



Spraying Systems Co.®
Experts in Spray Technology

PHARMACEUTICALS AND BIOLOGICS

CATALOG 12



PHARMA & BIOLOGICS CATALOG

TABLE OF CONTENTS

TECHNICAL REFERENCE

	PAGE
Table of Equivalents	4
Basic Nozzle Characteristics	5
Spray Drop Size (Atomization)	6
Drop Size Terminology	7
Capacity	8
Spray Angle and Coverage	9
Impact	10
Estimating Pressure Drops Through Fluidline Accessories	11
Flow of Water Through Schedule 40 Steel Pipe	12
Other Spray Performance Considerations	13
Common Causes of Spray Nozzle Problems	14
Preventing and Solving Spray Nozzle Problems	15
General Safety Instructions	16

TABLET COATING

	PAGE
Application Overview	18
VMAU Spray Nozzles	21
JAU Spray Nozzles	25
Modular Air Atomizing Manifolds	29

FLUID BED PROCESSING

	PAGE
Application Overview	32
Fluid Bed Granulation and Wurster Coating	33
Nozzles and Lances for Top-Spray Granulation	34
Nozzles for Wurster Coating	38

HIGH-SHEAR GRANULATION

	PAGE
Application Overview	46
Fluid Bed Granulation and Wurster Coating	47

SPRAY DRYING

	PAGE
Application Overview	50
SV Series SprayDry® Nozzles	51
SB Series SprayDry® Nozzles	52
SK Series SprayDry® Nozzles	53

VESSEL CLEANING

	PAGE
Application Overview	55
Selection and Optimization Tips	56
CIP / WIP Solutions	58
Fixed Spray Balls	60
Fluid-Driven Rotary Nozzles	62
Regulated Fluid-Driven Rotary Nozzles	70

SPECIALTY NOZZLES

	PAGE
Ultrasonic Atomizing Nozzle and Controller	73
GunJet® Spray Guns	76
WindJet® Air Nozzles	77

SOLID DOSAGE PROCESSING

	PAGE
Application Overview	79
Fluid Air, a Division of Spraying Systems Co.®	80
Fluid Bed Systems	81
High-Shear Granulators	83
Size Reduction Systems	85
Control Options and More	87

APPENDIX

	PAGE
Accessories	90
Glossary	92
Terms and Conditions of Sale	94



TECHNICAL REFERENCE

	PAGE		PAGE
Table of Equivalents	4	Estimating Pressure Drops Through Fluidline Accessories	11
Basic Nozzle Characteristics	5	Flow of Water Through Schedule 40 Steel Pipe	12
Spray Drop Size (Atomization)	6	Other Spray Performance Considerations	13
Drop Size Terminology	7	Common Causes of Spray Nozzle Problems	14
Capacity	8	Preventing and Solving Spray Nozzle Problems	15
Spray Angle and Coverage	9	General Safety Instructions	16
Impact	10		

TABLE OF EQUIVALENTS

VOLUMETRIC UNIT EQUIVALENTS

	Cubic Centimeter	Fluid Ounce	Pound of Water	Liter	US Gallon	Cubic Foot	Cubic Meter
Cubic Centimeter	1	.034	2.2×10^{-3}	.001	2.64×10^{-4}	3.53×10^{-5}	1.0×10^{-6}
Fluid Ounce	29.4	1	.065	.030	7.81×10^{-3}	1.04×10^{-3}	2.96×10^{-5}
Pound of Water	454	15.4	1	.454	.12	.016	4.54×10^{-4}
Liter	1000	33.8	2.2	1	.264	.035	.001
US Gallon	3785	128	8.34	3.785	1	.134	3.78×10^{-3}
Cubic Foot	28320	958	62.4	28.3	7.48	1	.028
Cubic Meter	1.0×10^6	3.38×10^4	2202	1000	264	35.3	1

LIQUID PRESSURE EQUIVALENTS

	Lb/In ² (psi)	Ft Water	Kg/Cm ²	Atmosphere	Bar	Inch Mercury	kPa
Lb/In ² (psi)	1	2.31	.070	.068	.069	2.04	6.895
Ft Water	.433	1	.030	.029	.030	.882	2.99
Kg/Cm ²	14.2	32.8	1	.968	.981	29.0	98
Atmosphere	14.7	33.9	1.03	1	1.01	29.9	101
Bar	14.5	33.5	1.02	.987	1	29.5	100
Inch Mercury	.491	1.13	.035	.033	.034	1	3.4
kPa (kilopascal)	.145	.335	.01	.009	.01	.296	1

LINEAR UNIT EQUIVALENTS

	Micron	Mil	Millimeter	Centimeter	Inch	Foot	Meter
Micron	1	.039	.001	1.0×10^{-4}	3.94×10^{-5}	—	—
Mil	25.4	1	2.54×10^{-2}	2.54×10^{-3}	.001	8.33×10^{-5}	—
Millimeter	1000	39.4	1	.10	.0394	3.28×10^{-3}	.001
Centimeter	10000	394	10	1	.394	.033	.01
Inch	2.54×10^4	1000	25.4	2.54	1	.083	.0254
Foot	3.05×10^5	1.2×10^4	305	30.5	12	1	.305
Meter	1.0×10^6	3.94×10^4	1000	100	39.4	3.28	1

MISCELLANEOUS EQUIVALENTS AND FORMULAS

Unit	Equivalent	Unit	Equivalent
Ounce	28.35 Gr.	Acre	43,560 ft ²
Pound	.4536 Kg.	Fahrenheit (°F)	= 9/5 (°C) + 32
Horse-Power	.746 Kw.	Celsius (°C)	= 5/9 (°F – 32)
British Thermal Unit	.2520 Kg. Cal.	Circumference of a Circle	= 3.1416 x D
Square Inch	6.452 cm ²	Area of a Circle	= .7854 x D ²
Square Foot	.09290 m ²	Volume of a Sphere	= .5236 x D ³
Acre	.4047 Hectare	Area of a Sphere	= 3.1416 x D ²

DIMENSIONS

The catalog tabulations show orifice dimensions as “Nom.” (nominal). Specific dimensions are available on request.

BASIC NOZZLE CHARACTERISTICS

Spray nozzles are precision components designed to yield very specific performance under specific conditions. To help you determine the best nozzle type for your application, the following reference chart summarizes the performance that each nozzle type is designed to deliver.

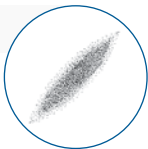


FLAT SPRAY (TAPERED)

General Spray Characteristics
A tapered-edge flat spray pattern nozzle is usually installed on a header to provide uniform coverage over the entire swath as a result of overlapping distributions

Comments
Designed to be used on a spray manifold or header for uniform, overall coverage across the impact area.

Spray pattern:



Spray angles:
15° to 110°

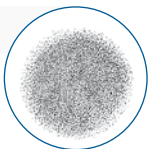


FULL CONE

General Spray Characteristics
Provides relatively coarse drops in a full cone pattern with minimal flow obstruction.

Comments
Provides full spray pattern coverage with medium-to-large flow rates. Some vaneless models and oval spray models are also available.

Spray pattern:



Spray angles:
15° to 125°

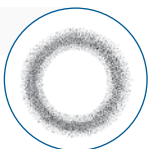


ATOMIZING (HYDRAULIC, FINE MIST)

General Spray Characteristics
A hydraulic, finely atomized, low capacity spray in a hollow cone pattern.

Comments
Used to produce finely atomized sprays when compressed air is not desirable.

Spray pattern:



Spray angles:
35° to 165°

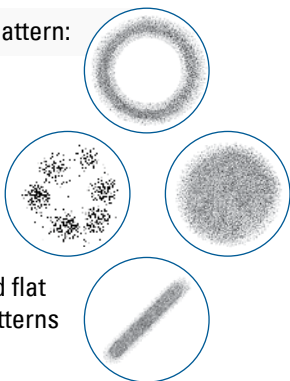


AIR ATOMIZING AND AIR ASSISTED

General Spray Characteristics
Atomization produced by a combination of air and liquid pressures. Air assisted nozzles feature internal impingement atomization to assist fine drop formation.

Comments
The most widely used nozzle group for producing finely atomized sprays in a wide range of capacities.

Spray pattern:



Cone and flat
spray patterns

SPRAY DROP SIZE (ATOMIZATION)

Accurate drop size information is an important factor in the overall effectiveness of spray nozzle operation. Drop size refers to the size of the individual spray drops that comprise a nozzle's spray pattern. Each spray provides a range of drop sizes; this range is referred to as drop

size distribution. Drop size distribution is dependent on the spray pattern type and varies significantly from one type to another. The smallest drop sizes are achieved by air atomizing nozzles while the largest drops are produced by full cone hydraulic spray nozzles.



Liquid properties, nozzle capacity, spraying pressure and spray angle also affect drop size. Lower spraying pressures provide larger drop sizes. Conversely, higher spraying pressures yield smaller drop sizes. Within each

type of spray pattern, the smallest capacities produce the smallest spray drops, and the largest capacities produce the largest spray drops.

DROP SIZE (BY SPRAY PATTERN TYPE AT VARIOUS PRESSURES AND CAPACITIES)

Spray Pattern Type	10 psi (0.7 bar)			40 psi (2.8 bar)			100 psi (7 bar)		
	Capacity gpm	Capacity l/min	VMD microns	Capacity gpm	Capacity l/min	VMD microns	Capacity gpm	Capacity l/min	VMD microns
Air Atomizing	.005 .02	.02 .08	20 100	.008 8	.03 30	15 200	12	45	400
Fine Spray	.22	.83	375	.03 .43	.1 1.6	110 330	.05 .69	.2 2.6	110 290
Hollow Cone	.05 12	.19 45	360 3400	.10 24	.38 91	300 1900	.16 38	.61 144	200 1260
Flat Fan	.05 5	.19 18.9	260 4300	.10 10	.38 38	220 2500	.16 15.8	.61 60	190 1400
Full Cone	.10 12	.38 45	1140 4300	.19 23	.72 87	850 2800	.30 35	1.1 132	500 1720

Based on a sampling of nozzles selected to show the wide range of possible drop sizes available.

One of the most common drop size distribution functions used in industry is the **ASTM® Standard E799-03** analysis:

$$d_{pq}^{(p-q)} = \left[\frac{S}{N} \frac{N d_i^p}{N d_i^q} \right]$$

The ASTM Standard E799-03 is best suited for use with analyzers that are classified as single particle counters such as the PMS-OAP and PDPA. This standard is used to classify the drop counts/diameters and also to calculate the distribution and the characteristic or mean diameters.

DROP SIZE TERMINOLOGY

Terminology is often the major source of discrepancy and confusion in understanding drop size. The mean and characteristic diameters are the diameters extracted from the drop size distribution (see Figure 1). To compare the drop size from one nozzle to another, the same diameters have to be used as the source of comparison.

For example, one cannot compare the $D_{v0.5}$ from one nozzle to the D_{32} from another nozzle. The following lists the most popular mean and characteristic diameters, definitions and most appropriate use. Drop size terminology can be found in ASTM® Standard E1620-97.

$D_{v0.5}$: Volume Median Diameter (also known as VMD or MVD). A means of expressing drop size in terms of the volume of liquid sprayed. The VMD is a value where 50% of the total volume (or mass) of liquid sprayed is made up of drops with diameters larger than the median value and 50% smaller than the median value. This is best used for comparing the average drop size from various analyzers.

D_{32} : Sauter Mean Diameter (also known as SMD) is a means of expressing the fineness of a spray in terms of the surface area produced by the spray. SMD is the diameter of a drop having the same volume to surface area ratio as the total volume of all the drops to the total surface area of all the drops. This diameter is best suited to calculate the efficiency and mass transfer rates in chemical reactions.

$D_{v0.1}$: A value where 10% of the total volume (or mass) of liquid sprayed is made up of drops with diameters smaller or equal to this value. This diameter is best suited to evaluate drift potential of individual drops.

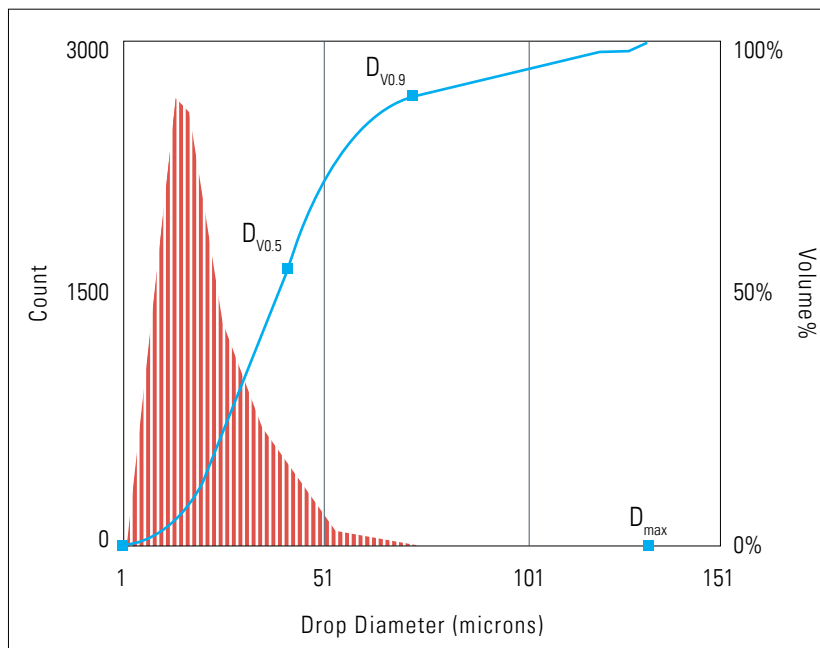
$D_{v0.9}$: A value where 90% of the total volume (or mass) of liquid sprayed is made up of drops with diameters smaller or equal to this value. This measurement is best suited when complete evaporation of the spray is required.

$D_{n0.5}$: Number Mean Diameter (also known as NMD) is a means of expressing drop size in terms of the number of drops in the spray. This means that 50% of the drops by count or number are smaller than the median diameter and 50% of the drops are larger than the median diameter.

Drop Size Distribution: The size distribution of drops present in a spray sample. This distribution is typically expressed by the size vs. the cumulative volume present.

Relative Span Factor (RSF): A dimensionless parameter indicative of the uniformity of the drop size distribution. RSF is defined as:

$$\frac{D_{v0.9} - D_{v0.1}}{D_{v0.5}}$$



Typical Drop Size
Distribution

CAPACITY

Nozzle capacity varies with spraying pressure. In general, the relationship between flow rate and pressure is as follows:

$$\frac{Q_1}{Q_2} = \frac{(P_1)^n}{(P_2)^n}$$

Q: Flow rate (in gpm or l/min)

P: Liquid pressure (in psi or bar)

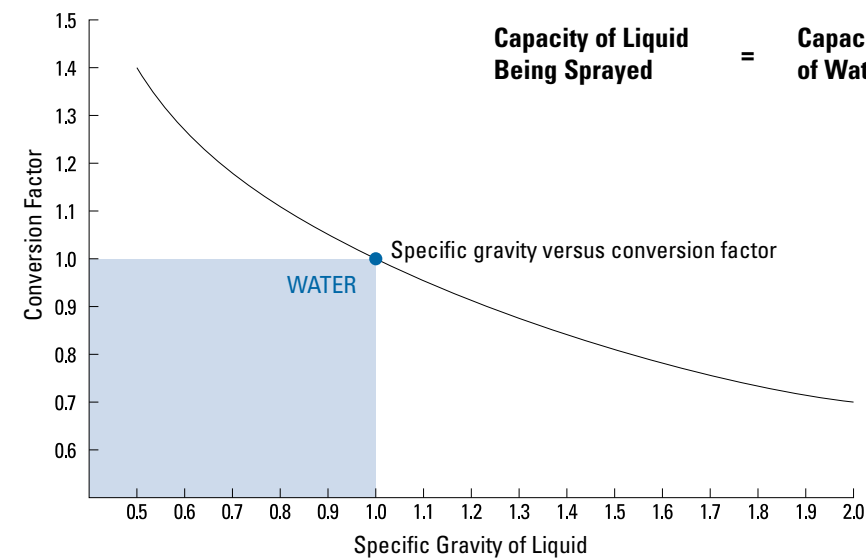
n: Exponent applying to the specific nozzle type

Since the specific gravity of a liquid affects its flow rate, tabulated catalog capacities must be multiplied by the conversion factor that applies to the specific gravity of the liquid being sprayed as explained in the Specific Gravity section below.

SPECIFIC GRAVITY

Specific gravity is the ratio of the mass of a given volume of liquid to the mass of the same volume of water. In spraying, the main effect of the specific gravity of a liquid (other than water) is on the capacity of the spray nozzle. Since the values in this catalog are based on spraying water, a conversion factor or formula can be applied to determine the nozzle capacity when using a liquid other than water.

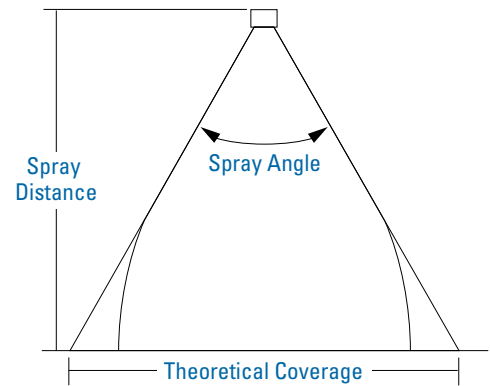
Nozzle Type	Exponent "n"
Hollow Cone Nozzles (All) Full Cone Nozzles (Vaneless) Full Cone Nozzles (15° and 30° Series) Flat Spray Nozzles (All) Solid Stream Nozzles (All) Spiral Nozzles (All)	.50
Full Cone Nozzles (Standard) Full Cone Nozzles (Square Spray) Full Cone Nozzles (Oval Spray) Full Cone Nozzles (Large Capacity)	.46



KEY: Conversion factor multiplied by the capacity of the nozzle when spraying water gives the capacity of the nozzle when spraying a liquid with a specific gravity corresponding to the conversion factor. This conversion factor accounts only for the effect of specific gravity on capacity and does not account for other factors affecting capacity.

SPRAY ANGLE AND COVERAGE

Tabulated spray angles indicate approximate spray coverages based on spray of or distribution of water. In actual spraying, the effective spray angle varies with spray distance. Liquids more viscous than water form relatively smaller spray angles (or even a solid stream), depending upon viscosity, nozzle capacity and spraying pressure. Liquids with surface tensions lower than water will produce relatively wider spray angles than those listed for water. This table lists the theoretical coverage of spray patterns as calculated from the included spray angle of the spray and the distance from the nozzle orifice. Values are based on the assumption that the spray angle remains the same throughout the entire spray distance. In actual practice, the tabulated spray angle does not hold for long spray distances. If the spray coverage requirement is critical, request data sheets for specific spray coverage data.



THEORETICAL SPRAY COVERAGE (AT VARIOUS DISTANCES FROM NOZZLE ORIFICE)

Spray Angle	2 in.	5 cm	4 in.	10 cm	6 in.	15 cm	8 in.	20 cm	10 in.	25 cm	12 in.	30 cm	15 in.	40 cm	18 in.	50 cm	24 in.	60 cm	30 in.	70 cm	36 in.	80 cm	48 in.	100 cm
5°	0.2	0.4	0.4	0.9	.5	1.3	.7	1.8	.9	2.2	1.1	2.6	1.3	3.5	1.6	4.4	2.1	5.2	2.6	6.1	3.1	7.0	4.2	8.7
10°	0.4	0.9	0.7	1.8	1.1	2.6	1.4	3.5	1.8	4.4	2.1	5.3	2.6	7.0	3.1	8.8	4.2	10.5	5.2	12.3	6.3	14.0	8.4	17.5
15°	0.5	1.3	1.1	2.6	1.6	4.0	2.1	5.3	2.6	6.6	3.2	7.9	3.9	10.5	4.7	13.2	6.3	15.8	7.9	18.4	9.5	21.1	12.6	26.3
20°	0.7	1.8	1.4	3.5	2.1	5.3	2.8	7.1	3.5	8.8	4.2	10.6	5.3	14.1	6.4	17.6	8.5	21.2	10.6	24.7	12.7	28.2	16.9	35.3
25°	0.9	2.2	1.8	4.4	2.7	6.7	3.5	8.9	4.4	11.1	5.3	13.3	6.6	17.7	8.0	22.2	10.6	26.6	13.3	31.0	15.9	35.5	21.2	44.3
30°	1.1	2.7	2.1	5.4	3.2	8.0	4.3	10.7	5.4	13.4	6.4	16.1	8.1	21.4	9.7	26.8	12.8	32.2	16.1	37.5	19.3	42.9	25.7	53.6
35°	1.3	3.2	2.5	6.3	3.8	9.5	5.0	12.6	6.3	15.8	7.6	18.9	9.5	25.2	11.3	31.5	15.5	37.8	18.9	44.1	22.7	50.5	30.3	63.1
40°	1.5	3.6	2.9	7.3	4.4	10.9	5.8	14.6	7.3	18.2	8.7	21.8	10.9	29.1	13.1	36.4	17.5	43.7	21.8	51.0	26.2	58.2	34.9	72.8
45°	1.7	4.1	3.3	8.3	5.0	12.4	6.6	16.6	8.3	20.7	9.9	24.9	12.4	33.1	14.9	41.4	19.9	49.7	24.8	58.0	29.8	66.3	39.7	82.8
50°	1.9	4.7	3.7	9.3	5.6	14.0	7.5	18.7	9.3	23.3	11.2	28.0	14.0	37.3	16.8	46.6	22.4	56.0	28.0	65.3	33.6	74.6	44.8	93.3
55°	2.1	5.2	4.2	10.4	6.3	15.6	8.3	20.8	10.3	26.0	12.5	31.2	15.6	41.7	18.7	52.1	25.0	62.5	31.2	72.9	37.5	83.3	50.0	104
60°	2.3	5.8	4.6	11.6	6.9	17.3	9.2	23.1	11.5	28.9	13.8	34.6	17.3	46.2	20.6	57.7	27.7	69.3	34.6	80.8	41.6	92.4	55.4	115
65°	2.5	6.4	5.1	12.7	7.6	19.1	10.2	25.5	12.7	31.9	15.3	38.2	19.2	51.0	22.9	63.7	30.5	76.5	38.2	89.2	45.8	102	61.2	127
70°	2.8	7.0	5.6	14.0	8.4	21.0	11.2	28.0	14.0	35.0	16.8	42.0	21.0	56.0	25.2	70.0	33.6	84.0	42.0	98.0	50.4	112	67.2	140
75°	3.1	7.7	6.1	15.4	9.2	23.0	12.3	30.7	15.3	38.4	18.4	46.0	23.0	61.4	27.6	76.7	36.8	92.1	46.0	107	55.2	123	73.6	153
80°	3.4	8.4	6.7	16.8	10.1	25.2	13.4	33.6	16.8	42.0	20.2	50.4	25.2	67.1	30.3	83.9	40.3	101	50.4	118	60.4	134	80.6	168
85°	3.7	9.2	7.3	18.3	11.0	27.5	14.7	36.7	18.3	45.8	22.0	55.0	27.5	73.3	33.0	91.6	44.0	110	55.0	128	66.0	147	88.0	183
90°	4.0	10.0	8.0	20.0	12.0	30.0	16.0	40.0	20.0	50.0	24.0	60.0	30.0	80.0	36.0	100	48.0	120	60.0	140	72.0	160	96.0	200
95°	4.4	10.9	8.7	21.8	13.1	32.7	17.5	43.7	21.8	54.6	26.2	65.5	32.8	87.3	39.3	109	52.4	131	65.5	153	78.6	175	105	218
100°	4.8	11.9	9.5	23.8	14.3	35.8	19.1	47.7	23.8	59.6	28.6	71.5	35.8	95.3	43.0	119	57.2	143	71.6	167	85.9	191	114	238
110°	5.7	14.3	11.4	28.6	17.1	42.9	22.8	57.1	28.5	71.4	34.3	85.7	42.8	114	51.4	143	68.5	171	85.6	200	103	229	—	286
120°	6.9	17.3	13.9	34.6	20.8	52.0	27.7	69.3	34.6	86.6	41.6	104	52.0	139	62.4	173	83.2	208	104	243	—	—	—	—
130°	8.6	21.5	17.2	42.9	25.7	64.3	34.3	85.8	42.9	107	51.5	129	64.4	172	77.3	215	103	257	—	—	—	—	—	—
140°	10.9	27.5	21.9	55.0	32.9	82.4	43.8	110	54.8	137	65.7	165	82.2	220	98.6	275	—	—	—	—	—	—	—	—
150°	14.9	37.3	29.8	74.6	44.7	112	59.6	149	74.5	187	89.5	224	112	299	—	—	—	—	—	—	—	—	—	—
160°	22.7	56.7	45.4	113	68.0	170	90.6	227	113	284	—	—	—	—	—	—	—	—	—	—	—	—	—	—
170°	45.8	114	91.6	229	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: The data in this table applies to hydraulic sprays only. Coverage data for pneumatic/air atomizing sprays will vary.

