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A Guide to Optimizing In-Tank Agitation and Mixing Using Eductors

Eductors Ensure Thorough Mixing to Improve Product Quality and Reduce Maintenance Time

Tank mixing eductors are widely used in many applications to effectively and efficiently mix tank solutions. Offering many benefits over other approaches such as pipes with holes, liquid agitators and pumps, tank mixing eductors feature different operating principles and are available in many styles, sizes and materials. To ensure optimal mixing performance, it is important to understand these product differences and how to specify and install eductors.

This bulletin provides guidelines to help you select the best eductor for your application. However, many application requirements are unique and a consultation with one of our technical experts can help ensure proper eductor specification and placement. Our sales engineers are spray technology experts, helping processors in hundreds of industries with parts cleaning, washing, mixing, plating, stripping and other spray operations. They're standing by and ready to help.




Tank Mixing Eductor Benefits

- **Ensures homogeneous fluid mix throughout the tank**
 - More thorough mixing results in solution uniformity – temperature, pH level, solids/gas dispersion and chemical distribution – to help ensure product/process quality
 - Eliminates sludge build-up and reduces tank cleaning time
- **Enables the use of small pumps to circulate large volumes of tank solution**
 - Smaller pumps are less costly to purchase
 - Smaller pumps are less costly to operate
- **Simplifies operation and maintenance – no moving parts**
- **Eliminates the need for compressed or blower air and the resulting oil contamination and/or ventilation problems**





TANK MIXING EDUCTOR OVERVIEW

Model	Inlet Flow Rate Range*	Circulation Rate Range*	Effective Flow Field Range*	Liquid Flow Rate/Air Flow Rate Range**	Page
 <p>46550 Tank Mixing Eductor</p>	3.5 to 75 gpm (11.3 to 308 l/min)	16.2 to 375 gpm (53.3 to 1540 l/min)	3' to 46' of flow per second (.91 to 14 m of flow per second)	Not Applicable	6-7
 <p>46550-ME Mini Tank Mixing Eductor</p>	.31 to 2.9 gpm (1 to 11.7 l/min)	1.9 to 10.7 gpm (6.2 to 43.6 l/min)	3" to 24" of flow per second (7.6 to 61 cm of flow per second)	Not Applicable	8-9
 <p>46550-AIE Air Induced Tank Mixing Eductor</p>	Not Applicable	Not Applicable	Not Applicable	0.82 to 3 gpm (3 to 12.1 l/min) and 0.11 to 1.50 scfm (3 to 48 NI/min)	10-11

*10 to 50 psi (.5 to 4 bar). **15 to 60 psi (1 to 5 bar).

Guidelines for Specifying Tank Mixing Eductors

1. Start by determining the needed turnover rate

How many times per hour does the tank solution need to circulate through the eductors? The answer is application-dependent and based on solution viscosity and the number of particulates. A general rule of thumb is 20 turnovers per hour

Here are some typical guidelines:

- **Plating and rinsing tanks:** 10 to 20 turnovers per hour although some plating tanks may require more than 30 turnovers per hour
- **Cleaning tanks:** at least 10 turnovers per hour
- **Heavily soiled tanks:** up to 20 turnovers per hour
- **Critical cleaning tanks:** more than 20 turnovers per hour

2. Then calculate the needed flow rate

Multiply the appropriate turnover rate by the tank volume and then divide by 60

Example:

$$\begin{array}{c} 10 \times 800 \text{ (3028.3)} = 8,000 \text{ gph (30,283 l/hr)} \\ \text{turnover rate} \quad \text{tank volume} \\ \text{per hour} \quad \text{in gallons (liters)} \end{array}$$

$$\begin{array}{c} 8,000 \text{ gph} \div 60 = 133.3 \text{ gpm} \\ \text{(30,283 l/hr)} \quad \quad \quad \text{(504.7 l/min)} \end{array}$$

