



**Spraying Systems Co.<sup>®</sup>**  
Experts in Spray Technology



Spray  
Nozzles



Spray  
Control



Spray  
Analysis



Spray  
Fabrication



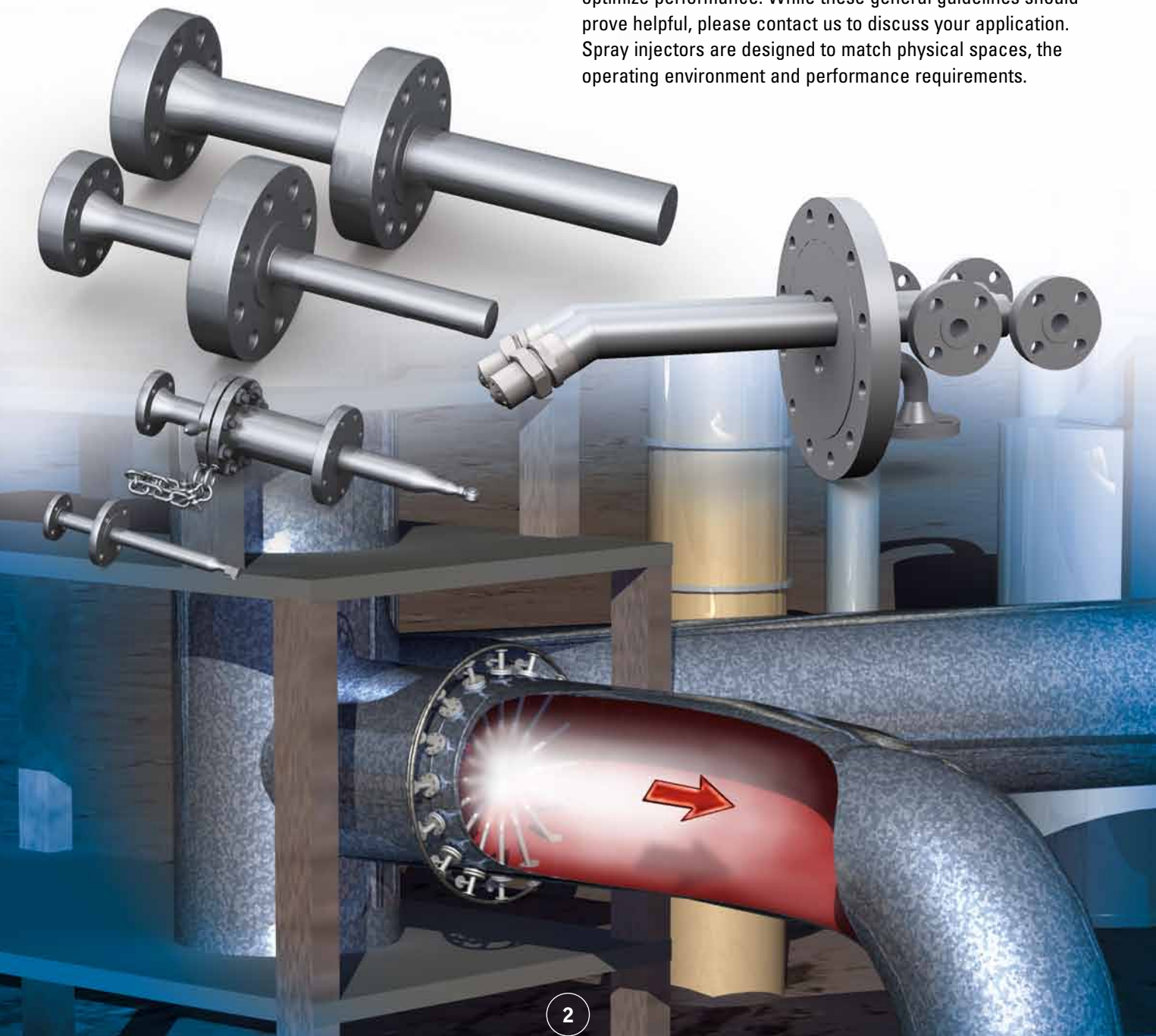
## **Optimizing Spray Injector Performance in Petroleum Refining**