IMPACT

Impact, or the impingement of a spray onto the target surface, can be expressed in several different ways. The most useful impact value with regard to spray nozzle performance is the impact per square inch (cm). Basically, this value depends on the spray pattern distribution and spray angle.

Then, from the chart below, obtain the impact per square inch (cm) as a percent of the theoretical total impact and multiply by the theoretical total. The result is the unit impact in lbs.-f/sq. inch (kg/cm²) at 12" (30 cm) distance from the nozzle.

The highest unit impact in lbs.-f/sq. inch (kg/cm²) is provided by solid stream nozzles and can be closely approximated by the formula: $1.9 \times [\text{spraying pressure, psi (bar)}]$. As with all spray patterns, the unit impact decreases as the distance from the nozzle increases, thereby increasing the impact area size.

To obtain the impact per square inch (cm) [pounds (kg)-force per square inch (cm)] of a given nozzle, first determine the theoretical total impact using the following formula:

$$I = K \times Q \times P \sqrt{T}$$

I: Total theoretical spray impact

K: Constant

Q: Flow Rate

P: Liquid Pressure

I	pounds	kilograms
K	.0526	.024
Q	gpm	l/min
P	psi	kg/cm ²

OPERATING PRESSURE

The values given in the tabulation sections of this catalog indicate the most commonly used pressure ranges for the associated spray nozzle or accessory. Some spray nozzles and accessories can perform below or above the pressures shown, while others can be modified at our factory or redesigned to accommodate the requirements of specific new applications.

Contact your local Spraying Systems Co. sales engineer if your application requires pressure ranges beyond those stated in this catalog.

UNIT IMPACT* PER INCH² / CM²

Spray Pattern	Spray Angle	Percent of Theoretical
Flat Fan	15°	30%
	25°	18%
	35°	13%
	40°	12%
	50°	10%
	65°	7.0%
	80°	5.0%
Full Cone	15°	11%
	30°	2.5%
	50°	1.0%
	65°	0.4%
	80°	0.2%
	100°	0.1%

*At 12" (30 cm) distance from the nozzle.

ESTIMATING PRESSURE DROPS THROUGH FLUIDLINE ACCESSORIES

The rated capacities listed in this catalog for valves, strainers and fittings typically correspond to pressure drops of approximately 5% of their maximum operating pressure. Use the following formula to estimate the pressure drop of other flow rates.

$$\frac{Q_1}{Q_2} = \frac{(P_1)^5}{(P_2)^5}$$

Q: Flow rate (in gpm or l/min)
P: Liquid pressure (in psi or bar)

For pressure drop information on a specific product, contact your local sales engineer for data sheets listing pressure drops at various flow rates.

Example:

$$\frac{3 \text{ gpm}}{5 \text{ gpm}} = \frac{(P_1)^5}{(25 \text{ psi})^5} \quad P_1 = 9 \text{ psi}$$

$$\frac{11 \text{ l/min}}{19 \text{ l/min}} = \frac{(P_1)^5}{(1.8 \text{ bar})^5} \quad P_1 = 0.6 \text{ bar}$$

Accessory rated capacity 5 gpm (19 l/min)

Maximum recommended operating pressure 500 psi (35 bar)

Estimated pressure drop at
5 gpm (19 l/min) = 5% x 500 psi (35 bar) = 25 psi (1.8 bar)

APPROXIMATE FRICTION LOSS IN PIPE SETTINGS

Pipe Size Std. Wt. (in.) (in.)	Actual Inside Dia. in. (mm)	Gate Valve FULL OPEN ft. (m)	Globe Valve FULL OPEN ft. (m)	45° Elbow ft. (m)	Run of Std. Tee ft. (m)	Std. Elbow or Run of Tee Reduced 1/2 ft. (m)	Std. Tee Through Side Outlet ft. (m)
1/8	.269 (.68)	.15 (.05)	8.0 (2.4)	.35 (.11)	.40 (.12)	.75 (.23)	1.4 (.43)
1/4	.364 (9.2)	.20 (.06)	11.0 (3.4)	.50 (.15)	.65 (.20)	1.1 (.34)	2.2 (.67)
1/2	.622 (15.8)	.35 (.11)	18.6 (5.7)	.78 (.24)	1.1 (.34)	1.7 (.52)	3.3 (1.0)
3/4	.824 (21)	.44 (.13)	23.1 (7.0)	.97 (.30)	1.4 (.43)	2.1 (.64)	4.2 (1.3)
1	1.049 (27)	.56 (.17)	29.4 (9.0)	1.2 (.37)	1.8 (.55)	2.6 (.79)	5.3 (1.6)
1-1/4	1.380 (35)	.74 (.23)	38.6 (11.8)	1.6 (.49)	2.3 (.70)	3.5 (1.1)	7.0 (2.1)
1-1/2	1.610 (41)	.86 (.26)	45.2 (13.8)	1.9 (.58)	2.7 (.82)	4.1 (1.2)	8.1 (2.5)
2	2.067 (53)	1.1 (.34)	58 (17.7)	2.4 (.73)	3.5 (1.1)	5.2 (1.6)	10.4 (3.2)
2-1/2	2.469 (63)	1.3 (.40)	69 (21)	2.9 (.88)	4.2 (1.3)	6.2 (1.9)	12.4 (3.8)
3	3.068 (78)	1.6 (.49)	86 (26)	3.6 (1.1)	5.2 (1.6)	7.7 (2.3)	15.5 (4.7)
4	4.026 (102)	2.1 (.64)	113 (34)	4.7 (1.4)	6.8 (2.1)	10.2 (3.1)	20.3 (6.2)
5	5.047 (128)	2.7 (.82)	142 (43)	5.9 (1.8)	8.5 (2.6)	12.7 (3.9)	25.4 (7.7)

AIR FLOW (SCFM AND NL / MIN) THROUGH SCHEDULE 40 STEEL PIPE

Applied Pressure psig	Nominal Standard Pipe Size (scfm)											Applied Pressure bar	Nominal Standard Pipe Size (NL/min)										
	1/8"	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"		1/8"	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"
5	.5	1.2	2.7	4.9	6.6	13.0	27	40	80	135	240	0.3	14.2	34.0	76.5	139	187	370	765	1130	2265	3820	6796
10	.8	1.7	3.9	7.7	11.0	21	44	64	125	200	370	0.7	22.7	48.1	110	218	310	595	1245	1810	3540	5665	10480
20	1.3	3.0	6.6	13.0	18.5	35	75	110	215	350	600	1.4	36.8	85.0	187	370	525	990	2125	3115	6090	9910	16990
40	2.5	5.5	12.0	23	34	62	135	200	385	640	1100	2.8	70.8	155	340	650	960	1755	3820	5665	10900	18120	31150
60	3.5	8.0	18.0	34	50	93	195	290	560	900	1600	4.1	99.1	227	510	965	1415	2630	5520	8210	15860	25485	45305
80	4.7	10.5	23	44	65	120	255	380	720	1200	2100	5.5	133	297	650	1245	1840	3400	7220	10760	20390	33980	59465
100	5.8	13.0	29	54	80	150	315	470	900	1450	2600	6.9	164	370	820	1530	2265	4250	8920	13310	25485	41060	73625



FLOW OF WATER THROUGH SCHEDULE 40 STEEL PIPE

Flow gpm (l/min)	Pressure Drop in psi (bar) for Various Pipe Diameters*															
	0.125"	0.25"	0.375"	0.5"	0.75"	1.0"	1.25"	1.5"	2.0"	2.5"	3.0"	3.5"	4.0"	5.0"	6.0"	8.0"
0.3 (1.0)	.42 (.07)															
0.4 (1.5)	.70 (.16)	.16 (.04)														
0.5 (2.0)	1.1 (.26)	.24 (.06)														
0.6 (2.5)	1.5 (.40)	.33 (.08)														
0.8 (3.0)	2.5 (.56)	.54 (.12)	.13 (.03)													
1.0 (4.0)	3.7 (.96)	.83 (.21)	.19 (.05)	.06 (.02)												
1.5 (6.0)	8.0 (2.0)	1.8 (.45)	.40 (.10)	.12 (.03)												
2.0 (8.0)	13.4 (3.5)	3.0 (.74)	.66 (.17)	.21 (.05)	.05 (.01)											
2.5 (10)		4.5 (1.2)	1.0 (.25)	.32 (.08)	.08 (.02)											
3.0 (12)		6.4 (1.7)	1.4 (.35)	.43 (.11)	.11 (.03)											
4.0 (15)		11.1 (2.6)	2.4 (.54)	.74 (.17)	.18 (.04)	.06 (.01)										
5.0 (20)			3.7 (.92)	1.1 (.28)	.28 (.07)	.08 (.02)										
6.0 (25)			5.2 (1.2)	1.6 (.45)	.38 (.11)	.12 (.03)										
8.0 (30)			9.1 (2.1)	2.8 (.62)	.66 (.15)	.20 (.04)	.05 (.01)									
10 (40)				4.2 (1.1)	1.0 (.25)	.30 (.08)	.08 (.02)									
15 (60)					2.2 (.54)	.64 (.16)	.16 (.04)	.08 (.02)								
20 (80)					3.8 (9.3)	1.1 (.28)	.28 (.07)	.13 (.03)	.04 (.009)							
25 (100)						1.7 (.43)	.42 (.12)	.19 (.05)	.06 (.01)							
30 (115)						2.4 (.58)	.59 (.14)	.27 (.06)	.08 (.015)							
35 (130)						3.2 (.72)	.79 (.18)	.36 (.08)	.11 (.02)	.04 (.01)						
40 (150)							1.0 (.23)	.47 (.10)	.14 (.03)	.06 (.012)						
45 (170)							1.3 (.29)	.59 (.13)	.17 (.04)	.07 (.016)						
50 (190)							1.6 (.36)	.72 (.16)	.20 (.05)	.08 (.02)						
60 (230)							2.2 (.50)	1.0 (.23)	.29 (.07)	.12 (.03)	.04 (.009)					
70 (260)								1.4 (.32)	.38 (.09)	.16 (.04)	.05 (.01)					
80 (300)								1.8 (.38)	.50 (.11)	.20 (.04)	.07 (.02)					
90 (340)								2.2 (.50)	.62 (.14)	.25 (.06)	.09 (.02)	0.4 (.009)				
100 (380)								2.7 (.61)	.76 (.18)	.31 (.07)	.11 (.03)	0.5 (.01)				
125 (470)									1.2 (.28)	.47 (.11)	.16 (.04)	0.6 (.02)	.04 (.009)			
150 (570)									1.7 (.39)	.67 (.15)	.22 (.05)	0.8 (.03)	.06 (.01)			
200 (750)									2.9 (.64)	1.2 (.26)	.39 (.09)	0.3 (.04)	.10 (.02)			
250 (950)											.59 (.14)	0.4 (.06)	.15 (.03)	.05 (.01)		
300 (1150)											.84 (.19)	0.5 (.09)	.21 (.05)	.07 (.02)		
400 (1500)												0.6 (.16)	.37 (.08)	.12 (.03)	.05 (.01)	
500 (1900)													.57 (.13)	.18 (.04)	.07 (.02)	
750 (2800)														.39 (.09)	.16 (.03)	.04 (.009)
1000 (3800)														.68 (.16)	.27 (.06)	.07 (.02)
2000 (7500)															1.0 (.23)	.26 (.06)

Recommended capacity range for each size is displayed in bold type.

*Psi values are based on a pipe length of 10 feet. Bar values are based on a pipe length of 10 meters.

OTHER SPRAY PERFORMANCE CONSIDERATIONS

VISCOSITY

Absolute (dynamic) viscosity is the property of a liquid which resists change in the shape or arrangement of its elements during flow. Liquid viscosity is a primary factor affecting spray pattern formation and, to a lesser degree, capacity. High viscosity liquids require a higher minimum pressure to begin formation of a spray pattern and provide narrower spray angles as compared to those of water. See the chart below for the general effects of viscosity other than water.

SURFACE TENSION

The surface of a liquid tends to assume the smallest possible size; acting, in this respect, like a membrane under tension. Any portion of the liquid surface exerts a tension upon adjacent portions or upon other objects with which it is in contact. This force is in the plane of the surface and its amount per unit of

TEMPERATURE

The values given in this catalog are based on spraying water at 70°F (21°C). Although liquid temperature changes do not affect the spray performance of a nozzle, they often affect viscosity, surface tension and specific gravity which do influence spray nozzle performance. See the chart below for the effects of temperature changes on spray nozzle performance.

length is surface tension. Its value for water is about 73 dynes per cm at 70°F (21°C). The main effects of surface tension are on minimum operating pressure, spray angle and drop size.

SUMMARY OF SPRAY PERFORMANCE CONSIDERATIONS

This chart summarizes the various factors that affect a spray nozzle's performance. However, because there are so many different types and sizes of spray nozzles, the effects may vary for your specific application. In some applications, there are interrelated factors which may counteract certain effects.

For instance, in the case of a hollow cone spray nozzle, increasing the temperature of the liquid decreases the specific gravity, thereby producing a greater flow rate while at the same time decreasing the viscosity which reduces the flow.

Nozzle Characteristics	Increase in Operating Pressure	Increase in Specific Gravity	Increase in Viscosity	Increase in Fluid Temperature	Increase in Surface Tension
Pattern Quality	Improves	Negligible	Deteriorates	Improves	Negligible
Drop Size	Decreases	Negligible	Increases	Decreases	Increases
Spray Angle	Increases then decreases	Negligible	Decreases	Increases	Decreases
Capacity	Increases	Decreases	Full cone – increases Flat – decreases	Depends on fluid sprayed and nozzle used	No effect
Impact	Increases	Negligible	Decreases	Increases	Negligible
Velocity	Increases	Decreases	Decreases	Increases	Negligible
Wear	Increases	Negligible	Decreases	Depends on fluid sprayed and nozzle used	No effect



COMMON CAUSES OF SPRAY NOZZLE PROBLEMS

Many spray nozzle problems cannot be easily detected with a visual inspection. You should check the performance of your nozzles for damage during every preventive maintenance shutdown. What to look for depends on your application – sometimes it's wear

from a high-pressure process or caking from spraying a viscous liquid. Nozzle performance can be compromised or rendered totally ineffective by eroded, damaged or obstructed nozzle orifices.

EROSION / WEAR

Gradual removal of the nozzle material causes the nozzle orifice and internal flow passages to enlarge and/or become distorted. As a result, flow is usually increased, pressure may be decreased, pattern becomes irregular and the spray drops become larger.



Hollow Cone Nozzle

HIGH TEMPERATURE

Certain liquids must be sprayed at elevated temperatures or in high temperature environments. The nozzle may soften and break down unless special high temperature resistant materials are used.



Full Cone Nozzle

CORROSION

Nozzle material may break down due to the chemical action of the sprayed material or environment. The effect is similar to that caused by erosion and wear, with possible additional damage to the outside surfaces of the nozzle. In particular, the performance of air atomizing nozzles is highly sensitive to corrosion. Even small amounts of corrosion will negatively impact drop size and uniformity.



Full Cone Nozzle

CLOGGING

Unwanted solid particles can block the inside of the orifice, restricting the flow and disturbing the uniformity of the spray pattern.



Flat Spray

Flat Spray

BEARDING / CAKING

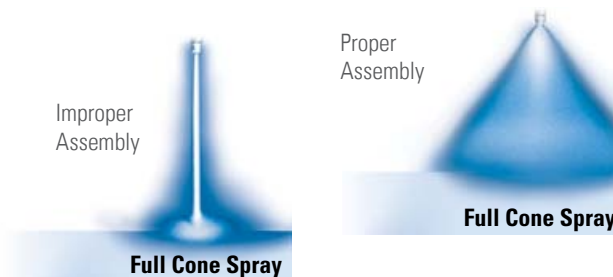
Build-up of material on the inside or outer edges of the orifice can occur and is caused by liquid evaporation. A layer of dried solids remains and obstructs the orifice or internal flow passages. Bearding, the build-up of materials near the orifice of the nozzle, is also detrimental to nozzle performance and can have serious consequences in some nozzle types such as air atomizing.



Hollow Cone Nozzle

IMPROPER ASSEMBLY

Some nozzles require careful re-assembly after cleaning so that internal components, such as gaskets, O-rings and internal vanes, are properly aligned. Improper positioning may result in leakage and inefficient spray performance. Over-tightening of nozzle caps onto bodies can cause thread stripping.

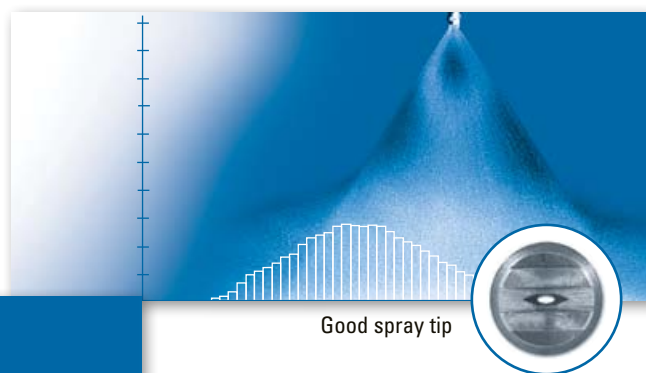
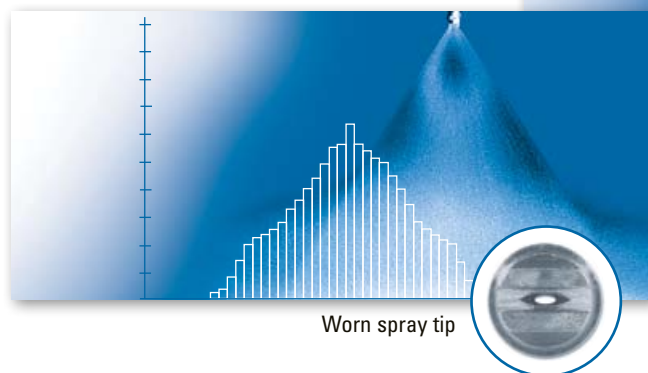


Full Cone Spray

Full Cone Spray

PREVENTING AND SOLVING SPRAY NOZZLE PROBLEMS

Some spray nozzle problems require special testing to detect. Consistent evaluation of the following factors will enable you to detect wear early and take appropriate action. Your own application will determine how often each factor should be checked. The proper frequency could range from the end of every shift to every few months. The checklist that follows should become the foundation of your maintenance program.



Visual inspection of nozzle tips and spray patterns show little evidence of wear. An analysis of spray collection data reveals a 30% increase in capacity from the worn tip.



FLOW RATE

For centrifugal pumps:

Monitor flow meter readings to detect increases. Or, collect and measure the spray from the spray nozzle for a given period of time at a specific pressure. Compare these readings to the flow rates listed in the manufacturer's catalog or compare them to flow rate readings from new, unused spray nozzles.

For positive displacement pumps:

Monitor the liquid line pressure for decreases; the flow rate will remain constant.

SPRAY PRESSURE
(IN SPRAY NOZZLE MANIFOLDS)**For centrifugal pumps:**

Monitor for increases in liquid volume sprayed. The spraying pressure is likely to remain the same.

For positive displacement pumps:

Monitor pressure gauge for decreases in pressure and reduction in impact on sprayed surfaces. The liquid volume sprayed is likely to remain the same. Also, monitor for increases in pressure due to clogged spray nozzles.



DROP SIZE

Drop size increases are difficult to detect. Examine application results for changes. An increase in flow rate or decrease in spraying pressure will affect drop size.



SPRAY PATTERN

Visually inspect the spray pattern for changes. Check the spray angle with a protractor. Measure the width of the spray pattern on the sprayed surface. If the spray nozzle orifice is wearing gradually, you may not detect changes until there is a significant increase in flow rate.



SPRAY NOZZLE ALIGNMENT

Check uniformity of spray coverage of flat spray nozzles on a manifold. Spray patterns should be parallel to each other. Spray tips should be rotated 5° to 10° from the manifold centerline.

PRODUCT QUALITY /
APPLICATION RESULTS

Check for uneven coating, cooling, cleaning or drying. Check for changes in temperature, dust content and humidity.



GENERAL SAFETY INSTRUCTIONS

Please read this important safety information before using any spray device, spray system or pressurized spray equipment.

WARNING

All safety related and operating instructions should be read before the nozzle is operated. Follow all operating instructions. Failure to do so could result in serious injury.

WARNING

It is important to recognize proper safety precautions when using a pressurized spray system. Fluids under pressure can penetrate skin and cause severe injury.

WARNING

When dealing with pressure applications, the system pressure should never exceed the lowest rated component. Always know your system and all component capabilities, maximum pressures, and flow rates.

WARNING

Before performing any maintenance, make sure all liquid supply lines to the machine are shut off and/or disconnected and any chemicals or fluids are drained.

WARNING

Spraying Systems Co. does not manufacture or supply any of the chemicals used with our nozzles and is not responsible for their effects. Because of the large number of chemicals that could be used (and their different chemical reactions), the buyer and user of this equipment should determine compatibility of the materials used and any of the potential hazards involved.

NOTE: Always remember to carefully read the chemical manufacturer's label and follow all directions.

WARNING

The use of any chemicals requires careful control of all worker hygiene.

WARNING

Spraying Systems Co. strongly recommends the use of appropriate safety equipment when working with potentially hazardous chemicals.

This equipment includes but is not limited to:

- Protective headgear
- Safety glasses and/or face shields
- Chemical-resistant gloves and aprons
- Long sleeve shirts and long pants

WARNING

Before use, be sure appropriate connections are secure and made to withstand weight and reaction forces of the operating unit.

WARNING

It is important to operate equipment within the temperature range of all components. Always ensure that the appropriate time has elapsed or proper safety equipment is used when handling components after they've been exposed to high temperatures.

WARNING

Do not use any equipment or product outside of its intended use or purpose. Misuse can result in personal injury or product damage.





TABLET COATING

	PAGE
Application Overview	18
VMAU Spray Nozzles	21
JAU Spray Nozzles	25
Modular Air Atomizing Manifolds	29



APPLICATION OVERVIEW



PRECISE CONTROL ENSURES UNIFORM COATING

Tablet coating is a process that can be summarized as the application of an “edible paint” to the surface of a pharmaceutical dosage form. In the past, sugar coating was a common solution for coating tablets, but this process has many disadvantages. Modern tablet coatings are typically film coatings, flexible formulations that are applicable to a wide range of dosage forms (such as tablets, capsules, pellets, granules and drug crystals). The tablet coating process is complex, and involves parameters such as the spray pattern, drop size, and nozzle spacing (in addition to multiple other non-spray related parameters) which must all be precisely controlled in order to ensure uniform distribution of the coating material.

ADDITIONAL RESOURCES

For more information on nozzles for tablet coating

[Click here ►](#)



VMAU SPRAY SET-UPS

A spray set-up consists of a needle, an air cap, and a fluid tip. Spray set-ups are interchangeable, but each set-up uses a different size needle. The VMAU can utilize a number of different spray set-ups depending on the desired performance. Reference the information below to determine the most appropriate spray set-up for your application.

ANTI-BEARDING SET-UPS

Frequent shutdowns to clean coating material from air atomizing spray gun components have a serious impact on productivity. Anti-bearding spray set-ups can help to improve process quality, volume, and profitability in these situations.

P-SERIES ANTI-BEARDING SET-UPS*

P-Series Anti-Bearding Spray Set-Ups are designed to virtually eliminate nozzle build-up while greatly reducing product waste and maintenance downtime.



Anti-Bearding Set-Ups



P-Series Anti-Bearding Set-Ups

PERFORMANCE DATA

For performance data on VMAU spray set-ups, [click here](#) to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
SUVM113AAB SUVM113AABP*	Coverage and Flow Rate	Water
	Drop Size Information	OPADRY® / EUDRAGIT®
	Spray Velocity	OPADRY® / EUDRAGIT®
SUVM113AB SUVM113ABP*	Coverage and Flow Rate	Water
	Drop Size Information	OPADRY® / EUDRAGIT®
	Spray Velocity	OPADRY® / EUDRAGIT®

*P-Series anti-bearding spray set-ups are designated with a 'P' suffix. For the purposes of spray coverage, flow rate, drop size, and spray velocity, performance is approximately equivalent to anti-bearding spray set-ups. For performance data on other available spray set-ups not listed in this catalog, contact your local sales representative.

SPRAY TIP: DRAMATICALLY REDUCE NOZZLE BUILD-UP

The new P-Series anti-bearding set-ups allow users to run their spray operations for up to two times as long as standard anti-bearding set-ups with minimal nozzle build-up, greatly reducing maintenance downtime due to cleaning or clogging.

Results after spraying OPADRY®. The P-Series cap is pictured after being sprayed for twice as long as the standard air cap.