3. Determine the needed inlet flow rate

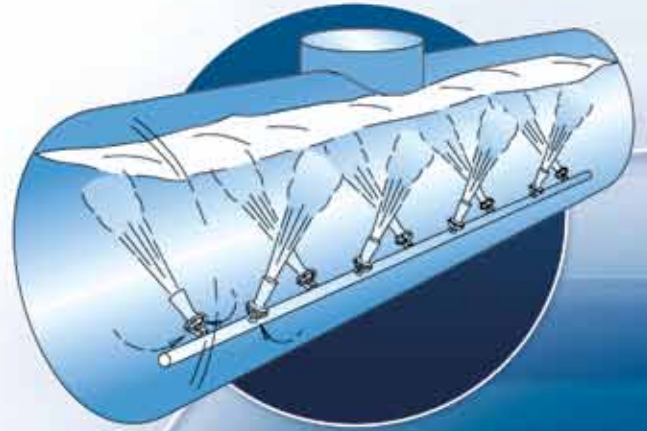
Take the gallons (liters) per minute and divide by 5 since the eductors mix at a 5:1 ratio

Example:

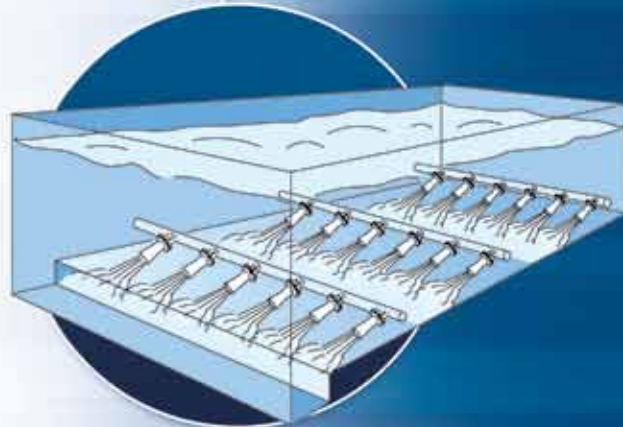
$$\begin{array}{c} 133.3 \div 5 = 26.7 \text{ gpm} \\ \text{(504.7} \div 5 = 100.9 \text{ l/min)} \end{array}$$

4. Determine the eductor size needed by consulting the performance table

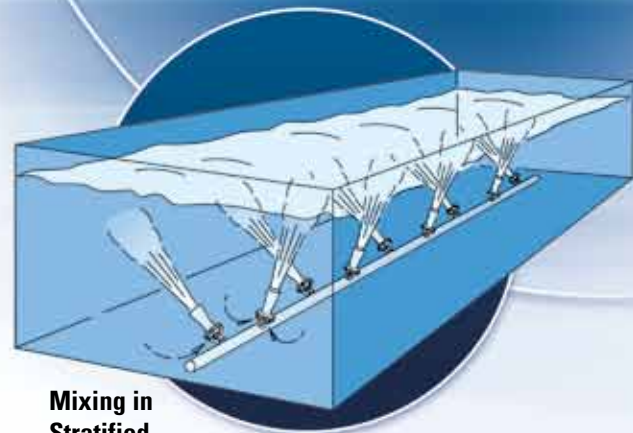
Example: One 3/4" eductor will produce a flow rate of 27 gpm at 40 psi (106 l/min at 3 bar). If multiple eductors are to be used due to the configuration of the tank, take the needed inlet flow rate and divide by the flow rate of the eductors. In this case, using four, 1/4" eductors will provide a liquid flow rate of 28 gpm at 40 psi (121 l/min at 3 bar)



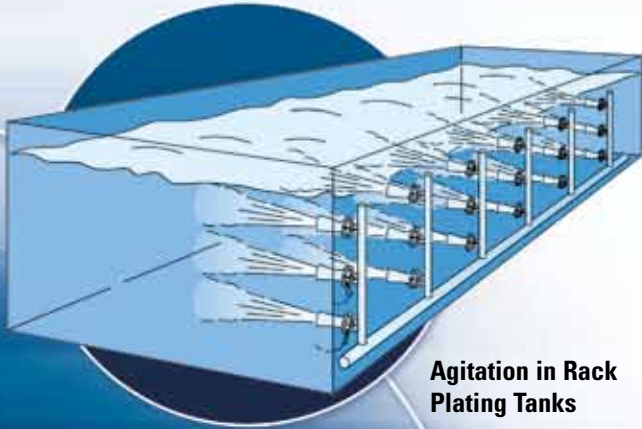
Mixing in Elongated Tanks



Directional Sweeping in Electrocoat Tanks



Mixing in Stratified Layer Tanks



Agitation in Rack Plating Tanks



Mixing in Cylindrical Tanks

5. Determine how many eductors you need

- You may need to use multiple eductors to obtain the needed flow rate
- You may want to use multiple eductors to prevent stagnation which is a common problem in square and rectangular tanks
- In general, using multiple eductors in larger tanks will provide more effective mixing than one centrally located eductor

