Spraying Systems Co.®



Gas Cooling and Conditioning Guide

Using Spray Technology to Optimize Efficiency and Maximize Performance



AutoJet® TECHNOLOGIES

Spray Technology: Still the Best Solution

If you have gases to cool or condition, you know technology is advancing rapidly and you have more options than ever before. However, the basic need to cool hot gases and reduce volume quickly still remains. And, in the final analysis, spray technology remains the easiest and most effective solution.

Historically, evaporative cooling systems have used high pressure hydraulic nozzles to meet cooling requirements. In recent years, evaporative cooling utilizing air atomization has become the preferred solution for a variety of reasons:

- More efficient reduction of gas volume results in lower energy costs.
- Maintenance is minimized.
- Wet deposits and wet walls are eliminated.
- Precise control of humidity prior to electrostatic precipitators (ESPs) improves dust collection efficiency and opacity correction.
- Significant reductions in the creation and emission of toxic dioxins and furans are also possible, making compliance with government regulations less costly.

Many pulp and paper mills, steel mills, power plants, waste incineration facilities and cement plants use air atomizing for evaporative cooling in a variety of applications. Cooling prior to baghouse or ESP, NO_X control and SO_2 removal are areas where evaporative cooling via spray technology is ideally suited.

Now Spray Technology Solutions are Easier Than Ever to Source and Install

Spraying Systems Co. is the worldwide leader in the manufacture of spray nozzles. For more than 60 years, our sole focus has been solving process control problems through spray technology. Our engineers are actively involved in the environmental and energy industries and develop products to meet specialized needs. Our patented FloMax® air atomizing nozzle that offers unmatched efficiency is the result of these collaborations.

Spraying Systems Co. has expanded our service offering with AutoJet Technologies, a new division devoted to turnkey automated spray systems. In addition, our Spray Analysis and Research Services group provides spray nozzle performance testing unmatched in the industry. Together, these resources make the job of sourcing your gas conditioning solution easier than ever before.



Manufacturing and Testing Capabilities Assure Quality

Need documentation? Special testing?
We're ISO 9001-2000 certified and can provide these services:

- ASME code welding
- Complete documentation for material traceability, material test reports, certificates of conformance
- Ultrasonic and radiographic weld testing
- Liquid penetrate testing
- Hardness testing
- Hydrostatic testing
- Third-party witness testing
- Spray and flow testing
- All testing is done in accordance with ANSI and ASTM standards

Solutions that Have Worked for Your Peers and May Help You **Boost Performance,** Too

Efficient Gas Cooling Improves Production

Small droplet sizes produced by FloMax air atomizing nozzles allow greater volumes of gas to be cooled without wetting and maintenance headaches.

Induct Gas Cooling Prior to ESP

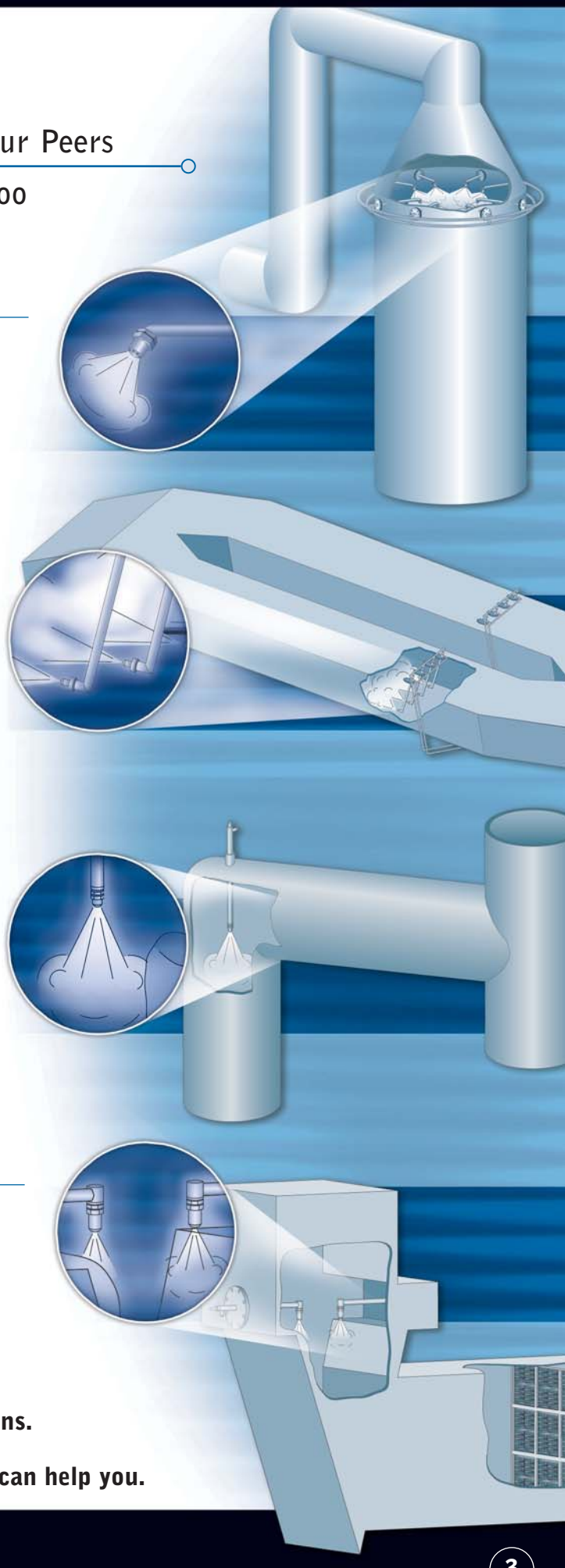
High-efficiency FloMax air atomizing nozzles reduce gas temperature and correct opacity to improve ESP performance.