# Spray Injection Technology: Critical to Dozens of Refining Operations

Spray injectors, sometimes referred to as quills or lances, are widely used in every refinery. With the demand for refined product rising, so is the demand for spray injectors as petroleum producers embark on upgrade/expansion projects and new construction. Spray injectors are often viewed as simple devices that deliver fluid or gas to the nozzle prior to injection. However, spray injectors can have a significant impact on the performance of the entire spray system and should be given careful consideration during design and fabrication.

Optimizing spray injector performance requires an extensive knowledge of spray technology. And that's where we come in. We work with leading engineering firms and oil companies around the world to design and build durable, dependable, low maintenance injectors that deliver the required performance be it in the FCCU riser, catalyst regenerator, coker, pollution control equipment or other areas of the refinery.

In the pages that follow, you'll learn more about spray technology, key design considerations for spray injectors and ways to optimize performance. While these general guidelines should prove helpful, please contact us to discuss your application. Spray injectors are designed to match physical spaces, the operating environment and performance requirements.



# Key Factors in Spray Injector Design and Performance

## Size of duct, vessel, tower

- Impacts the size of the injector, number of nozzles, spray pattern, spray angle, placement of nozzles and drop size/residence time of the spray

## Bends, miters and elbows in ducts

- Impacts flow profiles, placement of injectors to avoid erosion of process equipment and wall wetting

## Proximity to upstream or downstream equipment

- Impacts spray plume shape, pattern and velocity

## Operating conditions such as gas and liquid properties, temperature, corrosiveness

- Impacts materials of construction, coatings, spray distance

## Liquid composition

- Impacts materials of construction, spray pattern, maximum free passage

## Fluid service category

- Impacts safety design requirements per ASME® and other construction codes

## Co-current or counter-current sprays

- Impacts residence times, drop size, spray angles, build-up, vibration, stress

## Connection types

- Impacts safety, other design standards, current field connections

## Physical restrictions on injector placement

- Impacts flexible or rigid design, weight limitations

## Service life requirements

- Impacts materials of construction, design requirements

## Maintenance requirements

- Impacts design features such as mechanical retraction devices



# Injector Solutions

Refinery injectors need to meet exacting performance requirements. And to achieve those performance goals, injector designs are typically complex, comply with extreme engineering standards for safety and necessitate the use of special materials and coatings to withstand harsh environments. While each injector is unique, there are many common design attributes.

(See chart to right.)

## A. Defoaming Injectors

These injectors are used to uniformly disperse defoaming agents into the process stream or onto a surface.

## B. Distillation Column Injectors

Water wash injections, typically continuous and low volume, are used to avoid salt build-up or reduce corrosiveness in the distillation column overheads.

## C. FCCU Overhead Water Wash Injectors

Used to minimize corrosion, cracking or hydrogen blistering from exposure to ammonia and cyanide, these devices inject water wash or corrosion inhibitors into ductwork above the FCCU.

## D. FCCU Feed Injectors

Fresh feed is injected into catalyst-laden gas stream in the FCCU to atomize the feed for best cracking. These injectors are designed to operate for several years without maintenance.

## E. Steam Quench Injectors

Light cycle oil is injected into the gas stream prior to entry into a cracking or reforming heater to lower temperature and stop the cracking process.

## F. Slurry Backflush Injectors

Hydrocarbons entrained with catalyst are re-injected into the FCCU via robust, wear resistant injectors.

## G. Packed Tower Headers

Injectors distribute fluid evenly to thoroughly clean packing material.

## H. Heat Exchanger Injectors

To prevent corrosion problems, glycol or other inhibitors are injected onto the ends of heat exchanger tubes.

## I. Additive Injectors

Small volumes of chemicals, inhibitors and/or detergents are injected into petroleum products to improve quality or add special characteristics.

