Spray Technology Solutions for NOx Control

or

NOx Control System

for Selective Non Catalytic Reduction (SNCR)
Precise Injection of Ammonia or Urea: An Effective and Efficient NOx Control Solution

Regulations for nitrogen oxides (NOx) emission are stringent and likely to become even more so in the future. Spray technology is widely used in waste incinerators, steel mills, cement kilns, power plants, pulp & paper recovery boilers and other manufacturing operations to control NOx. Dual-fluid atomization, where ammonia or urea is mixed with compressed air and injected into the gas stream, is the preferred approach in both Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) systems.

However, there are many differences in dual-fluid systems and it is important to partner with a company that has a full range of services to ensure the desired system performance and emission reductions are achieved.

Spraying Systems Co. is uniquely qualified to help you with your NOx control needs. More than 75 years of spray technology experience has enabled us to develop the broadest product line of spray nozzles and lances in the industry. AutoJet® Spray Controllers provide precise, closed-loop control for our turnkey spray systems. Our industry-leading research and testing services allow us to evaluate your requirements and help ensure your performance goals are met.

On the pages that follow, you’ll learn more about our:

• High-efficiency air atomizing nozzles that outperform all other similar nozzles
• Standard and custom spray lances to ensure proper delivery of the liquid and gas to the spray nozzles
• Performance testing services in the world’s largest spray laboratory and the use of Computational Fluid Dynamics (CFD) to predict spray performance using actual operating conditions
• Turnkey AutoJet® NOx Control Systems that provide total automation and optimize the performance of air atomizing nozzles
Effective NOx control requires superior air atomizing nozzles

Spray nozzles are critical components in a NOx control system. If drop size and spray coverage aren’t precisely right, problems like these can occur:

- Insufficient NOx reduction
- Ammonia slip
- Odor and plume visibility
- Formation of ammonium bisulfate
- Increased energy consumption

All air atomizing nozzles are not alike

In fact, very few are suitable for NOx control applications. High efficiency nozzles provide tight control of drop size and spray coverage. Very small drop sizes cannot be achieved with a single-step atomization process. A multi-stage process is required.

FloMax nozzles use a patented atomization principle to produce a highly focused air stream that shears the liquid with minimal air. The result of the unique processes is that FloMax nozzles use less air and produce smaller drops than competitive nozzles.

The benefits of small drop size are many:

- Energy costs are lowered
- Compressor life is extended
- Dwell time for complete reaction is reduced
- The liquid being sprayed generates more surface area per gallon (liter)

The uniformity of drop size distribution produced by our nozzles ensures precise, tight control of drop size. This is another unique attribute—our nozzles provide a narrower Relative Span Factor (RSF) than many other air atomizing nozzles at most air pressures.

Spray Nozzles for NOx Control

A wide range of nozzles can be used for ammonia and urea injection. The operating conditions and requirements of the chemical reaction will determine which nozzles will provide the proper performance.

Nozzles typically used for SCR and SNCR NOx control include:

- Gas atomizing nozzles
- 1/4J Series nozzles
- FMX FloMax® nozzles
- Standard and Anti-Bearding FloMax Nozzles
- Hydraulic spray nozzles
- FullJet® full cone nozzles
- WhirJet® hollow cone nozzles
- Computational Fluid Dynamics (CFD) modeling is recommended to validate nozzle selection and placement. The model accounts for tower/duct/boiler structure, gas composition, temperature, velocity and flow to determine the effect on nozzle performance and identify possible problems such as wall wetting. This data is then used along with the chemical mixing efficiency to determine the expected reduction in NOx and ammonia or urea slip.
Dual-Fluid Nozzles Outperform All Others

In addition to drop size, there are many ways nozzles provide superior performance

• Maximum flexibility because of high turndown ratios
  High turndown of flow rate – up to 10:1 – is possible. This allows the air pressure to be constant while the liquid varies based on process requirements.

• Fewer nozzles required
  Nozzles offer a large flow rate per nozzle. Competitive nozzles with equivalent flow rates produce larger drops. Fewer nozzles can be used, resulting in lower initial costs and less maintenance time on an on-going basis.

• Reduced maintenance time
  Durable, long-wearing parts require little maintenance. But when maintenance is required, it is fast and easy. Replacement of the nozzle or just the air cap and/or air annulus can be done without special tools. Competitive nozzles require more maintenance and more frequent replacement because of smaller free passages and the use of higher air and liquid pressures.

• Effective even in harsh environments
  A wide choice of materials ensures optimal nozzle performance even in high-temperature and corrosive applications. Typical materials include 316 and 310 stainless steel, HASTELLOY®, Stellite® and reaction-bonded silicon carbide. Others are available upon request.

Mounting options and easy installation

0°, 45° and 90° lightweight lances are available in standard materials with quick-release or bolt-on flanges and with quick delivery. Adapters, cooling jackets, purge tubes and protective tubes can be added. Custom lances in a wide range of materials and configurations for challenging spaces are also available.
Spray Testing and Modeling

Understanding drop size in NOx control is critical

Many problems can result from improper drop size. Drops that are too small don’t mix well with in the gas stream. Drops that are too large require a longer dwell time for a complete reaction to take place.