Carbon Black Production

FloMax air atomizing nozzles provide precise cooling prior to heat exchanger. Complete evaporation prevents fouling of the heat exchanger, eliminating costly maintenance and downtime.

Selective Catalytic Reduction (SCR) NOx Control

Precise control of urea injection and distribution using FloMax air atomizing nozzles improves chemical reaction, reduces ammonia slip and prevents fouling of the catalyst grid.



These are just a few examples of our **successful gas conditioning solutions.**

Contact us to learn how we can help you.

Assessing Your Application:

Selecting the Best Method to Improve Productivity and Lower Costs

If your application can benefit from complete evaporation of liquid, hydraulic high pressure nozzles can be used. Multiple nozzles, simple manifolds, high pressure pumps and basic controllers work together to inject liquids to clean and/or cool gases. However, the trend is to utilize air atomizing nozzles that offer better performance and lower overall cost of ownership. While the initial system cost will be similar to hydraulic systems, operating costs and ongoing maintenance costs will be significantly lower and will yield much greater savings over time. Turnkey AutoJet Gas Conditioning Systems can be built with either hydraulic or air atomizing nozzles.

An Overview of Hydraulic and Air Atomizing Nozzles

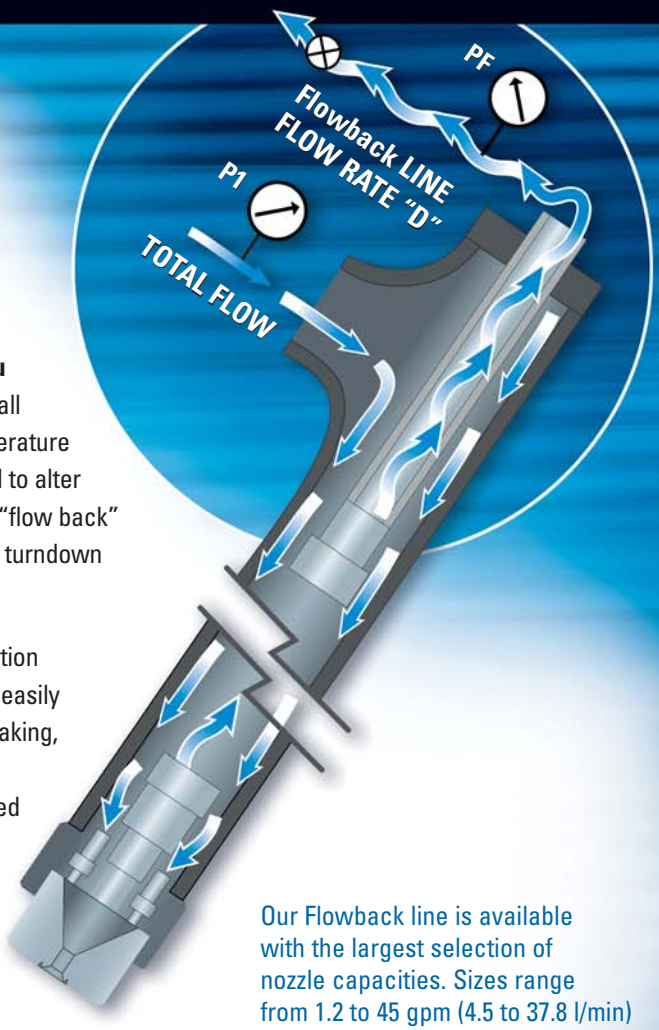
Hydraulic Nozzles	Air Atomizing Nozzles
• Drop size will vary with pressure changes. • Constant flow rate at a given pressure; change in flow requires change in inlet pressure.	• Greater control of both air and liquid enables tighter control of drop size. • Precise control of drop size as flow rate varies. • Smaller drop size reduces dwell time and risk of wetting — allows for more compact cooling tower.
• Require high-pressure pumps, piping, valves, flanges, etc.	• Low pressure components require less maintenance. • Low pressure piping lowers cost.
• Higher number of lances required.	• One air atomizing lance can potentially replace four hydraulic lances.
• Small free passage prone to clogging. Clean water supply required.	• Large free passage means less clogging. Can use river water, basins and run-off water.
• High maintenance costs.	• Wear-resistant materials require less maintenance.
—	• Higher production levels can be achieved using existing ESP or baghouse equipment.