## J. Mix Temperature Control (MTC) Injectors

Positioned above the fresh feed injectors in the riser, these injectors are used to control riser outlet temperature. Light cycle oil is injected on a continuous basis.

The list below and illustration to the right show some of the more the common applications in refineries where spray injectors are used. There are many others so be sure to contact us for additional information. We have wide ranging experience with dozens of different injector types for dozens of refinery operations.

## K. Torch Oil Injectors

For heat during start-up, shutdown, or feed-outage conditions, liquid oil is injected and burned in FCC regenerators.

## L. Regenerator Bypass Injectors

When the waste heat steam generator is offline, these injectors are used to cool gases prior to SCR NO<sub>x</sub> reduction equipment.

## M. Catalyst Reformer Gas Cooling Injectors

Injectors are used to cool the exterior of the catalytic reformers to control temperature.

## N. Chloride Injectors

Used for propylene dichloride and alcohol injection into naphtha feed line for corrosion resistance.

## O. Fractionator Water Wash Injectors

Water wash injections, typically continuous and low volume, are used to avoid salt build-up or reduce corrosiveness in the fractionator overheads.

## P. Coker Off-Gas Cooling Injectors

Steam atomizing injectors are used to cool coker gas with 100% evaporation prior to entry to downstream particulate collection devices.

## Q. Flue Gas Desulfurization Injectors

Injectors equipped with clog-resistant nozzles constructed of silicon carbide or other ceramic materials are used to neutralize gas or liquid in a tower.

## R. SNCR NO<sub>x</sub> Control Injectors

Injection of aqueous ammonia is used to act as a reagent and mix with molecular NO<sub>x</sub> at high temperatures to reduce NO<sub>x</sub> emissions.

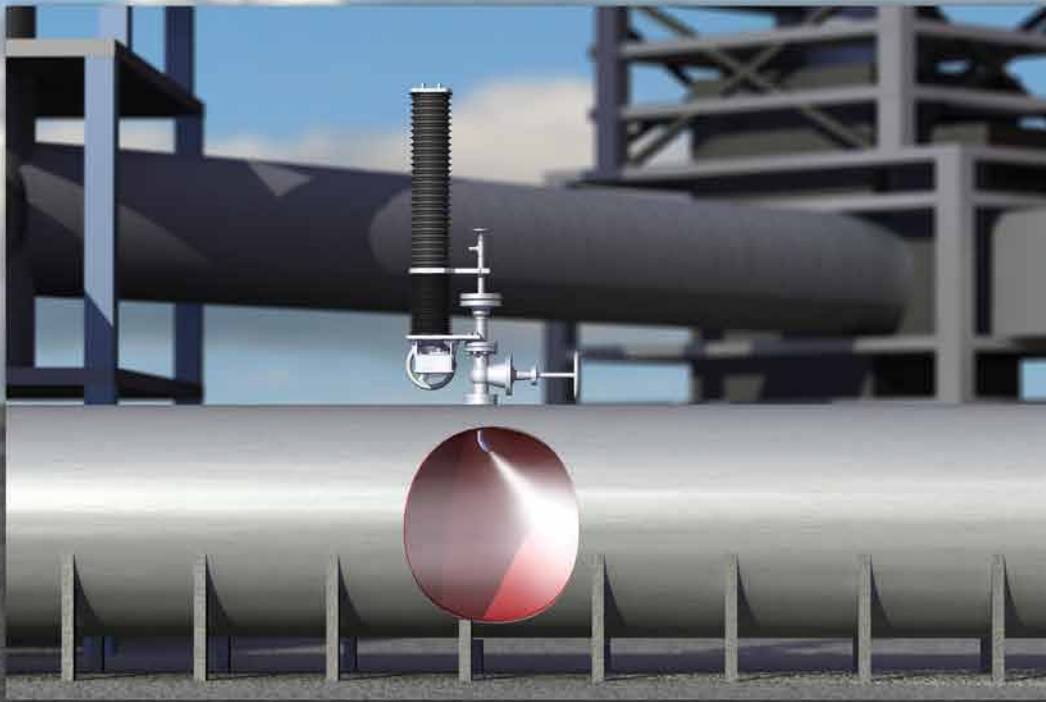
## S. SCR NO<sub>x</sub> Control Injectors

Injection of aqueous ammonia is used to act as a reagent and mix with molecular NO<sub>x</sub> at high temperatures to reduce NO<sub>x</sub> emissions.