Running sophisticated gas cooling calculations provides a starting point to determine the type of nozzles and the number of nozzles required and how they need to be positioned. However, with complicated gas flows, unusual operating conditions or a typical duct work or tower shape, gas cooling calculations alone may not tell the entire story. This is when we head to our spray laboratories and conduct spray characterization studies to determine dwell time simulating 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 our research and testing group that operates the most fully equipped spray laboratory in the world. Phase Doppler Particle Analyzers, Laser Imaging, Particle/Image Analyzers and Laser Diffraction Analyzers are among the instruments we use to measure drop size.

Computational Fluid Dynamics (CFD) and NOx control

Some spray operations cannot be replicated in our labs. While we can spray solutions other than water, there are some gases and liquids that are not safe to use during testing. Plus, it is not always feasible to reproduce some mixing conditions and chemical reactions. That’s when we rely on our extensive library of proprietary spray characterization data and CFD.

**CFD is the science of predicting:**

- Fluid flow
- Heat transfer
- Mass transfer
- Chemical reactions

CFD uses numerical methods and algorithms to solve and analyze problems involving fluid flows. Sophisticated software performs the millions of calculations required to simulate the interaction of fluids and gases with related physical phenomena.

**We use CFD to predict:**

- Liquid and gas flow in scrubbers, towers and ducts
- Internal flow characteristics in spray nozzles
- Gas and liquid mixing in dual-fluid nozzles

CFD models illustrate flow patterns, velocity, temperature, gas/liquid distributions, droplet trajectories, pressures within the entire system and impact forces and stress caused by liquid flow.
**AutoJet® NOx Control Systems**

Optimized performance and total automation

If you think of nozzles as the heart of your NOx reduction operation, the AutoJet NOx Control System is the brain. It controls all system components and ensures optimized performance without operator intervention.

### Seven benefits the AutoJet System can bring to your NOx control application

1. **Optimal performance:** Our AutoJet Spray Controller, with patented SprayLogic® software, monitors and automatically adjusts the closed loop system. By regulating liquid and air flow to the nozzles based on data gathered from the NOx sensor, the controller offers the highest level of reactivity and accuracy for the system.

2. **Plug and spray convenience:** AutoJet Spray Controllers will save you time and money during installation because they are equipped with complete “spray knowledge” and are pre-programmed with parameters and function screens specific to NOx control applications.

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. **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.

5. **Reduced energy costs:** Variable Frequency Drive (VFD) pumps provide proportional liquid regulation. In addition, energy-efficient proportional air regulation reduces air consumption and operating costs.

6. **Easy integration:** You can easily integrate the AutoJet NOx 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.

7. **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.

### The benefits of a “turnkey” solution

- The Spraying Systems nozzles guarantee a very high “turndown ratio”.
- Standard solutions with air cooling (water cooling upon request).
- Maximum operational reliability.
- Specific design which minimizes air consumption and operating costs.
- Limited need for maintenance.
- OPC or SCADA (upon request) communication systems
- The system is easy to install and requires minimum installation space.
A Closer Look at How the AutoJet® NOx Control System Works

The AutoJet Spray Controller, equipped with powerful SprayLogic™ software, continuously monitors feedback from the NOx sensor(s) and regulates the system response by proportionally adjusting liquid and air flow to the injector nozzles. This “closed loop” system provides the highest level of control possible. The system is easy to install and requires minimum installation space. Once installed, the system provides maximum operational reliability and minimizes air consumption and operating costs.

NOx control software features:

- Multiple PID regulation for controlling ammonia/urea injection with dual-fluid nozzles
- Fast response time and minimum energy consumption
- Dual VFD pump management and dual filtration
- Intelligent error detection and continuous system integrity checking
- Multiple protection levels with password
- Ammonia/urea supply reservoir management (optional)
- Proportional liquid regulation valve or VFD pumps
- Electromagnetic flow meter and Liquid and atomization air pressure sensors
- Optional OPC/SCADA support and IP54 control panel
- Nozzles, complete with flexible and quick connections for coupling with fixed utilities
**Other Helpful Resources**

**FloMax® Air Atomizing Nozzles**
**Bulletin 487C**
Features details and performance data on the unmatched energy-efficient FloMax nozzles and lances.

**FloMax Nozzle Performance Data**
Contact your local sales office for comprehensive performance data, dimensional information and more.

**Gas Cooling and Conditioning Guide**
**Bulletin 540B**
12-page bulletin describes how using spray technology can improve efficiency and performance in gas cooling and conditioning applications.

**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.

**A Guide to Optimizing Spray Injector Performance**
**Bulletin 579A**
Addresses the specification, design and fabrication of spray injectors/lances to ensure optimal nozzle performance.

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