The Hydraulic Solution:

Flowback Nozzle Systems

In applications where residence time for complete evaporation is not critical, our Flowback hydraulic nozzle system can help you improve performance. Constant pressure is applied to the nozzle at all times to produce a consistent drop size. When the desired gas temperature is reached and a reduction in volume is called for, a valve is adjusted to alter the amount of fluid leaving the nozzle. The excess fluid is allowed to "flow 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.

Flowback nozzles feature a simple two-piece design for easy installation and maintenance. Competitive lances utilize a bellows design that is easily damaged during operation or maintenance. This results in internal leaking, poor atomization and wetting. These lances require special tools for installation and maintenance. Our Flowback nozzles are often selected to replace competitive nozzles in existing systems because of the advantages offered in installation and maintenance.



Our Flowback line is available with the largest selection of nozzle capacities. Sizes range from 1.2 to 45 gpm (4.5 to 37.8 l/min) at 600 psi (41.1 bar).

The Air Atomizing Solution:

FloMax Nozzle Systems

High Flow Rates, Small Drop Size and Minimal Energy Consumption Have Made FloMax Air Atomizing Nozzles the #1 Choice for Gas Cooling and Conditioning. The patented three-stage atomization process used by FloMax air atomizing nozzles is extremely efficient and minimizes D_{max} (the maximum drop size by volume present in the spray). The result is a finely atomized spray with Sauter Mean Diameter (SMD) less than 80 microns at 25 gpm (95 l/min), reducing the dwell time required for complete evaporation. The liquid being sprayed generates more surface area per gallon. This allows the liquid to react more completely with the gas stream for complete absorption without wetting.

Unlike competitive nozzles that utilize single step atomization, FloMax nozzles can produce a D_{max} drop size that is 85% smaller utilizing 45% less air. (Flow rate of 10 gpm at 20 psi [37 l/min]) This energy efficiency will lower energy costs and extend air compressor life.

For more information on the importance of drop size, refer to **page 7**



Eight More Reasons Why

FloMax Air Atomizing Nozzles Are Preferred

1. FloMax nozzles allow for a high turndown of flow rate so a set air pressure can be maintained while liquid pressure and flow varies.

2. A large flow rate per nozzle means that fewer nozzles are required for cooling resulting in a lower initial purchase cost and less maintenance.

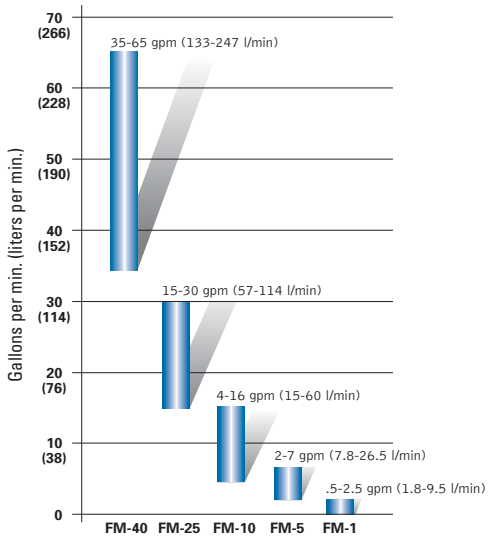
3. FloMax nozzles are available in a variety of corrosion and erosion resistant materials, such as Hastelloy®, Stellite® and reaction-bonded silicon carbide, to ensure optimal performance in harsh environments.

