




**OPTIMIZED SPRAY  
TECHNOLOGY FOR SULFURIC  
ACID PRODUCTION**



***Spraying Systems Co.***  
Experts in Spray Technology





Molten sulfur spray plume illustrated by an isosurface

# INCREASE PRODUCTION, MINIMIZE WASTE WITH OPTIMIZED SPRAY TECHNOLOGY

**Achieving the proper sulfur droplet size and maintaining the proper temperature are the keys to maximizing production and furnace efficiency.**

If droplets are too big, the droplet size distribution too large or the sulfur isn't in the ideal temperature range:

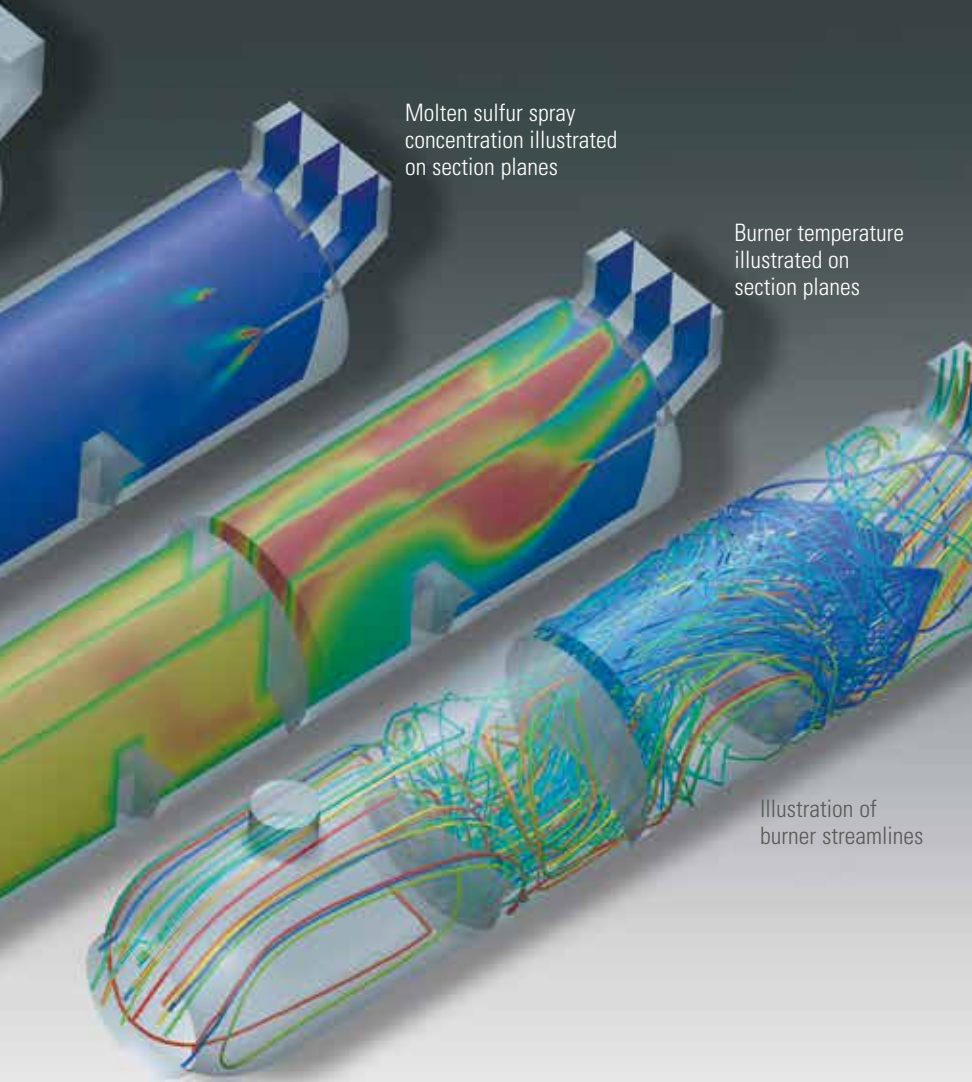
- Vaporization and combustion can be compromised
- Build-up on the waste heat boiler tube sheet face and damage to the furnace refractory and/or downstream equipment can occur
- Guns can plug, dramatically increasing maintenance time

**Avoiding problems like these and maximizing production is possible. It requires a partner with specialized expertise, tools and products.**

