Improving Process and Product Quality in Chemical Production through Spray Technology
How many applications in your plant involve spray technology? It’s likely there are several or maybe even dozens of applications in your manufacturing operation that require the spraying of liquid. You may think of these applications on a functional level such as cooling, coating or cleaning. But, no matter how you categorize them, the common denominator and the key to success in many applications is spray technology.

The most common applications involving spray technology in chemical processing include:

- Spraying liquid into gas – absorption, to create a chemical reaction.
- Spraying liquid onto solids – coating.
- Spraying liquid and/or air to lower temperatures – cooling.
- Spraying liquid into air – spray drying, evaporation, moisture control.
- Spraying liquid into containers or vessels – cleaning.

Product and/or process quality and operating cost containment is often dependent upon the performance of the spray system. Optimizing spray performance frequently requires expert assistance and that’s why we work closely with chemical processing plants around the world. We offer the products, services and expertise needed to ensure maximum spray system efficiency and effectiveness:

- Spray nozzles: Thousands of nozzles readily available in hundreds of sizes, configurations and materials.
- Spray analysis: Consulting, spray performance testing, proof-of-concept testing through Spray Analysis and Research Services.
- Spray fabrication: Standard and custom lances, manifolds and spray headers.
- Global network of dedicated sales engineers with decades of experience helping chemical processing plants optimize spray performance.

In the pages that follow, you’ll find an overview of how we’ve helped your peers improve quality and reduce operating costs and maintenance time in a wide variety of applications involving spray technology. With more than 65 years of experience with chemical processing plants, we’re confident we can do the same for you.
Transferring components between liquid and gas

**Absorption, Scrubbing and Stripping Solutions for Efficient and Effective Gas Conditioning**

Drop size is one of the most important factors in successful gas absorption, gas scrubbing and gas stripping applications. Since the surface area of the drop controls the reaction, drop size must be precise. If the drops are too large, adequate surface area for the reaction to take place will not exist. If the drops are too small, they may evaporate prior to the reaction occurring. In both cases, the gas stream will remain unchanged and emission problems and damage to downstream equipment may result.

Published drop size data can help with nozzle specification but actual process conditions will ultimately determine drop size, distribution and velocity. Expert assistance is typically required – and that's where we can help. We have several state-of-the-art laser measurement instruments in our laboratories to ensure complete and accurate testing of high-density sprays. Our data measurement complies with and/or exceeds ASTM Standard E799 and our reports are consistent with ASTM Standard E1296-93 (1.3). Our drop size experts will help determine the precise performance required in your absorption, scrubbing or stripping application.

Achieving the right interaction between gas and liquid is primarily dependent on drop size. However, there are other factors to consider when ensuring effective gas absorption or scrubbing.

- Corrosive, high-temperature environment: Scrubbers operate at high temperatures and use corrosive solutions. Our nozzles are readily available in 316 stainless steel and special materials such as Hastelloy®, Inconel®, Stellite®, reaction-bonded silicon carbide and more.
- Clogging: Nozzle clogging can be problematic especially if water quality is a concern and can lead to drop size and other performance issues. We have an extensive line of maximum free passage nozzles – the largest in the industry – for this very reason.

**Typical Applications:**
- SO₂ removal – semi-dry scrubbers that spray lime and water solutions.
- HCL and H₂SO₄ packed-bed acid scrubbers.
- NOx control – SCR and SNCR.

**Typical Product Solutions:**
- High-efficiency FloMax® Air Atomizing nozzles.
- WhirlJet® hollow cone spray nozzles.
- FullJet® full cone spray nozzles.
- SpiralJet® full cone and hollow cone spray nozzles.
- Standard and custom lances in dozens of configurations and specialty materials.

Spray nozzles used in scrubbers and absorbers must produce precisely sized drops to ensure proper gas and liquid interaction and effective gas conditioning.
If you have a coating application, you already know how important precision is. Uneven application of the coating solution, overspray of the coating and/or clogging of viscous solutions can wreak havoc with quality, production uptime and the cost of consumables.