Hastelloy is a registered trademark of Haynes International Inc.
Stellite is a registered trademark of Stoody Deloro Stellite, Inc.

4. Large free passage reduces clogging and allows flexibility in water sources.

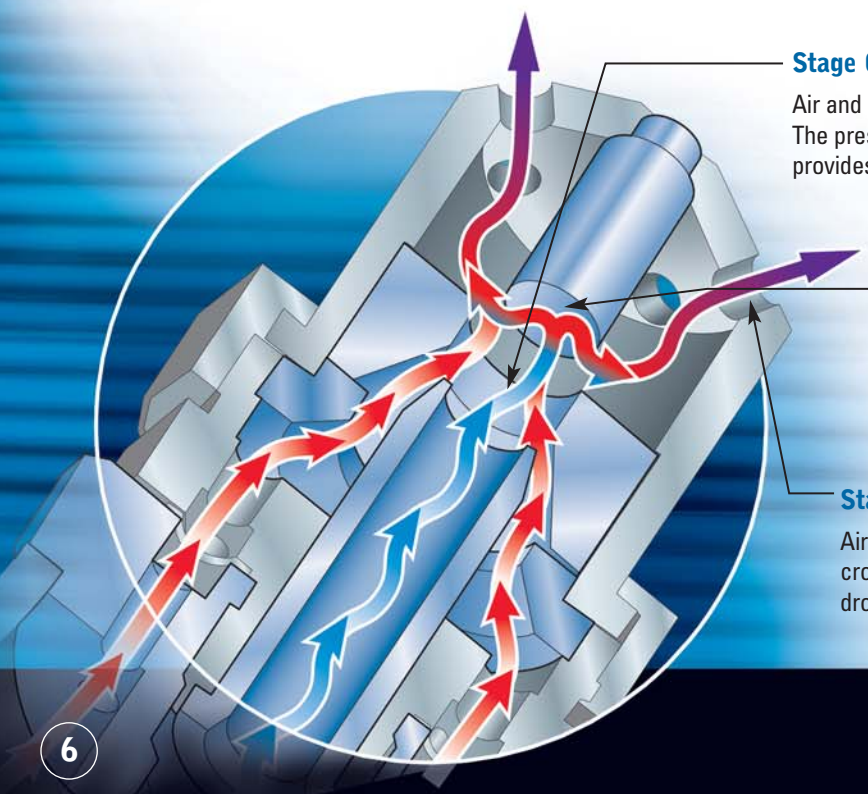
5. Low maintenance since FloMax nozzles operate at low pressures.

6. Wide range of flow rates available – 0.5 gpm to 65 gpm (1.8 l/min to 247 l/min)



FloMax Atomizing Nozzles

FloMax Principle of Operation



Stage One: Primary Fluid Breakup

Air and liquid combine behind the air guide. The pressure drop across the air guide orifice provides primary atomization of the liquid stream.

Stage Two: Secondary Fluid Breakup

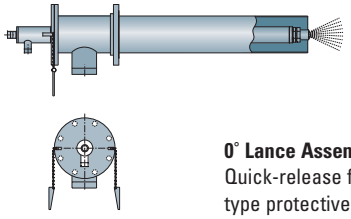
Focused stream impacts the target bolt forcing additional mechanical breakup.

Stage Three: Final Mixing

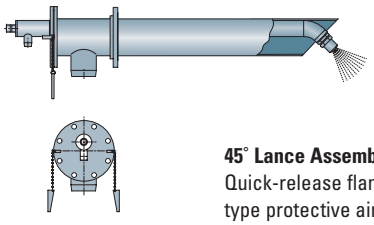
Air cap acts as a final mixing chamber. As liquid crosses multiple orifices, an additional pressure drop provides the final atomization.

