig (41.4 barg)
LIQUID VOLUME PER LANCE	10.5 gpm (39.7 l/min)	7.0 gpm (26.5 l/min)
AIR PRESSURE	50 psig (3.5 barg)	—
AIR VOLUME PER LANCE	57 scfm (98 Nm3/hr)	—
DWELL TIME FOR EVAPORATION	3.5 seconds	7.6 seconds

OPERATIONAL PARAMETERS

GAS VOLUME
250,734 acfm
(426,000 Nm3/hr)

INLET GAS TEMPERATURE
514° F (268° C)

OUTLET GAS TEMPERATURE
302° F (150° C)

TOTAL LIQUID SPRAYED
63.4 gpm (240 l/min)



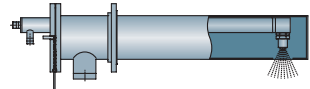
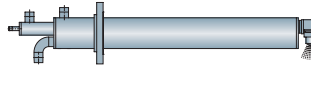
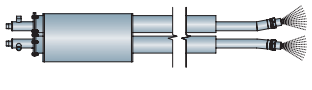
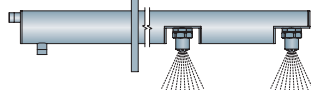
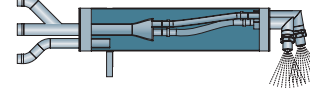
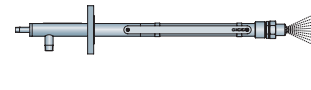
FloMax® nozzles

outperform other air atomizing nozzles

PERFORMANCE COMPARISON

	FLOMAX AIR ATOMIZING NOZZLES	OTHER AIR ATOMIZING NOZZLES
DROP SIZE	<ul style="list-style-type: none"> • 34% smaller drop size reduces dwell time and risk of wetting • Unsurpassed uniformity of drop size distribution 	<ul style="list-style-type: none"> • Producing larger drops utilizes more air and increases energy costs
TURNDOWN RATIOS	<ul style="list-style-type: none"> • Up to 10:1 turndown ratio is possible without choking off air or liquid supplies 	<ul style="list-style-type: none"> • Limited turndown ratio typical of standard air atomizing design
FLOW RATES	<ul style="list-style-type: none"> • Large flow rate per nozzle. Fewer nozzles required for cooling resulting in lower initial purchase cost and less maintenance. Wide range of flow rates available, 0.7 gpm to 30 gpm (2.6 l/min to 114 l/min) 	<ul style="list-style-type: none"> • Larger drops are produced by nozzles that provide equivalent flow rates. To avoid wetting, 2 to 3 times as many lances are used. Higher initial purchase cost and greater ongoing maintenance
MATERIAL SELECTION	<ul style="list-style-type: none"> • Standard materials include 316 and 310SS • Other materials are available upon request to ensure optimal performance in harsh environments, including HASTELLOY®, Stellite® and reaction-bonded silicon carbide 	<ul style="list-style-type: none"> • Limited choices
FREE PASSAGE	<ul style="list-style-type: none"> • Large free passage enables flexibility in water sources 	<ul style="list-style-type: none"> • Small free passage increases risk of clogging and limits water supply options
MAINTENANCE	<ul style="list-style-type: none"> • Durable, long wearing parts require little maintenance • Easy to replace components when required — no special tools needed 	<ul style="list-style-type: none"> • Small free passage requires more frequent maintenance • High air and liquid pressures lead to more frequent nozzle replacement
CONTROL SYSTEM	<ul style="list-style-type: none"> • Single 	<ul style="list-style-type: none"> • Separate control of air and water required
MOUNTING/INSTALLATION	<ul style="list-style-type: none"> • Lightweight lances, manifolds and headers available to facilitate installation • Adapters, cooling jackets, purge tubes and protective tubes also available for special requirements 	<ul style="list-style-type: none"> • More lances required. Lances are typically larger and heavier

