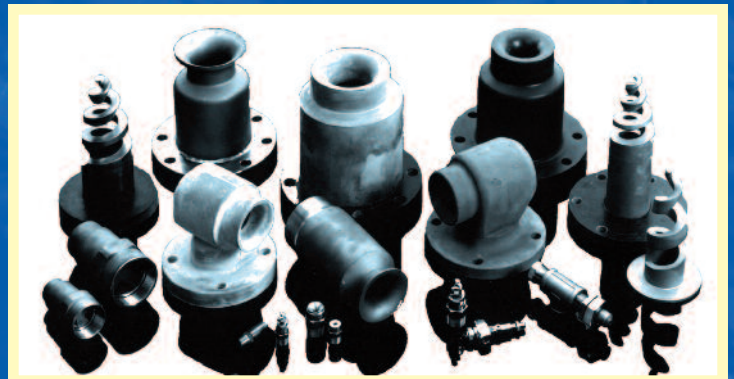


BETE®

HIGH EFFICIENCY NOZZLES FOR
THE POLLUTION CONTROL INDUSTRY





Knowing the challenges,

The Spray Nozzle Company

In the 21st century industries world wide will face increasing demands for cleaner, more efficient operations.

BETE Fog Nozzle, Inc. is committed to doing our part to protect the environment. Since 1950, BETE has been the leader in spray nozzle design and technological innovation for the pollution control industry.

BETE is more than just a spray nozzle supplier!

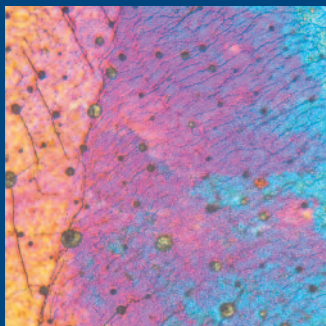
BETE innovation has virtually revolutionized scrubbing and pollution control design. Through higher spray nozzle efficiency and reliability, lower toxic emissions into our air and water are now being achieved. BETE's superior nozzle designs feature reduced nozzle plugging, improved spray pattern distribution, lengthened nozzle life, and increased reliability and efficiency.

BETE . . .

Is the inventor of the the spiral nozzle. This highly efficient nozzle produces the smallest droplet diameter at the lowest pressure resulting in reduced power requirements for pumping.

BETE has:

- **The broadest line of spiral nozzles** including improved clog-resistant designs, wider angles, and a complete range of flows.
- **A full range of the standard nozzle designs:** tangential inlet, whirl disk nozzles, and fan nozzles, as well as low- and high-flow air atomizing nozzles for quench and dry scrubbing applications.
- **Unparalleled ability to design, manufacture and deliver customized nozzles.** We work with you to meet the toughest government regulations. We can meet your special requirements, helping you to achieve optimum system performance.
- **Over 200,000 nozzles successfully operating in over 200 power plants domestically and overseas,** and an international reputation for commitment, innovation, experience and service.



A substantial portion of BETE's production is devoted to nozzles custom designed for specific customer requests. Combine your process experience with our nozzle expertise today.

Call BETE and find out about the expertise that makes a difference

. . . the BETE Difference.

Finding the solutions

For All Your Environmental Applications

Brief Description of FGD Scrubber Zones

Quench:

In this section of the scrubber, the hot flue gases are reduced in temperature before entering the pre-scrubber or absorber. This will protect any heat sensitive components in the absorber and reduce the volume of the gas, thereby increasing the residence time in the absorber. *See page 4.*

Pre-Scrubber:

This section is used to remove particulates, chlorides, or both from the flue gas. *See page 4.*

Absorber:

This is normally an open spray tower that brings the scrubber slurry into contact with the flue gas, allowing the chemical reactions that tie up the SO₂ to take place in the sump. *See page 5.*

Packing:

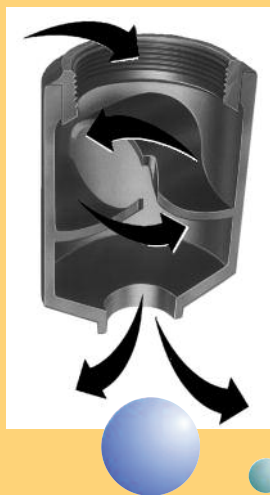
Some towers have a packing section. In this section, the slurry is spread on loose or structured packing in order to increase the surface in contact with the flue gas. *See page 5.*

Bubble Tray:

Some towers have a perforated plate above the absorber section. Slurry is deposited evenly on this plate, which both equalizes the gas flow and provides surface area in contact with the gas.