Standard Air Cap

P-Series Air Cap

DETERMINING SPRAY NOZZLE SET-UPS

A VMAU spray set-up consists of a fluid tip and an air cap, each of which has its own part number consisting of several smaller numbers (as shown below) which correspond to basic characteristics, such as orifice size and diameter. Determining the correct size spray set-ups when placing an order is critical to ensure that you get exactly the performance you need from your spray nozzle. After viewing the example below, use the chart to choose the right spray set-up for your application.

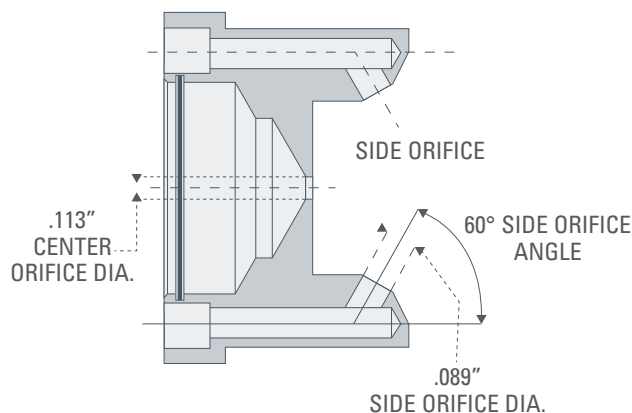
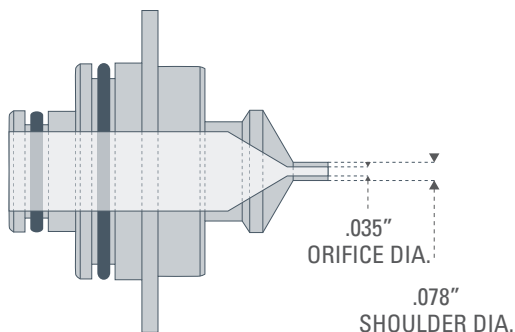
VMAU Set-Up No.	Fluid Tip No.	Air Cap No.
SUVM113AAB	VMFAB3578	VMAAB113289-60
SUVM113AB	VMFAB4078	VMAAB113289-60

EXAMPLE: VMAU SET-UP NUMBER SUVM113AAB*

Fluid Tip No. VMFAB3578

+

Air Cap No. VMAAB113289-60°



FLUID TIP PART NUMBER EXAMPLE



AIR CAP PART NUMBER EXAMPLE



*Note: VMAU fluid caps have a prefix of "VMF" while air caps have a prefix of "VMA." Anti-bearding set-ups bear the additional prefix "AB," so for the anti-bearding spray set-up SUVM113AAB, the air cap would have a combined prefix of "VMAAB."

ORDERING INFORMATION

VMAU spray set-ups can be used for the VMAU spray nozzle, the VMAU Lab Coater and the 54000 Modular Manifold.

First reference the performance data. [Click here ►](#)

Then, select the desired nozzle, body size, actuator/needle assembly, and materials.

VMAU Lab Coater [Click here ►](#) | VMAU Spray Nozzle [Click here ►](#) | 54000 Modular Manifold [Click here ►](#)



STANDARD AND SANITARY VMAU SPRAY NOZZLES

PRODUCT OVERVIEW

The VMAU variable automatic spray nozzle is designed with modular components to provide solutions to even the most demanding spray application challenges.

FEATURES AND BENEFITS

- Maximizes uniform spray distribution
- Modular design offers the flexibility to fit various unique spray applications
- Easy access dramatically cuts cleaning and maintenance downtime
- Threadless sanitary design with no internal threads in the liquid chamber
- Increases throughput with improved spray and product quality

PERFORMANCE DATA

VMAU Spray Nozzles use VMAU anti-bearding set-ups. For performance data, [click here](#) ►



ADDITIONAL RESOURCES

For more information on VMAU spray nozzles, [click here](#) ►

To download a 3D model (CAD-format STEP file), click the links below.

[Standard VMAU Nozzle](#) ►
[Sanitary VMAU Nozzle](#) ►

SPRAY TIP: IMPROVE PERFORMANCE FOR AIR ATOMIZING SPRAY APPLICATIONS

In addition to tablet coating, VMAU nozzles are also suitable for use in a wide variety of other applications. With multiple body styles, actuator assemblies, and interchangeable spray set-ups available, VMAU spray nozzles are suited to virtually any air atomizing spray application.



ORDERING INFORMATION – STANDARD AND SANITARY VMAU SPRAY NOZZLES

To customize your VMAU nozzle, specify the following:

BODY STYLE

First, select either a standard or sanitary body with NPT or BSPT connections.

Standard Body	1/4VMAU-XX	1/4 NPT Connections
	B1/4VMAU-XX	1/4 BSPT Connections
Sanitary Body	S1/4VMAU-XX	Sanitary fluid connections and 1/4 NPT air connections
	SB1/4VMAU-XX	Sanitary fluid connections and 1/4 BSPT air connections

Example

Model No.

Material Code

1/4VMAU

316SS

SPRAY SET-UP

Next, choose from a wide range of spray set-ups to fit your application's needs.

For more information on available spray set-ups for the VMAU, [Click here](#) ►

Anti-Bearding Spray Set-Ups	P-Series Spray Set-Ups
SUVM113AAB-XX	SUVM113AABP-XX
SUVM113AB-XX	SUVM113ABP-XX
SUVM128AB-XX	SUVM128ABP-XX

Example

Model No.

Material Code

SUVM113AAB

316SS

ACTUATOR ASSEMBLY

Last, choose an actuator assembly to match the desired spray set-up.

Single Action (52519)	NPT Style	BSPT Style	Corresponding Set-up
Standard Spray	004	104	113A
	005	105	113
	006	106	128
Anti-Bearding Spray	404	504	113A
	405	505	113
	406	506	128

Example

Actuator
Style

Actuator
Endcap

Material
Code

52519

004

316SS



Material Code = XX

SS = 303 stainless steel

316SS = 316 stainless steel

VMAU LAB COATER SPRAY NOZZLE

PRODUCT OVERVIEW

The 54200 VMAU Lab Coater spray nozzle features a compact design and simple assembly ideal for your R&D/laboratory scale spray applications.

FEATURES AND BENEFITS

- Maximizes uniform spray distribution
- Threadless sanitary design with no internal threads in the liquid chamber
- Increases throughput with improved spray and product quality
- 316 stainless steel nozzle and fittings for corrosion resistance
- Disassembles quickly
- Uses the same set-ups as our VMAU nozzle



VMAU Lab Coater
Spray Nozzle

ADDITIONAL RESOURCES

For more information on VMAU Lab Coater spray nozzles, [click here ▶](#)

To download a 3D model (CAD-format STEP file), [click here ▶](#)

PERFORMANCE DATA

VMAU Lab Coater Nozzles use VMAU anti-bearding set-ups. For performance data, [click here ▶](#)

PRODUCT VIDEO

To view a video of the VMAU Lab Coater nozzle in operation, [click here ▶](#)




SPRAY TIP: SCALE UP YOUR R&D COATING APPLICATIONS WITH EASE

The spray set-up (fluid tip and air cap) on the 54200 VMAU Lab Coater is the same size used for the 54000 Modular Air Atomizing Manifold and VMAU/53000 “J” type set-up automatic spray nozzles, making it simple to scale up from smaller lab scale applications to full production.



DIMENSIONS AND WEIGHTS – VMAU LAB COATER SPRAY NOZZLE

	Nozzle Type	A in. (mm)	B in. (mm)	C in. (mm)	D. in. (mm)	Net Weight lbs (oz.)
	54200	2.0 (50.8)	2.18 (55.5)	1.5 (38.1)	3.74 (95.1)	1.8 (0.82)

ORDERING INFORMATION – VMAU LAB COATER SPRAY NOZZLE

To order, specify body, spray set-up, needle assembly, and optional rod mount kit (28945-007-316SS).

OPTIONS

Spray Set-Ups	Orifice Dia. in. (mm)	Needle Assembly
SUVM113AABP-VIF	.035 (0.89)	54200-304-316VIF
SUVM113ABP-VIF	.040 (1.02)	54200-305-316VIF
SUVM128ABP-VIF	.060 (1.52)	54200-306-316VIF
SUVM113AABP-EPF	.035 (0.89)	54200-314-316EPF
SUVM113ABP-EPF	.040 (1.02)	54200-315-316EPF
SUVM128ABP-EPF	.060 (1.52)	54200-316-316EPF

BODY STYLE

Example



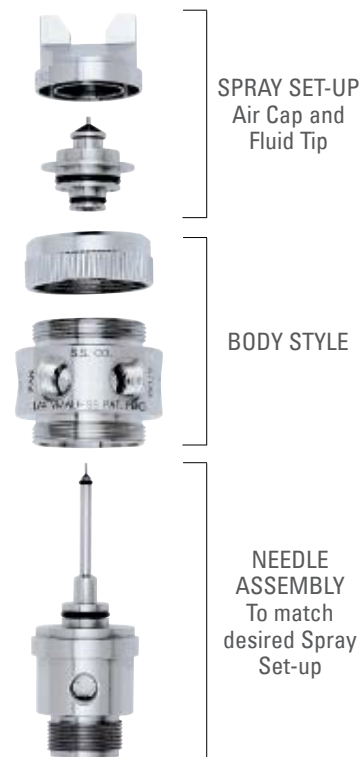
SPRAY SET-UP

Example



NEEDLE ASSEMBLY

Example



Material Code

SS= 303 stainless steel

316L= 316 stainless steel

316VIF = FDA Viton

316EPF = FDA EPDM

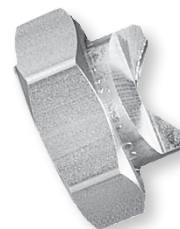
JAU AND J-TYPE SPRAY SET-UPS

Spray set-ups are interchangeable, but each set-up uses a different size needle. The JAU can utilize a number of different spray set-ups depending on the desired performance and nozzle configuration.

1/4J SET-UPS

The standard 1/4 JAU nozzle can utilize a number of different interchangeable spray set-ups available in standard and anti-bearding versions.

(Example: SUE15)



1/4J Set-Ups

JAUSF SET-UPS*

JAUSF set-ups are designed to fit the sanitary 51460-JAUSF spray nozzle and are available in anti-bearding versions.

(Example: SUE15ABP)



JAUSF Set-Ups

53000 J-TYPE SET-UPS*

53000 J-Type set-ups are specially designed to fit our 54000 modular manifolds, and are available in anti-bearding versions.

(Example: 53000-SUE15AB)

*Performance for 53000 J-Type Set-Ups is approximately equivalent to JAUSF set-ups.

PERFORMANCE DATA

For performance data on JAU and J-Type spray set-ups, [click here](#) to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
SUE15 (.028" / 0.7 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SUE25B (.035" / 0.9 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SUE25A (.040" / 1.0 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
53000-SUE15AB SUE15AB / SUE15ABP (.028" / 0.7 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
53000-SUE25BAB SUE25BAB / SUE25BABP (.035" / 0.9 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
53000-SUE25AAB SUE25AAB / SUE25AABP (.040" / 1.0 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®



DETERMINING SPRAY NOZZLE SET-UPS

A JAU or J-Type spray set-up, like a VMAU set-up, consists of a fluid cap and an air cap, each of which has its own part number. A standard 1/4 J anti-bearding spray set-up is shown below. Our JAUSF nozzle uses a modified version of this set-up, as do our 54000 manifolds.

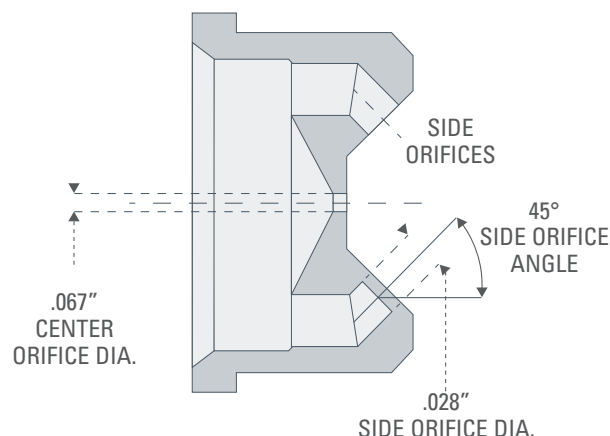
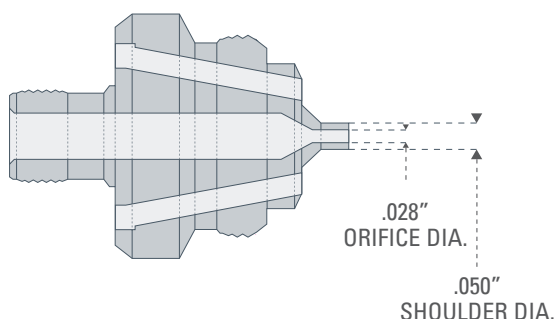
1/4J Set-Up No.	Fluid Cap No.	Air Cap No.
SUE25AAB	AB35100	AB134255-45
SUE25BAB	AB40100	AB134255-45
SUE15AB	AB2850	AB67228-45

EXAMPLE: JAU SET-UP NUMBER SUE15AB*

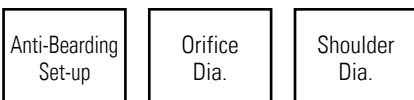
Fluid Cap No. AB2850

+

Air Cap No. AB67228-45°



FLUID CAP PART NUMBER EXAMPLE



AB 28 50

AIR CAP PART NUMBER EXAMPLE



AB 67 2 28 - 45°

*Note that anti-bearding set-ups bear the additional prefix "AB," so for the anti-bearding spray set-up SUE15AB, both the fluid and air caps would have a prefix of "AB."

ORDERING INFORMATION

JAU, JAUSF and 53000 J-Type spray set-ups can be used for either the standard 1/4 JAU spray nozzle, the JAUSF spray nozzle or the 54000 Modular Manifold.

First reference the performance data. [Click here ▶](#)

Then, select the desired nozzle, body size, actuator/needle assembly, and materials.

51460-JAUSF Spray Nozzle [Click here ▶](#) | 54000 Modular Manifold [Click here ▶](#)



JAUSF SPRAY NOZZLE

PRODUCT OVERVIEW

The new, sanitary 51460-JAUSF spray nozzle is an update to the popular JAU series of spray nozzles. Designed for sanitary applications, the nozzle features a simpler design for easier cleaning and a welded external mount configuration.

FEATURES AND BENEFITS

- New, simpler design offers greatly improved cleanability
- Available in a wide variety of configurations
- Air atomizing nozzle helps achieve precise, consistent coating
- Offers similar performance to standard JAU
- No internal seals
- Features a pull-out needle for easy clean out
- Threadless sanitary design with no internal threads in the liquid chamber



JAUSF Spray Nozzle

ADDITIONAL RESOURCES

To download a 3D model (CAD-format STEP file), [click here](#) ►

PERFORMANCE DATA

JAUSF nozzles use 51460-JAUSF anti-bearding set-ups. To view performance data, [Click here](#) ►

PRODUCT VIDEO

To view a video of the new JAUSF spray nozzle in operation [Click here](#) ►

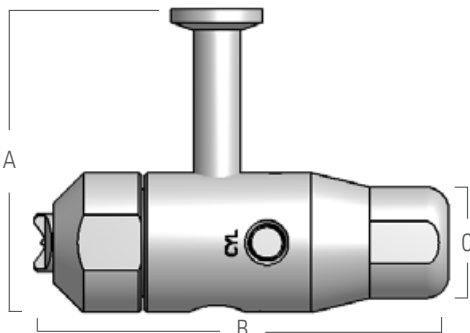


SPRAY TIP: REPLACE OLDER NOZZLES FOR IMPROVED CLEANABILITY

The 51460-JAUSF uses the same spray set-ups and orifice sizes as our standard 1/4JAU nozzle and provides similar performance with fewer components for improved cleanability. It can be used as a direct replacement for older style JAU nozzles without the need for revalidation.



DIMENSIONS AND WEIGHTS – JAUSF SPRAY NOZZLE

	Nozzle Type	A in. (mm)	B in. (mm)	C in. (mm)	D. in. (mm)	Net Weight lbs (oz.)
	51460	3.25 (82.5)	4.44 (112.8)	1.50 (38.1)	3.74 (95.1)	1.6 (.72)

ORDERING INFORMATION – JAUSF SPRAY NOZZLE

To order, specify body, spray set-up and needle assembly.

OPTIONS

Spray Set-Ups	Orifice Dia. in. (mm)	Needle Assembly
SUE25AABP-XX	.040 (1.02)	54008-705-XX
SUE25BABP-XX	.035 (0.89)	54008-704-XX
SUE15ABP-XX	.028 (0.71)	54008-703-XX

BODY STYLE

Example

Model No.

Material Code

54160 – JAUSF

316L

*Add B for BSPT connections, leave blank for NPT connections

SPRAY SET-UP

Example

Model No.

Material Code

SUE25AABP

316VIF

NEEDLE ASSEMBLY

Example

Model No.

Needle
Assembly

Material
Code

54008

705

316VIF

Material Code = XX

SS = 303 stainless steel

316L = 316L stainless steel

316VIF = FDA Viton

316EPF = FDA EPDM

MODULAR AIR ATOMIZING MANIFOLDS

PRODUCT OVERVIEW

54000 series modular manifolds are customizable, integrated coating systems designed to cut costs, simplify installation, and reduce maintenance. Each manifold consists of an end hub, connection hub, spacer blocks, and 2-12 spray nozzles – all configured to suit your process needs.

FEATURES AND BENEFITS

- Superior surface finish reduces contamination risk
- Manufacturing environment exceeds industry standards for hygienic products
- Complete turnover package available with material test reports, welder certification and other relevant data
- Lightweight- half the weight of other manufacturers' designs
- Disassembles in seconds, saving time and money
- Polished 316/316L stainless steel and stain-resistant TecaPro® for easy cleaning
- Improved spray performance maximizes throughput and product quality
- Ideal for spraying viscous liquids
- Can be used in batch or continuous processes

STANDARD AND LARGE CAPACITY VERSIONS AVAILABLE

Standard 54000 Manifold

- For precision coating in batch coating applications
- Fully customizable, designed to meet your coater's exact specifications
- Houses up to 6 spray nozzles in a single manifold

Large Capacity 54000LC Manifold

- Ideal for large scale batch or continuous coating applications
- Houses up to 12 spray nozzles in a single manifold.



54000 Manifold



54000LC Manifold

ADDITIONAL RESOURCES

For more information on 54000 modular manifolds, [Click here ►](#)

PRODUCT VIDEO

To view a video of the 54000 Manifold in operation, [click here ►](#)



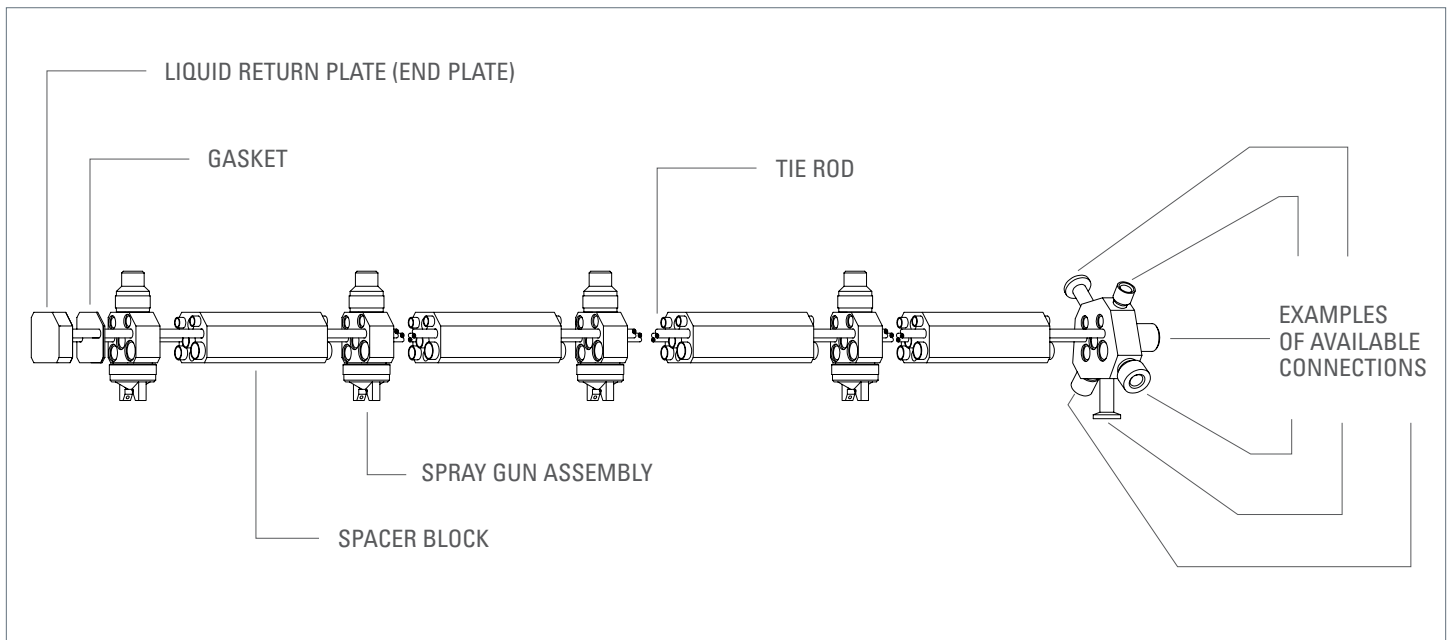
PERFORMANCE DATA

VMAU Lab Coater nozzles use VMAU or JAU anti-bearding set-ups.

For VMAU performance data, [click here ►](#)

For JAU performance data, [click here ►](#)

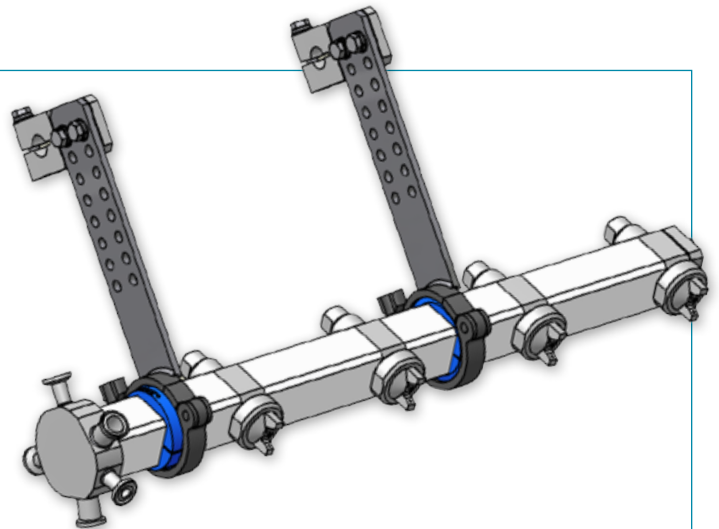
MODULAR AIR ATOMIZING MANIFOLD ASSEMBLY



SPRAY TIP: SAVE TIME WITH ADJUSTABLE SANITARY MOUNTING CLAMPS

The 54000LC manifold is available with a fully-adjustable sanitary mounting clamp which permits users to quickly and precisely rotate the manifold to the necessary spray angle – eliminating the hassle of trial-and-error positioning. The sanitary clamp can be customized to your coater's exact specifications and allows for easy installation of the manifold in a variety of different coating systems.

For more information, [Click here](#)



ORDERING INFORMATION

To view the specification sheets for either the 54000 or the 54000LC, click the links to view the corresponding worksheets. Use these forms to describe your specific requirements and then submit to your local sales representative.

54000 Modular Manifold [Click here](#) | 54000LC Modular Manifold [Click here](#)





FLUID BED PROCESSING

	PAGE
Application Overview	32
Fluid Bed Granulation and Wurster Coating	33
Nozzles and Lances for Top-Spray Granulation	34
Nozzles for Wurster Coating	38



SUPERIOR RESULTS FOR FLUID BED COATING AND GRANULATION

A **fluidized bed** occurs when a quantity of solid particles (generally contained in a holding vessel, most commonly a fluid bed processor) are placed under appropriate conditions to cause the mixture to behave as a fluid. This is typically done by forcing pressurized air, gas, or other fluids through the bed of solid particles. This causes the solid medium to acquire properties and attributes similar to those of normal fluids, resulting in what is known as **fluidization**.

Fluidized beds are commonly used in the pharmaceutical industry to dry, granulate, and coat any number of different active pharmaceutical ingredients (APIs), excipients, or other formulations.

ADDITIONAL RESOURCES

For more information on nozzles for fluid bed processing,
[click here ►](#)



FLUID BED GRANULATION

The fluid bed granulation process (also known as agglomeration) involves suspending particles in an air stream and spraying a liquid from the top of the system down onto the fluidized bed (**top-down spray**). Particles in the path of the spray get slightly wet and become sticky. The sticky particles collide with other particles in the bed of material and adhere to them to form granules. There are two different modes of fluid bed granulating: **wet stage** and **dry stage**.