7 Easy maintenance when required – no special tools are necessary.

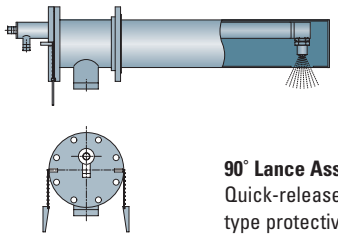
8 Lances, manifolds and headers are available as installation options along with adapters, cooling jackets, purge tubes and protective tubes as needed.



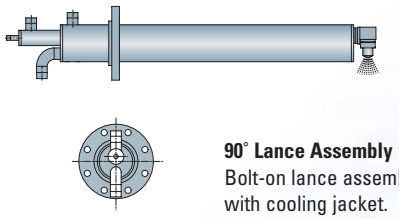
0° Lance Assembly
Quick-release flange with bolt-on type protective air/purge tube.



45° Lance Assembly
Quick-release flange with bolt-on type protective air/purge tube.



90° Lance Assembly
Quick-release flange with bolt-on type protective air/purge tube.



90° Lance Assembly
Bolt-on lance assembly with cooling jacket.

Examples of optional lance designs

Drop Size and Its Importance in Gas Conditioning

Measuring drop size and velocity is important in many applications but is critical in gas cooling. The catalyst for change is carried within the drop and will affect system performance. In addition to Sauter Mean Diameter data, D_{max} data should be evaluated because of its impact on wetting.

It is important that you obtain accurate information and understand how that data was collected. There are different ways to collect and record drop size data but the industry-preferred guideline is ASTM Standard E799. While ASTM E799 permits D_{max} to make up as much as 1% of the volume, all of our measurements keep D_{max} at 0.20% of the volume. This conservative measurement method means we can precisely predict spray system performance. As you are evaluating nozzle options, be sure to ask about the drop size measurement techniques. Many manufacturers provide only imprecise theoretical information.

All of our data and 60 years of drop size expertise is available to you at no charge during the process of selecting and configuring your gas conditioning system. Should your application require special additional testing, our Spray Analysis and Research Services (SARS) will design and quote the testing required. Utilizing the industry's most fully equipped, state-of-the-art testing lab, SARS has the expertise and equipment to help gather and analyze drop size performance data to help determine your exact requirements and ensure your gas conditioning system delivers optimal performance.

Our laboratories are the most fully equipped in the world and include Phase Doppler, Laser Imaging and Laser Diffraction Particle analyzers. Also, our staff is actively involved in the international drop size community - Institute of Liquid Atomization and Spraying Systems (ILASS) and ASTM. We have authored several white papers on drop size measurement techniques, drop size instrumentation, factors affecting drop size and how to interpret and use drop size.

For more information
on our Spray Analysis and Research Services, please visit us at
www.sprayconsultants.com