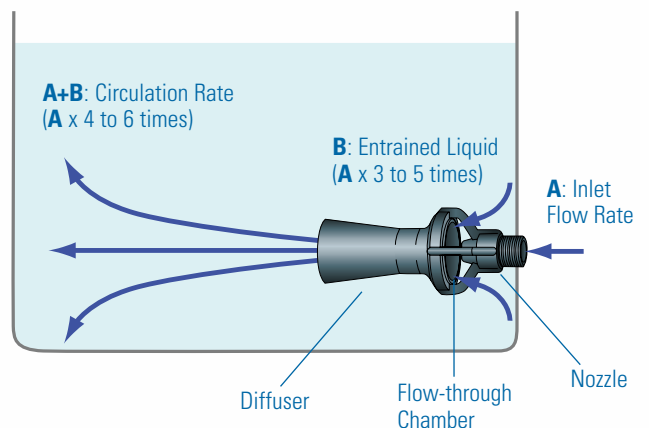
6. Determine eductor placement

- Little agitation occurs below the level of the eductor, so eductors should be positioned as close as possible to the bottom of the tank for maximum liquid turnover
- If settling cannot be tolerated, install the eductors at 1' (.3 m) above the bottom of the tank
- In general, eductors should be placed so the flow field will reach the farthest and highest liquid level at the opposite side of the tank
- Typical eductor configurations for various types of tanks and applications are shown to the left. Mounting adapters are available to direct flow as needed. Be sure to consult with your nozzle manufacturer to ensure optimal placement
- Typically, eductors are placed 12" (.3 m) apart for even and uniform agitation

Tank Mixing Eductor Operating Principle

Pressurized liquid is pumped into the eductor. As the liquid exits at high velocity, it draws surrounding solution through the eductor's flow-through chamber. This additional liquid flow mixes with the pumped solution and multiplies its volume.

Eductors can entrain up to five times the amount of pumped solution depending on the eductor size and design.



Model 46550 Tank Mixing Eductors

Large flow passages minimize clogging,
maximize liquid circulation

Benefits

- Entraines four times more solution than pumped solution
- Large flow opening allows particulates to pass through with minimal clogging
- Flow chamber design eliminates internal material build-up
- Compact design minimizes interference with plating racks and other in-tank equipment
- Wide range of material options
- In-tank mounting design eliminates the need for above tank mounting devices
- Mounting accessories simplify installation and allow easy, precise adjustment of eductor flow (See page 12 for mounting accessories ordering information)
- Ideal for use in anodizing, cleaning, electroplating, mixing, paint booth, phosphating, plating, rinsing and stripping applications



Model 46550 eductors are available in a wide range of sizes and materials with inlet flow rates up to 75 gpm (308 l/min).

Ordering Information

Model 46550 Tank Mixing Eductors

4 6 5 5 0 - 3 / 8 - P P

Model No.	Inlet Conn.	Material Code

BSPT connections require the addition of a "B". Example B46550 – 3/8 – PP.

Specifications

Materials: Kynar®, polypropylene**, cast 316 stainless steel

Inlet Conn. (in.): 1/4, 3/8, 3/4 and 1-1/2 NPT or BSPT (M)

Effective Flow Field: 3' to 46' of flow per second
(.91 to 14 m of flow per second)

Dimensions: 3" to 10" length (76 to 254 mm);
1-1/4" to 4-1/2" (32 to 114 mm) outside diameter

Materials

Materials	Material Code	Inlet Conn.			
		1/4	3/8	3/4	1-1/2
Kynar®	KY	•			
Polypropylene	PP	•	•	•	•
Cast 316 stainless steel	316SS	•	•	•	