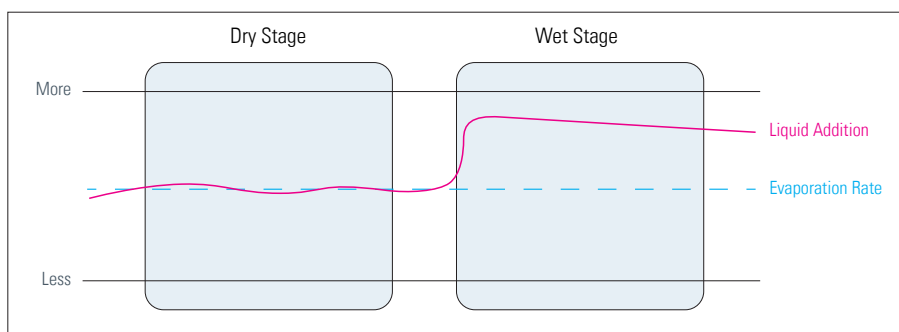
DRY STAGE GRANULATION

In dry stage granulation, the particles only require a slight wetting to become tacky and stick to each other. The granulating solution is applied at a rate less than or equal to its evaporation rate. Thus, the particles remain “dry” through the entire process.

WET STAGE GRANULATION

In wet stage granulation, the particles require a significant amount of moisture or granulating solution before they become tacky enough to stick to each other. The granulating solution is applied at a rate higher than the evaporation rate until the particles build up enough moisture to granulate.

Note: The characteristics of the particles when wet and the type of granulating solution being used will determine which mode of granulating is most appropriate. While dry stage is more common, wet stage granulating allows for denser products.



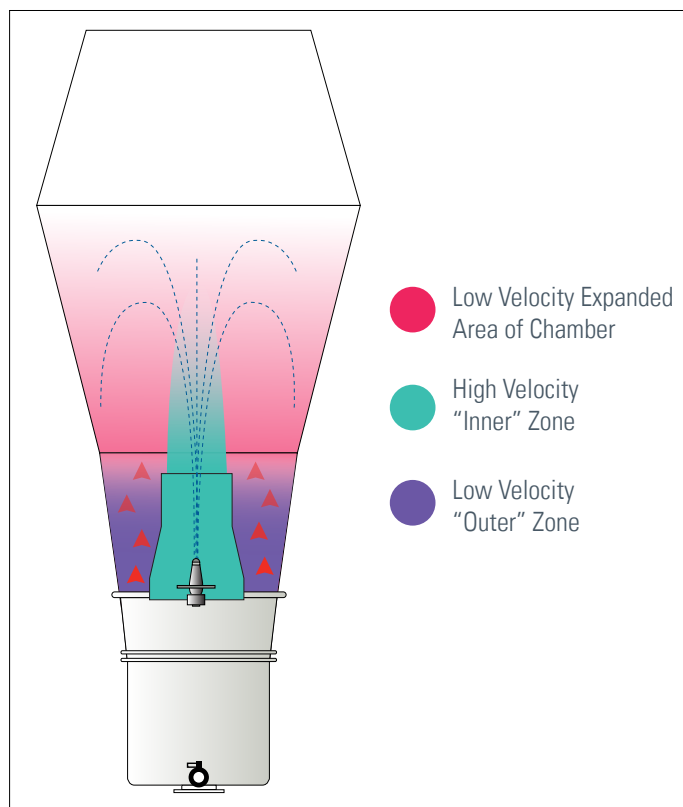
WURSTER COATING (FLUID BED COATING)

The Wurster process has been used for years to coat particles, spheres, granules, and tablets. Systems have been developed for use with a variety of coating formulations, including aqueous/organic solvents, hot saturated solutions and hot melts.

The basic concept in Wurster coating is to separate the particles in the fluid bed from one another in an air (gas) stream. While the particles are suspended, a coating formulation is sprayed from the bottom of the bed up onto the particles (**bottom-up spray**).

The process takes place inside a specially modified fluid bed that is divided into two zones by a partition. The inner area is a high velocity zone that separates the particles and pneumatically transports them past the spray nozzle. After passing the nozzle, the particles enter the expanded area of the chamber, slow down and fall back into the outer section of the fluid bed product bowl. The coating dries while the particles are suspended to prevent agglomeration from occurring when they enter the tranquil part of the bed.

The coated particles in the tranquil storage area remain fluidized just enough to allow them to continue moving towards the bottom of the bowl. When the particles reach the bottom, they are drawn back into the high velocity air stream and the cycle is repeated. This process continues until the desired level of coating has been achieved.



Wurster Process inside a fluid bed. The path of the particles in the air stream is illustrated by the dashed blue lines. The red triangles represent the fluidizing gas.



R&D SCALE

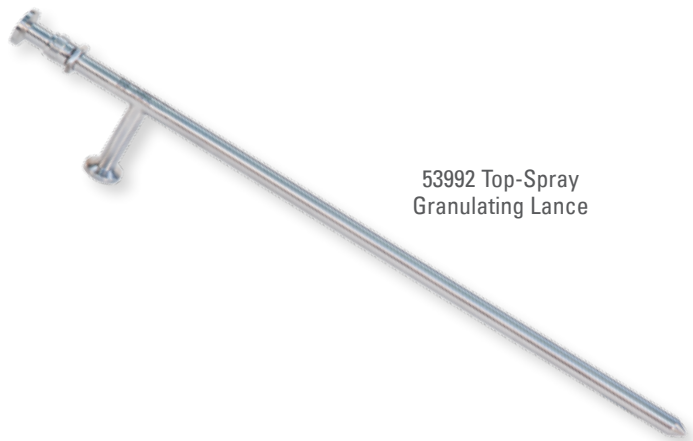
53992 TOP-SPRAY GRANULATING LANCE

PRODUCT OVERVIEW

Designed for use in R&D scale fluid bed dryers/granulators, and spray dryers, the completely customizable 53992 Top-Spray Granulating Lance is available in a range of orifice sizes to provide precision granulation and spray drying.

FEATURES AND BENEFITS

- For R&D scale applications
- 316SS construction
- Available in .016", .020", .028", and custom orifice sizes
- Spray pattern: full circular cone (top-down spray)
- Welded air cap and seamless tubing
- Sanitary design and connections
- Available with insertion graduations and anti-bearding set-ups to ensure optimal performance



53992 Top-Spray
Granulating Lance

ADDITIONAL
RESOURCES

For more information on the 53992 Top-Spray Granulating Lance, [click here](#) ►

To download a 3D model (CAD-format STEP file), [click here](#) ►

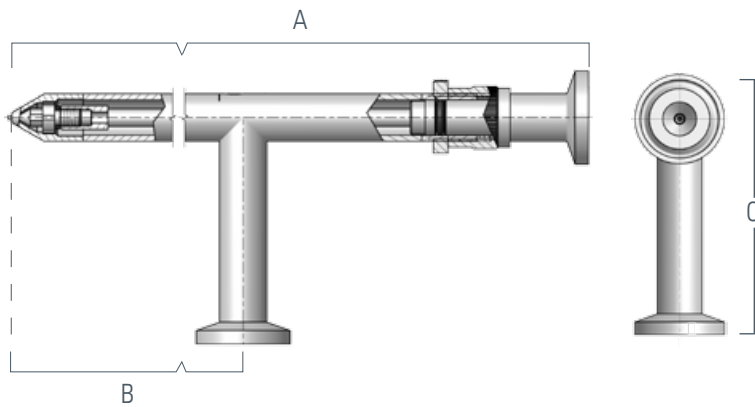
SPRAY TIP: ENHANCE THE PERFORMANCE OF R&D SCALE FLUID BED GRANULATORS

Get the most out of your R&D scale fluid bed system with the new 53992 Top-Spray Granulating Lance. Available at custom lengths and with insertion graduations to ensure optimal spray height for fluid bed granulation, the lance is designed to provide superior spray performance and improve batch uniformity.

For more information on fluid bed systems, [click here](#) ►



DIMENSIONS — 53992 TOP-SPRAY GRANULATING LANCE

	A in. (mm)	B in. (mm)	C in. (mm)
	33.63 (854.20)	30.00 (762.00)	2.38 (60.45)

PERFORMANCE DATA

For performance data on the 53992 Top-Spray Granulating Lance, [click here ►](#) to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
CP53992-301 (.016" / 0.4 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
CP53992-302 (.020" / 0.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
CP53992-303 (.028" / 0.7 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®

ORDERING INFORMATION — 53992 TOP-SPRAY GRANULATING LANCE

To view the specification sheets for the 53992 Top-Spray Granulating Lance, click the link below.
 Use this form to describe your specific requirements and then submit to your local sales representative.

53992 Top-Spray Granulating Lance | [click here ►](#)



PRODUCTION SCALE

46920/46925 TOP-SPRAY GRANULATING NOZZLES

PRODUCT OVERVIEW

Our new production scale top-spray granulating nozzles are intended for use in larger-size fluid bed granulators. Engineered with a three or six-orifice “cluster-head” configuration, the nozzle produces a fine spray for consistent, uniform granulation, even at larger batch sizes.

FEATURES AND BENEFITS

- For pilot/production scale applications
- Fine spray
- Materials: 316L stainless steel, FDA-approved EPDM O-rings and Teflon® gaskets
- Modular design for quick disassembly
- Spray pattern: wide cone (top-down spray)
- Models available with air-actuated liquid shut-off feature (46925 Only)



46920 Top-Spray
Granulating Nozzle

ADDITIONAL
RESOURCES

For more information on 46920 / 46925 Top-Spray Granulating Nozzles, [click here ▶](#)

To download a 3D model (CAD-format STEP file), click the links below.

[46920 Nozzle ▶](#)

[46925 Nozzle ▶](#)

PRODUCT VIDEO

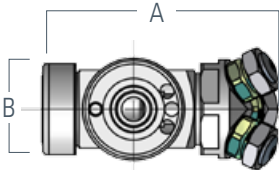
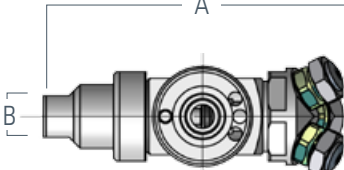
To view a video of the 46925 top-spray nozzle in operation, [click here ▶](#)

SPRAY TIP: RETROFIT EXISTING MACHINES
FOR SUPERIOR GRANULATION

Production scale top-spray granulating nozzles are designed to replace old or worn nozzles supplied with large batch fluid bed granulating systems, and are available with customizable lance configurations to fit your system's exact specifications.



DIMENSIONS — 46920 / 46925 TOP-SPRAY GRANULATING NOZZLES

46920 (No liquid shut-off)	46925 (With liquid shut-off)	Nozzle Number	A in. (mm)	B Flats in. (mm)
		46920	4.66 (118.36)	1.75 (44.45)
		46925	6.04 (153.42)	0.81 (20.57)

PERFORMANCE DATA

For performance data on 46920 / 46925 Top-Spray Granulating nozzles, [click here](#) ► to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
SU1A (.016" / 0.4 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SU1 (.020" / 0.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SU2A (.020" / 0.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SU2 (.028" / 0.7 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SU4 (.060" / 1.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
SU5 (.100" / 2.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®

ORDERING INFORMATION — 46920 / 46925 TOP-SPRAY GRANULATING NOZZLES

To order, select either model 46920 or 46925, spray-set up (see above), and materials.

Example

Model Number	—	Material Code
46925	—	316EPF

Material Code

316EPF = FDA EPDM

316SS = 316 stainless steel

SPRAY SET-UP

Example

Set-Up Number	—	Material Code
SU1A	—	316SS

LANCE ASSEMBLY

46920 / 46925 nozzles are also available as part of a complete lance assembly for fluid bed granulation. To view the specification sheet, [click here](#) ►

R&D SCALE

54057 FLUID BED COATING NOZZLES

PRODUCT OVERVIEW

Our new R&D scale fluid bed coating nozzles are designed to provide superior Wurster coating performance for R&D scale fluid bed coating systems.

FEATURES AND BENEFITS

- For R&D scale applications
- Medium to fine spray
- Materials: 316L stainless steel, EPDM O-rings, FDA-approved Teflon® gaskets
- 0.020", 0.032", 0.040", 0.047" and custom nozzle orifice sizes available
- Spray pattern: full circular cone (bottom-up spray)
- Anti-bearding setups



54057 Fluid Bed
Coating Nozzle

ADDITIONAL
RESOURCES

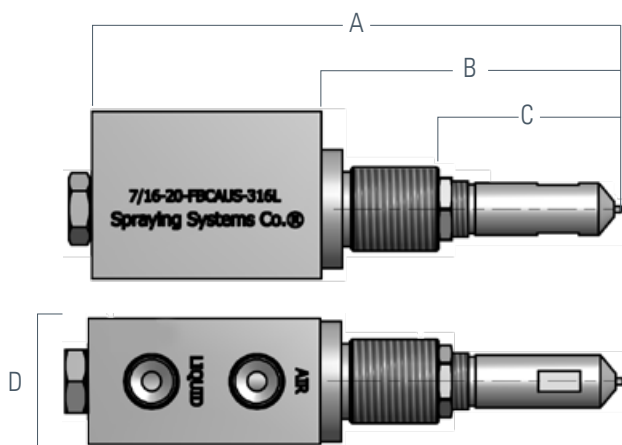
To download a 3D model (CAD-format STEP file), [click here](#) ►

SPRAY TIP: USE MULTIPLE NOZZLES FOR LARGER COATING APPLICATIONS

R&D scale fluid bed nozzles are designed for small-scale fluid bed coating applications— specifically Wurster coating— requiring only one spray nozzle, but they also may be used as part of a larger, multi-nozzle fluid bed Wurster coating system.



DIMENSIONS — 54057 FLUID BED COATING NOZZLES

	A* in. (mm)	B* in. (mm)	C* in. (mm)	D Flats in. (mm)
	4.76 (120.90)	2.69 (68.33)	1.64 (41.66)	1.75 (44.45)

*Custom lengths available.

PERFORMANCE DATA

For performance data on 54057 Fluid Bed Coating nozzles, [click here ►](#) to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
VAR. 001 (.020" / 0.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
VAR. 002 (.032" / 0.8 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
VAR. 003 (.040" / 1.0 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
VAR. 004 (.047" / 1.2 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®

ORDERING INFORMATION — 54057 FLUID BED COATING NOZZLES

To order, specify nozzle number, set-up and material code.

Example

Nozzle Number	—	Set-Up Number	—	Material Code
------------------	---	------------------	---	------------------

7/16-20-FBCAU — 001 — 316L

Material Code

316L = 316L Stainless Steel



PILOT SCALE

54499 FLUID BED COATING NOZZLES

PRODUCT OVERVIEW

Intended to replace existing nozzles in pilot and small production scale fluid bed systems, 54499 fluid bed coating nozzles provide superior spray performance and are designed to meet your system's exact specifications.

FEATURES AND BENEFITS

- For pilot/production scale applications
- Fine spray
- Materials: 316L stainless steel, EPDM O-rings, FDA-approved Teflon® gaskets
- 0.047" and 0.059" nozzle orifice sizes available
- Spray pattern: narrow full cone (bottom-up spray)



54499 Fluid Bed
Coating Nozzle

ADDITIONAL
RESOURCES

To download a 3D
model (CAD-format
STEP file), [click here](#) ►

SPRAY TIP: SIMPLIFY SCALE-UP
TO LARGER BATCH SIZES

Pilot scale fluid bed coating nozzles are designed to minimize the challenge of scale-up from small R&D applications to larger pilot and production scale batches. 54499 pilot scale fluid bed coating nozzles retain the same fluid tip size as the smaller, R&D scale nozzles, making it simple to achieve the same results in larger systems.



DIMENSIONS — 54499 FLUID BED COATING NOZZLES

A* in. (mm)	B* in. (mm)	C* in. (mm)	D in. (mm)	E dia. in. (mm)	F in. (mm)	G in. (mm)
4.50 (114.30)	2.75 (69.85)	1.87 (47.50)	0.06 (1.52)	2.50 (63.50)	1.09 (27.69)	1.50 (38.10)

*Custom lengths available.

PERFORMANCE DATA

For performance data on 54499 Fluid Bed Coating nozzles, [click here](#) ►
to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
VAR. 001 (.047" / 1.2 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Spray Velocity	Water / OPADRY®
VAR. 002 (.059" / 1.5 mm Orifice)	Coverage and Flow Rate	Water / OPADRY®
	Drop Size Information	Water / OPADRY®
	Spray Velocity	Water / OPADRY®

ORDERING INFORMATION — 54499 FLUID BED COATING NOZZLES

To order, specify nozzle number, set-up and material code.

Example

Nozzle Number	—	Set-Up Number	—	Material Code
54499	—	001	—	316L

Material Code

316L = 316L Stainless Steel



PRODUCTION SCALE

46910 / 46915 FLUID BED COATING
NOZZLES

PRODUCT OVERVIEW

Intended to replace existing nozzles already in use in larger pilot or production scale fluid bed systems, our customizable production scale fluid bed coater nozzles are designed to improve your Wurster coating application.

FEATURES AND BENEFITS

- For pilot/production scale applications
- Fine spray
- Materials: 316L stainless steel, EPDM O-rings, FDA-approved Teflon® gaskets
- 1.5mm, 2.2mm and 4.0mm nozzle orifice sizes available
- Spray pattern: narrow full cone (bottom-up spray)
- Models available with air-actuated liquid shut-off feature (46915 Only)
- Custom nozzle lengths available



46915 Fluid Bed
Coating Nozzle

ADDITIONAL
RESOURCES

For more information on 46910 / 46915 fluid bed coating nozzles, [click here ►](#)

To download a 3D model (CAD-format STEP file), click the links below.

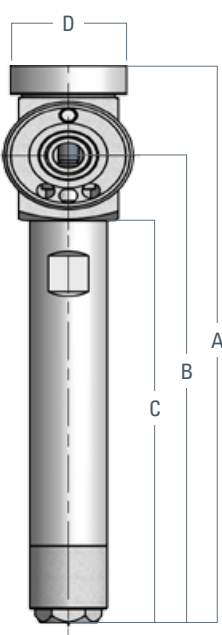
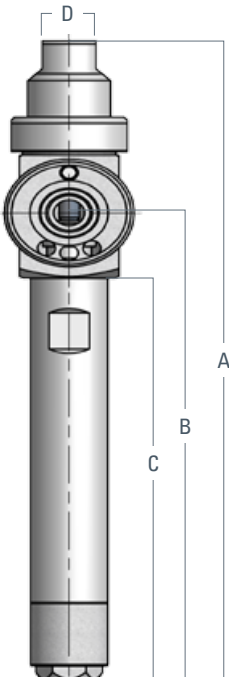
[46910 Nozzle ►](#)
[46915 Nozzle ►](#)

**SPRAY TIP: CUSTOM LANCE ASSEMBLIES
AVAILABLE FOR FLUID BED COATERS**

In addition to fluid bed coating nozzles, we are able to manufacture customizable lance assemblies to fit your existing fluid bed system.



DIMENSIONS — 46910 / 46915 FLUID BED COATING NOZZLES

46910 (No liquid shut-off)		46915 (With liquid shut-off)						
				Nozzle Number	A* in. (mm)	B* in. (mm)	C* in. (mm)	D Flats in. (mm)
				46910	10.37 (263.40)	8.50 (215.90)	7.01 (178.05)	1.75 (44.45)
				46915	11.75 (298.45)	8.50 (215.90)	7.01 (178.05)	0.81 (20.57)

*Custom lengths available. For 46910 and 46915 Wurster Coating Nozzles, length B determines both length A and C. Choose length B based on your system's requirements.

PERFORMANCE DATA

For performance data on 46910 / 46915 Fluid Bed Coating nozzles, [click here ►](#) to view a bookmarked PDF containing the following information:

Data on Spray Set-Up(s)	Type of Data	Available Spraying Material(s) for Data Type
VAR. 001 (.059" / 1.5 mm Orifice)	Coverage and Flow Rate	Water
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
VAR. 002 (.086" / 2.2 mm Orifice)	Coverage and Flow Rate	Water
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®
VAR. 003 (.157" / 4.0 mm Orifice)	Coverage and Flow Rate	Water
	Drop Size Information	Water / OPADRY®
	Relative Span Factor	Water / OPADRY®



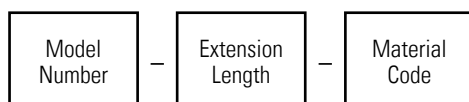
ORDERING INFORMATION — 46910 / 46915 FLUID BED COATING NOZZLES

To order a complete 46910 / 46915 fluid bed coating nozzle, first specify a nozzle assembly. Then, use the chart below and the performance data on the previous page to determine the appropriate fluid cap and air cap to complete your nozzle.

NOZZLE ASSEMBLY

Choose either model number 46910 (no liquid shut-off) or model 46915 (with liquid shut-off) and specify an extension length.

Example



46915

8.5*

316EPF

Material Code

316EPF = FDA EPDM

316L = 316L stainless steel

*Custom lengths available. Specify extension length based on your system's requirements.

VARIATION TABLE

Set-Up Number		Fluid Cap Number		Air Cap Number
VAR. 001 (.059" / 1.5 mm Orifice)	<i>Consists of:</i>	WF15-316L (1.5 mm Orifice)	+	WA95-316L (9.5 mm Orifice)
VAR. 002 (.086" / 2.2 mm Orifice)	<i>Consists of:</i>	WF22-316L (2.2 mm Orifice)	+	WA95-316L (9.5 mm Orifice)
VAR. 003 (.157" / 4.0 mm Orifice)	<i>Consists of:</i>	WF40-316L (4.0 mm Orifice)	+	WA95-316L (9.5 mm Orifice)

FLUID CAP

Reference the performance data and use the table above to select the appropriate size fluid cap and air cap for your application.

Example



WF

15

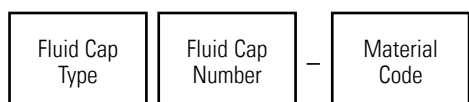
316L

LANCE ASSEMBLY

46910 / 46915 nozzles are also available as part of a complete lance assembly for fluid bed coating. To view the specification sheet, [click here](#) ►

AIR CAP

Example



WA

95

316L



HIGH-SHEAR GRANULATION

	PAGE
Application Overview	46
Lances for High-Shear Granulation	47



SOLUTIONS FOR EFFICIENT, HOMOGENEOUS GRANULATION

Fluid undergoes “**shear**” when a certain area of its surface is traveling with a different velocity relative to an adjacent area. A high-shear mixer uses a rotating impeller or high-speed rotor (or both) to create flow and shear. The tip velocity, or speed of the fluid at the outside edge of the rotor, will be higher than the velocity at the center of the rotor, and it is this difference in velocity that creates shear.

High-shear granulation is an effective way to turn powders into dense granules for tableting or coating. To create the granules, powders are added to the mixing bowl and the bowl is sealed. A large impeller rotates at slow speeds, spinning the powders into a vortex. After the powders are blended together, liquid is added to the product using a pump or pressurized container. A high-speed chopper tool located in the bowl shears the granules and removes air. The mixing continues until the desired granule size and density are achieved.

ADDITIONAL RESOURCES

For more information on high-shear granulators,
[click here ►](#)



CUSTOM-FABRICATED GRANULATION LANCES

PRODUCT OVERVIEW

We are able to provide fully customized lances for your high-shear granulation application. The lances are available in either adjustable hydraulic or fixed length and use TP style UniJet® or TeeJet® spray tips.

FEATURES AND BENEFITS

- Completely customizable, designed to fit your mixer's exact specifications
- Threadless, sanitary design – all components are welded in place
- Sanitary connections
- Materials of construction: 316L stainless steel



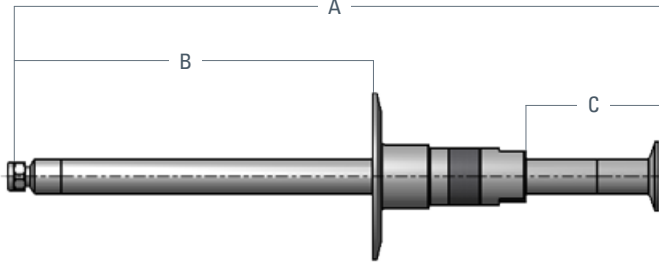
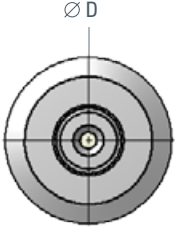
SPRAY TIP: RETROFIT YOUR HIGH-SHEAR MIXER TO ENHANCE GRANULATION RESULTS

Replace your existing spray assembly with a completely customized high-shear granulation lance for improved performance and sanitation. We are able to customize high-shear granulation lances to fit a range of high-shear mixers, including Fluid Air PHARMX® systems as well as those of other manufacture.

For more information on high-shear mixers, [click here](#) ►



DIMENSIONS — CUSTOM-FABRICATED GRANULATION LANCES

				A* in. (mm)	B* in. (mm)	C* in. (mm)	D dia. in. (mm)
				18.00 (457.20)	10.00 (254.00)	3.71 (94.23)	4.66 (118.36)

*Custom lengths available.