EXAMPLES OF OPTIONAL LANCE DESIGNS

 <p>0° Lance Assembly Quick-release flange with bolt-on type protective air/purge tube</p>	 <p>45° Lance Assembly Quick-release flange with bolt-on type protective air/purge tube</p>	 <p>90° Lance Assembly Quick-release flange with bolt-on type protective air/purge tube</p>	 <p>90° Lance Assembly Bolt-on lance assembly with cooling jacket</p>
 <p>Long Kiln Lance Available in lengths 12 ft (3.6 m) and up</p>	 <p>Multiple Nozzle Lance Multi-nozzle configuration provides small drops and high flow rates</p>	 <p>Multiple Nozzle Lance — Cluster Head Enables better nozzle placement</p>	 <p>Flexible Lance Allows nozzle position to be easily adjusted after installation</p>

A closer look

at high efficiency FloMax[®] air atomizing nozzles

All air atomizing nozzles are not alike

In fact, very few are suitable for use in gas conditioning. High efficiency nozzles offer tight control of drop size and spray coverage. The goal is to minimize D_{max} and achieve a finely-atomized spray with D_{32} less than 100 microns at 10 gpm (37.8 l/min). A multi-stage atomization process must be used to achieve this very small drop size.

The patented three-stage atomization process used by FloMax air atomizing nozzles is extremely air efficient and is the primary reason why it is the preferred nozzle for gas conditioning in steel mills.

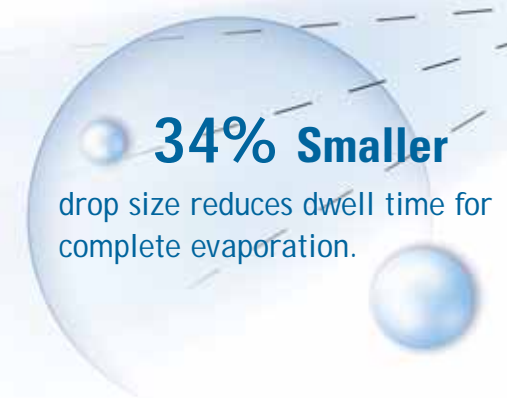
Unlike competitive nozzles using single-step atomization, FloMax nozzles produce a D_{32} drop size that is 34% smaller utilizing 20% less air than competitive nozzles. [Flow rate of 10 gpm (37.8 l/min)] Each nozzle uses as little as 45 scfm (76 Nm³/hr).

FloMax nozzles are available in a wide range of flow rates

NOZZLE TYPE	CAPACITY (gpm)	CAPACITY (l/min)
FM5A	0.7 to 7.0	2.6 to 26.5
FM10A	1.3 to 13.0	4.9 to 49.2
FM25A	10.0 to 30.0	37.8 to 114

Smaller drop size benefits:

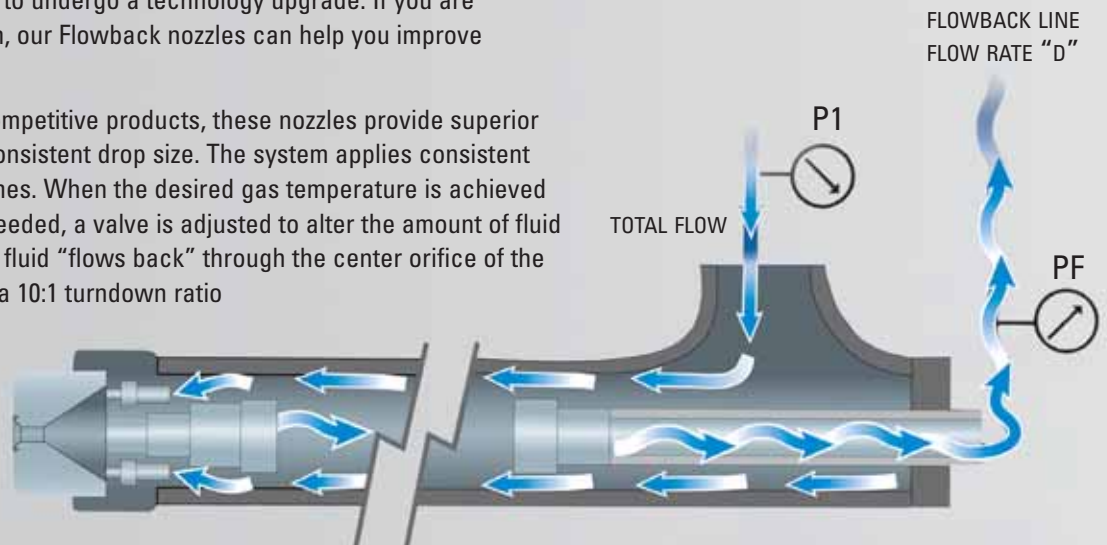
- Lower installation and maintenance costs due to the wide range of flow rates per nozzle.
- The liquid being sprayed generates more surface area per gallon for a more complete reaction and total absorption without wetting.
- Lower energy costs.
- Longer compressor life due to lower air consumption.