SPRAYING SYSTEMS CO.  
OFFERS ALL THIS AND MORE

- **Unmatched droplet size data** compiled by decades of research and testing
- **Computational modeling services** that validate sulfur gun performance prior to purchase. If you're experiencing problems like carryover or wall wetting or installing a new furnace, modeling can help determine the ideal droplet size and gun placement
- **A wide range of hydraulic and air atomizing guns** for spraying molten sulfur and spent acid
- **A proven track record** that started with the industry-standard BA WhirlJet® hollow cone spray nozzles that feature small droplets and open flow passages to minimize plugging. Energy-efficient FloMax® air atomizing guns soon followed and are now widely used in operations requiring very small droplets and quick evaporation. Our newest sulfur gun, the CBA WhirlJet, offers producers the performance of the BA WhirlJet with greatly reduced plugging





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HERE ARE A FEW RECENT EXAMPLES OF HOW WE'VE HELPED OTHER PRODUCERS IMPROVE OPERATING EFFICIENCY

### LET US DO THE SAME FOR YOU

#### **Wear Life of Makeup Sulfur Injection Nozzles Tripled, Maintenance Simplified with New CBA WhirlJet Guns**

A producer in the gulf coast region of the US was challenged by excessive replacement and maintenance costs of sulfur guns. A change to CBA WhirlJet sulfur guns made from HASTELLOY® and 310 stainless steel solved the issues. Wear life of the nozzles has increased by 200% and require replacement every six months instead of every four months. When maintenance is required, the threaded design and easy access of the nozzle make replacement fast and easy. In addition, the design of the CBA sulfur gun eliminates the need to remove the gun from service when not in use – reducing labor costs and downtime even further.

#### **FloMax Sulfur Guns in Spent Acid Regeneration Furnace Eliminates Pooling and Premature Shutdowns**

A producer on the west coast of the US was plagued by wetting and pooling in the furnace. After just a few weeks of use, the nozzle in the gun would begin to wear. Droplet size quickly increased and evaporation was compromised. The excess moisture created a maintenance nightmare and poor combustion efficiency resulted in reduced output. New FloMax-A sulfur guns, made of HASTELLOY C276 with a thermal expansion joint to account for the extreme environment, enabled an increase in wear life. The nozzles on the guns are now replaced every six months, pooling has been eliminated and decomposition efficiency remains high throughout the service life of the nozzles.







## SOLUTIONS FOR SULFUR COMBUSTION FURNACES

### BA WHIRLJET® SULFUR GUN: THE INDUSTRY STANDARD FOR DECADES

BA WhirlJet sulfur guns are precision-engineered to produce the exact droplet size and droplet size distribution required for complete vaporization and efficient combustion. Our state-of-the-art manufacturing and stringent quality control/testing programs ensure BA WhirlJet sulfur guns deliver the expected performance day in and day out. Similar looking competitive guns are available, but they fail to match the tight droplet size control and performance consistency of the BA WhirlJet guns.



### INTRODUCING THE CBA WHIRLJET SULFUR GUN: SAME PERFORMANCE AS BA WHIRLJET SULFUR GUN, BUT WITH DRAMATICALLY REDUCED PLUGGING

Plugging occurs in sulfur guns when the temperature of the sulfur falls outside of the optimal range. This commonly happens when the sulfur flow is decreased or turned off. Producers try to compensate for this by purging or removing guns quickly at the end of a production run. However, this creates safety issues and isn't always possible. The design of the new CBA WhirlJet nozzle eliminates both problems.

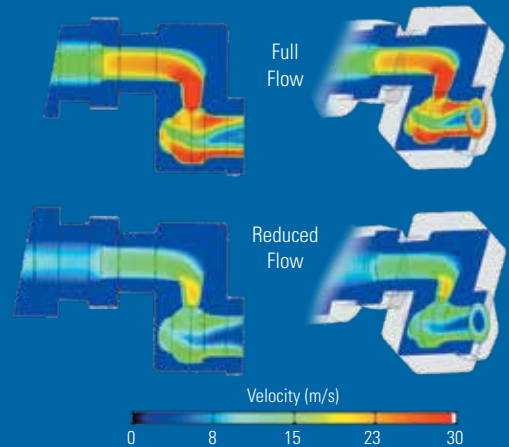




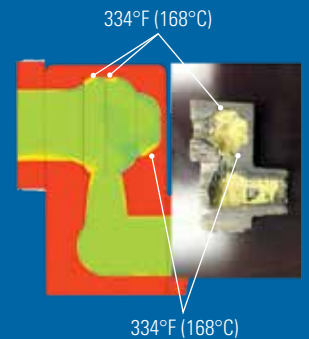
## CBA WHIRLJET® DESIGN VALIDATION

Computational Fluid Dynamics (CFD) was utilized to model heat transfer in the BA and CBA WhirlJet sulfur guns.