PERFORMANCE DATA

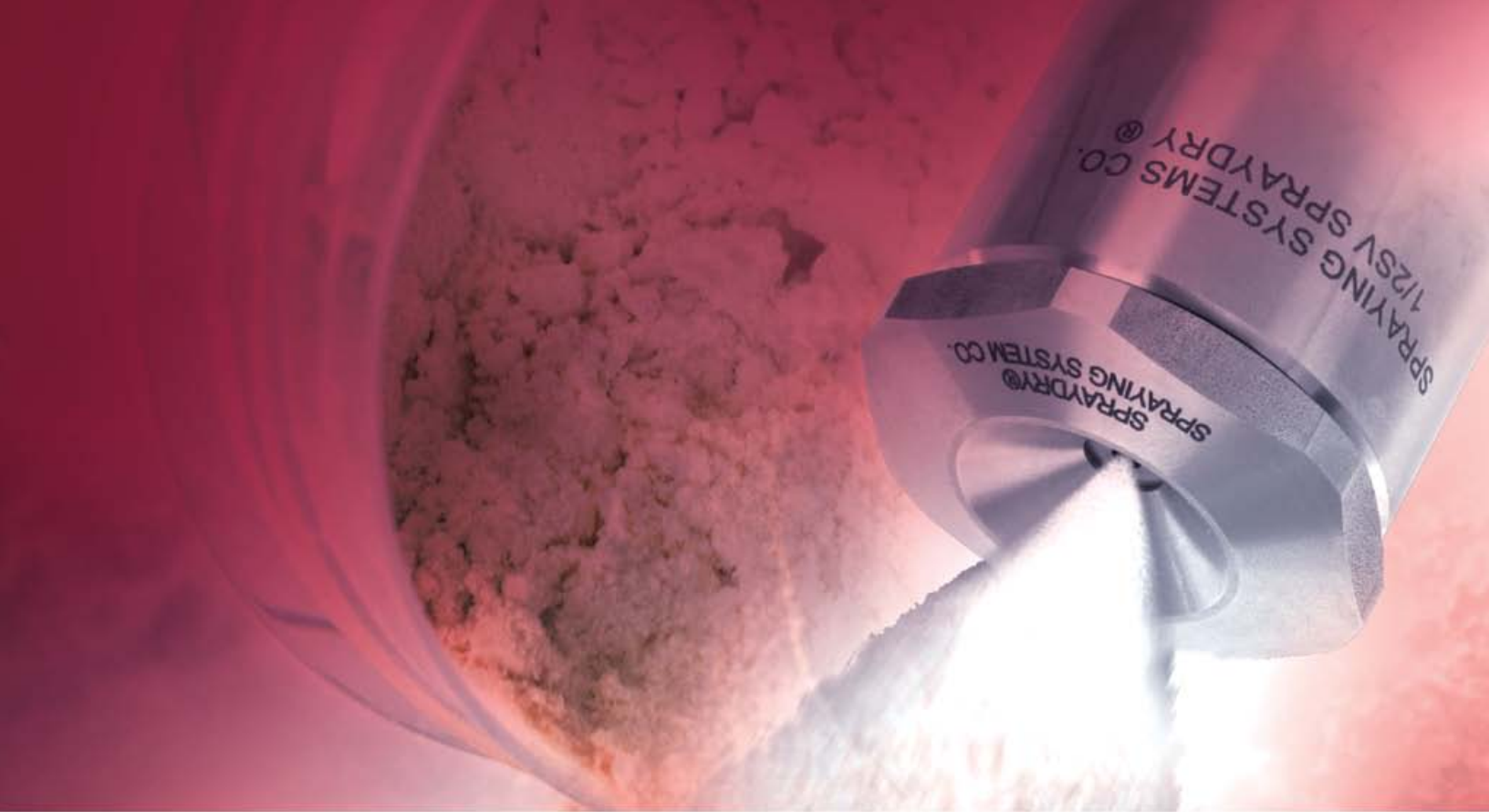
Spray Angle at 40 PSI	Capacity Size	Orifice Dia. (in.)*	Capacity gpm**												Spray Angle (°)			
			5	10	20	30	40	60	80	100	200	300	500	20	40	80	200	
80°	0050	.018	--	--	.035	.043	.050	.060	.07	.08	.11	.14	.18	61	80	95	101	
	0067	.021	--	.033	.05	.06	.067	.08	.09	.11	.15	.18	.24	67	80	94	99	
	01	.026	--	.05	.07	.09	.10	.12	.14	.16	.22	.27	.35	68	80	89	92	
	015	.032	--	.08	.11	.13	.15	.18	.21	.24	.34	.41	.53	68	80	89	92	
	02	.035	.07	.10	.14	.17	.20	.24	.28	.32	.45	.55	.71	69	80	88	91	
	03	.043	.11	.15	.21	.26	.30	.37	.42	.47	.67	.82	1.1	70	80	87	90	
	04	.050	.14	.20	.28	.35	.40	.49	.57	.63	.89	1.1	1.4	71	80	86	89	
	045	.053	.16	.23	.32	.39	.45	.55	.64	.71	1.0	1.2	1.6	71	80	86	89	
	05	.056	.18	.25	.35	.43	.50	.61	.71	.79	1.1	1.4	1.8	71	80	86	89	
	06	.061	.21	.30	.42	.52	.60	.73	.85	.95	1.3	1.6	2.1	72	80	85	88	
	07	.066	.25	.35	.49	.61	.70	.86	.99	1.1	1.6	1.9	2.5	72	80	85	88	
	08	.071	.28	.40	.57	.69	.80	.98	1.1	1.3	1.8	2.2	2.8	72	80	84	87	
	09	.075	.32	.45	.64	.78	.90	1.1	1.3	1.4	2.0	2.5	3.2	73	73	73	73	
	10	.079	.35	.50	.71	.87	1.0	1.2	1.4	1.6	2.2	2.7	3.5	73	80	84	87	
	11	.083	.39	.55	.78	.95	1.1	1.3	1.6	1.7	2.5	3.0	3.9	73	73	73	73	
	12	.087	.42	.60	.85	1.0	1.2	1.5	1.7	1.9	2.7	3.3	4.2	73	73	73	73	
	13	.090	.46	.65	.92	1.1	1.3	1.6	1.8	2.1	2.9	3.6	4.6	73	73	73	73	
	14	.093	.49	.70	.99	1.2	1.4	1.7	2.0	2.2	3.1	3.8	4.9	73	73	73	73	
	15	.097	.53	.75	1.1	1.3	1.5	1.8	2.1	2.4	3.4	4.1	5.3	74	80	83	86	
	16	.100	.57	.80	1.1	1.4	1.6	2.0	2.3	2.5	3.6	4.4	5.7	74	80	83	86	
	17	.103	.60	.85	1.2	1.5	1.7	2.1	2.4	2.7	3.8	4.7	6.0	74	80	83	86	
	20	.112	.71	1.0	1.4	1.7	2.0	2.4	2.8	3.2	4.5	5.5	7.1	74	80	83	86	
	25	.121	.88	1.3	1.8	2.2	2.5	3.1	3.5	4.0	5.6	6.8	8.8	74	80	83	86	
	30	.133	1.1	1.5	2.1	2.6	3.0	3.7	4.2	4.7	6.7	8.2	10.6	74	80	83	86	
	40	.153	1.4	2.0	2.8	3.5	4.0	4.9	5.7	6.3	8.9	11.0	14.1	74	80	83	86	
	50	.172	1.8	2.5	3.5	4.3	5.0	6.1	7.1	7.9	11.2	13.7	17.7	74	80	83	85	
	60	.188	2.1	3.0	4.2	5.2	6.0	7.3	8.5	9.5	13.4	16.4	21	75	80	83	85	
	70	.203	2.5	3.5	4.9	6.1	7.0	8.6	9.9	11.1	15.7	19.2	25	75	80	83	86	

ORDERING INFORMATION — CUSTOM-FABRICATED GRANULATION LANCES

Use this form to describe your specific requirements and then submit to your local sales representative.

Custom Fabricated Granulation Lances (Coming Soon)





SPRAY DRYING

	PAGE
Application Overview	50
SV Series SprayDry® Nozzles	51
SB Series SprayDry® Nozzles	52
SK Series SprayDry® Nozzles	53



PIONEERS OF SPRAY DRYING TECHNOLOGY

Spray drying is a means of producing a dried powder from a liquid or thick, semisolid solution by rapidly drying with a hot gas. This is a common method used to dry many temperature-sensitive materials like foods, chemicals and pharmaceuticals. The roots of spray drying can be traced back to the 1800's when rotary atomizers were used to produce particles. Spraying Systems Co. developed the first line of commercially available nozzles for spray drying in the 1940's.

The term "SprayDry®" was first used by Spraying Systems Co. in 1943 and became a registered trademark of the company in 1951. As demand for products like dried milk and eggs increased during World War II and after, our SprayDry line evolved rapidly to accommodate a wide variety of applications. Spraying Systems Co. offers the broadest selection of SprayDry® nozzles available, including core, whirlchamber and swirlchamber designs.



ADDITIONAL RESOURCES

For more information on spray drying,
[click here ►](#)



SV SERIES SPRAYDRY® NOZZLE

PRODUCT OVERVIEW

New SV Series SprayDry® nozzles feature maximum-free-passage orifices and a one-piece swirlchamber made from special tungsten carbide material to deliver consistent performance with superior resistance to wear and clogging.

FEATURES AND BENEFITS

- Hand-tight design for easy assembly and disassembly
- Large maximum-free-passage helps reduce clogging and maintenance downtime
- Rated at 10,000 psi
- Long wear life
- Quick delivery

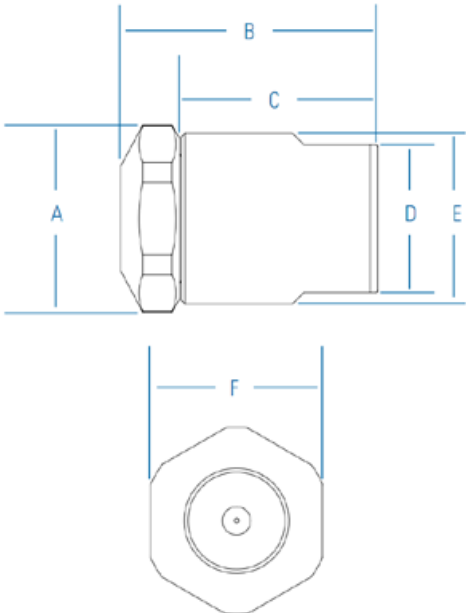


SV Series
SprayDry® Nozzles

ADDITIONAL RESOURCES

For more information on SV Series SprayDry® Nozzles including performance data, [click here ►](#)

DIMENSIONS

									
Nozzle Type	Inlet Conn.	A Dia. in. (mm)	B Length in. (mm)	C Length in. (mm)	D Flat in. (mm)	E Dia. in. (mm)	F Flat in. (mm)	Weight lbs. (kg)	
SV	1/4", 3/8", 1/2"	1.90 (48.3)	2.62 (66.4)	2.00 (50.8)	1.5 (38.1)	1.74 (44.2)	1.75 (44.5)	1.5 (0.67)	



SK SERIES SPRAYDRY® NOZZLE

PRODUCT OVERVIEW

SK series SprayDry® nozzles produce a fine, hollow-cone spray with a very narrow drop size distribution ideal for spray drying applications. SK SprayDry® nozzles are also available with hand-tight (H) and maximum-free-passage features (MFP) and are available with 145 different orifice insert/core combinations to suit your application's exact needs.

FEATURES AND BENEFITS

- Hand-tight design for easy assembly and disassembly
- Large maximum-free-passage helps reduce clogging and maintenance downtime
- Anti-bearding design reduces dangerous contamination
- Long wear life
- Improved sanitary features for regulatory compliance in pharmaceutical applications



SB Series
SprayDry® Nozzles

ADDITIONAL
RESOURCES

For more information on SK Series SprayDry® Nozzles including performance data, [click here](#) ►

DIMENSIONS

	Nozzle Type	Inlet Conn.	A Dia. in. (mm)	B Length in. (mm)	Weight lb. (kg)
	SKH-MFP	1/4"	1.12 (28.4)	2.99 (75.9)	0.75 (0.34)
		3/8"	1.12 (28.4)	2.99 (75.9)	0.69 (.031)



SB SERIES SPRAYDRY® NOZZLE

PRODUCT OVERVIEW

SB series SprayDry® nozzles are similar to the SK series nozzles. The SB SprayDry® nozzle is available with hand-tight (H) and maximum-free-passage features (MFP) as well as over 120 different orifice insert/core combinations to suit your application's exact needs.

FEATURES AND BENEFITS

- Hand-tight design for easy assembly and disassembly
- Large maximum-free-passage helps reduce clogging and maintenance downtime
- Anti-bearding design reduces dangerous contamination
- Long wear life
- Improved sanitary features for regulatory compliance in pharmaceutical applications




SK Series
SprayDry® Nozzles

ADDITIONAL RESOURCES

For more information on
SB Series SprayDry®
Nozzles including
performance data,
[click here ►](#)

DIMENSIONS

	Nozzle Type	Inlet Conn.	A Dia. in. (mm)	B Length in. (mm)	Weight lb. (kg)
	SBH-MFP	3/8"	1.49 (37.8)	4.01 (101.9)	1.6 (0.73)
		1/2"	1.49 (37.8)	4.17 (105.9)	1.7 (0.77)



VESSEL CLEANING

	PAGE
Application Overview	55
Selection and Optimization Tips	56
CIP / WIP Solutions	58
Fixed Spray Balls	60
Fluid-Driven Rotary Nozzles	62
Regulated Fluid-Driven Rotary Nozzles	70

A collection of medical vials and a syringe on a reflective surface. In the foreground, a syringe with a needle is positioned horizontally, its needle pointing towards a vial that is lying on its side. Behind it, several other vials stand upright. The background is a soft, out-of-focus blue gradient. The entire scene is reflected on the surface below.

EFFECTIVE CLEANING FOR VIRTUALLY ANY APPLICATION

Unlike tablets or capsules intended for oral consumption, drugs manufactured through bio-processing methods are usually administered parent-erally (intravenously) or by routes other than the digestive tract. The stakes are, therefore, much higher, and the risk of contamination must be reduced or eliminated at all costs – sterility and cleanability become the highest priorities. All markets in the bio-processing industry strive for some level of bioburden control (control over a biological product's level of contamination with microorganisms), the stringency of which is dependent on the type of product being processed.

ADDITIONAL RESOURCES

For more information on nozzles for vessel cleaning,
[click here ►](#)



SELECTION AND OPTIMIZATION TIPS

Address these factors first to identify the best tank cleaning solution for your application.

1. HYGIENIC EQUIPMENT CLEANING

- Regular and thorough cleaning of hygienic equipment is essential to maintaining bioburden control and preventing cross contamination.
- Spray device selection is critical to passing a wetting test of the internal surfaces of the hygienic equipment.
- Spray device selection is dependent on a review of the device's design and operation parameters as well as the intended process.
- Proper equipment design and spray device selection will ensure a robust cleanability potential.

2. VESSEL REVIEW

- Vessel size (volume)
- Nozzle size, total number of nozzles, location(s) on vessel
- Internal vessel geometry and appurtenances (agitator, baffles, spargers, dip tubes, instrument wells, sample ports, etc.)
- Shadowing concerns

3. CLEAN UTILITIES AND PROCESS REVIEW

- Clean utility capacity (gpm/lpm) at pressure (psi/bar) available
- Chemistry employed (aqueous vs. solvent-based materials)
- Temperature (hot water or steam)
- Air blows

4. CLEANING METHODOLOGY*

Clean in Place (CIP): Cleaning equipment left in place during product manufacture.

Steam in Place (SIP): Cleaning equipment left in place during the steam process and/or used to deliver the steam.

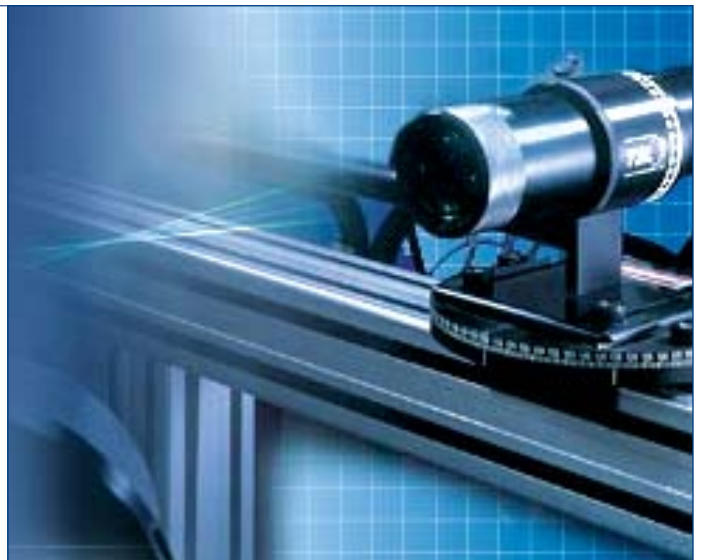
Wash in Place (WIP): Cleaning equipment removed during product manufacture. Typically not used for applications requiring a high level of bioburden control or sterile applications. Rotary spray devices and spray balls can be considered for these applications.

*Note: Applications requiring a high level of bioburden control or sterile CIP applications require equipment designed and fabricated to the ASME® BPE standard. Typically a unique keyed wand with a precision drilled spray ball is required for a successful riboflavin wetting test.

SPRAY TIP: USE SPRAY ANALYSIS TO SELECT THE RIGHT CLEANING SOLUTION

Unsure which spray device is right for you? Our Spray Analysis and Research Services team is able to provide state-of-the-art analysis of your equipment, including sophisticated CFD (Computational Fluid Dynamics) and PDI (Phase Doppler Interferometry) technology to simulate the efficacy of different spray patterns and device configurations inside a 3D model of your vessel to determine which solution is right for your application.

For more information on Spray Analysis and Research Services, [click here ►](#)



SELECTION AND OPTIMIZATION TIPS (CONTINUED)

Address these factors first to identify the best tank cleaning solution for your application.

5. FLOW RATE

- The ASME® BPE standard targets a flow rate of 2.5 to 3 gpm (9.4 to 11.4 lpm) per foot (0.3m) of inner vessel circumference using a 180° up spray ball. This flow results in a turbulent sheeting action down the vessel walls.
- Consider using a lower flow rate when static or dynamic spray devices are used that have a 360° spray pattern.
- A lower flow rate of 1.9 to 2.3 gpm (7.2 to 8.7 lpm) per foot (0.3 m) of inner vessel circumference can be targeted when specifying a single-axis rotary spray device.

6. SPRAY DEVICE REVIEW

- Review external and internal surfaces for best hygienic design. Design should consider drainability and cleanability of all surfaces.
- Determine the device's materials of construction, including all subcomponents. Review for compatibility with clean utility and process solutions.
- Orifice selection and resultant spray pattern (jet, fan, etc.) ensures complete wetting of all targeted surfaces.
- Ease of device disassembly for cleaning, maintenance and inspection
- Device connection style (e.g., clipped, butt weld) meets intended cleaning methodology
- Cleaning equipment data package meets the owner's/end user's requirements for material test reports, surface finish certificates, welder certificates, no ADI certificates, elastomeric USP Class VI certificates, etc.

7. SPRAY IMPACT

- Rinsing targeted surfaces (numerous small orifices, low pressure)
- Cleaning targeted surfaces (fewer, larger orifices, higher pressure)
- Note: Increasing flow rate is more effective than increasing pressure. Doubling the flow rate increases impact by as much as 100%, while doubling pressure provides only 40% greater impact.



A typical vessel used for bioprocessing.



CUSTOM-FABRICATED WANDS, MANIFOLDS, AND MORE

PRODUCT OVERVIEW

Nozzles are just one part of a total cleaning solution. In addition to our entire line of customizable spray devices, we are able to design and fabricate custom wands, manifolds, and other solutions for nearly any application or process requirement. Our custom solutions can optimize spray performance, improve product quality and simplify system installation while minimizing physical changes to existing operations.

METALLIC / WELDED SOLUTIONS

- Custom CIP Lances/Wands, dip tubes, tube manifolds, spray rings and more designed and fabricated to your exact requirements
- Materials of construction: 316L stainless steel, Hastelloy®, AL6XN®, and other exotics
- Welders and weld/fabrication procedures BPVC Sect. IX compliant as required by the ASME® BPE

NON-METALLIC SOLUTIONS

- Non-metallic materials available upon request, including: Polypropylene, PVDF, PTFE and more
- Plastics and elastomers available with FDA or USP Class VI certificates
- GMP manufacturing procedures and fabrication

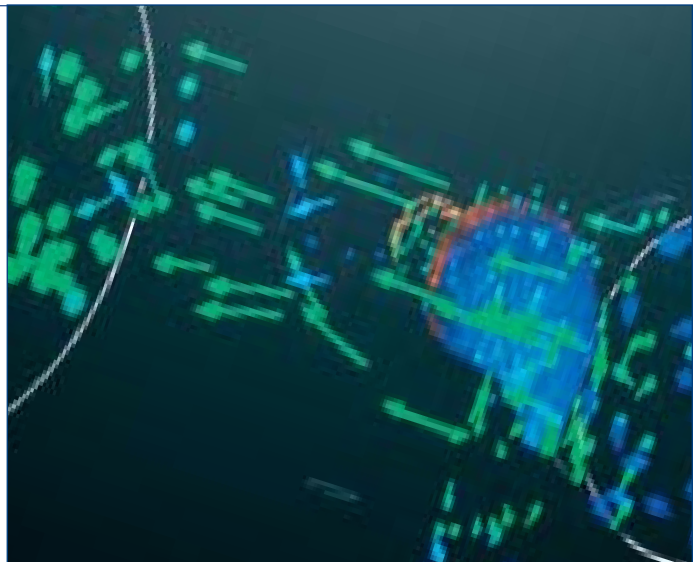


Polypropylene and
PTFE Lances

SPRAY TIP: STATE-OF-THE-ART SPRAY TESTING ENSURES SUPERIOR RESULTS

As part of our manufacturing process, our custom-welded solutions undergo rigorous testing and analysis to ensure superior results for our customers. Our sophisticated, in-house wet laboratory facilities enable us to collect and analyze complex data.

We will first work with you to develop a set of testing criteria which are relevant to your process parameters and application requirements. Once the data is collected, we are then able to generate a range of spray characterization data to allow us to determine the right solution for you. We are also able to perform wettability testing, certify calibrated flow testing, provide nozzle throw data and more per your process/acceptance requirements or requests.



BIOPHARMACEUTICAL PRECISION-DRILLED SPRAY BALLS

PRODUCT OVERVIEW

In addition to standard vessel cleaning products, we are able to provide completely customizable, precision-drilled, directionally-controlled spray ball solutions for your biopharmaceutical tank cleaning application.

DESIGN STAGE

First, a 3D solid model of your vessel, generated by our own experienced engineering group, is used to develop the directionally controlled orifice pattern to your exact specifications. The orifice pattern is then manufactured using CNC technology, ensuring that the orifice pattern is precise and repeatable.

FABRICATION STAGE

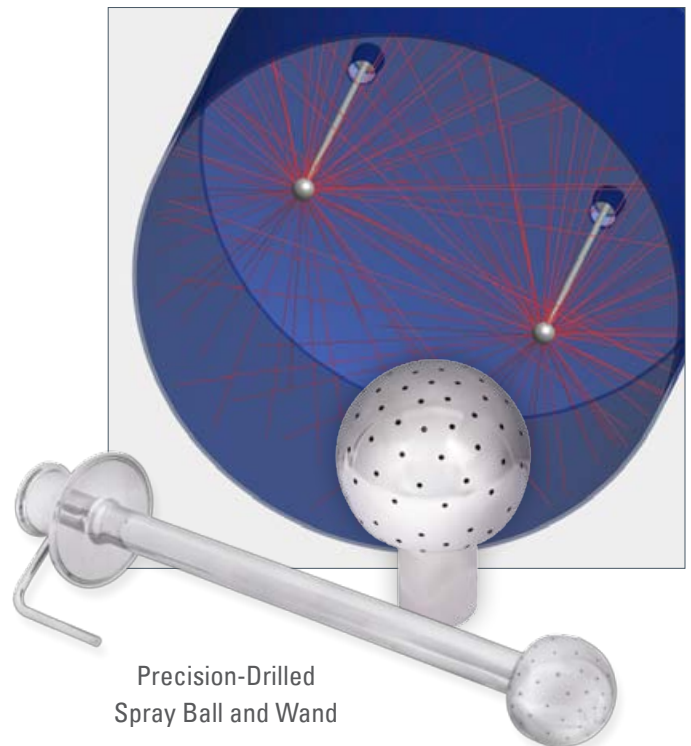
Next, our welding and manufacturing group fabricates the spray ball using procedures and welders in compliance with BPVC Sect. IX as required by ASME® BPE.