Mist Eliminator:

All wet FGD systems generate a certain percentage of extremely fine droplets that are carried by the movement of the flue gas toward the tower exit. The mist eliminator is a series of convoluted vanes that trap and condense the droplets, allowing them to be returned to the system. In order to maintain high droplet removal efficiency, the mist eliminator vanes must be cleaned periodically. *See page 5.*



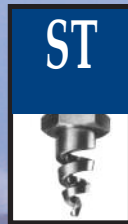
At BETE you get more than just hardware, you get experience, expertise and the leading technology.

BETE complements its extensive standard offerings with many unique designs. One such nozzle, the original BETE MaxiPass™ (MP) series, was designed to solve the plugging problems found in many power plants. With a free passage diameter equal to the orifice diameter, no other whirl nozzle on the market today can match the BETE MaxiPass series for clog resistance.

A comparison of the free passage available with the BETE MaxiPass whirl nozzle compared to the more traditional x-vane nozzle. The BETE MaxiPass has an orifice that can pass up to twice the particle diameter and four times the volume as the same size x-vane.

Nozzle Selection For Wet Flue Gas

The Quencher/ Pre-Scrubber



The Quencher/Pre-Scrubber
Since the primary cooling mechanism is the evaporation of water, the first consideration in nozzle selection is achieving the smallest possible droplets at the available operating pressure. This is also true in the pre-scrubber where the gas-liquid contact is the key to effective mass transfer.

Factors to consider:

- **Size of any particles in the quench liquid**
- **Corrosive and erosive conditions**
- **Select the TF or ST spiral nozzle** that has the best atomization
- **Select the TFXP or STXP spiral** if plugging is a potential problem
- **Select the MaxiPass™** for uniform distribution and the ultimate in clog resistance
- **Select the TH** for right angle hollow cone design

Hollow Cone Tangential Whirl TH Series

Design

- Series of right angle nozzles using a tangential inlet to produce the whirl
- **Clog-resistant:** nozzles have no internal parts
- **Construction:** one-piece casting
- **Connections:** flanged or female, NPT or BSP threads

Spray Characteristics

- Extremely even spray distribution
- **Spray patterns:** hollow cone
- **Spray angles:** 70° to 120°
- **Flow rates:** 5 to 1500 gpm (15.3 to 2230 l/min)
With special sizes to meet your exact specifications

Materials

- 316 Stainless Steel
- Nickel Alloy C
- Nitride Bonded Silicon Carbide (SNBSC)
- Other materials on application.

Full Cone Spiral ST, STXP, TF, TFXP Series

Design

- The original spiral nozzle
- High discharge velocity
- High energy efficiency
- **Clog-resistant:** one-piece construction with no internal parts
- **Construction:** one, two or three-piece casting
- **Connections:** NPT or BSP threads male connection standard, female threads and flanged connection available by special order

Spray Characteristics

- Fine atomization
- **Spray pattern:** full and hollow cone
- **Flow rates:** 0.5 to 3320 gpm (2.26 to 10700 l/min)
higher flow rates available

Materials

- Cobalt Alloy 6
- 316 Stainless Steel
- 317 Stainless Steel
- Nickel Alloy 625
- Nickel Alloy C
- Reaction Bonded Silicon Carbide (RBSC)

Full Cone MaxiPass™ Large Free Passage Whirl MaxiPass Series

Design

- Ultimate large, free passage, clog-resistant full cone design.
- Two unique S-shaped internal vanes allow free passage of large particles.
- **HIGH ENERGY EFFICIENCY**
- Easily handles dirty, lumpy and stringy liquids.
- **Connections:** male or female NPT or BSP threads, or flanged

Spray Characteristics

- Uniform distribution
- Fine atomization
- **Spray pattern:** full cone
- **Spray angles:** 30°, 60°, 90°, and 120°
- **Flow rates:** 0.74 to 4500 gpm (2.75 - 17000 l/min)
- Highly reliable spray performance under the most difficult conditions.