In simplistic terms, the coating process begins with the formation of the drop. As drops exit the nozzle, they spread and coalesce with neighboring drops to form a coating on a solid surface. As additional drops are applied, layers are created. A dry, uniform film results as drops evaporate. In order to achieve uniform coating in most applications, drop size and the distribution of the drops must meet exacting standards.

Selecting spray nozzles, accessories and spray headers to deliver the precise coating needed can get complicated since there are many variables and little margin for error.

Ways we can help:
- Providing drop size data.
- Conducting drop size tests in our labs so recommendations are based on actual spraying conditions.
- Conducting tests to determine precise positioning of nozzles on the spray header for uniform coverage.
- Adding spray control to your system. Model 2250 AutoJet® Spray Controllers provide precise spray control to eliminate overspray and automatically adjust cycle timing to adapt to changing line speeds. A turnkey system, AccuCoat® Low Mist Spray System from AutoJet Technologies, offers complete automation for coating operations.
- Process assessment and specification assistance. Our expert sales engineers can help you choose from hundreds of hydraulic and air atomizing nozzles in a wide variety of sizes, configurations, capacities, spray angles and materials.

Typical Applications:
- Tablet coating.
- Mold release.
- Spraying scents, aromatics and detergents.
- Coating targets on conveyors.

Typical Product Solutions:
- Air atomizing nozzles.

Spraying liquid onto solids

Chemical Coating Solutions to Minimize Waste and Improve Product Quality

Air atomizing nozzles provide even distribution of the liquid and include features such as clean-out needles to minimize clogging and maximize production time.

Our JAU Series Air Atomizing nozzles are available in standard and automatic versions with dozens of liquid set ups and a variety of sizes and material options.

Our VMAU Variable Automatic Spray Gun allows independent control of liquid, atomizing air and fan air for fine-tuning of spray capacity, drop size and spray patterns — making it ideal for use with viscous liquids.

Our JAU Series of automatic air atomizing nozzles applying a liquid detergent on powder in the manufacture of laundry detergent.

The AccuCoat System allows precise control over coating applications for improved product quality — even when spraying low volumes of viscous liquids.
**Spraying liquid into air**

**Humidification and Dehumidification Solutions for Controlling Moisture Content**

Adding moisture to air without wetting requires nozzles that produce very small drops that evaporate prior to hitting a critical surface. Reducing moisture or dehumidifying requires nozzles that produce small drops below the dew point to absorb the surrounding air or gas.

Drops that are just microns too big or microns too small can result in over wetting or poor absorption and cause costly quality control problems and increased operating costs. Choosing the proper nozzle for your application is essential to achieving the optimal moisture content and that's where our expertise in liquid atomization can help.

Fine spray hydraulic nozzles and air atomizing nozzles that produce drops in the 10 to 50 µm range are typically used for humidification and dehumidification. However, other considerations – temperature, absorption distance, chemical additives in the water and gas composition – will ultimately determine the drop size required for your application. We have a variety of resources available to assist with spray nozzle selection – published performance data, on-line humidification calculation tools or consultation with one of our technical experts.

**Typical Applications:**
- Humidifying paint tanks.
- Cooling and humidifying air prior to entering a chemical plant.
- Filter humidification.
- Odor control.

**Typical Product Solutions:**
- Air atomizing nozzles.
- Hydraulic fine spray nozzles.

AirJet® Fogger spray nozzles provide 100% humidity in paint tanks to prevent paint from drying on the sides and top of the tanks and to reduce static electricity in mixing and storage areas. AirJet foggers often replace maintenance intensive steam systems.

Fine spray hydraulic atomizing nozzles use the liquid pressure alone to produce very finely atomized drops in a hollow cone pattern.
Spraying liquids and air to lower temperatures

Gas and Liquid Cooling Solutions for Maximum Process Efficiency and Product Quality

There are three ways to cool:

- Evaporative cooling occurs as a result of spraying a liquid into hot gas. The drops in the liquid absorb the heat, lowering the temperature of the gas.
- Liquid cooling involves spraying liquid into cooler surrounding air. The heat is transferred out of the liquid into the air, lowering the temperature of the liquid. Depending on the application, the objective can be either partial or complete liquid evaporation.
- Liquid cooling can also involve spraying liquid on a hot solid surface for heat removal.