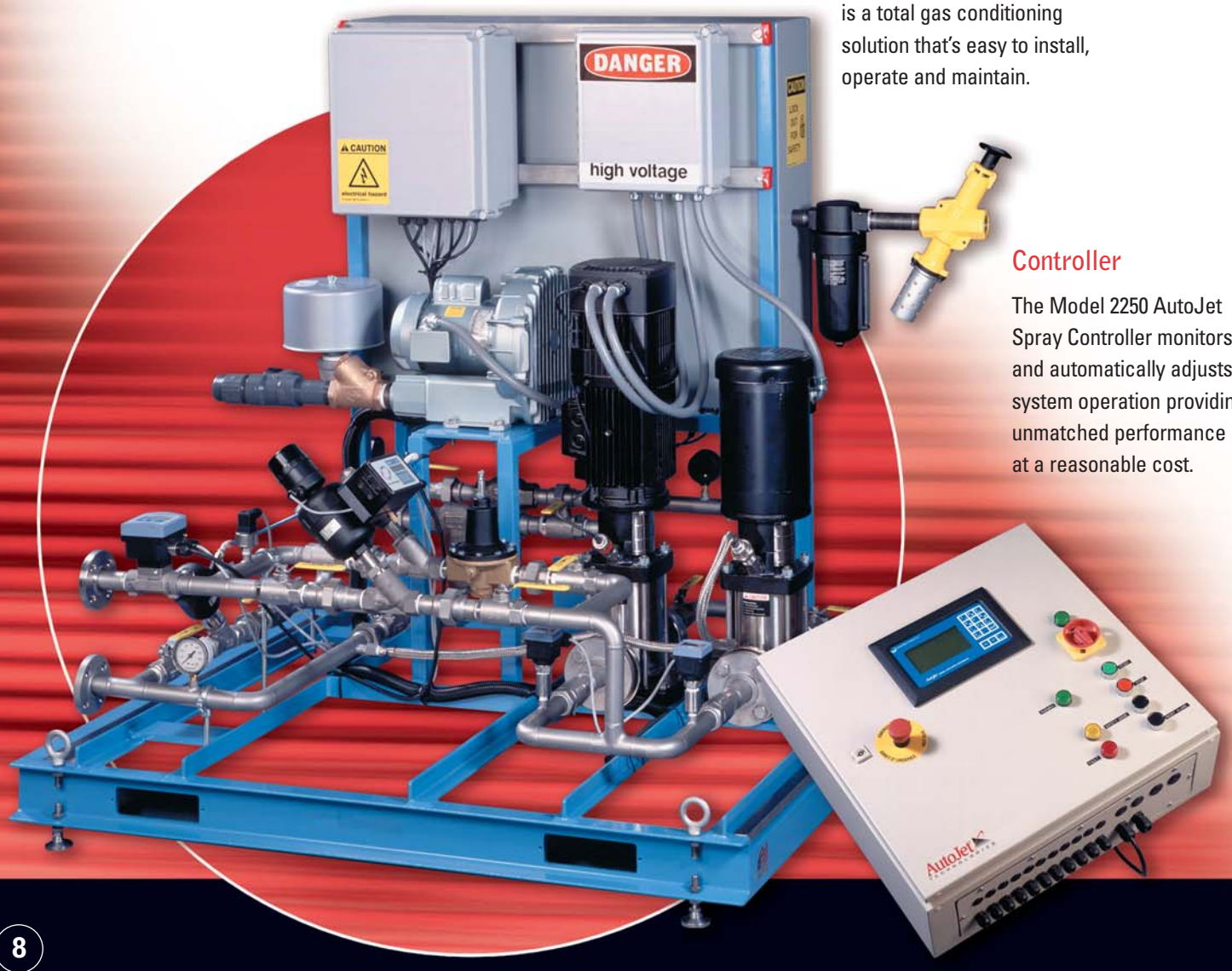
The Gas Conditioning System:

A Total Solution Tailored to Your Exact Requirements

AutoJet Technologies, the systems division of Spraying Systems Co., provides turnkey systems for gas conditioning and other industrial spray applications. As the experts in spray technology, this is a logical extension of our business. After all, a spray nozzle can only perform properly if the entire spray system operates properly. All system components — spray nozzles, pumps, sensors and other hydraulic and pneumatic components — must be accurately controlled. AutoJet Technologies systems, featuring our patent-pending Model 2250 spray controller and SprayLogic™ software, provide that level of control.

Gas Conditioning System

The AutoJet skidded system is a total gas conditioning solution that's easy to install, operate and maintain.



Controller

The Model 2250 AutoJet Spray Controller monitors and automatically adjusts system operation providing unmatched performance at a reasonable cost.

AutoJet Technologies is Uniquely Qualified

to Help You Achieve Effective, Efficient Gas Conditioning.

- Our Gas Conditioning System is a total skidded custom solution. It is easy to install, easy to operate and easy to maintain. The System is unsurpassed in energy efficiency and occupies minimal space.

- We've applied our spray technology expertise and developed other proprietary system components to optimize performance. The AutoJet Spray Controller, equipped with patent-pending SprayLogic™ software, monitors and automatically adjusts system operation providing unmatched performance at a reasonable cost.

- Technical information is readily available as is training and ongoing support. No other supplier can provide as much information on drop size and system performance or do specialized testing. That's because no other supplier has as much expertise or experience with spray technology.

- Single-source convenience: If you have a question once your system is installed, you know whom to contact. You don't have to worry about contacting multiple suppliers and trying to get them to work together to provide the information you need to solve your problem. Our worldwide network of sales engineering offices provides local system support.

- The technical staff at AutoJet Technologies has decades of experience with optimizing spray performance in pollution control applications in plants just like yours. Ask us for examples of how we've helped your peers.