Materials

- PTFE
- PVC
- Polypropylene
- Polyurethane
- Nickel Alloy C
- 316 Stainless Steel
- Cobalt Alloy 6
- Nitride Bonded Silicon Carbide (SNBSC)

Desulphurization Scrubbers

The Absorber, Packing Sprays, The Mist Eliminator



Whirl Disk NC, SC, WL Series Design

- Series of full cone nozzles designed for use wherever uniform coverage is required
- **Features:** an orifice body with a vane that generates turbulence within a whirl chamber
- Produces substantially uniform coverage over a circular area
- Choose when large particulate is not present

Spray Characteristics

- **Atomization:** medium to coarse
- **Spray pattern:** full cone
- **Spray angles:** 30°, 80°, 90° and 120° (SC also available in 60°)
- **Flow rates:** WL- 0.12 to 59 gpm (0.497 to 192 l/min)
SC, NC- 1.7 to 2150 gpm (6.25 - 8180 l/min)

Materials

- PTFE
- PVC
- 303 Stainless Steel
- 316 Stainless Steel
- PDVF
- Other materials on application
- SC not available in plastic

High Flow Air Atomizer SpiralAir™ Series Design/Spray Characteristics

- Low air-to-liquid ratios
- **Flow rates:** from 0.3 to 20 gpm (2 - 80 l/min)
- 3-Stage atomization for the highest performance reliability
- **Very fine atomization available**
- Successful operation under extremely corrosive conditions
- **Available in a range of wear resistant alloys:** Stainless Steel, Cobalt Alloy 6, Nickel Alloy C22

Low Flow Air Atomizer XA Series Design/Spray Characteristics

- **Flow rates:** 0.3 to 306 gpm (1.0 - 1158 l/h)
- **Internal or external mixing of air and liquid**
- **Finest atomization available**
- Siphon, gravity and direct pressure feeds
- **Available in:** Nickel-plated Brass and 303 Stainless Steel and other materials.

The Absorber

The scrubber slurry is brought into contact with the flue gas, allowing chemical reactions that tie up the SO₂ to take place in the sump.

The main selection criteria is to achieve the greatest possible contact between gas and liquid for maximum diffusion.

Other considerations:

- Size of any particle in the scrubber slurry
- Corrosive and erosive conditions

Best Choices:

- **ST spiral** is the most effective for mass transfer
- **Select the STXP large free passage spiral** if plugging is a potential problem
- **Select the MaxiPass™** for uniform distribution and the ultimate in clog-resistance
- **Select the TH** for right angle hollow cone design

Packing Sprays

In this section, the slurry is spread on loose or structured packing in order to increase the liquid surface area in contact with the flue gas. The primary function for packing spray nozzles is the even distribution of liquid across the top of the packing.

Best Choice:

- **Select the large free passage MaxiPass** for packing sprays

The Mist Eliminator

In this section a labyrinth is placed in the path of the exiting treated flue gas to prevent droplets from escaping into the environment. The de-mister profiles need to be kept clean of particulate in order to maintain high mist removal efficiencies.

Best Choices:

- **Select the WL series** for low flow of clean water
- **Select the SC or NC** for higher flow rates of clean water
- **Select the MaxiPass** for low or high flow when there is particulate in the water or if plugging is a problem.

Other Utility Applications for BETE Nozzles

- Flue Gas Humidification
- Dry Scrubbing
- Odor Control
- Cooling Ponds
- F.M. approved nozzles for transformer fire protection
- Retractable nozzles for fire protection in coal conveying ducts

Improving Existing Designs

BETE Engineers Work With You



How BETE meets your needs

Throughout its 55+ year history, BETE has been designing nozzles to meet special industry requirements. The following are a few examples of ways in which BETE design and engineering can solve your application needs.

Examples:

Problem: A utility operating a power plant with a restriction on stack emissions opacity was faced with an expensive problem: high ambient temperatures reduced the efficiency of the ESP, requiring the boiler output to be restricted in warm weather.

Solution: The utility had determined that the ESP efficiency could be increased if the flue gas humidity was raised by spraying finely atomized water into the flue gas duct. The problem was complicated by the fact that there was only 50 feet of duct in which to accomplish the humidification and that no

unevaporated water could be allowed to enter the ESP. A two-fluid nozzle was the clear choice for the project, but which nozzle? The limiting factor was the maximum droplet diameter for the nozzle, because in the 50 foot duct length, the largest droplet that would completely evaporate was 100 microns in diameter.