Similar to many other spray applications in the chemical market, drop size and the distribution of the drops are key.

- In evaporative cooling, drops need to be small so complete evaporation can occur quickly and avoid wetting of walls, ductwork and other solid surfaces. Excess liquid can create maintenance problems such as dust and sludge-build up and can have a negative impact on downstream equipment.
- In liquid cooling, drops need to be small enough to provide quick cooling but not so small they evaporate prematurely and are carried away by air movement.
- In product cooling, the liquid distribution needs to be precisely controlled to ensure the desired cooling rate is achieved and that uniform cooling occurs. Drop size can have a significant impact on heat transfer cooling efficiencies.

Product quality, maintenance time and operating costs can all be negatively affected if the drops produced by the spray nozzles don't meet exacting standards. That's why we do more than sell spray nozzles – our goal is to help customers achieve optimized spray system performance. This includes analyzing process requirements and determining how to maximize spray cooling effectiveness and efficiency.

Typical Applications:

- Gas conditioning in kilns, cooling towers, ductwork and dryers.
- Spray ponds to cool water from a heat exchanger or condenser.
- Spray evaporation ponds to remove water from toxic waste for proper disposal.
- Cooling materials for use in additional products or processes.
- Cooling products prior to storage or shipping.
- Cooling pipes or tanks to prevent sparking, fires or explosions.

Typical Product Solutions:

- High-efficiency FloMax® Air Atomizing nozzles.
- AutoJet® Gas Conditioning system.
- Standard and custom spray lances.
- Flowback nozzle system.
- Standard air atomizing nozzles.
- WhirlJet® hollow cone spray nozzles.
- FullJet® full cone spray nozzles.
- VeeJet® flat spray nozzles.

Gas Cooling: FloMax nozzles provide effective gas cooling without wetting to ensure compliance with emission regulations. They also offer the greatest energy efficiency available and maximum flexibility with a high turndown ratio of flow rate.
**Spraying liquids and air to lower temperatures**

**Gas Cooling:** A patented multi-stage atomization process that produces small drops using minimal air is why FloMax® nozzles offer superior performance. Spray lances are available in both standard and custom configurations. If you’re looking for a completely automated solution, our AutoJet® Gas Conditioning System provides total system control and optimizes the performance of FloMax nozzles.

**Gas Cooling:** If you’re maintaining a hydraulic gas conditioning system, our Flowback nozzles can help improve system performance. Flowback nozzles deliver consistent drop size and feature a unique two-piece design to make installation and maintenance quick and easy.

**Liquid Cooling/Evaporation:** As shown here, hot water from a plant is pumped directly to a spray pond system where it is sprayed into the pond basin. The cooled water is pumped back to the plant. Finely atomized drops provide quick heat transfer. Nozzle junction boxes and piers are used to strategically position the nozzles above the pond.

**Liquid Cooling/Evaporation:** CX WhirlJet® spray nozzles, shown right, produce small drops with large surface areas to facilitate evaporation and minimize drift. A special whirlchamber design extends nozzle life—an important feature because of the debris often found in recirculated plant water and spray ponds.

Spray evaporation ponds typically require smaller capacity nozzles such as the AX and BX WhirlJet nozzles, shown bottom right. These nozzles feature a two-piece design with removable caps and the same wear-resistant design as the CX WhirlJets.
Spraying liquids and air to lower temperatures

**Product Cooling:** Air atomizing nozzles are a popular choice for cooling products because they provide a precise, finely atomized spray and uniform spray pattern. In this example, air atomizing nozzles are used to cool melted polyethylene to prevent the material from clinging to the dryer as it is formed into a non-woven fabric.

**Product Cooling:** To ensure trouble-free performance, air atomizing nozzles used in cooling applications often include assemblies for shut-off and clean-out functions. The model on the left features a clean-out needle and the model on the right includes an air cylinder for controlled on/off operation up to 180 cycles per minute.