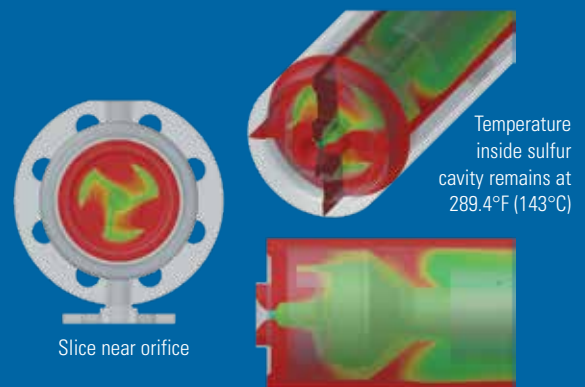
Full flow rate conditions of 9,410 kg/hr. (20,745 lbs./hr.) sulfur at 150 psig  $\Delta P$  (10 bar) were compared to reduced flow rate conditions of 1,745 kg/hr. (3,847 lbs./hr.) sulfur at 5 psig  $\Delta P$  (0.35 bar). The feed sulfur temperature was set at 284°F (140°C) and steam in the steam jacket pipe was at 293°F (145°C) and 60 psig (4.1 bar).



At the reduced flow conditions, the sulfur polymerizes inside the BA WhirlJet gun as the temperature rises above 305.6°F (152°C). A skin forms and grows thicker over time eventually plugging the gun.



At the same reduced flow condition, the sulfur temperature remains at 289.4°F (143°C) as it passes through the CBA WhirlJet gun and no polymerization occurs.



**Our new CBA WhirlJet sulfur gun features a unique design that keeps the temperature of the sulfur consistent as it passes through the gun, even when flow rates change:**

- Unlike conventional sulfur guns that protrude slightly from the steam jacket, the CBA sulfur gun is recessed into the steam jacket. This ensures temperature uniformity and eliminates or dramatically reduces the chance the sulfur will solidify and plug the gun
- The recessed design of the CBA gun also helps increase wear life
- The CBA nozzle is threaded on the front of the gun and offers easy access when maintenance is required

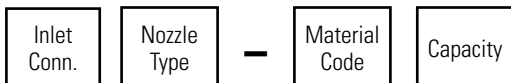
**The CBA WhirlJet sulfur gun provides the same droplet size and droplet size distribution as the BA WhirlJet sulfur gun.** Upgrading is easy. Producers can upgrade guns one at a time with no negative impact on performance.