Working with the **BETE** laboratory, engineers from the utility evaluated several competing designs. They were able to determine that the largest droplet produced by the **BETE SpiralAir** nozzle was not only below the required maximum, but was significantly smaller than the largest droplet produced by competing designs.

Problem: A utility was experiencing extreme plugging problems with their full cone silicon carbide absorber nozzles. The plugging was so severe that even a silicon carbide **BETE MaxiPass™**, with a free passage that was 3 times larger than the original nozzles, would plug. Attempting to unplug silicon carbide nozzles inevitably resulted in a high number of broken nozzles.

Solution: **BETE** supplied the MaxiPass nozzle in a one-piece construction, in polyurethane material. Even though the nozzle still plugged occasionally, the polyurethane material was so strong and flexible that the blockage could be removed by beating the nozzle with a sledge hammer without damaging the nozzle.

Problem: The absorption tower of a wet limestone FGD system using right angle hollow cone silicon carbide spray nozzles failed to meet the specified SO₂ removal rate. The scrubber O.E.M. tried many avenues to improve the process performance, but the unit still failed to meet the removal requirements. If the unit did not meet the specifications within 12 weeks, the O.E. M. was faced with a sizable penalty.

Solution: Because the one remaining possibility was that the chemical process was surface area limited, the O.E.M. turned to us for assistance. Laboratory testing confirmed that a **BETE** spiral nozzle made of Cobalt Alloy 6

would decrease the Sauter Mean Droplet diameter by 40%. **BETE** designed and manufactured the nozzles within eight weeks. The O.E.M. installed them, and the SO₂ removal rate was brought within specification.

Problem: A utility was having difficulty loading fly ash into an open truck body. Ash discharged from the chute flowed like water into the center of the truck body, up the sides and over the top. On windy days the problem was especially acute.

Solution: From the description and photographs provided by the utility maintenance supervisor, **BETE** engineers designed a special manifold to encircle the discharge chute. The manifold combined fine atomizing P and TF-spiral nozzles to confine the small droplets. **BETE** manufactured the manifold complete with the nozzles. The utility maintenance people declared it: "the best thing since sliced bread!"

Creating Advanced New Designs

The Best Nozzle For Your Pollution Control Application



Our Investment Casting Foundry

BETE has been involved with the electric utility industry for over 40 years. From the beginning, we realized that there are problems unique to this industry.

Second, there is the demand by the industry for extremely rapid service, especially during shut-downs.

In 1979 BETE decided to enhance its service to the market by establishing an in-house investment foundry capable of providing all of the alloys needed, including 316, 316L, 316LM, 317, 317L, Nickel Alloy C-22, Nickel Alloy G, and Cobalt Alloy 6.

Because our foundry is dedicated to the production of our nozzles, we can manage deliveries that border on the miraculous. Our engineers have extensive

experience in selecting appropriate alloys for all utility applications, and are available to provide assistance if you need it.

First, there is the wide variety of extremely hostile environments in which nozzles are expected to survive. These environments necessitate a range of metallic alloys that are not commonly available.



The BETE Difference

Superior State-of-the-Art Laboratory Facilities

Analyzer Overview

BETE Fog Nozzle developed the BETE Droplet Analyzer specifically for fast, accurate dynamic droplet size analysis utilizing the latest technology in digital imaging, analysis and data processing. The result is a remarkably versatile system capable of in-the-spray measurement of droplets for 2.5 to 32,000 microns at high velocities. This unique system now makes it a reality at Bete Fog Nozzle to quantitatively develop, specify and evaluate customer spray nozzle requirements quickly. To our customers this means the ability to optimize process performance while minimizing capital and operating costs related to pumping and horsepower.

BETE Liquid Distribution Analyzer

Distribution of liquid discharged from spray nozzles is of critical importance for many applications, and precise measurement of this distribution is also necessary to determine the proper sampling areas for droplet size measure-



ment.

BETE Fog Nozzle developed a unique high speed "Patternator" for liquid distribution measurement that is totally integrated with the Droplet Analyzer System, enabling precise measurement of spray coverage, uniformity, density, and droplet size.



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