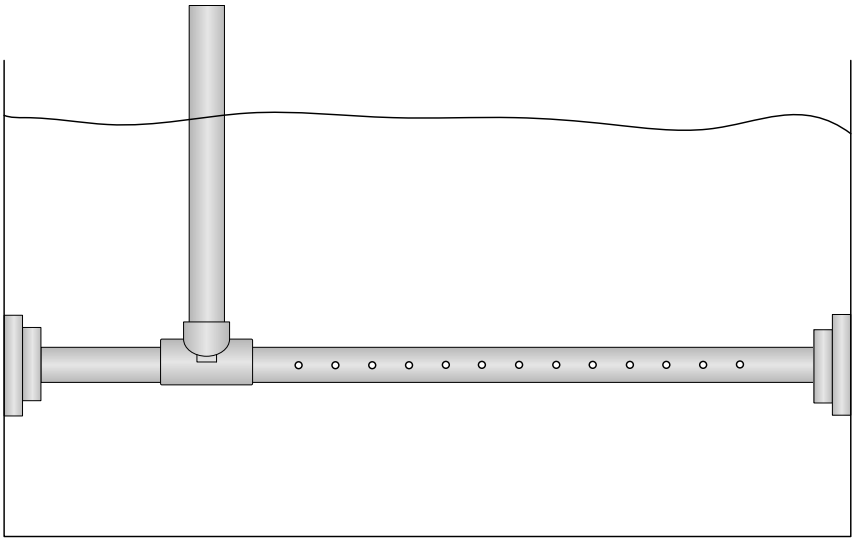
Open Channel Diffusers



Application Information:

Open channel diffusers are used to increase mixing and absorbance efficiency of a chemical solution into the process water. Specifically designed penetrations in the open channel diffuser pipe provide multiple locations of chemical introduction along the diffuser pipe which then allows for more adequate and complete mixing. This design guide shall provide the parameters and framework necessary to size a complete and efficient open channel diffuser for chemical injection.

Ordering Through Hydro Instruments:

Hydro Instruments is able to offer a variety of open channel diffuser options to fit the needs of specific customer requirements. All open channel diffusers are made to order and the following parameters need to be specified:

Diffuser diameter and material of construction.
Diffuser length.
Diameter and number of penetrations.
Number of rows required.
Spacing of penetrations.
Additional Supports.

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Open Channel Diffuser Design Guide

Initial Assumptions:

Due to the variability of open channel diffuser design and specific site mixing conditions, the following assumptions have been developed to ensure that Hydro Instruments open channel diffusers will operate at peak efficiency.

1. The pressure drop through the diffuser shall be set at 4 psi. This will allow complete mixing and injection through all penetrations in the diffuser.
2. The distance between holes should be approximately 4-6 inches laterally on diffusers over 8 feet long.
3. The diffuser shall be at least 12 inches below the surface of the water. This shall ensure adequate absorbance of the chemical into the process water without off gassing.
4. Diffusers placed in any open channel shall be placed in the channel area of maximum turbulence.

1. Determine New Backpressure and Water Flow Requirements:

Based on the initial assumptions, the open channel diffuser will add approximately 4 psi of backpressure to the application backpressure. This additional backpressure must be added to original design estimates (if not included) in order to adequately size the ejector for the required inlet pressure and flow rate. Once a new backpressure is determined, refer to Hydro Instruments ejector performance curves to find the inlet pressure and water flow rate necessary for your application.

2. Pipe Diameter and Material of Construction:

The diffuser material of construction should be selected for maximum corrosion resistance. Standard material provided by Hydro Instruments is schedule 80 PVC pipe and is recommended for most applications, especially chlorine injection.

The diffuser diameter shall be sized by similar methodologies used to size other pipes in the plant. Generally, these methods limit the velocity through the pipe to approximately 3-6 ft./sec. Based on the water flow rate required in step one, an adequate pipe diameter can be determined using the equation below.

$$v = \frac{0.41\ x\ Q}{D^2}$$

Where:

D = Diffuser inner diameter (inches)
Q = Water/solution flow rate (GPM)
v = Velocity (ft./sec). Must be between 3-6.

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3. Determine Size and Number of Penetrations:

Use the table below and the water flow rate requirements determined in step one to determine the diameter of and the number of penetrations needed for the diffuser.