## T. Desuperheating Injectors

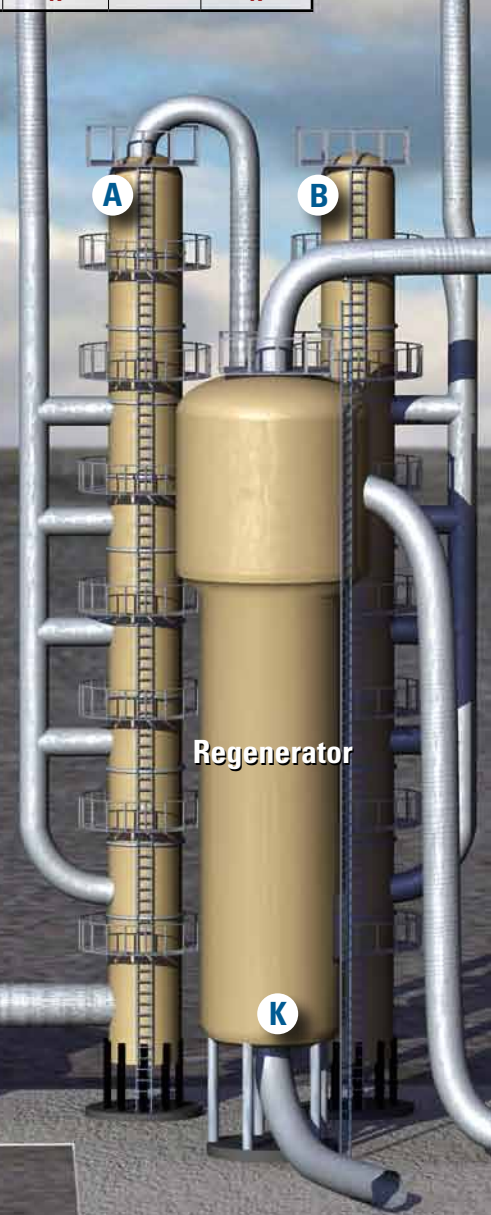
Injection of a fine spray of feed water into superheated steam provides cooling so the steam can be used in lower pressure processes downstream.