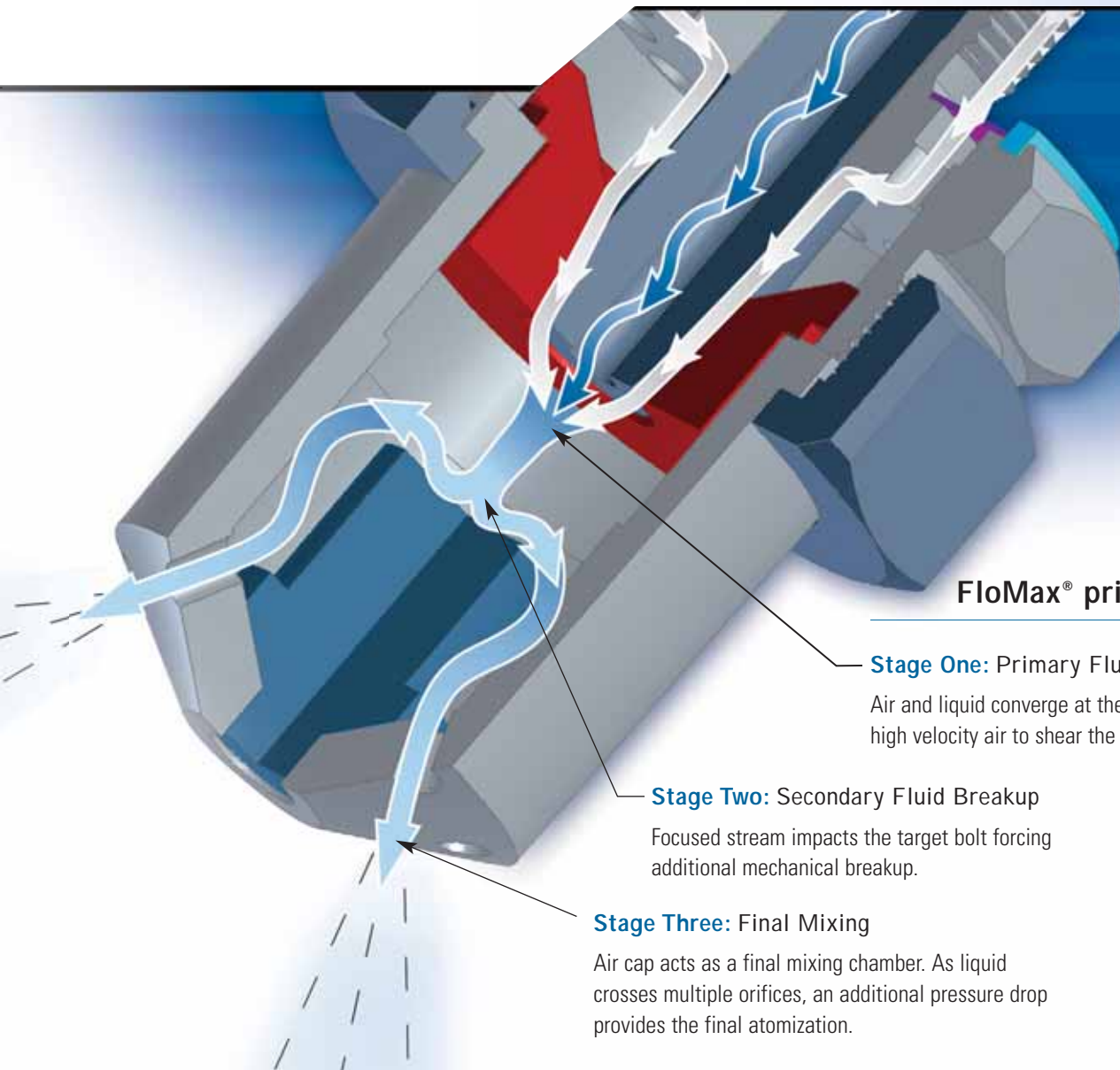


If you have a hydraulic system to maintain, our Flowback nozzles may help improve performance

Not every plant is in a position to undergo a technology upgrade. If you are maintaining a hydraulic system, our Flowback nozzles can help you improve performance.

Easily interchangeable with competitive products, these nozzles provide superior performance by delivering a consistent drop size. The system applies consistent pressure to the nozzle at all times. When the desired gas temperature is achieved and a reduction in volume is needed, a valve is adjusted to alter the amount of fluid leaving the nozzle. The excess fluid “flows back” through the center orifice of the nozzle body. The nozzle offers a 10:1 turndown ratio to accommodate variations in gas temperature or volume.





FloMax® principle of operation

Stage One: Primary Fluid Breakup

Air and liquid converge at the annulus allowing high velocity air to shear the liquid column.

Stage Two: Secondary Fluid Breakup

Focused stream impacts the target bolt forcing additional mechanical breakup.

Stage Three: Final Mixing

Air cap acts as a final mixing chamber. As liquid crosses multiple orifices, an additional pressure drop provides the final atomization.

Advantages of a Flowback nozzle system



Flowback nozzle

Large selection of nozzle capacities. Sizes range from 1.2 to 45 gpm (4.5 to 170.3 l/min) at 600 psi (41.4 bar). A simple but unique two-piece design makes installation and maintenance quick and easy. No special tools are required — the orifice slides into the nozzle and can be tightened with a wrench.