Water/Solution Flow Rate (Q) GPM	Number Of Penetrations (N)						
	Orifice/Penetration Diameter (d) inches						
	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"
20	**16**	9	-	-	-	-	-
25	**20**	11	7	-	-	-	-
30	**24**	13	9	-	-	-	-
35	27	**16**	10	7	-	-	-
40	31	**18**	11	8	-	-	-
45	35	**20**	13	9	-	-	-
50	39	22	**14**	10	-	-	-
55	43	24	**15**	11	-	-	-
60	47	26	**17**	12	7	-	-
65	51	28	**18**	13	7	-	-
70	54	31	**20**	**14**	8	-	-
75	58	33	**21**	**15**	8	-	-
80	62	35	**22**	**16**	9	-	-
85	66	37	**24**	**17**	9	-	-
90	70	39	**25**	**18**	10	-	-
100	78	44	**28**	**19**	11	7	-
120	93	53	**34**	**23**	13	8	-
140	109	61	**39**	**27**	15	10	7
160	125	70	**45**	**31**	18	11	8
180	146	79	**50**	**35**	20	13	9
200	156	88	**56**	**39**	22	14	10
220	171	96	**62**	**43**	24	15	11
240	187	105	67	**47**	**26**	17	12
260	202	114	73	**51**	**28**	18	13
280	218	123	78	**54**	**31**	20	14
300	233	131	84	**58**	**33**	21	15
320	249	140	90	**62**	**35**	22	16
340	-	149	95	**66**	**37**	24	17
360	-	158	101	**70**	**39**	25	18
380	-	166	106	**74**	**42**	27	18
400	-	175	112	**78**	**44**	28	19

Bold = Recommended

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4. Determine Number of Rows:

Based on the number of penetrations required in step 3, it may be more effective to go with two rows instead of one. To determine the number of rows use the equation below. If R_{est} is greater than 1.5, then two rows should be used. If R_{est} is less than 1.5, then one row should be used.

$$R_{est} = \frac{N}{2.5\ x\ L - 1}$$

Where:

N = Number of penetrations
*L = Effective Length (feet)**

*The effective length (L) is the length of the diffuser that is available to make the diffuser penetrations. Since there are requirements for mounting the diffuser and space required for the inlet connection, the whole length of the channel cannot be used, and this is why an effective length is required. Based on Hydro Instruments open channel diffuser design configurations, the following lengths can be subtracted from the diffuser/open channel length to obtain the effective length.

Nominal Pipe Size (inches)	Length To Subtract From Overall (inches)
1	9.75
1.5	11.5
2	14.75
2.5	17.75
3	21
4	22.75

5. Orientation and Spacing of Penetrations:

Penetrations should face directly upstream of the process water to allow for better mixing. If two rows of penetrations are required then each row will be spaced 22.5 degrees from center. The center to center spacing of penetrations in the same row can be determined from the equation below.

$$s = \frac{12\ x\ R\ x\ L}{N + R}$$

Where:

S = Center to center spacing (inches)
L = Effective length (feet)
R = Actual number of rows
N = Number of penetrations

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Example:

Design a diffuser for a 120 GPM system (determined from step 1). Channel width is 7 feet.

Initial data:

$$Q = 120\ GPM$$
$$D = 3"$$
$$L = (7\ x\ 12) - 21 = 63"\ or\ 5.25\ ft.$$

2. Confirm pipe is appropriate diameter:

$$v = \frac{0.41\ x\ 120}{3^2} = 5.46\ ft./sec$$

3. Find recommend penetration diameter and number of penetrations based on required flow rate. 34 penetrations are required at 5/16" DIA.

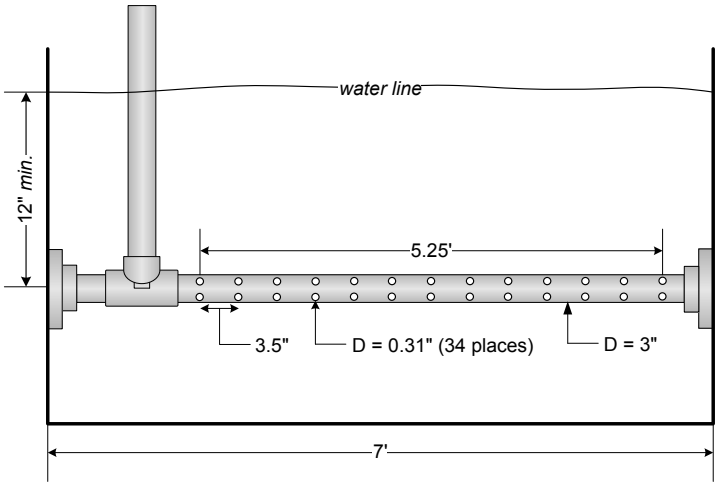
4. Determine the number of rows:

$$R_{est} = \frac{34}{2.5\ x\ 5.25 - 1} = 2.80$$

Since the value is greater than 1.5, two rows are required.

5. Determine center to center spacing:

$$S = \frac{12\ x\ 2\ x\ 5.25}{34 + 2} = 3.5"$$



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