**Product Cooling:** Automatic air atomizing nozzles are being used to cool resin pellets as they pass through the cooling drum to prevent the pellets from sticking together.
Spray Drying Solutions to Ensure Product Quality and Minimize Maintenance Time

Of all processes involving spray technology in your plant, spray drying may be the most complex. And, once again, drop size plays a critical role. Drops must be precisely sized to ensure particles dry completely but aren’t over-dried.

Spray drying usually involves pumping a solution, suspension or emulsion to a spray nozzle at the top of the drying chamber. The spray nozzle sprays the liquid into a stream of hot air or gas to produce drops. As the drops pass through the hot air flow, the moisture content evaporates quickly. Larger particulates fall to the bottom of the chamber and are collected.

The type of spray nozzle determines the drop size and distribution. Liquid properties, nozzle capacity, spraying pressure and spray angle also affect drop size. Many applications can benefit from drop size testing as a way to identify the source of spray dry performance problems and determine if changing drop size could improve powder quality or process efficiency. Our fully equipped testing labs include highly specialized drop size analyzers and spray dryers for performance testing.

Spray dry design can also have a big impact on production. Nozzle clogging and nozzle wear can result in quality problems, excessive maintenance time and increased operating costs. We have an extensive range of spray dry nozzles designed to cover a wide range of applications. Choose from maximum free passage, high pressure and quick maintenance types in a variety of wear-resistant materials.

Typical Applications:
- Soaps and detergents.
- Dyes and pigments.
- Fine chemicals.
- Pharmaceuticals.
- Dairy.

Typical Product Solutions:
- Maximum Free Passage SK and SB SprayDry® nozzles.
- WhirlJet® SprayDry® nozzles.

High capacity WhirlJet SprayDry nozzles, shown left, feature quick and easy assembly and an open whirl chamber design. Maximum Free Passage SB SprayDry nozzle, shown right, features a special core and cap design to reduce clogging and increase production time.
Spraying liquid into a gas to create a chemical reaction

Chemical Injection and Desuperheating Solutions to Ensure Process Quality

Chemical injection involves spraying liquid into a gas to cause a reaction. This is another common use of spray technology in chemical processing and another application that requires high precision. A portion of the sprayed liquid must evaporate within a certain distance so the reaction with the gas can occur completely and evenly to avoid potentially dangerous concentrations of heat, wetting and waste. Similar to gas scrubbing and cooling, drop size documentation is critical and, depending on the application, drop size testing may be recommended.

Spraying a fine spray of feed water into superheated steam in order to desuperheat it is another common application in chemical processing that requires precision. As the water is absorbed into the steam, it absorbs heat and reduces the quantity of superheat.

A wide variety of spray nozzles can be used for chemical injection and desuperheating. High-efficiency air atomizing nozzles, hydraulic fine spray nozzles and standard narrow spray nozzles are popular choices. In addition to offering a wide variety of nozzle types, sizes and materials, we fabricate custom spray lances. We have extensive in-house engineering and manufacturing capabilities and offer:

- Fabrication to national standards.
- Testing in accordance with ANSI and ASTM standards.
- Destructive and non-destructive examinations.
- Quality assurance including ISO 9001-2000 and ISO 14001, complete material traceability, material test reports and certificates of conformance plus more.

Typical Applications:
- Aqueous ammonia injection for NOx control.
- Corrosion inhibitor injection.
- Glycol injection keeps pipes from freezing.
- Desuperheating.

Typical Product Solutions:
- FloMax® Air Atomizing nozzles.
- J Series Air Atomizing nozzles.
- FogJet® hydraulic fine spray nozzles.
- FullJet® full cone narrow angle spray nozzles.
- WhirlJet® hollow cone spray nozzles.
- Standard and custom spray lances.

The nozzle type used will depend on the drop size required, solution being sprayed and material requirements. In the example above, a hydraulic fine spray nozzle is used to inject glycol into gas lines to prevent freezing.