# PERFORMANCE DATA: CBA WHIRLJET®



Inlet Conn. (in.)	Capacity Size	Approx. Free Passage Dia. in. (mm)	Flow Rate Capacity gallons per minute (liters per minute)			Spray Angle (°)	Droplet Size, D32 (microns)		
			50 psi (3.5 bar)	100 psi (7 bar)	150 psi (10 bar)		50 psi (3.5 bar)	100 psi (7 bar)	150 psi (10 bar)
2	20	0.18 (4.6)	4.4 (16.7)	6.1 (23.1)	7.5 (28.4)	65	484	323	228
	30	0.18 (4.6)	6.6 (25.0)	9.2 (34.8)	11.2 (42.6)	65	529	353	250
	40	0.18 (4.6)	8.8 (33.3)	12.3 (46.6)	15.0 (56.8)	65	561	374	265
	50	0.20 (5.1)	11.0 (41.6)	15.4 (58.3)	18.8 (71.1)	75	586	391	277
	60	0.20 (5.1)	13.0 (49.2)	18.5 (70.0)	22.5 (85.3)	75	606	404	286
	70	0.20 (5.1)	15.4 (58.3)	21.6 (81.8)	26.3 (99.6)	75	623	416	295
	80	0.20 (5.1)	17.6 (66.6)	24.7 (93.5)	30.1 (113.8)	80	638	426	302
	90	0.20 (5.1)	19.8 (75.0)	27.8 (105.2)	33.8 (128.1)	80	651	435	308
2 1/2	100	0.28 (7.1)	22.0 (83.3)	30.9 (117.0)	37.6 (142.3)	75	663	443	314
	110	0.28 (7.1)	24.2 (91.6)	34.0 (128.7)	41.4 (156.6)	75	674	450	319
	120	0.28 (7.1)	26.4 (99.9)	37.0 (140.1)	45.1 (170.9)	75	683	456	323
	130	0.28 (7.1)	28.6 (108.3)	40.0 (151.4)	48.9 (185.2)	70	692	462	328
	140	0.28 (7.1)	30.8 (116.6)	43.2 (163.5)	52.7 (199.4)	70	700	468	332
	150	0.28 (7.1)	33.0 (124.9)	46.3 (175.3)	56.5 (213.7)	70	708	473	335
	160	0.28 (7.1)	35.0 (132.5)	49.4 (187.0)	60.2 (228.0)	70	715	478	339
	170	0.28 (7.1)	37.5 (142.0)	52.5 (198.7)	64.0 (242.3)	70	722	482	342
	180	0.28 (7.1)	39.7 (150.3)	55.6 (210.5)	67.8 (256.6)	70	728	486	345
	190	0.28 (7.1)	41.9 (158.6)	58.7 (222.2)	71.6 (270.9)	70	734	490	347
	200	0.28 (7.1)	44.1 (166.9)	61.8 (233.9)	75.3 (285.2)	70	740	494	350

## ORDERING INFORMATION: CBA WHIRLJET



Example



# PERFORMANCE DATA: BA WHIRLJET®



Prefix	Inlet Conn. (in.)	Capacity Size	Approx. Free Passage Dia. in. (mm)	Flow Rate Capacity gallons per minute (liters per minute)			Spray Angle (°)
				50 psi (3.5 bar)	100 psi (7 bar)	150 psi (10 bar)	
-	3/8	5	0.13 (3.2)	1.1 (4.2)	1.6 (6.0)	1.9 (7.3)	75
		10	0.17 (4.4)	2.2 (8.5)	3.2 (12.0)	3.9 (14.7)	75
		15	0.22 (5.6)	3.4 (12.7)	4.7 (18.0)	5.8 (22.0)	70
		20	0.25 (6.4)	4.5 (16.9)	6.3 (23.9)	7.7 (29.3)	70
		25	0.30 (7.5)	5.6 (21.2)	7.9 (29.9)	9.7 (36.7)	70
-	1/2	10	0.13 (3.3)	2.2 (8.5)	3.2 (12.0)	3.9 (14.7)	65
		25	0.25 (6.4)	5.6 (21.2)	7.9 (29.9)	9.7 (36.7)	65
		30	0.29 (7.4)	6.7 (25.4)	9.5 (35.9)	11.6 (44.0)	70
		35	0.31 (7.9)	7.8 (29.6)	11.1 (41.9)	13.6 (51.3)	75
		40	0.36 (9.1)	8.9 (33.9)	12.6 (47.9)	15.5 (58.6)	75
		45	0.38 (9.5)	10.1 (38.1)	14.2 (53.9)	17.4 (66.0)	75
		50	0.38 (9.5)	11.2 (42.3)	15.8 (59.9)	19.4 (73.3)	80
		55	0.38 (9.5)	12.3 (46.6)	17.4 (65.8)	21.3 (80.6)	80
		60	0.38 (9.5)	13.4 (50.8)	19.0 (71.8)	23.2 (88.0)	85
		65	0.38 (9.5)	14.5 (55.0)	20.6 (77.8)	25.2 (95.3)	85
56967	1/2	60	0.43 (10.9)	13.4 (50.8)	19.0 (71.8)	23.2 (88.0)	75
		65	0.47 (11.9)	14.5 (55.0)	20.6 (77.8)	25.2 (95.3)	75
		70	0.50 (12.7)	15.7 (59.3)	22.1 (83.8)	27.1 (102.6)	75
		75	0.50 (12.7)	16.8 (63.5)	23.7 (89.8)	29.0 (110.0)	80
		80	0.50 (12.7)	17.9 (67.7)	25.3 (95.8)	31.0 (117.3)	80
		90	0.50 (12.7)	20.1 (76.2)	28.5 (107.7)	34.9 (131.9)	80
-	3/4	25	0.21 (5.3)	5.6 (21.2)	7.9 (29.9)	9.7 (36.7)	70
		30	0.24 (6.1)	6.7 (25.4)	9.5 (35.9)	11.6 (44.0)	70
		40	0.31 (7.9)	8.9 (33.9)	12.6 (47.9)	15.5 (58.6)	75
		50	0.37 (9.4)	11.2 (42.3)	15.8 (59.9)	19.4 (73.3)	75
		60	0.43 (10.9)	13.4 (50.8)	19.0 (71.8)	23.2 (88.0)	75
		70	0.50 (12.7)	15.7 (59.3)	22.1 (83.8)	27.1 (102.6)	80
		80	0.50 (12.7)	17.9 (67.7)	25.3 (95.8)	31.0 (117.3)	80
		90	0.50 (12.7)	20.1 (76.2)	28.5 (107.7)	34.9 (131.9)	85
		100	0.50 (12.7)	22.4 (84.6)	31.6 (119.7)	38.7 (146.6)	85
		110	0.50 (12.7)	24.6 (93.1)	34.8 (131.7)	42.6 (161.3)	90
120	0.50 (12.7)	26.8 (101.6)	37.9 (143.6)	46.5 (175.9)	90		