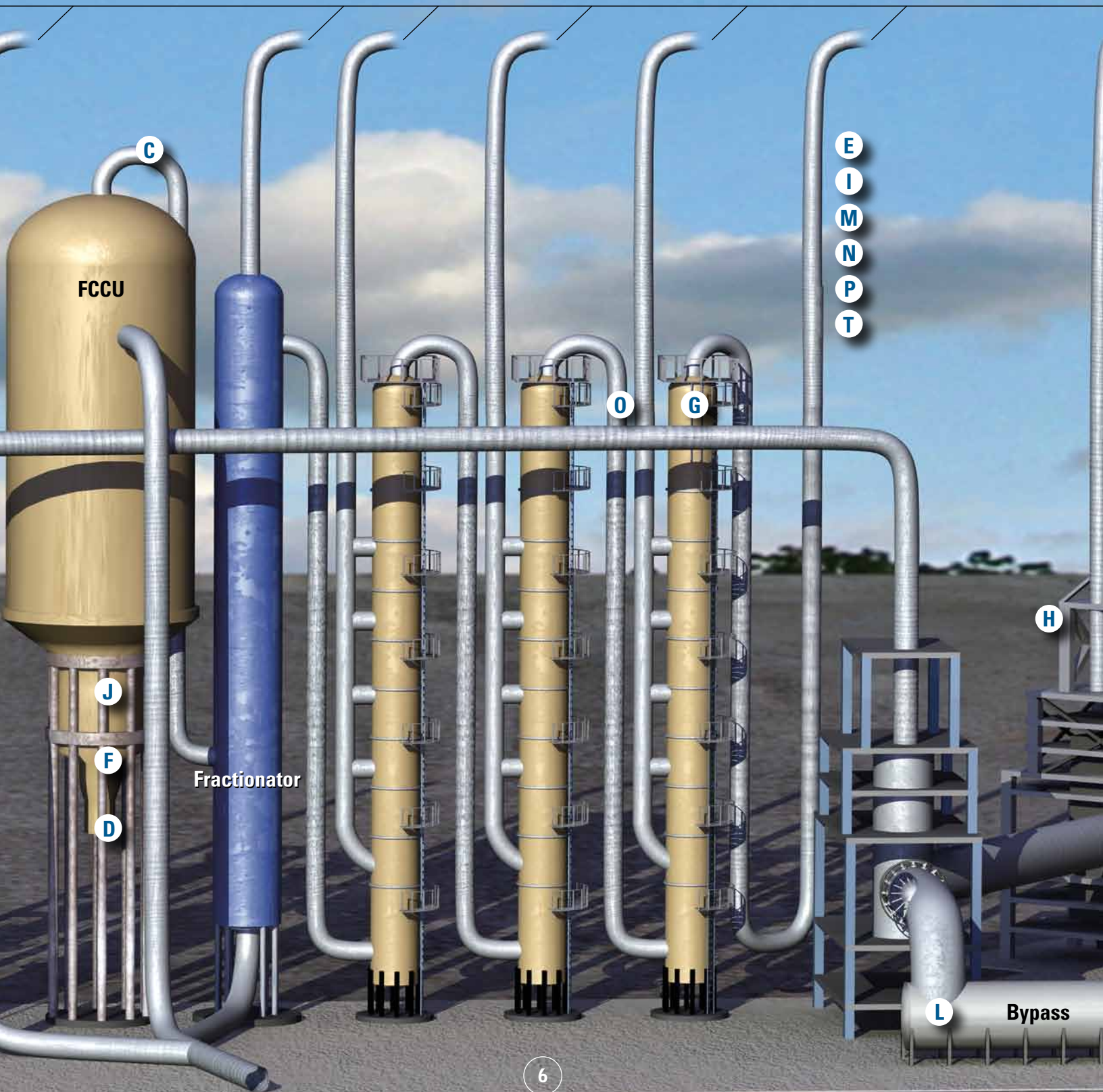
Injector Type	Flat Fan Pattern	Full Cone Pattern	Hollow Cone Pattern	Gas Atomizing Fine Spray	Hydraulic Atomizing Fine Spray	Wear Resistant Materials	High Pressure	High Temperature Alloys	Corrosion Resistant Materials	Tight Drop Size Distribution
Defoaming		X			X				X	
Distillation Column		X			X				X	
FCCU Overhead Water Wash		X	X		X	X				
FCCU Feed Injector				X		X		X	X	X
Steam Quench Injector	X	X		X		X				X
Slurry Backflush Injector	X		X	X		X		X	X	X
Packed Tower Headers		X								
Heat Exchanger Bundle Sprays		X					X			X
Additive Injection				X	X				X	
Mix Temperature Control	X		X	X		X		X	X	
Torch Oil	X	X		X		X		X		
Regenerator Bypass		X		X		X		X		X
Catalyst Reformer Gas Cooling	X		X	X				X	X	
Chloride Injection		X			X				X	
Fractionator Water Wash Injection		X			X				X	X
Coker Off-Gas Cooling		X	X	X		X		X	X	X
Flue Gas Desulfurization			X			X				X
SNCR NO <sub>x</sub> Control	X	X	X		X			X		X
SCR NO <sub>x</sub> Control	X	X		X						X
Desuperheating	X	X			X		X	X		X