- Customer-specified surface finishes applied in-house and checked using profilometer (surface finish certification available)
- Experienced in fabricating and welding a broad range of exotic materials, including Hastelloy®, AL6XN®, and other high-nickel materials and coatings
- Any level of customer-defined positive material identification, destructive and non-destructive testing available

TURNOVER STAGE

Finally, we prepare either a standard or customer-defined turnover/data package to meet your process requirements, including (but not limited to):

- Welder/weld certification
- Material certification and material test reports (MTRs)
- Surface finish/electropolish certification
- GMP compliance



TANKJET® 63225-3A FIXED SPRAY BALLS

PRODUCT OVERVIEW

TankJet 63225-3A fixed spray balls are vessel cleaning nozzles ideal for sanitary rinsing and removal of light residues.

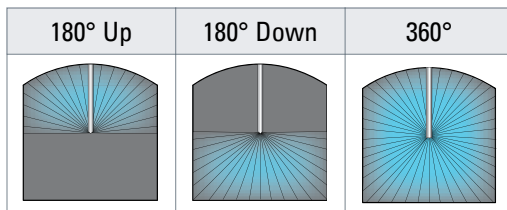
FEATURES AND BENEFITS

- Suitable for CIP – no moving parts
- Can be installed in any position
- Low-cost way to rinse easy-to-remove residues
- 316L stainless steel construction permits the use of a wide array of chemicals
- Polished 32Ra interior and exterior surface finish
- Custom drilling upon request
- Suitable for cleaning tanks up to 13' (4 m) in diameter



TankJet 63225-3A
Fixed Spray Balls

SPRAY COVERAGE



A = 180° Up, B = 180° Down, E = 360°

PRODUCT VIDEO

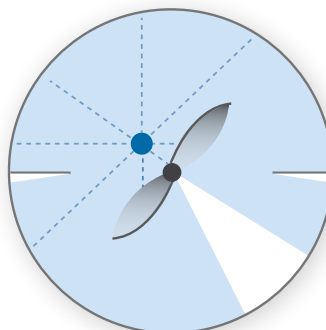
To view a video of the new TankJet 63225 spray ball in operation, [click here](#) ▶



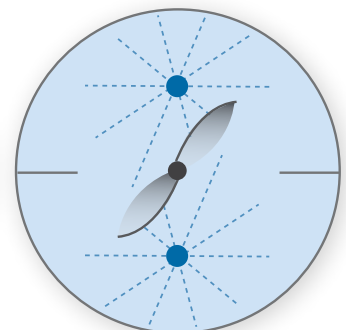
SPRAY TIP: ELIMINATE SHADOWING WITH MULTIPLE SPRAY NOZZLES

Obstructions in the vessel such as agitators or baffles can cause "shadowing" – areas where the spray cannot reach – greatly reducing the cleaning efficacy of a single spray ball. In these cases, two or more nozzles may be required to effectively clean the entire vessel.

Top-Down View of Vessel



Single Spray Ball
(Shadowing Shown in White)



Two Spray Balls
(No Shadowing)



DIMENSIONS — TANKJET® 63225-3A FIXED SPRAY BALLS

	Nozzle Type/Size	Inlet Tube Size A	Ball dia. B in. (mm)	C in. (mm)	D in. (mm)	E in. (mm)	Pin dia. F in. (mm)
	63225E-.75-1.5-40-3A	0.75"	1-1/2 (38.1)	2-17/32 (64.3)	3/8 (9.5)	1/4 (6.4)	9/64 (3.6)
	63225E-A-2-40-3A	1"	2 (50.8)	3-5/16 (84.1)	3/8 (9.5)	3/8 (9.5)	9/64 (3.6)
	63225A-1.5-2.5-40-3A	1.5"	2-1/2 (63.5)	4-1/4 (108)	1/4 (6.4)	3/4 (19.1)	13/64 (5.2)

PERFORMANCE DATA

Nozzle Type/Size	Capacity gpm (l/min)			Max. Tank Dia. ft. (m)
	15 psi (1.0 bar)	25 psi (1.7 bar)	40 psi (3.0 bar)	
63225E-.75-1.5-40-3A	31 (115)	40 (151)	51 (192)	10 (3.0)
63225E-A-2-40-3A	31 (115)	40 (151)	51 (192)	13 (4.0)
63225A-1.5-2.5-40-3A	31 (115)	40 (151)	51 (192)	13 (4.0)

ORDERING INFORMATION — TANKJET® 63225-3A FIXED SPRAY BALLS

To order, specify nozzle and coverage type, inlet tube size, ball diameter, and capacity.

Example

Nozzle Type	Coverage Type	—	Inlet Tube Size	Ball Dia.	—	Capacity Size	—	3A (Optional)
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63225	E	—	0.75	1.5	—	40	—	3A
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TANKJET® 30473 FLUID-DRIVEN ROTARY NOZZLES

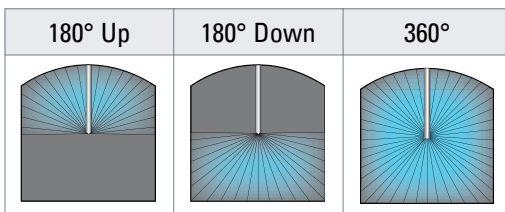
PRODUCT OVERVIEW

30473 Mini-Spinner Nozzles are cost-effective, fluid-driven rotary nozzles designed to effectively clean and rinse small vessels for pharmaceutical and biopharmaceutical applications.

FEATURES AND BENEFITS

- Effective cleaning and rinsing of tanks up to 3' (0.91 m) in diameter
- For low flow/pressure applications
- Self-lubricated with cleaning fluid and self-draining
- Rotating spray head can be easily removed for inspection and maintenance
- USP Class VI components are manufactured using material stock produced with USP Class VI resins; available with USP Class VI Viton O-ring
- Data package includes material test reports for 316L stainless materials

SPRAY COVERAGE



A = 180° Up, B = 180° Down, E = 360°

CUSTOM CIP WAND CONFIGURATION AVAILABLE

The 30473 Mini-Spinner nozzles are also available as part of a customizable CIP wand configuration. For more information on custom-fabricated wands, [click here ►](#)

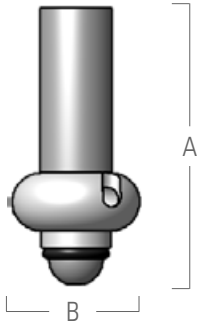


PRODUCT VIDEO

To view a video of the TankJet 30473 rotary nozzle in operation, [click here ►](#)



DIMENSIONS — TANKJET® 30473 FLUID-DRIVEN ROTARY NOZZLES

	Nozzle No.	A	B Dia.	Weight
	30473-1/4-TEF	1.75 in (44.4 mm)	.87 in (22 mm)	0.5 oz
	30473-3/8-316STF	1.90 in (48.3 mm)	.87 in (22 mm)	1.7 oz
	30473-BW	1.90 in (48.3 mm)	.87 in (22 mm)	1.0 oz

PERFORMANCE DATA

Capacity gpm					Capacity l/min				
10 psi	20 psi	30 psi	40 psi	50 psi	0.7 bar	1.5 bar	2.0 bar	3.0 bar	3.4 bar
2.1	2.9	3.5	4.0	4.5	7.8	11.3	13.0	15.0	17.0

ORDERING INFORMATION — TANKJET® 30473 FLUID-DRIVEN ROTARY NOZZLES

To order, specify nozzle type, spray pattern, inlet connection, and material code (see configuration options).

Example

Inlet Type*	Nozzle Type	—	Spray Coverage	—	Conn. Type	—	Material Code
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*Add B for BSPT connections, leave blank for NPT connections

—	30473	—	B	—	BW	—	SSTEF6
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CONFIGURATION OPTIONS

Non-Metallic	TEF (TEFLON) or TEFUSP (USP Class VI TEFLON)
Metallic/ Non-Metallic	316STF (316SS / TEFLON) or SSTEF6 (316L / USP Class VI Teflon)

Material Code

TEF= TEFLON®

TEFUSP= USP Class VI TEFLON®

316SS= 316 stainless steel

316L= 316L stainless steel



TANKJET® 28500 FLUID-DRIVEN ROTARY NOZZLES

PRODUCT OVERVIEW

TankJet 28500 fluid-driven tank cleaning nozzles are constructed of durable, non-metallic materials and are ideal for use in CIP systems as well as other sanitary vessel cleaning applications.

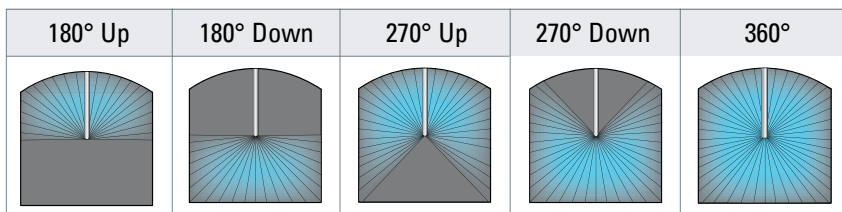
FEATURES AND BENEFITS

- Ideal for cleaning tanks, vessels and containers up to 18' (5.5 m) in diameter
- Threadless and tapered design promotes self-draining to prevent nozzle build-up
- Conforms to 3A sanitary standard 78-01 for spray cleaning devices to remain in place (does not apply to 180° spraying up coverage or 28500-R-3/4-8-TEF)
- 28500R has a rotating spray head that can be removed from the body for inspection and maintenance
- PTFE components manufactured using material stock produced with USP Class VI resins; available with USP Class VI Viton O-ring
- Data package available



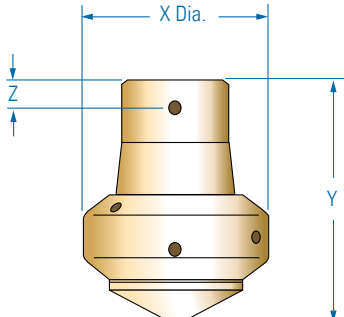
TankJet 28500
Fluid-Driven Rotary Nozzles

SPRAY COVERAGE



A = 180° Up, B = 180° Down, C = 270° Up, D = 270° Down, E = 360°

DIMENSIONS — TANKJET® 28500 FLUID-DRIVEN ROTARY NOZZLES

	Nozzle Inlet ID	Inlet Dia.	X Dia.	Y	Z
	3/4"-8	.76"	1.94 (49.3)	2.50 (63.5)	0.375 (9.5)
	3/4"	.76"	2.25 (57.2)	2.625 (66.6)	0.375 (9.5)
	DN20	22.2 mm	2.25 (57.2)	2.625 (66.6)	0.375 (9.5)
	1"	1.02"	2.75 (69.8)	2.875 (73.0)	0.5 (12.7)
	DN25	28.2 mm	2.75 (69.8)	2.875 (73.0)	0.5 (12.7)
	1-1/2"	1.52"	3.625 (92.0)	3.625 (92.0)	0.75 (19.0)
	DN40	40.2 mm	3.625 (92.0)	3.625 (92.0)	0.75 (19.0)

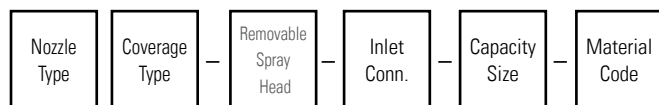
PERFORMANCE DATA

Nozzle No.	Orifice Dia. in. (mm)	Capacity gpm (l/min)				
		10 psi (0.7 bar)	20 psi (1.5 bar)	30 psi (2 bar)	40 psi (3 bar)	50 psi (3.5 bar)
28500 (A - E)-3/4-8-TEF	0.093 (2.4)	4.0 (15.1)	5.7 (21.6)	6.9 (26.1)	8.0 (30.3)	8.9 (33.7)
28500 (A - E)-3/4-18-TEF	0.089 (2.3)	9.0 (34.0)	12.7 (50.0)	15.6 (58.0)	18.0 (71.0)	20.1 (77)
28500 (A - E)-DN20-18-TEF	0.089 (2.3)	9.0 (34.0)	12.7 (50.0)	15.6 (58.0)	18.0 (71.0)	20.1 (77)
28500 (A - E)-3/4-23-TEF	0.110 (2.8)	11.5 (44.0)	16.3 (60.0)	19.9 (74.0)	23.0 (91.0)	26.0 (99.0)
28500 (A - E)-DN20-23-TEF	0.110 (2.8)	11.5 (44.0)	16.3 (60.0)	19.9 (74.0)	23.0 (91.0)	26.0 (99.0)
28500 (A - E)-3/4-32-TEF	0.154 (3.9)	16.0 (61.0)	22.6 (89.0)	27.7 (103.0)	32.0 (126.0)	35.8 (136.0)
28500 (A - E)-DN20-32-TEF	0.154 (3.9)	16.0 (61.0)	22.6 (89.0)	27.7 (103.0)	32.0 (126.0)	35.8 (136.0)
28500 (A - E)-3/4-46-TEF	0.257 (6.5)	23.0 (88.0)	32.5 (128.0)	39.8 (148.0)	46.0 (181.0)	51.4 (196.0)
28500 (A - E)-DN20-46-TEF	0.257 (6.5)	23.0 (88.0)	32.5 (128.0)	39.8 (148.0)	46.0 (181.0)	51.4 (196.0)
28500 (A - E)-1-33-TEF	0.152 (3.9)	16.5 (63.0)	23.0 (92.0)	29.0 (106.0)	33.0 (131.0)	37.0 (141.0)
28500 (A - E)-DN25-33-TEF	0.152 (3.9)	16.5 (63.0)	23.0 (92.0)	29.0 (106.0)	33.0 (131.0)	37.0 (141.0)
28500 (A - E)-1-50-TEF	0.209 (5.3)	25.0 (95.0)	35.4 (140.0)	43.3 (161.0)	50.0 (197.0)	55.9 (213.0)
28500 (A - E)-DN25-50-TEF	0.209 (5.3)	25.0 (95.0)	35.4 (140.0)	43.3 (161.0)	50.0 (197.0)	55.9 (213.0)
28500 (A - E)-1-70-TEF	0.266 (6.8)	35.0 (133.0)	49.5 (195.0)	60.6 (226.0)	70.0 (276.0)	78.3 (298.0)
28500 (A - E)-DN25-70-TEF	0.266 (6.8)	35.0 (133.0)	49.5 (195.0)	60.6 (226.0)	70.0 (276.0)	78.3 (298.0)
28500 (A - E)-1-1/2-53-TEF	0.201 (5.1)	27.0 (101.0)	37.0 (148.0)	46.0 (171.0)	53.0 (209.0)	59.0 (226.0)
28500 (A - E)-DN40-53-TEF	0.201 (5.1)	27.0 (101.0)	37.0 (148.0)	46.0 (171.0)	53.0 (209.0)	59.0 (226.0)
28500 (A - E)-1-1/2-70-TEF	0.266 (6.8)	35.0 (132.0)	49.0 (185.0)	61.0 (231.0)	70.0 (265.0)	78.0 (295.0)
28500 (A - E)-DN40-70-TEF	0.266 (6.8)	35.0 (132.0)	49.0 (185.0)	61.0 (231.0)	70.0 (265.0)	78.0 (295.0)

ORDERING INFORMATION — TANKJET® 28500 FLUID-DRIVEN ROTARY NOZZLES

To order, specify nozzle and coverage type, R for removable spray head (optional), inlet connection, and capacity size.

Example



INTEGRATED LANCES AVAILABLE

The 28500 is also available as an integrated PTFE wand for CIP applications. For more information on custom - fabricated wands, [click here](#) ►



REVOJET® FLUID-DRIVEN ROTARY NOZZLE**PRODUCT OVERVIEW**

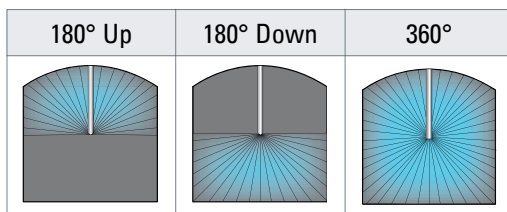
RevoJet® rotary vessel cleaning nozzles provide high-impact, low volume cleaning of large vessels and reactors with difficult-to-remove residues.

FEATURES AND BENEFITS

- Liquid-driven rotary nozzle device uses proprietary internal turbine geometry to ensure consistent rotation
- Eight capacity sizes to match performance to vessel size
- Available in NPT and BSPT, can be quoted with slip-joint connection
- Materials of construction: 316SS with PEEK bearings
- #300 electropolished exterior surfaces



RevoJet Fluid-Driven
Rotary Nozzle

SPRAY COVERAGE

A = 180° Up, B = 180° Down, E = 360°

PRODUCT VIDEO

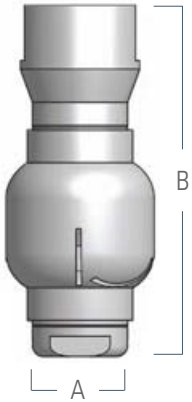
To view a video of the RevoJet rotary nozzle in operation, [click here](#) ►

**SPRAY TIP: CHOOSE FROM EIGHT DIFFERENT SIZES TO SUIT ANY APPLICATION**

Available in eight different capacity sizes and three spray patterns, the RevoJet fluid-driven rotary nozzle is a versatile solution for many different hygienic vessel cleaning and CIP applications.



DIMENSIONS — REVOJET® FLUID-DRIVEN ROTARY NOZZLES

	Nozzle Number/ Capacity Size	Pipe Conn. in. (mm)	A in. (mm)	B in. (mm)
	ECRV-316SS1.7	.125 (3.2)	.63 (16)	1.50 (38)
	ECRV-316SS2.9	.125 (3.2)	.79 (20)	2.09 (53)
	ECRV-316SS4.5	.25 (6.4)	.98 (25)	2.68 (68)
	ECRV-316SS6.9	.375 (9.5)	1.18 (30)	3.82 (97)
	ECRV-316SS9.2	.375 (9.5)	1.18 (30)	4.53 (115)
	ECRV-316SS15	.5 (12.7)	1.63 (41.5)	4.84 (123)
	ECRV-316SS32	.75 (19.1)	2.36 (60)	5.47 (139)
	ECRV-316SS44	1.0 (25.4)	2.95 (75)	6.42 (163)

PERFORMANCE DATA

Pressure	GPM (LPM)							
PSI (Bar)	Capacity 1.7	Capacity 2.9	Capacity 4.5	Capacity 6.9	Capacity 9.2	Capacity 15	Capacity 32	Capacity 44
14.5 (1.0)	1.3 (4.9)	1.9 (7.5)	2.1 (8.0)	4.8 (18.0)	6.2 (23.5)	10.6 (40.0)	22.2 (84.0)	31.7 (120)
29.0 (2.0)	1.7 (6.5)	2.8 (10.5)	4.5 (17.2)	6.9 (26.0)	8.9 (34.0)	15.5 (58.5)	32.5 (123)	44.4 (168)
43.5 (3.0)	2.1 (8.0)	3.4 (13.0)	5.8 (22.0)	8.0 (30.5)	10.8 (41.0)	19.0 (72.0)	37.8 (143)	53.6 (203)
58.0 (4.0)	2.4 (9.0)	3.9 (15.0)	6.5 (25.0)	9.2 (35.0)	12.7 (48.0)	21.1 (80.0)	43.9 (166)	62.9 (238)
72.5 (5.0)	2.6 (10.0)	4.4 (16.5)	7.4 (28.0)	10.2 (38.5)	14.0 (53.0)	24.3 (92.0)	48.1 (182)	69.2 (262)
87.0 (6.0)	3.0 (11.5)	4.8 (18.0)	8.0 (30.5)	11.2 (42.5)	15.5 (58.5)	26.4 (100)	53.1 (202)	76.1 (288)
102 (7.0)	3.2 (12.0)	5.2 (19.5)	8.7 (33.0)	12.0 (44.5)	16.6 (63.0)	28.5 (108)	58.1 (220)	82.4 (312)
116 (8.0)	3.4 (13.0)	5.5 (21.0)	9.4 (35.5)	12.9 (49.0)	17.7 (67.0)	31.2 (118)	62.1 (235)	88.5 (335)
131 (9.0)	3.7 (14.0)	5.8 (22.0)	9.9 (37.5)	13.7 (52.0)	18.8 (71.0)	31.7 (120)	65.5 (248)	93.8 (355)
145 (10.0)	3.8 (14.5)	6.3 (24.0)	10.4 (39.5)	14.4 (54.5)	19.8 (75.0)	34.3 (130)	68.7 (260)	98.5 (373)

ORDERING INFORMATION — REVOJET® FLUID-DRIVEN ROTARY NOZZLES

To order, specify nozzle type, pinned or threaded connection, materials, spray coverage, and capacity.

Example

Blank=NPT B=BSPT	Nozzle Type	Conn. Type*	Material Code	Coverage Type	Capacity Size
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*Blank = threaded, P = pinned

—	ECRV	—	P	—	316SS	—	B	—	4.5
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TANKJET® 14 & TANKJET® 19 FLUID-DRIVEN ROTARY NOZZLES

PRODUCT OVERVIEW

TankJet 14 fluid-driven tank cleaning nozzles are dynamic, rotary devices which provide more efficient cleaning than comparable, static spray balls for tanks up to 12' (3.6m) in diameter.

TankJet 19 fluid-driven tank cleaning nozzles are dynamic, rotary devices with a slim, sleek design ideal for cleaning tanks with small openings or ports.

FEATURES AND BENEFITS

- Similar design and appearance to static spray balls; unit rotates to ensure effective impingement of cleaning solution on tank walls (TankJet 14 only)
- Solid stream pattern provides full coverage (TankJet 14 only)
- Spray head is easily removed for inspection and maintenance (TankJet 14 only)
- Fits in tank openings as small as 2" (51mm) with 7/8" (22mm) probe for even smaller openings (TankJet 19 only)
- Sleek design helps prevent residue buildup and simplifies maintenance (TankJet 19 only)
- Carefully drilled solid stream orifices are strategically placed to provide four different spray coverages (TankJet 19 only)
- Mount vertically, horizontally or at any angle (TankJet 19 only)
- Fluid-driven unit rotates at slow speeds – 3 to 15 rpm – for increased dwell time on tank surface compared to free-spinning units (TankJet 14 and 19)
- Suitable for CIP or portable installation (TankJet 14 and 19)
- Made of 316 stainless steel and PTFE materials (TankJet 14 and 19)

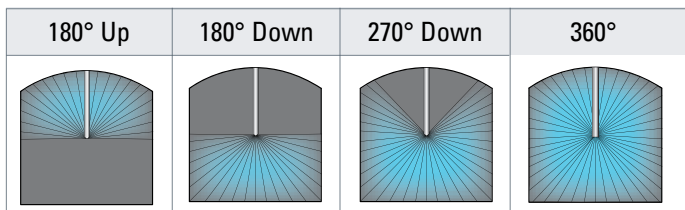


TankJet 14
Fluid-Driven Rotary Nozzle



TankJet 19
Fluid-Driven Rotary Nozzle

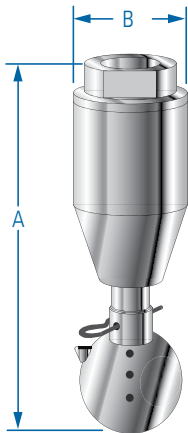
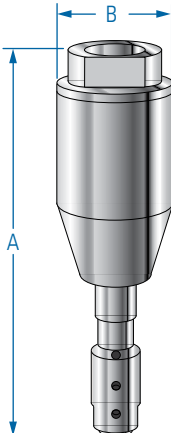
SPRAY COVERAGE



A = 180° Up, B = 180° Down, D = 270° Down, E = 360°



DIMENSIONS — TANKJET® 14 & TANKJET® 19 FLUID-DRIVEN ROTARY NOZZLES

TankJet 14		TankJet 19				
				Nozzle Type	A in. (mm)	B in. (mm)
				TankJet 14	6.56 (167)	1.97 (50)
				TankJet 19	6.65 (169)	1.97 (50)

PERFORMANCE DATA

Model No.	Spray Coverage	Capacity gpm (l/min)								
		50 psi (3.4 bar)	70 psi (4.8 bar)	90 psi (6.2 bar)	100 psi (6.9 bar)	120 psi (8.3 bar)	140 psi (9.7 bar)	160 psi (11.0 bar)	180 psi (12.4 bar)	200 psi (13.8 bar)
TJ-14	D	13.0 (49.0)	16.0 (61.0)	18.0 (68.0)	19.5 (74.0)	21.0 (79.0)	23.0 (87.0)	25.0 (93.0)	27.0 (100)	28.0 (106)
	A, B	16.0 (61.0)	18.5 (70.0)	21.0 (79.0)	23.0 (87.0)	24 (91.0)	26.0 (98.0)	28.0 (106)	30.0 (114)	32.0 (121)
	E	17.0 (64.0)	19.5 (74.0)	22.0 (83.0)	25.0 (93.0)	26.0 (98.0)	28.0 (104)	30.0 (112)	32.0 (121)	34.0 (129)
TJ-19	A	10.0 (38.0)	13.0 (49.0)	15.0 (57.0)	16.0 (61.0)	18.0 (68.0)	19.5 (74.0)	21.0 (79.0)	22.5 (85.0)	24.0 (91.0)
	B	12.0 (45.0)	14.0 (53.0)	16.5 (62.0)	17.5 (66.0)	19.0 (72.0)	21.0 (79.0)	22.5 (85.0)	24.0 (91.0)	26.0 (98.0)
	D	16.0 (61.0)	18.0 (68.0)	20.0 (76.0)	21.0 (79.0)	22.5 (85.0)	24.0 (91.0)	26.0 (98.0)	27.5 (104)	28.5 (108)
	E	17.0 (64.0)	19.0 (72.0)	21.0 (79.0)	22.0 (83.0)	24.0 (91.0)	25.5 (97.0)	27.5 (104)	29.0 (110)	30.0 (114)

ORDERING INFORMATION — TANKJET® 14 & TANKJET® 19 FLUID-DRIVEN ROTARY NOZZLES

To order, specify model number, inlet connection type and spray coverage.