## ORDERING INFORMATION: BA WHIRLJET

Inlet Conn.	Nozzle Type	-	Material Code	Capacity	Example
					1/2 - BA - 309SS 50

## ORDERING INFORMATION: WHIRLJET 56967

Nozzle Series	-	Inlet Conn.	Nozzle Type	-	Material Code	Capacity	Example
							56967 - 1/2 BA - 309SS 50





## SOLUTIONS FOR SPENT ACID PLANTS

Two-fluid guns are widely used in spent acid plants because the atomization process produces smaller droplets than hydraulic guns and provides better decomposition with reduced risk of carryover.



### FLOMAX® SULFUR GUNS

FloMax guns use a unique three-stage atomization process to produce a focused air stream that shears the liquid with minimal air. The result is a D32 droplet size 34% smaller using 20% less air than other two-fluid guns. The smaller, uniform droplets decompose at the same time and maximize process efficiency. The atomizing air flow provides a secondary benefit of purging the guns of potential build-up and ensuring uninterrupted operation.

The high turndown ratio of the FloMax sulfur guns – 10:1 – enables the air pressure to remain constant while the liquid flow rate varies and extends operating flexibility.

#### FLOMAX SULFUR GUNS: PERFORMANCE OVERVIEW

**FloMax FM10A:** 1.3 to 13 gpm (4.9 to 49.2 lpm)

**FloMax FM25A:** 10 to 30 gpm (37.8 to 114 lpm)

**Spray angles:** 20° and 55°

#### **Wide range of material options:**

310 stainless steel, HASTELLOY® C276 or C22.  
Different materials can be used for the internals, the gun and the shroud.



# ADDITIONAL SPRAY TECHNOLOGY FOR SULFURIC ACID PRODUCTION

## UNIFORM DISTRIBUTION (UD) FULLJET® NOZZLES

UD FullJet nozzles feature a special vane design that produces coarse droplets and unmatched uniform distribution. Constructed of chemically-resistant polypropylene, these nozzles provide the best performance in fume scrubbing applications.



## PTFE SPIRALJET® FULL CONE NOZZLES

Producing a uniform full cone spray pattern, SpiralJet nozzles provide excellent coverage and durability and are widely used in entrainment scrubbers.



## FLATJET® NOZZLES

Filter cloth cleaning is best achieved with FlatJet spray nozzles that produce a wide, thick, high-impact spray pattern. Z6 FlatJet nozzles, constructed of proprietary high molybdenum, high-chrome alloy Z6, provide excellent corrosion and erosion resistance and are widely used for cleaning vacuum table filters. Our P Series FlatJet nozzles that produce uniform impact and distribution are ideal for use with tilting pan and other similar filters.



### CASE STUDY:

## PRODUCTION GAINS ACHIEVED BY ELIMINATING COMBUSTION PROBLEMS WHEN SPRAYING MOLTEN SULFUR

Reduced combustion efficiency in two furnaces in a sulfur plant in Saudi Arabia was limiting production. The efficiency problem was caused by the rapid wear rate of the nozzles. The nozzles were replaced every two weeks but a steady decline in efficiency occurred throughout that period. Replacing the existing guns with new CBA WhirlJet® sulfur guns made from 316 stainless steel extended nozzle service life to six months. In addition, the nozzle performance remained consistent, enabling optimal combustion efficiency. Production increased as a result of improved combustion and dramatically reduced downtime for nozzle replacement.