Assistance Is Just a Call or Click Away

The specifics of your application will certainly determine the resources needed to design, manufacture and test your Gas Conditioning System. We have the tools, technology and technical staff to meet your needs.

Just give us a call or visit our web sites: www.spray.com, www.autojet.com or www.sprayconsultants.com. We're ready to help you cost-effectively optimize your gas cooling application.

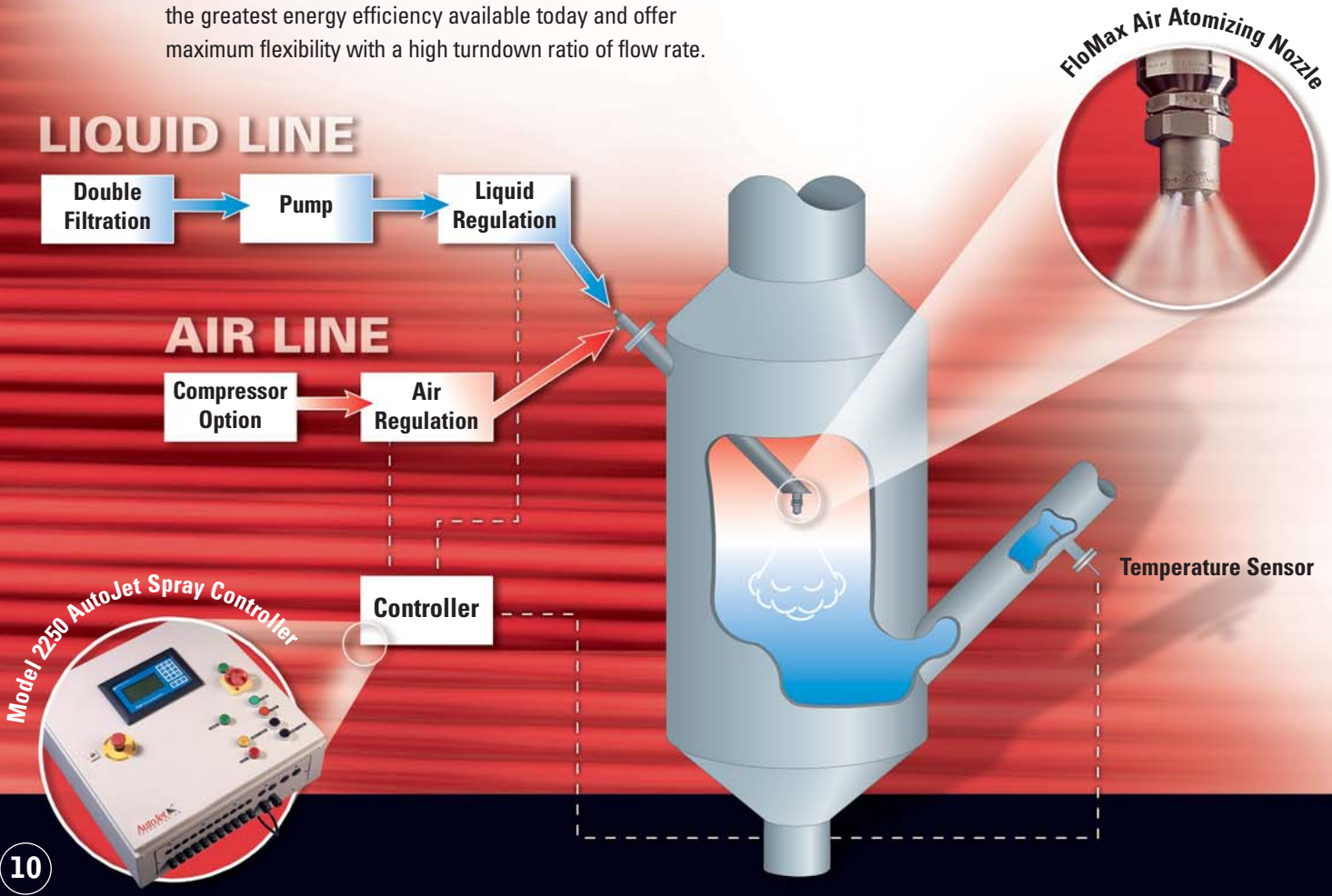


How the Gas Conditioning System Works: A Look Inside

The AutoJet Gas Conditioning System is designed around the most efficient air atomizing nozzle available — the FloMax nozzle. The system's controller monitors and automatically adjusts the operation of the entire system. Filters, temperature sensors, pumps, liquid regulators and air regulators are standard components. Air compressors are also available. For more detailed information on air and liquid flow through the AutoJet Gas Conditioning System, please visit **www.autojet.com/gasconditioning.**

