Porous Injector Sizing

Porous injector sizing is calculated by determining the velocity of the gas (*V*) through the porous metal media surface area (*A*). This velocity is kept below maximum limits *(Table 1)* to ensure small bubble sizes.

$$V = \frac{Q}{A}$$

This velocity (*V*) is calculated by determining the flow rate of gas (*Q*) (in ACFM) / porous injector surface area (*A*) (measured in ft^2).

If the injector is installed in an application such as a pipeline – with liquid passing across the surface of the injector, higher flow rates of gas can be injected as the pipeline flow will tend to shear off the bubbles from the injector's surface and allow for a slightly higher velocity across the porous media.

(Table 1) **Velocity Ranges for Different Types of Porous Injector Applications**

Type of installation	**Maximum Velocity (*V*) across porous media**
Injector inside of Tank or Vessel with non-moving liquid	5 ft/min
Injector inside of a Pipeline with liquid moving 1- 10 ft/sec	10 ft/min

When an injector is sized correctly, a bubble size of approximately 200-600 micron will be achieved in a clear water solution (Surface tension of the liquid can greatly affect bubble size). Smaller bubbles have greater surface area and will produce better process results.

If the velocity is too high, the smaller bubbles will tend to coalesce into a larger bubble. Significantly higher flow rates of gas can be forced through the sparger, however the gas will tend to come off in a much larger bubble. At a certain point, typically around 20 ft/min, the gas will travel off of the injector in one large bubble.

Calculating ACFM

ACFM is determined based upon the pressure and temperature of the liquid in the pipeline or tank where the gas is being dispersed.

ACFM = SCFM x (P_{atm} / (P_g + P_{atm})) x (T_{act} + 460)/ (T_{ref} + 460))

SCFM = gas flow (ft^3/min) at standard conditions (14.7 psi & 60^0F))
ACFM = Airflow in actual cubic feet per minute (uncorrected)
P_g = Gage pressure (psig)
P_{atm} = Atmospheric pressure (14.7psia)
T_{act} = Actual air temperature (°F)
T_{ref} = Reference air temperature (60°F)

Calculating Area of Injector *(A)*

The surface area of the injector is approximately the same as that of a cylinder:

$$\text{Surface Area of Injector (A)}(\text{ft}^2) = \frac{\pi d L}{144}$$

where *d* is the diameter of the injector (in) and *L* is the length (in)

(Table 2) **Surface Area (*A*) of Injectors (ft^2)**

	Injector Diameter (in)					
	3/8"	1/2"	3/4"	1"	1-1/2"	2"
Injector Length (in)						
1	0.008	0.011	-	-	-	-
2	0.016	0.022	0.033	-	-	-
4	0.033	0.044	0.065	0.09	-	-
6	-	0.065	0.098	0.13	0.20	-
8	-	0.087	0.131	0.17	0.26	0.35
10	-	-	0.164	0.22	0.33	0.44
12	-	-	0.196	0.26	0.39	0.52
14	-	-	0.229	0.31	0.46	0.61
16	-	-	0.262	0.35	0.52	0.70
18	-	-	-	0.39	0.59	0.79
20	-	-	-	-	0.65	0.87
24	-	-	-	-	0.79	1.05
30	-	-	-	-	-	1.31
36	-	-	-	-	-	1.57
48	-	-	-	-	-	2.09

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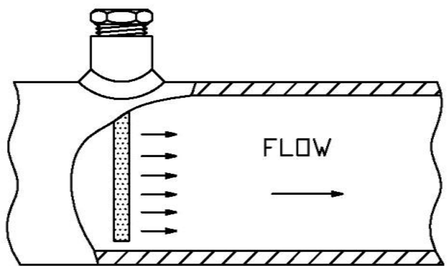
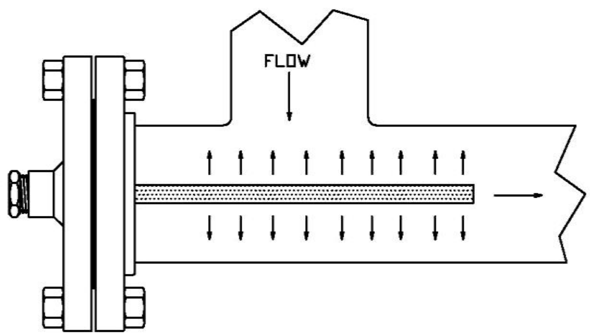


TANGENTIAL (FULL DIAMETER) MOUNTED



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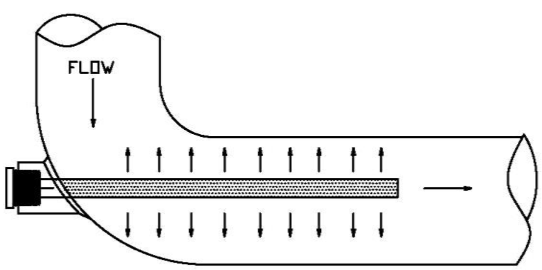

ELBOW MOUNTED

UNLESS OTHERWISE SPECIFIED		INYO PROCESS
DIMENSIONS ARE IN INCHES DO NOT SCALE DRAWING	DRAWN DBA	
DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994 AND APPLICABLE STANDARDS	CHECKED ET	PIPELINE SPARGER CONFIGURATIONS INTRUSIVE (TANGENTIAL) SPARGING
DECIMALS .XX ±.030 .XXX ±.010; ANGLES ±1°; SURFACE ROUGHNESS 125 √	DESIGN APPROVED	
	MFG. APPROVED	SIZE A; CAGE CODE –; DRAWING NO SP-1001; REV –
RUNOUT .010 TIR; BREAK CORNERS .005-.015; INTERNAL RADII .015-.030	QA APPROVED	
	RELEASE DATE 7/25/2004	SCALE –; WEIGHT –; SHEET 1 OF 1

Injector Sizing Example

- 1.5 SCFM of CO_2 gas is being injected into a 6" diameter pipeline of water for pH control (pipeline velocity is 5 ft/sec).
- The pressure in the pipeline is 60 psig.
- The temperature is 75 °F

Calculated ACFM:
= (1.5 SCFM) *((14.7 psi)/(60 psi+14.7 psi)) * ((75°F+460°F)/(60°F+460°F))
= 0.30 ft^3/min

If we are aiming for an allowable velocity (*V*) across the diffuser of 10 ft/min, the porous diffuser must have a minimum surface area (A) of:

$$A = \frac{Q}{V} = \frac{0.30\ \text{ft}^3/\text{min}}{10\ \text{ft}/\text{min}} = 0.03\ \text{ft}^2$$

As the pipeline diameter is only 6" we could easily use a 6" long ½" diameter diffuser with a surface area of 0.065 ft^2, which would have excess capacity and lower velocities to ensure that there are a small sized bubbles under operating conditions.