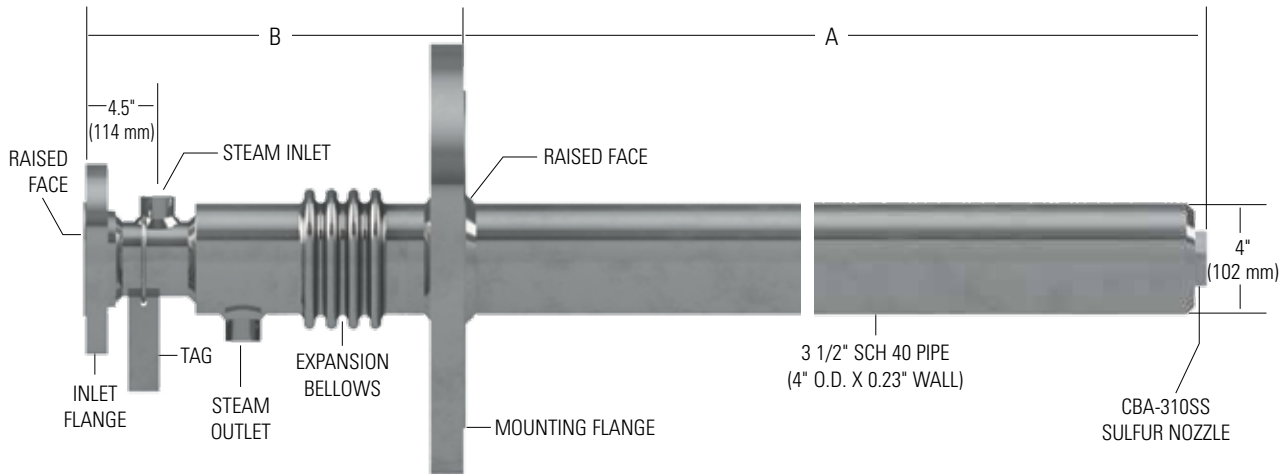
# CBA WHIRLJET® SULFUR GUN SPECIFICATIONS

**MATERIALS:**

Flanges: UNS S30400  
 Outer Pipe: 310SS  
 Inner Pipes: UNS S30400

Bellows:  
 UNS S32100 Convolutes  
 UNS S30400 Weld preps

Nozzle Holder: 310SS  
 Nozzle: 310SS  
 Tag: Stainless Steel



**CUSTOMER-SPECIFIED DIMENSIONS:**

(Indicate US or Metric)

**A:** \_\_\_\_\_  
 (in. or mm – Max. 72"/1,829 mm)

**B:** \_\_\_\_\_  
 (in. or mm – Min. 18"/457 mm)

**Inlet Flange:** \_\_\_\_\_  
 (2" class 150 RF flange Min.)

**Mounting Flange:** \_\_\_\_\_  
 (6" class 150 RF flange Min.)

**Steam Inlet/Outlet:** \_\_\_\_\_  
 (3/4" 3000 (F) NPT coupling Min.)

**ASME B31.3-2018 CODE REQUIRED?**

**PROVIDE DESIGN CONDITIONS:**

**Design Temperature:** \_\_\_\_\_ (°F or °C)

**Design Pressure:** \_\_\_\_\_ (PSIG or BARG)

**Corrosion Allowance:** \_\_\_\_\_ (in. or mm)

**NON-DESTRUCTIVE EXAMINATIONS?**

**Visual Examination (VT):** \_\_\_\_\_ %

**Radiographic Examination (RT):** \_\_\_\_\_ %  
 (On all butt welds)

**Liquid Penetrant Examination (PT):** \_\_\_\_\_ %  
 (On all butt and fillet welds)

**PSIG, Hydrostatic Testing (LT):** \_\_\_\_\_  
 (Per ASME B31.3 paragraph 345.4 for 10 minutes minimum)

**Certified Material Test Reports (CMTR's):** \_\_\_\_\_  
 (On all components)

**NOTES:**

All welds and welders are qualified per ASME IX Boiler and Pressure Vessel Code (BPVC).

All materials are procured from vendors on Spraying Systems Co.'s approved vendor list.