Example

Model Number	—	Inlet Type*	—	Coverage Type
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TJ14

—

E



TANKJET® D41800E REGULATED FLUID-DRIVEN ROTARY NOZZLE

PRODUCT OVERVIEW

The TankJet D41800E is a regulated, liquid-driven rotary nozzle. Its hygienic three-piece design uses patented, self-flushing liquid hydraulic bearings, eliminating the need for traditional bearings with races and reducing the downtime required for cleaning and maintenance.

FEATURES AND BENEFITS

- Cleans, rinses and sanitizes medium-size tanks up to 12' (3.7 m) in diameter
- Material of construction is 316L, clip material is 316SS
- Operating pressure range: 30 psi (2 Bar) to 174 psi (12 Bar), maximum operating temperature: 300° F (150° C)
- Internal and external surface finish is 20µin. Ra (0.5 micron) with electropolish
- Operates within a narrow speed range (2-30 rpm) over its entire operating pressure range
- The increase in impact of up to four times higher than a conventional rotating nozzle means cleaning efficiency is improved through minimized fluid consumption
- USP Class VI EPDM O-ring available



TankJet D41800E Regulated
Fluid-Driven Rotary Nozzle

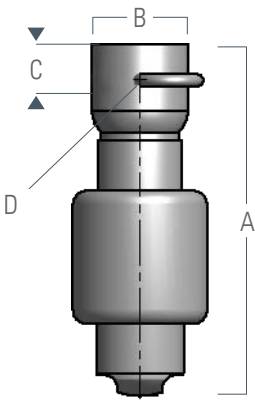
SPRAY TIP: USE LARGER CAPACITY SIZES FOR HIGHER-IMPACT CLEANING IN CIP/WIP SYSTEMS

The MiniRokon™ regulated fluid-driven nozzle is available in four capacity sizes and is ideally suited for CIP/WIP applications with stringent cleaning requirements.

For more information on CIP/WIP solutions, [click here](#) ►



DIMENSIONS — TANKJET® D41800E FLUID-DRIVEN ROTARY NOZZLES

	Nozzle Type	Inlet Conn.	A in. (mm)	B dia. in. (mm)	C dia. in. (mm)	D dia. in. (mm)	Weight lbs. (kg)
	D41800E	0.75"	3.22 (81.8)	1-3/16 (30.0)	0.85 (22.0)	0.94 (2.4)	0.28 (0.13)
		DN19	3-7/32 (82.0)	1-3/16 (30.0)	27/32 (21.0)	.094 (2.4)	0.29 (0.13)

PERFORMANCE DATA

Capacity Size	Capacity gpm (l/min)				
	30 psi (2 bar)	40 psi (3 bar)	100 psi (5 bar)	150 psi (10 bar)	230 psi (16 bar)
3.2	2.9 (10.8)	3.5 (14.0)	5.3 (17.0)	6.5 (24.0)	7.9 (30.0)
4.5	4.0 (15.1)	4.8 (19.0)	7.5 (24.0)	9.1 (34.0)	11.3 (43.0)
9.9	8.8 (33.2)	10.1 (40.0)	16.1 (52.0)	19.7 (73.0)	24.0 (93.0)
13.6	12.1 (45.7)	14.0 (55.0)	22.0 (71.0)	27.0 (101.0)	34.0 (128.0)

ORDERING INFORMATION — TANKJET® D41800E FLUID-DRIVEN ROTARY NOZZLES

To order, specify nozzle type, inlet connection, and capacity.

Example

Nozzle Type	—	Material Code	—	Capacity Size	—	Conn. Type	—	O-Ring
-------------	---	---------------	---	---------------	---	------------	---	--------

D41800

— 316L

9.9

— SJ

— FDA

DATA PACKAGE AVAILABLE

We are able to supply the following documentation as part of a data package:

- Material test reports in conformance with EN10204 Type 3.1
- Certificates of conformance for surface finish and electropolish
- Certificate of conformance for FDA EPDM O-Ring

Material Code

316L= 316L stainless steel





SPECIALTY NOZZLES

	PAGE
Ultrasonic Atomizing Nozzle and Controller	73
GunJet® Spray Guns	76
WindJet® Air Nozzles	77

ULTRASONIC ATOMIZING NOZZLE AND CONTROLLER

PRODUCT OVERVIEW

Ultrasonic atomizing nozzles use sonic vibrations to produce an extremely fine spray ideal for high-precision coatings, thin film coatings and micron coatings.

FEATURES AND BENEFITS — ULTRASONIC ATOMIZING NOZZLE

- Patent-pending nanotechnology produces superior accuracy in spray pattern formation
- Precise air-assisted round spray pattern optimizes coverage and allows adjustment of drop velocity independently from atomization
- Reduced overspray and product waste

FEATURES AND BENEFITS — ULTRASONIC SPRAY CONTROLLER

- Self-adjusting controller maintains consistent spray
- Control up to three Ultrasonic nozzles with a single controller
- Adjustable voltage, remote control/monitoring via 15 pin I/O connector
- Dimensions: 10" width x 5" height x 8" depth (254 mm x 127 mm x 203.2 mm)

OPERATING PRINCIPLES

Ultrasonic nozzles use very high-frequency vibration instead of high pressure or compressed air to produce extremely small and uniform droplets.

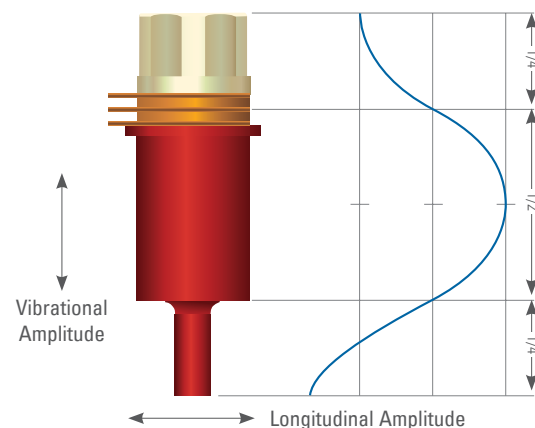
Capillary waves are produced on the surface of a liquid on a vibrating surface. During atomization, capillary waves are transformed into droplets by increasing the amplitude until the peak of the wave forms droplets. The wavelength and, subsequently the droplet size, are determined by vibration frequency. High vibration frequency generates fine droplets and low vibration frequency generates coarse droplets.

APPLICATIONS

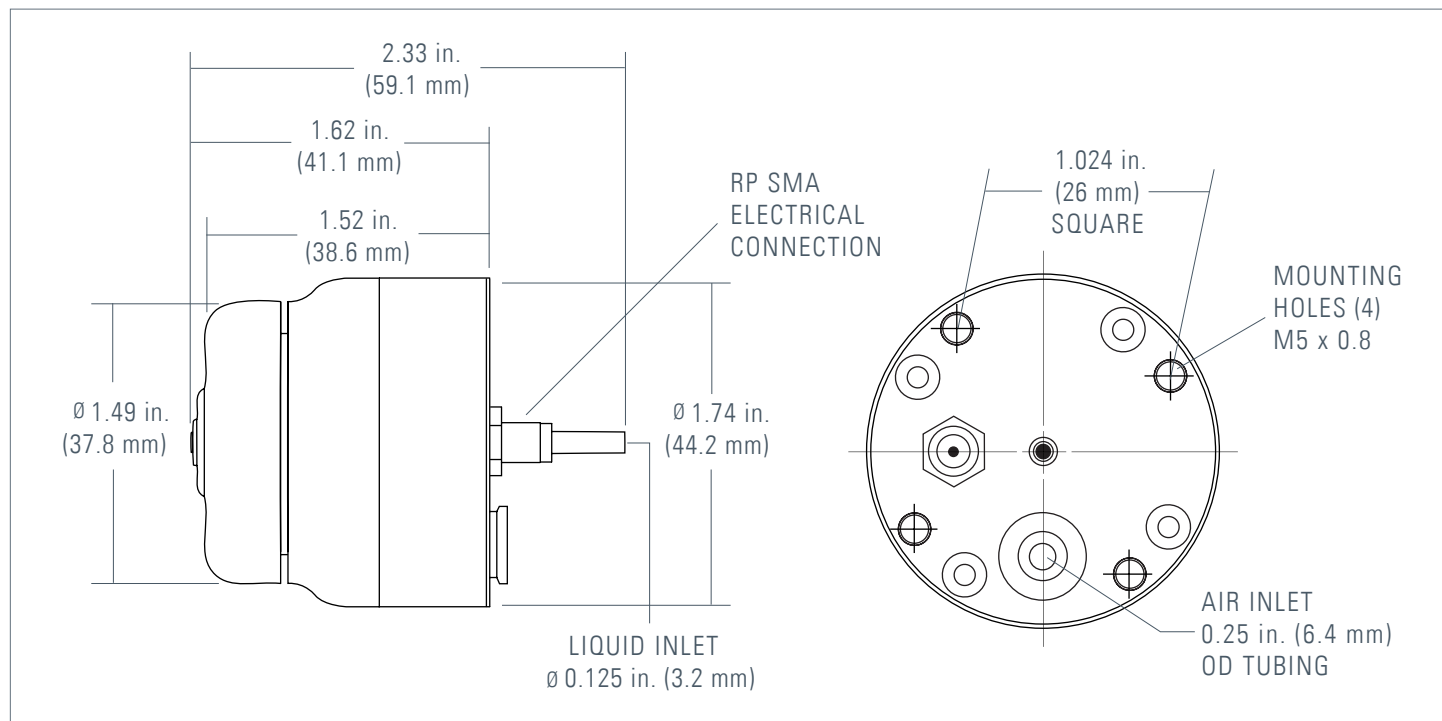
- High-Precision Coating • Spray Drying • Humidification



**ADDITIONAL
RESOURCES**
For more information
on Ultrasonic
Atomizing Nozzles,
[click here ▶](#)



DIMENSIONS — ULTRASONIC ATOMIZING NOZZLE



PERFORMANCE DATA

Air Cap	Water Flow (cc / min.)	Air Pressure (PSI)	Air Flow (SCFM)	Drop Size (Microns)				RSF**	Drop Velocity* V avg. (m / sec.)	Coverage at 2 in. / 50.8 mm Spray Height (in.)
				Dv0.1	Dv0.5	Dv0.9	D32			
ACUSN-150 (.032" / 0.8 mm Offset Orifice)	1.5	0.0	0.0	22	38	65	36	1.1	0.8	0.5
		0.5	0.32	20	30	48	30	0.9	7.1	0.8
		1.0	0.45	20	29	47	30	0.9	9.8	1.0
		3.0	0.79	20	28	46	29	0.9	11.8	1.0
	4.0	0.0	0.0	24	47	78	42	1.1	1.4	0.6
		0.5	0.32	23	40	66	37	1.1	8.1	0.9
		1.0	0.45	22	36	59	34	1.0	11.3	1.1
		3.0	0.79	21	35	60	34	1.1	14.8	1.1
	10.0	0.0	0.0	26	48	80	43	1.1	2.0	0.7
		0.5	0.32	26	48	78	43	1.1	7.3	0.9
		1.0	0.45	25	47	77	43	1.1	11.0	1.1
		3.0	0.79	25	46	77	42	1.1	16.6	1.1
ACUSN-156 (.094" / 2.4 mm Offset Orifice)	1.5	0.0	0.0	22	38	65	36	1.1	0.8	0.5
		0.5	0.32	20	31	52	31	1.0	3.3	2.3
		1.0	0.45	18	28	48	28	1.1	4.0	2.7
		3.0	0.79	17	27	44	27	1.0	6.0	3.0
	4.0	0.0	0.0	24	47	78	42	1.1	1.4	0.6
		0.5	0.32	20	34	58	33	1.1	3.8	2.4
		1.0	0.45	20	34	58	32	1.1	4.7	2.8
		3.0	0.79	19	32	54	31	1.1	7.1	3.1
	10.0	0.0	0.0	26	48	80	43	1.1	2.0	0.7
		0.5	0.32	24	48	80	43	1.1	4.9	2.4
		1.0	0.45	24	48	80	43	1.2	5.8	2.8
		3.0	0.79	22	41	71	37	1.2	9.5	3.1

*Drop velocity measured at 0.5 inches from exit orifice. **RSF - Relative Span Factor = (Dv0.9 - Dv0.1) / Dv0.5.



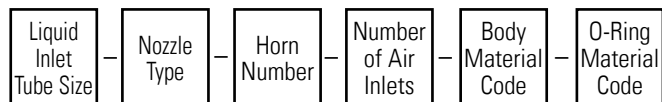
ORDERING INFORMATION — ULTRASONIC SPRAY SYSTEMS

Ultrasonic Spray Nozzles are part of a complete Ultrasonic Spray system, including nozzle(s), air cap, controller, and cables. Reference the information below to help you complete your order.

For more information, contact your local sales representative.

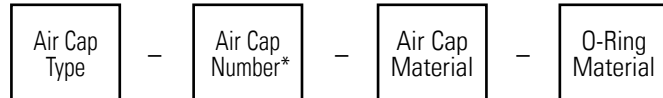
ULTRASONIC ATOMIZING NOZZLE

Example



ULTRASONIC AIR CAP

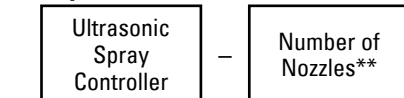
Example



*For the air cap number, use 150 for 30° full cone or 156 for 70° full cone spray.

ULTRASONIC SPRAY CONTROLLER

Example

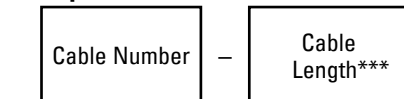


**Ultrasonic Spray Controller is available in 1 and 3-nozzle versions only.

SMA CABLE

Note: Ultrasonic Spray Controller requires an SMA cable for operation. To order, specify cable number (51274) and length.

Example



***For a 5 ft. (1.5 m) cable, use number 402. For a 10 ft. (3.0 m) cable, use number 403.

Material Code

316SS = 316SS Stainless Steel

VIF = FDA VITON

EPF = FDA EPDM



GUNJET® SPRAY GUNS

PRODUCT OVERVIEW

GunJet spray guns are the ideal choice for clean-up, rinsing and blow-off applications in many industries. Options range from a gentle spray to a high-impact solid stream.

FEATURES AND BENEFITS

- Interchangeable spray caps
- Adjustable spray patterns – solid stream to 50° hollow cone
- Corrosion resistant
- Available in aluminum



GunJet 60-21580

GunJet CU150

SPECIFICATIONS

Model	Pressure (psi)	Capacity (gpm)	Temp. °F (°C)	Inlet Conn.	Length	Width	Height	Weight
CU150	150	10-22	200 (93)	1/2" NPT or BSPT	6.5 in.	2.25 in.	6.5 in.	36 oz.
60-21580	250	16	300 (150)	3/8" NPT or BSPT	9.0625 in.	1.44 in.	6.5 in.	19.25 oz.

ORDERING INFORMATION

To order, specify model number, material code (AL for aluminum, blank for rubber) and capacity size.

Example

Model
NumberMaterial
CodeCapacity
(gpm)

CU150

AL

22

APPLICATIONS

- Cleaning of Tablet Coating Pans
- Drying/Blow-Off
- Low-Pressure Cleaning
- Spot Application of Chemicals



WINDJET® AIR NOZZLES

PRODUCT OVERVIEW

WindJet air nozzles can help you improve performance, reduce noise and save on air costs in drying, cooling and coating applications.

FEATURES AND BENEFITS

- Generates a quiet, efficient, controlled flat fan distribution of compressed air
- Air stream is discharged through 16 precision orifices that ensure uniform distribution and spray pattern integrity
- Recessed orifices protect against external damage and provide an air escape should the nozzle accidentally be placed against a flat surface
- Convenient mounting hole ensures correct position on the header or manifold for fixed applications
- Available in stainless steel, ABS (acrylonitrile butadiene styrene) and PPS (polyphenylene sulfide) versions



WindJet AA707



WindJet AA727

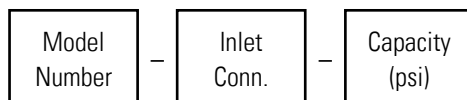
SPECIFICATIONS

Nozzle Type	Capacity Sizes	Inlet Conn.	Length	Width	Weight
AA727 (M)	11, 15, 23	1/4" (M)	3-9/16" (91 mm)	2" (51 mm)	4.1 oz. (0.12 kg)
AA727-F (F)	11, 15, 23	1/4" (F)	3-9/16" (91 mm)	2" (51 mm)	0.7 oz. (0.02 kg)
AA707 (M)	11, 15, 23	1/4" (M)	1-7/8" (91 mm)	1" (51 mm)	1.6 oz. (0.04 kg)

ORDERING INFORMATION

To order, specify model number, inlet connection and capacity size.

Example



AA727

1/4

11

APPLICATIONS

- Dust and Particle Blow-Off
- Leveling Coatings
- General Drying
- Cooling





SOLID DOSAGE PROCESSING

	PAGE
Application Overview	79
Fluid Air, a Division of Spraying Systems	80
Fluid Bed Systems	81
High-Shear Granulators	83
Size-Reduction Systems	85
Control Options and More	87

PERFECTING THE PROCESS

In the pharmaceutical industry, a solid dose is a dosage form, such as a tablet or capsule or powder which is ingested orally and generally consists of a mixture of active pharmaceutical ingredients (or APIs), the drugs being delivered) along with a combination of binders, fillers and other excipients designed to imbue the finished drug with specific characteristics. Processing methods for individual pharmaceutical drugs can vary widely depending on the type or types of drugs being manufactured, the dosage form (solid dosage vs. liquid) the intended route of administration, and the necessary duration of the API's release into the human body to achieve the pharmacological effects of the drug.

Two solid dosage forms, tablets and capsules, are among the most common drug dosage forms for consumers. Formulating the fill for capsules is generally easier than for tablets, but they are both manufactured using similar processes.

ADDITIONAL RESOURCES

For more information on equipment for solid dosage processing, [click here](#) ►





Experts in Solid Dosage Technology

A Division of *Spraying Systems Co.*®

MAGNAFLO® Fluid Bed Systems



PHARMX® High-Shear Granulators



GRANUMILL® Size Reduction Systems



FLUID AIR, A DIVISION OF SPRAYING SYSTEMS CO.®

Fluid Air is a division of Spraying Systems Co. specializing in solid dosage processing equipment for the pharmaceutical industry, including fluid bed dryers/granulators, Wurster coaters, high-shear granulators, size reduction systems and process control software for batch-type equipment.

Available in a full range of sizes from R&D to production scale, Fluid Air systems are designed to provide superior performance and batch uniformity for solid dosage processing applications while maintaining important process parameters from one size system to the next, making it easy for users to predict scale-up results. Configurable with a wide variety of optional features, each system is completely customizable to fit your exact specifications and process requirements, ensuring the perfect fit--no matter how challenging the application.

ADDITIONAL RESOURCES

For more information
on Fluid Air systems,
[click here](#) ▶



MAGNAFLO® & MAGNACOATER FLUID BED SYSTEMS

PRODUCT OVERVIEW

MAGNAFLO fluid bed dryer/granulators and MAGNACOATER Wurster coaters are completely customizable fluid bed systems designed to provide superior performance for solid dosage processing applications from R&D to production scale.

FEATURES AND BENEFITS

- Tapered expansion chamber improves granulation and reduces process time
- Agitator rake in bowl bottom ensures bed homogeneity
- Conidur and Turboflo bed plates provide uniform air distribution
- Specific geometry maintains critical scale-up factors
- Adjustable “shutter” plate allows for precise, user-controlled coating (MAGNACOATER Only)

Phase 1:
R&D Scale



Phase 2:
Pilot Scale



Phase 3:
Production Scale



ADDITIONAL RESOURCES

For more information
on fluid bed systems,
[click here ►](#)

PRODUCT VIDEO

To view a video of an
R&D scale fluid bed in
operation, [click here ►](#)



SPRAY TIP: IMPROVE WURSTER COATING RESULTS WITH MAGNACOATER SYSTEMS

Wurster coating in multi-partition fluid beds requires that each coating partition receive the proper volume and velocity of process air. An imbalance can lead to poor results, potentially even the loss of an entire batch. Fluid Air MAGNACOATER systems are equipped with multi-partition air balancing systems to ensure proper air flow is maintained throughout the coating process.



SPECIFICATIONS — MAGNAFLO® & MAGNACOATER® FLUID BED SYSTEMS

Model Number	0002	0005	0020	0050	0100	0120	0300	0500	0650	0800	1000	1200
Standard bowl volume (L)	2.0	13	46	57	97	148	346	617	797	967	1205	1437
Max. granulating capacity (L)	2	10	34	51	87	133	311	555	717	870	1084	1293
Max. coating capacity (L)	1.8	6	31	46	77	124	193	477	613	720	n/a	n/a
Extended bowl volume (L)	*	*	n/a	n/a	n/a	207	482	860	1110	1346	1645	1961
Reduced volume bowls (L)	0.5	2	5	5, 46	46, 57	46, 57, 97	148	346	n/a	n/a	n/a	n/a
System height (inches/mm)	72/ 1829	74/ 1880	80/ 2032	**	126/ 3200	138/ 3505	160/ 4064	148/ 3670	172/ 4369	174/ 4420	185/ 4699	192/ 4877
System width (inches/mm)	32/ 813	76/ 1930	78/ 1981	32/ 812	36/ 914	46/ 1168	72/ 1829	84/ 2134	90/ 2286	96/ 2538	105/ 2667	114/ 2896

ORDERING INFORMATION

For in-depth information on product components, features, and available options, click on the documents below to view the specification sheets. Use these forms to describe your specific requirements and then submit to your local sales representative.

R&D Scale MAGNAFLO / MAGNACOATER Systems [click here ►](#)

Pilot Scale MAGNAFLO / MAGNACOATER Systems [click here ►](#)

Production Scale MAGNAFLO / MAGNACOATER Systems (Coming Soon)



PHARMX® HIGH-SHEAR GRANULATORS**PRODUCT OVERVIEW**

PHARMX high-shear granulators are fully customizable bottom-driven mixing systems engineered to provide homogeneous mixing and efficient granulation across a range of available R&D, pilot, and production size models.

FEATURES AND BENEFITS

- Optimized bowl geometry allows for efficient mixing at up to 90% capacity
- Hydraulic drive system
- Bottom-driven mixing impeller and high-speed chopper ensure uniform mixing
- One-pot processing models available (mixing/drying)
- Water jacketing, vacuum loading/drying and nitrogen inerting options

**SPRAY TIP: PROCESS HAZARDOUS COMPOUNDS SAFELY WITH INTERCHANGEABLE BOWLS**

For processing potent compounds requiring total containment, we are able to provide customized interchangeable bowls. The bowls can be removed from the console and placed in a glove box / flexible containment structure without any dusting of product from the bowl. Charging and discharging from the mixer bowl is completely contained.



SPECIFICATIONS — PHARMX® HIGH-SHEAR GRANULATORS

Model Number	PX1	PX25	PX50	PX100	PX150	PX250	PX400	PX600	PX800	PX1000	PX1250
Total bowl volume (L)	1, 2, 4, 6, 8.4	31	58	119	167	274	432	633	864	1050	1286
Charge- max. liters @ light bulk, 0.3 - 0.5	0.9 - 7.5	28	58	107	150	246	389	569	778	945	1157
Charge- min. liters	0.3 - 2.5	8	15	30	42	69	109	159	218	265	324
Impeller speed range (RPM)	5 - 1107	37 - 318	29 - 260	14 - 205	12 - 185	10 - 172	1 - 148	1 - 127	1 - 118	1 - 110	1 - 103
Impeller power (HP)	0.5 - 1	3	5	10	15	40	50	75	100	125	150
Chopper speed range (RPM)	1500 - 9750	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600	500 - 3600
Chopper power (HP)	0.25	1	2	5	7.5	10	15	20	25	30	40

ORDERING INFORMATION

For in-depth information on product components, features, and available options, click on the documents below to view the specification sheets. Use these forms to describe your specific requirements and then submit to your local sales representative.