The Role of Key Components and How They Contribute to Overall System Performance

- **The Model 2250 AutoJet Spray Controller** monitors and adjusts the closed loop system by regulating liquid and air flow to the nozzles based on information provided by one or more temperature sensors. Patent-pending SprayLogic™ software ensures the highest level of reactivity and accuracy for the system. The controller is incredibly easy to use. Simply use the menu system to provide information about your application. The controller is equipped with complete spray "knowledge" and essentially configures itself based on your input. That's all there is to it.
- **FloMax air atomizing nozzles** deliver optimal drop size without creating excess moisture. The nozzles offer the greatest energy efficiency available today and offer maximum flexibility with a high turndown ratio of flow rate.
- **Liquid Line.** The system includes redundant pumps, double filtration and a liquid regulator with its bypass.
- **Air Line.** The system includes air filtration and either manual or proportional air regulation with its bypass. Proportional regulation is used when a high turndown ratio is required and energy can be saved by accurately monitoring air flow. Minimal air flow is maintained through the nozzle at all times to prevent clogging by ashes or dust carried by the gas.



Pre-programmed Functionality

Allows You to "Plug and Spray"



- Spray Controller ensures optimal FloMax nozzle performance for highly accurate temperature control and peak system performance.
- Energy-efficient proportional control reduces air consumption and operating costs.
- Model 2250 AutoJet Spray Controller is pre-programmed with parameters and function screens specific to gas conditioning applications, saving time and money during system implementation.
- SprayLogic firmware and application software contains more than 100,000 lines of debugged code for robust built-in functionality.
- Full LabVIEW® simulation and system pre-testing prior to shipping ensures that each installation works right "out of the box".
- "System Integrity Checking" and error handling capabilities of SprayLogic software provide worry-free automation by constantly monitoring and adjusting system operation.
- Maximum reliability including emergency modes and system redundancy.
- FloMax nozzles provide high turndown ratio for maximum flexibility.
- RS232 and Ethernet connections provide easy communications.
- Easy to install skid-mounted system with minimal space requirements.

LabVIEW is a registered trademark of National Instruments Corporation

How much can you save

with the AutoJet Gas Conditioning System Using FloMax Nozzles?

System Components*	Hydraulic System	FloMax System
		
	8 Hydraulic Nozzle Lances	5 FloMax Nozzle Lances
	2 High Pressure Pumps (50 HP)	2 Pumps (5 HP)
	Piping, Valves, Skid, Thermocouples, etc	Piping, Valves, Skid, Thermocouples, etc
	—	2 Compressors (20 HP)

*45-50 GPM (170-190 l/min) systems for existing cooling tower installation

Installation Savings

5% lower

Greater Savings
possible for new installations due to reduced tower height requirements.

Operating Savings

Lower operating pressures, wear resistant materials and easier maintenance result in:

50% less in electricity usage

50% less in replacement parts

75% less in labor maintenance

Estimated First Year Savings ..... US $25,000

Estimated Ongoing Annual Savings ..... US $16,000

Additional Information to Help Solve Your Gas Conditioning and Cooling Problems

FloMax Air Atomizing Nozzles
Bulletin No. 487B

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

FloMax Nozzle Performance Data Reference
Manual No. TM406D

Provides comprehensive performance data, dimensional information and sample lance configurations.

Flowback Nozzle Performance Data Reference
Manual No. TM408B

Provides comprehensive performance data, dimensional information and sample lance configurations.

An Engineer's Practical Guide to Drop Size
Bulletin No. 459

An invaluable technical guide. We've taken 60 years of spray drop knowledge and condensed it into a 28-page booklet to teach you the fundamentals of evaluating and interpreting drop size data.

Optimizing System Performance with Precision Spray Control
Bulletin No. AT 103B

Provides an overview of the benefits of automated spray systems. Includes application examples that show how to reduce overspray, improve product quality, increase throughput and improve regulatory compliance.

Model 2250 AutoJet Spray Controller
Bulletin No. AT 105B

Features the specification information and details of our unique control package that automates and optimizes spray performance.



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