Crude Furnace

Crude





To Downstream Processes  
(Not Shown)

Waste Heat Boiler

ESP

0

Wet Scrubber

R S

SCR (or SNCR)



## Our Credentials

### Engineering:

- Decades of experience with a sole focus on spray technology
- Engineering specialists, Professional Engineers (PE), piping and welding experts
- Spray characterization in our fully equipped spray laboratory to simulate injector operating conditions. Typical tests include:
  - Drop size and distribution
  - Gas velocity and density
- Computational Fluid Dynamics (CFD)
  - CFD and proprietary drop distribution functions allow determination of injector performance when operating conditions cannot be simulated
  - Ensures optimal nozzle placement, spray pattern type and angle

### Manufacturing:

- ASME® Boiler and Pressure Vessel Code
- ASME B31.1 Power Piping Code
- ASME B31.3 Process Piping Code
- Welding to ASME B&PV Code Section IX
- Canadian Registration Number requirements

### Testing in accordance with ANSI®, ASTM® standards:

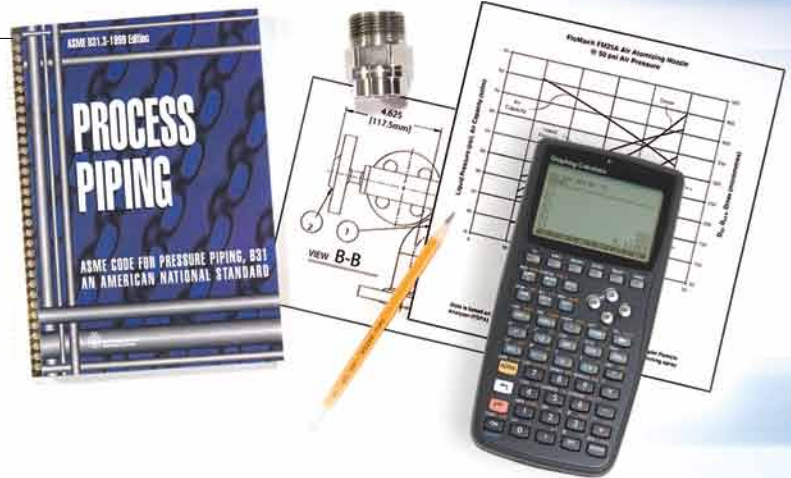
- Ultrasonic
- Radiographic
- Liquid penetrant
- Hardness
- Hydrostatic
- Magnetic particle examination
- Positive material identification

### References available upon request.

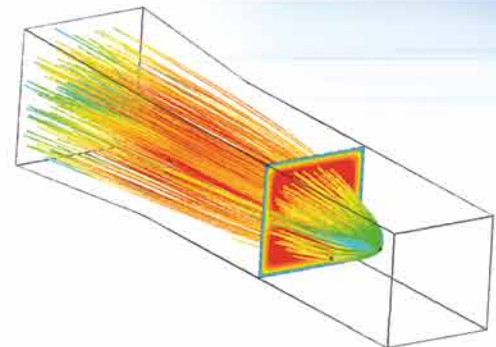
ASME® is a registered trademark of American Society of Mechanical Engineers (ASME, ASME International).

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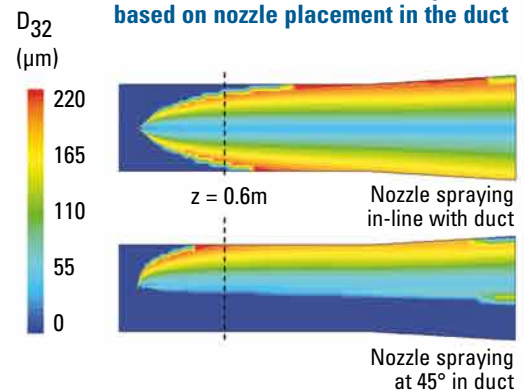
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### Use of Computational Fluid Dynamics Ensures Optimal Performance



### CFD shows the change in drop size based on nozzle placement in the duct



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