Desuperheating lances are available in single or multiple nozzle configurations. Hydraulic or air atomizing nozzles can be used.
Spraying liquid to clean vessels between batches

Tank Cleaning Solutions to Improve Cleaning Thoroughness and Reduce Maintenance Time

Every chemical plant has vats, vessels, totes or tanks to clean. Manual cleaning methods are quickly being replaced with automated solutions. Automated tank cleaning can result in significant savings and offers many other benefits as well:

• Cleaner tanks. Tanks are cleaned more thoroughly, minimizing the risk of contamination.
• Increased production uptime. Cleaning that once took hours can now be completed in minutes and maintenance workers can be deployed to other tasks.
• Worker safety. Human tank entry is eliminated.
• Reduced operating costs. Automated tank cleaning efficiently controls the use of chemicals and water resulting in additional savings on energy and wastewater removal.

There are many ways to automate your tank cleaning. The best method will be determined by the size of your tank and the residue to be removed.

• For small- and medium-sized tanks, clean in place (CIP) systems are often used. These systems use spray balls or tank wash nozzles mounted to a pipe. The nozzles either remain fixed in place or are fluid-driven and rotate in the tank.
• High-pressure motor-driven tank and fluid-driven (turbine) tank washers are typically used in medium to large tanks when more stubborn residues must be removed.
• Fluid-driven (turbine) tank washers utilize fluid to spin a turbine, which, in turn, powers a gear set for cleaning larger tanks. This allows solid stream sprays to rotate as the hub revolves around the central axis to provide complete coverage.
• Fully automated systems are also an option. Our AutoJet® Tank Cleaning System consists of a tank wash nozzle or motorized tank washer, a control panel, a pump and a process control package. These systems enable cleaning cycles, chemical injection and recirculation to be automated.

Typical Applications:
• Cleaning.
• Rinsing.
• Sanitizing.

Typical Product Solutions:
• 090, 190 and 290 Motor-Driven Tank Washers with air, electric or explosion-proof electric motors for tanks up to 80’ (24.4 m) in diameter.
• UltraClean Tank Machine – a powerful turbine-driven unit for tanks up to 157’ (48 m) in diameter.
• Fluid-driven nozzles – constant speed or reactionary force versions for tanks up to 20’ (6.0 m) in diameter. Options include our metal Rokon and mini-Rokon nozzles which meet the European ATEX standard for use in explosive environments.
• Fixed nozzles for tanks up to 22’ (6.7 m) in diameter.
• AutoJet Tank Cleaning System.

The AA290AG Tank Washer shown here is used to add liquid to a batch in a reactor vessel and then rinses the vessel when the reaction is finished.

We offer more than 35 different options for automated tank cleaning. Shown here are our UltraClean Tank Machine (top), our 6353 fixed tank wash nozzle utilizing FullJet® spray nozzles (left) and our fluid-driven TEFLO® 27500 with locking pin (right).
Additional Resources for Chemical Processors:

A Guide to Safe and Effective Tank Cleaning
Catalog 15C
52-page catalog features a variety of tank washing nozzles to meet the needs of a variety of tank cleaning applications.

Industrial Spray Products
Catalog 60B
522-page catalog features the entire line of industrial spray products manufactured by Spraying Systems Co.

Optimizing Your Spray System: Spray Nozzle Maintenance and Control for Improved Production Efficiency
Technical Manual 410
52-page handbook explains how to maximize performance and quality in your spray application.

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

An Engineer’s Practical Guide to Drop Size
Bulletin 459
28-page booklet provides a practical approach to drop size related issues.

WhirlJet® SprayDry® Nozzles
Bulletin 447
8-page bulletin features our complete line of WhirlJet hollow cone nozzles for spray drying applications.

MFP SB Series SprayDry® Nozzles
Bulletin 504
8-page bulletin explains how the clog-free design of the SB Series helps increase production time.

MFP SK Series SprayDry® Nozzles
Bulletin 527
8-page bulletin describes the increased free passage design, the resulting benefits and provides performance data.

Easily specify and order your nozzles online at www.spray.com/iSpray

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