Competitive nozzle

Complex bellows design with four separate components. The design of these nozzles is delicate.

As a result, they are often damaged during operation or maintenance. Internal leaking, poor atomization and wetting in the tower result. Special tools are required for both installation and maintenance.

Other resources:

FloMax® Air Atomizing Nozzles

Bulletin 487C

Features details and performance data on the unmatched energy-efficient FloMax nozzles and lances.



Bulletin 487C

Spray Technology Reference Guide: Understanding Drop Size

Bulletin 459B

An invaluable technical guide. We've taken 60 years of spray drop knowledge and condensed it into a 36-page booklet to teach you the fundamentals of evaluating and interpreting drop size data.

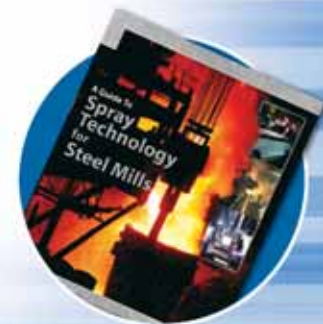


Bulletin 459B

A Guide to Spray Technology for Steel Mills

Catalog 44 and 44M

Detailed information on our full range of products for steel manufacturing is included in this 92-page catalog.



Catalog 44

A Guide to Optimizing Spray Injector Performance

Bulletin 579A

Addresses the specification, design and fabrication of spray injectors/lances to ensure optimal nozzle performance.



Bulletin 579A

Optimizing Your Spray System:

Spray Nozzle Maintenance and Control for Improved Production Efficiency

Technical Manual 410

Explains how to maximize performance and quality in your spray application.



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