# FLOMAX® SULFUR GUN SPECIFICATIONS

**MATERIALS:**

Flanges: 316SS

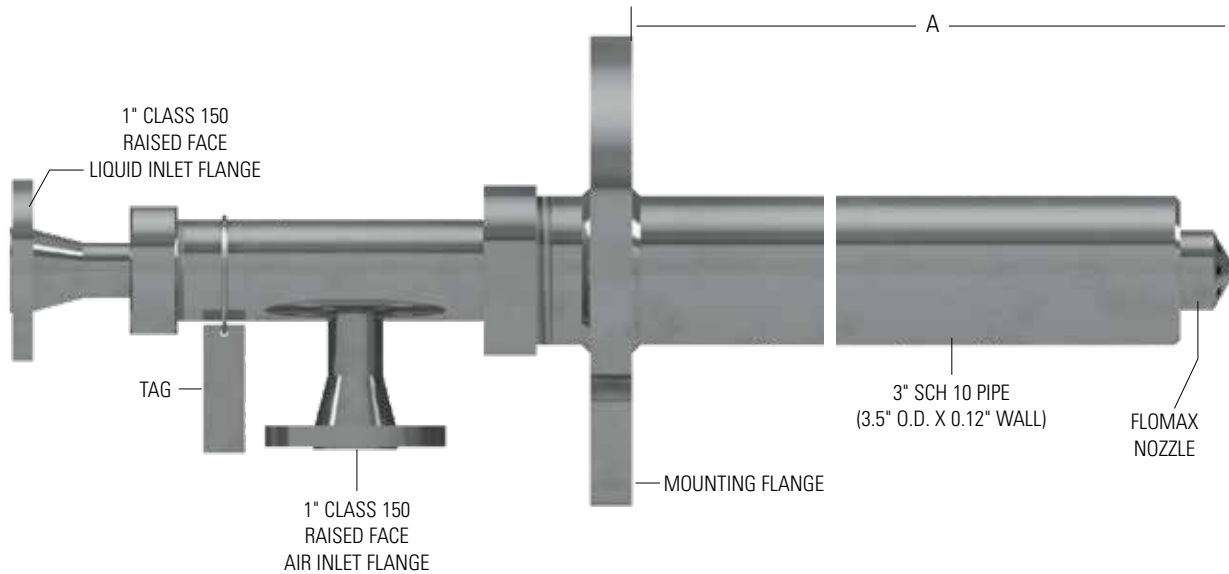
Inner Pipes: 316SS

Nozzle: HASTELLOY C276 or C22

Outer Pipe: HASTELLOY® C276 or C22

Nozzle Holder: HASTELLOY C276 or C22

Tag: Stainless Steel



**CUSTOMER-SPECIFIED DIMENSIONS AND MATERIALS:**

(Indicate US or Metric)

A: \_\_\_\_\_  
(in. or mm – Max. 72"/1,829 mm)

FloMax Nozzle: \_\_\_\_\_

Mounting Flange: \_\_\_\_\_  
(4" class 150 RF flange Min.)

Liquid Inlet Flange: \_\_\_\_\_  
(1" class 150 RF flange Min.)

Air Inlet Flange: \_\_\_\_\_  
(1" class 150 RF flange Min.)

**ASME B31.3-2018 CODE REQUIRED?**

**PROVIDE DESIGN CONDITIONS:**

Design Temperature: \_\_\_\_\_ (°F or °C)

Design Pressure: \_\_\_\_\_ (PSIG or BARG)

Corrosion Allowance: \_\_\_\_\_ (in. or mm)

**NON-DESTRUCTIVE EXAMINATIONS?**

Visual Examination (VT): \_\_\_\_\_ %

Radiographic Examination (RT): \_\_\_\_\_ %  
(On all butt welds)

Liquid Penetrant Examination (PT): \_\_\_\_\_ %  
(On all butt and fillet welds)

PSIG, Hydrostatic Testing (LT): \_\_\_\_\_  
(Per ASME B31.3 paragraph 345.4 for 10 minutes minimum)

Certified Material Test Reports (CMTR's): \_\_\_\_\_  
(On all components)

**NOTES:**

All welds and welders are qualified per ASME IX Boiler and Pressure Vessel Code (BPVC).

All materials are procured from vendors on Spraying Systems Co.'s approved vendor list.





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Experts in Spray Technology

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