R&D Scale PHARMX Systems [click here ►](#)

Pilot Scale PHARMX Systems [click here ►](#)

Production Scale PHARMX Systems (Coming Soon)



GRANUMILL® SIZE REDUCTION SYSTEMS

PRODUCT OVERVIEW

GRANUMILL size reduction systems are wet and dry mill systems designed for precision particle size reduction and de-agglomeration applications, available in R&D, pilot, and production scale sizes.

FEATURES AND BENEFITS

- Variable speed rotor allows for both high-speed fine grinding and low speed de-agglomeration
- Quick-release housing allows mill to be broken down in minutes for cleaning or inspection
- Robust rotor design available in three different shapes – square/flat, round, and knife
- One-pot processing models available (mixing/drying)
- Quiet operation
- Multiple feed and discharge options available to suit your process



SPRAY TIP: SAVE TIME AND MONEY WITH FLEXIBLE CONTAINMENT ENCLOSURES

In cooperation with ILC-Dover, we are able to provide custom-designed, flexible containment systems for GRANUMILL Jr. size reduction systems. The Flexible enclosure set-up allows for use in both containment and non-containment applications, eliminating the need to purchase a second machine solely for containment use.

For more information on flexible containment systems, [click here](#) ►



SPECIFICATIONS — GRANUMILL® SIZE REDUCTION SYSTEMS

Model Number	GRANUMILL Jr.*	GRANUMILL 007*	GRANUMILL 014*
Speed (RPM)	500 - 10000	500 - 5000	600 - 3600
Finished particle size mesh (micron)	10 - 400 (2000 - 27)	10 - 400 (2000 - 27)	10 - 400 (2000 - 27)
Throughput (lbs/kg)/hour	0.2 - 60 / 0.1 - 25	2 - 2250 / 1 - 1000	4 - 3860 / 2 - 1750
System Height (inches/mm)	25 - 635	80 / 2032	80 / 2032
System Width (inches/mm)	12 / 304	32 / 813	40 / 1016
System Length (inches/mm)	15 / 381	60 / 1524	68 / 1727
Screen Width (inches/mm)	4 / 102	7 / 178	14 / 356

ORDERING INFORMATION

For in-depth information on product components, features, and available options, click on the documents below to view the specification sheets. Use these forms to describe your specific requirements and then submit to your local sales representative.

GRANUMILL Jr. (R&D Scale) Systems [click here ►](#)

Pilot / Production Scale GRANUMILL Systems [click here ►](#)



BATCH ARCHITECT™ PROCESS CONTROL SOFTWARE

PRODUCT OVERVIEW

Fluid Air systems run on Batch Architect process control software, a flexible solution for controlling virtually any batch-type equipment. The easy-to-use software allows users to control complex pharmaceutical processing equipment with little to no training, and is available in either standard or Pro versions.

FEATURES AND BENEFITS

- Provides direct access to manual machine control and optional features for increased automation
- Equipped with a graphical user interface (GUI) which provides current status information of critical machine functions through animation and text
- Runs on FactoryTalk® HMI platform and Allen-Bradley Logix™ series processors
- Recipe control feature allows batches to be easily created, stored, and reproduced
- 21 CFR Part 11 Capability (Pro Version Only)
- Offers convenient electronic batch record data logging and report creation services
- Increased product lifecycle through virtualization technology



Batch Architect™ Pro Status Screen

ADDITIONAL RESOURCES

For more information on process control software, [click here](#) ►

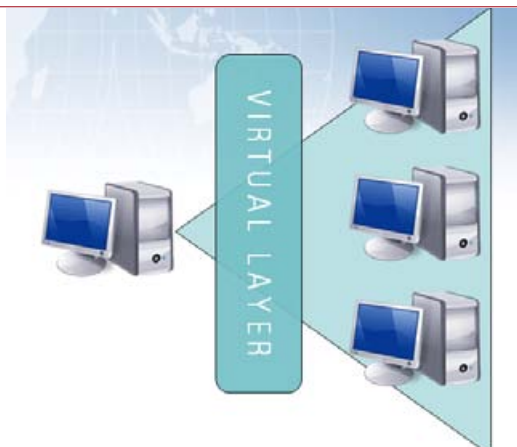
PRODUCT VIDEO

To view a video about process control software, [click here](#) ►



SPRAY TIP: REDUCE COSTS WITH SOFTWARE VIRTUALIZATION TECHNOLOGY

As software development teams move through the software development lifecycle and new software versions are created to improve the product, the use of "virtual machines" can now store a simple file containing the entire operating system configuration. Systems running on Batch Architect Pro can use these virtual machine files to save time and considerable cost during set-up, also reducing the need for spare legacy hardware.



RETROFIT SERVICES AND MORE

SERVICE OVERVIEW

In addition to new equipment, Fluid Air offers a range of services to make your used machines feel like new again. Update your process with the latest in spray technology, process controls, retrofit services and more provided by our global network of trained sales and support personnel.

FEATURES AND BENEFITS

- Upgrade almost any type and brand of pharmaceutical batch-type processing equipment
- Convert equipment to perform new functions, like fluid bed granulating or Wurster coating
- Add new features to existing equipment such as humidification, modern filter systems, solvent recovery systems and more
- Update your existing control system to robust, recipe-driven Batch Architect™ process control software



Tablet Coater Operating with Batch Architect™ Process Control Software

ADDITIONAL RESOURCES

For more information
on retrofit services,
[click here ►](#)

SPRAY TIP: REVITALIZE YOUR EXISTING EQUIPMENT WITHOUT REPLACING IT

Replace your worn or existing factory-supplied nozzles with new, state-of-the-art fluid bed nozzles from Spraying Systems Co. Intended to fit either new or existing Fluid Air fluid bed systems as well as competitor systems, our line of customizable nozzles and lances for Wurster coating and top-spray granulation are designed to help you get the most out of your machine.

For more information on fluid bed nozzles,
[click here ►](#)



APPENDIX

	PAGE
Accessories	90
Glossary	92
Terms and Conditions of Sale	94

ACCESSORIES

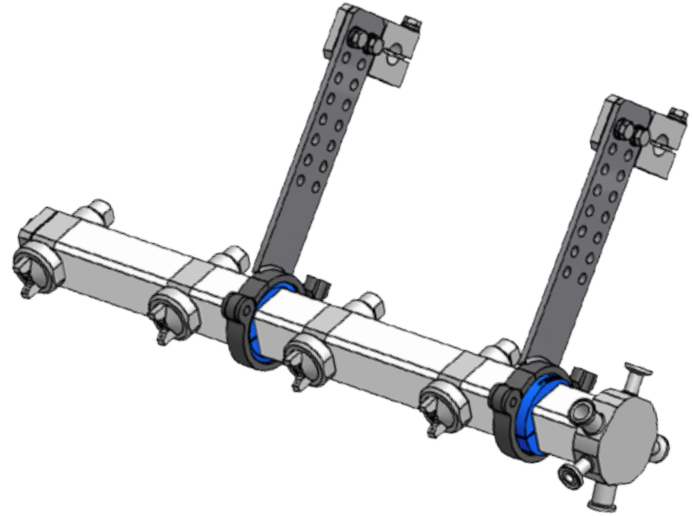
**SANITARY MOUNTING CLAMP FOR
54000 MODULAR MANIFOLDS**

PRODUCT OVERVIEW

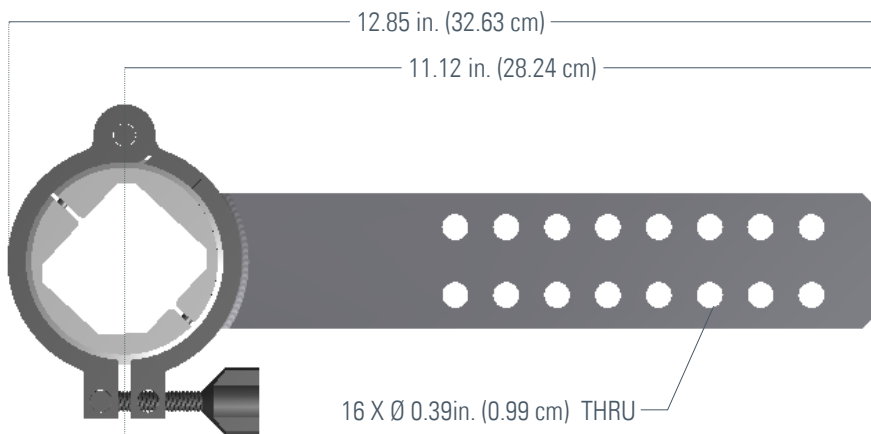
The sanitary mounting clamp system for 54000 Modular Manifolds is a set of stationary clamps which attach to the spacer blocks of the manifold. The clamps stay in place, but allow the manifold to index a full 360° inside the coater without the need to reposition the entire manifold.

FEATURES AND BENEFITS

- Clamp can index a full 360°, permitting the manifold to be positioned exactly as needed
- Can be used for both 54000 and 54000LC manifolds
- Allows manifold to be positioned for optimal coating results



DIMENSIONS



ACCESSORIES

O-RING KITS, TUBE FITTINGS AND MORE

O-RING KITS

For our line of air atomizing/tablet coating products, we offer spare O-ring kits and more. Each O-ring kit consists of all of the different sizes of O-rings required for operation of the given product, eliminating the need for you to source and purchase larger-than-necessary quantities of multiple sizes of O-rings, saving time and money.

AVAILABLE KITS (FOR TABLET COATING PRODUCTS)

54200 VMAU Lab Coater Spray Nozzle	51460 JAUSF Spray Nozzle	54000 Modular Air Atomizing Manifolds	54000LC Modular Air Atomizing Manifolds	P-Series Anti-Bearding Spray Set-Ups
54200-300-VIFDA-KIT		54028-200-VIFDA-KIT (for Tube Holder Assemblies)	54028-700-VIFDA-KIT (for Tube Holder Assemblies)	
54200-300-EPRFDA-KIT	54008-700-VIFDA-KIT	54028-200-EPRFDA-KIT (for Tube Holder Assemblies)	54028-700-EPRFDA-KIT (for Tube Holder Assemblies)	52533-VIFDA-KIT
28945-007-316SS (Rod Mount Kit)	54008-700-EPRFDA-KIT	54008-700-VIFDA-KIT (for Needle Actuators)	54008-700-VIFDA-KIT (for Needle Actuators)	52533-EPRFDA-KIT
		54008-700-EPRFDA-KIT (for Needle Actuators)	54008-700-EPRFDA-KIT (for Needle Actuators)	

TUBE FITTINGS AND CONNECTIONS

In addition to O-Ring kits and other accessories, we also offer ferrule type and push-in tube fittings for all of our spray nozzles, lances, and modular manifolds to ensure that your installation and set-up is as simple as possible. Instead of sourcing the numerous components required to connect and install a system from multiple vendors, let us serve you as your single-source supplier for all of your spray system needs.

For information on available fittings and connections, [click here](#) ► or contact your local sales representative.



GLOSSARY

Active Coating- A coating that contains active ingredients (APIs).

API- Active Pharmaceutical Ingredient (see also **active coating**), or active - is the part of a pharmaceutical drug that is biologically active. This is the ingredient that triggers the desired pharmacological reaction in a patient's body. To formulate a dosage form (e.g., tablet) that could be efficiently produced and delivered to the body, some inactive ingredients (see also **excipient**) are often added to the formulation. Most commercial dosage forms typically consist of both API(s) and excipients.

ASME BPE- The American Society of Mechanical Engineers Bio Processing Equipment (ASME BPE) Standard standardizes specifications for the design, manufacture, installation, inspection and acceptance of equipment used in the pharmaceutical and biological products industries.

ASME BPVC Section IX- The American Society of Mechanical Engineers Boiler Pressure and Vessel Code. Section IX defines welding procedures and how the procedures and welders are qualified.

Autogeneous Welding- A fusion welding process using heat without the addition of filler metal to join two pieces of the same metal.

Biopharmaceutical- A pharmaceutical derived from biological sources and especially one produced by biotechnology. A therapeutic product created through the genetic manipulation of living things, including (but not limited to) proteins and monoclonal antibodies, peptides, and other molecules that are not chemically synthesized along with gene therapies, cell therapies and engineered tissues.

Batch- The amount of product being processed at hand. Batches can be processed either individually (single batch) or continuously (continuous batch).

Batch Record- Documents prepared for each processed batch which include all ingredients, process details and equipment used to make the product. Manufacturers of regulated drug products are also required to prepare a master batch record. An approved master batch record is the source document for all individual batch records, which are prepared and executed each time a new batch of the given product is manufactured.

cGMP- Current Good Manufacturing Practices. Good Manufacturing Practice guidelines (GMPs) are published by the FDA and are used by pharmaceutical, medical device, and food manufacturers as they produce and test products that people use.

Change Control Record- A record which documents any changes made to the master batch record for the manufacture of a product. The change must be supported, documented and approved by management personnel responsible for the manufacture and release of the product to the public.

CIP- Clean-in-Place, equipment and techniques that allow process equipment to be cleaned without dismantling or manual cleaning.

Drug- A drug is a substance intended for use in the diagnosis, cure, treatment or prevention of a disease or to otherwise affect or modify the function or behavior of any part of the body.

Electropolishing- A method of importing brilliance to a surface by removing a thin surface layer. It is an electro-chemical process, sometimes called "super passivation," capable of improving surface finish by up to 50%.

Enteric Coating- A barrier applied to an oral medication that controls the location in the digestive system where it is absorbed. Enteric refers to the small intestine; enteric coatings are manufactured to prevent release of medication before reaching the small intestine.

Excipient- Generally a pharmacologically inactive substance used as a carrier (or enhancer, stabilizer, modifier, etc.) for the active ingredients of a medication. Some of the types of excipients may include anti-adherents, binders, coatings (those that do not contain "active drugs"), flavors, lubricants, preservatives, etc.

Formulation- A mixture of structures prepared according to a specific procedure (a "formula").

Full Penetration- Describes the type of weld wherein the weld metal extends through the complete thickness of the parts being joined.

Functional Coating- see **Modified Release Coating**.

HPC- Hydroxypropyl cellulose, a type of coating polymer.

HPMC- Hydroxypropyl methylcellulose, an early – and still commonly used – tablet coating material. In modern coating systems (formulations), additional substances are added to it as plasticizers, anti-tacking agents, etc. but it still remains a main component of many coatings. It is used in many complete coating systems, for instance Opadry® by Colorcon®.

Installation Qualification (IQ)- Documents which establish that the critical components of a system are installed correctly and in accordance with design documentation requirements (i.e. specifications, purchase orders, contracts, bid packages, etc).

Modified Release Coating- film coatings applied to the solid dose form (tablet, bead, capsule) to alter the release of API in a dosage form after it is ingested. The drug release characteristics of time, course, and/or location (in the GI tract) are chosen to accomplish therapeutic or convenience objectives not offered by conventional dosage forms. Examples of modified release functionality could be: sustained release coating, enteric coating (see **enteric coating**).

MTR- Mill test report, a quality assurance document in the steel industry that certifies a material's compliance with appropriate ASTM standards and applicable dimensions as well as physical and chemical specifications.

Non-Functional Coatings (also referred to as conventional coatings)- film coatings applied to tablets for improved product appearance (color, gloss), improved handling (e.g. moisture and UV protection), etc.



GLOSSARY (CONTINUED)

Operational Qualification (OQ)- Documents which establish, through testing, that all critical components and “direct impact” systems are capable of operating within established limits and tolerances.

Orbital Welding- Automatic or machine welding of tubes or pipe-in-place with the electrode rotating (or orbiting) around the work.

Passivation- The formation of the protective layer of nickel and chromium oxides that prevent the formation of iron oxide (rust). Stainless steel self-passivates when exposed to air. The process known as passivation is actually an acid cleaning process that removes surface contaminants and allows the stainless steel to form the integral passive layer when exposed to air. Passivation doesn't change the appearance or surface finish.

Potency- a measure of drug activity expressed in terms of the amount required to produce an effect of given intensity. A highly potent drug evokes a larger response at low concentrations, while a drug of lower potency evokes a small response at low concentrations.

Process Qualification (PQ)- Process qualification is the final qualification activity before process validation. PQ integrates procedures, personnel, systems, and materials to verify that the given pharmaceutical grade utility, environment, equipment, or support system produces the required output.

PVA- Polyvinyl alcohol. Used in certain coating systems (complete coating formulations).

Quality Control- A process by which a given entity (e.g. the FDA) reviews the quality of all factors involved in production of a given drug, product or compound.

Quarantine- The compulsory isolation of a person, animal or substance, typically to contain the spread of something considered dangerous, often (but not always) disease.

Riboflavin Test- In cases of organic residues in vessels, a common practice is to spray the inner surfaces with a solution of riboflavin (vitamin B6), which adheres to the residue. When the surfaces of the vessel are exposed to UV light, adhering riboflavin fluoresces, indicating which areas need to be cleaned.

Rouge- A form of pitting corrosion found in pharmaceutical water for injection (WFI) systems. It must be removed chemically, either by electropolishing or repassivation.

Seal Coat or Base Coat- First layer of coating sprayed on the tablet. This first barrier is then used as a foundation to apply additional coatings.

SIP- Steam-in-place, heating or chemical sterilization of process equipment.

Solid Dosage- Term used in the pharmaceutical industry to refer to drugs that are intended for ingestion (vs. injection). Types of solid dosage drugs include tablets, capsules, granules, and powders.

SOP- Standard Operating Procedure.

Sterilization- a term referring to any process that removes or kills all forms of life present on a surface, contained in a fluid, in medication, or in a compound.

Surface Finish- There are three primary means of classifying surface finish. The first is called the standard mechanical sheet finish and is given with a number and a letter that indicates a process sequence used in the manufacture of stainless steel sheets. The second type of classification is by grit or mesh size. The third is by surface finish measurement using a device such as a profilometer.

Turnover Package- A package prepared to identify documentation that will readily allow operating companies to demonstrate that the vendor/contractor provided goods and services in compliance with good manufacturing and good laboratory practices for licensed products. The TOP provides the information that will allow the owner to validate, qualify, operate and maintain the equipment and facilities.

USP- United States Pharmacopeia, a drug regulating agency.

Validation- As it relates to the spray equipment, the process of validation involves the qualification of the manufacturing process to insure that it is stable and reliable so that the corresponding manufactured drugs meet specifications. Once an equipment or a process is validated, a new validation is required if any change is made.

Welder Certificates- (also known as welder qualifications)- specially designed tests to determine a welder's skill and ability to deposit sound weld material. The test consists of many variables, including the specific welding process, type of metal, thickness, joint design, position, and others. Most often, the test is conducted in accordance with a particular code.

Weld Maps- An isometric drawing showing the location and numerical identification of each weld used in the construction of a process piping system. Each weld, when completed, is labeled with the weld number indicated on the weld map, the date completed, and the welder/welding operator identification number or code.

WFI- Water for injection (RO- reverse osmosis, DI- deionized water)

316L Stainless Steel- 316SS contains 0.08% carbon. It may develop a heat-affected zone that is sensitized. If this area is exposed to active electrolytes, inter-granular corrosion may occur. 316LSS contains 0.03% carbon, which minimizes this problem.



TERMS AND CONDITIONS OF SALE

(1) Modification of Terms

Seller's acceptance of any order is expressly subject to Buyer's assent to each and all of the terms and conditions set forth below and Buyer's assent to these terms and conditions shall be conclusively presumed from Buyer's receipt of this document without prompt written objection thereto or from Buyer's acceptance of all or any part of the goods ordered. No addition to or modification of said terms and conditions shall be binding upon Seller unless specifically agreed to by Seller in writing. If Buyer's purchase order or other correspondence contains terms or conditions contrary to or in addition to the terms and conditions set forth below, acceptance of any order by Seller shall not be construed as assent to such contrary or additional terms and conditions or constitute a waiver by Seller of any of the terms and conditions.

(2) Price

Unless otherwise specified: (a) all prices, quotations, shipments and deliveries by Seller are f.o.b. Seller's plant; (b) all base prices, together with related extras and deductions, are subject to change without notice and all orders are accepted subject to Seller's price in effect at the time of shipment; and (c) all transportation and other charges are for the account of Buyer, including all increase or decrease in such charges prior to shipment. Payment of said price shall be due at the remittance address shown on the Seller's invoice 30 days after the date of Seller's invoice. Interest will be charged at a rate of 1 to 1-1/2% per month on all balances outstanding more than 30 days after the date of the invoice.

(3) Minimum Billing

The minimum billing by the Seller for any order shall be \$50.00.

(4) Warranties

Seller warrants that its products will conform to and perform in accordance with the products' specifications. Seller warrants that the products do not infringe upon any copyright, patent or trademark. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THOSE CONCERNING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

(5) Limitation on Liabilities

Because of the difficulty of ascertaining and measuring damages hereunder, it is agreed that, except for claims for bodily injury, Seller's liability to the Buyer or any third party, for any losses or damages, whether direct or otherwise, arising out of the purchase of product from Seller by Buyer shall not exceed the total amount billed and billable to the Buyer for the product hereunder. IN NO EVENT WILL SELLER BE LIABLE FOR ANY LOSS OF PROFITS OR OTHER SPECIAL OR CONSEQUENTIAL DAMAGES, EVEN IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

(6) Quality Assurance

Seller shall have no obligation to ensure that any goods purchased from Seller meet any special Buyer quality assurance specifications and/or other special Buyer requirements unless such specifications and/or other requirements are specifically set forth in Buyer's purchase order and expressly accepted by Seller. In the event that any such goods supplied by Seller in connection therewith, are applied to an end use without the appropriate specification and/or other requirement therefore having been set forth in Buyer's purchase order and expressly accepted by Seller, Buyer shall indemnify and hold Seller harmless against any and all damages or claims for damages made by any person for any injury, fatal or nonfatal, to any person or for any damage to the property of any person incident to or arising out of such application.

(7) Claims

Claims respecting the condition of goods, compliance with specifications or any other matter affecting goods shipped to Buyer must be made promptly and, unless otherwise agreed to in writing by Seller, in no event later than one (1) year after receipt of the goods by Buyer. In no event shall any goods be returned, reworked or scrapped by Buyer without the express written authorization of Seller.

(8) Default in Payment

If Buyer fails to make payments on any contract between Buyer and Seller in accordance with Seller's terms, Seller, in addition to any other remedies available to it, may at its option, (i) defer further shipments until such payments are made and satisfactory credit arrangements are re-established or (ii) cancel the unshipped balance of any order.

(9) Technical Assistance

Unless otherwise expressly stated by Seller: (a) any technical advice provided by Seller with respect to the use of goods furnished to Buyer shall be without charge; (b) Seller assumes no obligation or liability for any such advice, or for any results occurring as a result of the application of such advice; and (c) Buyer shall have sole responsibility for selection and specification of the goods appropriate for the end use of such goods.

(10) Cancellation of Special Orders

Special orders or goods specially manufactured for Buyer cannot be canceled or modified by Buyer, and releases cannot be held up by Buyer, after such goods are in process except with the express written consent of the Seller and subject to conditions then to be agreed upon which shall include, without limitation, protection of Seller against all loss.

(11) Patents

The Seller shall not be liable for any costs or damages incurred by the Buyer as a result of any suit or proceeding brought against Buyer so far as based on claims (a) that use of any product, or any part thereof, furnished hereunder, in combination with products not supplied by the Seller or (b) that a manufacturing or other process utilizing any product, or any part thereof furnished hereunder, constitute either direct or contributory infringement of any patent of the United States. The Buyer shall hold the Seller harmless against any expense or loss resulting from infringement of patents or trademarks arising from compliance with Buyer's designs or specifications or instructions.

(12) Complete Agreement

The terms and conditions set forth herein, together with any other documents incorporated herein by reference constitute the sole and entire agreement between Buyer and Seller with respect to any order superseding completely any oral or written communications. No additions to or variations from such terms and conditions whether contained in Buyer's purchase order, any shipping release or elsewhere shall be binding upon Seller unless expressly agreed to in writing by Seller.

(13) Governing Law

All orders are accepted by Seller at its mailing address in Wheaton, Illinois, and shall be governed by and interpreted in accordance with the laws of the State of Illinois.

(14) Customer Return Policy

We recognize that at times it is necessary for our customers to return products for a variety of reasons. Returns are a normal part of an on-going business relationship. To make the process as straightforward and fair as possible, our policy is based upon the following:

- An error on our part: Seller will credit you for the product and shipping costs, up to one year from ship date.
- An error on your part: Standard products can be returned for full credit, freight prepaid, also up to one year from date of shipment. There is the normal restocking charge of 20%.

Returns are subject to inspection.

For quick handling and authorization of returns, contact your local sales office.

Spraying Systems Co. reserves the right to make changes in specifications or design of the products shown in the catalog or to add improvements at any time without notice or obligation.