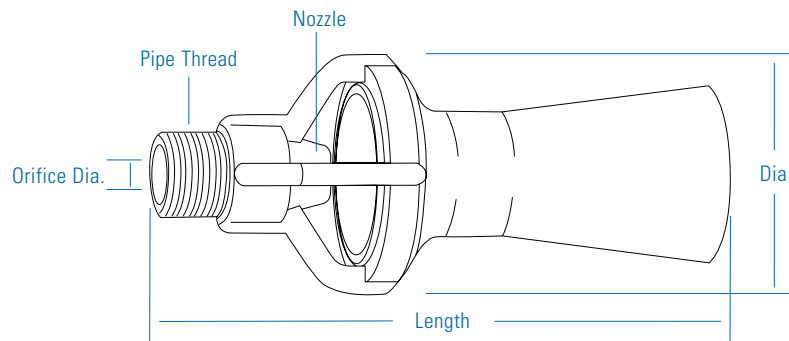
*Maximum operating temperature with water is 220°F (104°C) at 50 psi (3.5 bar)

**Maximum operating temperature with water is 200°F (93°C) at 50 psi (3.5 bar)

Performance Data

Nozzle No.	Flow Rate	Inlet Liquid Pressure psi (bar)							
		10 (.5)	15 (1)	20 (1.5)	25 (2)	30 (2.5)	35 (3)	40 (3.5)	50 (4.0)
46550-1/4—	Inlet Flow Rate gpm (l/min)	3.5 (11.3)	4.3 (16.0)	5.0 (19.5)	5.5 (23)	6.1 (25)	6.6 (28)	7.0 (30)	7.8 (32)
	Circulation Rate gpm (l/min)	16.2 (53.3)	19.4 (75)	22.8 (91.5)	25.1 (107)	28.1 (118)	30.6 (130)	33 (140)	36.8 (150)
	Effective Flow Field* ft. (m)	3.0 (.91)	5.0 (1.5)	7.0 (2.1)	8.5 (2.6)	10.0 (3.0)	12.0 (3.7)	14.0 (4.3)	17.0 (5.2)
46550-3/8—	Inlet Flow Rate gpm (l/min)	9.0 (29)	11.0 (42)	12.5 (51)	14.0 (59)	16.0 (65)	17.0 (70)	18.0 (77)	20 (82)
	Circulation Rate gpm (l/min)	45 (145)	55 (210)	62.5 (255)	70 (295)	80 (325)	85 (350)	90 (385)	100 (410)
	Effective Flow Field* ft. (m)	4.0 (1.2)	6.0 (1.8)	8.0 (2.4)	10.0 (3.0)	12.0 (3.7)	14.0 (4.3)	16.0 (4.9)	22 (6.7)
46550-3/4—	Inlet Flow Rate gpm (l/min)	13.5 (43)	17.0 (64)	19.0 (74)	21 (85)	23 (97)	25 (106)	27 (116)	30 (124)
	Circulation Rate gpm (l/min)	67.5 (215)	85 (320)	95 (370)	105 (425)	115 (485)	125 (530)	135 (580)	150 (620)
	Effective Flow Field* ft. (m)	5.0 (1.5)	8.0 (2.4)	11.0 (3.4)	14.0 (4.3)	17.0 (5.2)	20 (6.1)	24 (7.3)	33 (10.1)
46550-1-1/2—	Inlet Flow Rate gpm (l/min)	33 (106)	40 (151)	47 (184)	53 (215)	58 (243)	63 (259)	66 (288)	75 (308)
	Circulation Rate gpm (l/min)	165 (530)	200 (755)	235 (920)	265 (1075)	290 (1215)	315 (1295)	330 (1440)	375 (1540)
	Effective Flow Field* ft. (m)	7.5 (2.3)	12.0 (3.7)	16.0 (4.9)	20 (6.1)	24 (7.3)	29 (8.8)	34 (10.4)	46 (14.0)

*Effective Flow Field is defined as 1' (30 cm) of flow/second.



Dimensions

Nozzle No.	Inlet Conn. (in.) NPT or BSPT (M)	Orifice Dia. in. (mm)	Length in. (mm)	Dia. in. (mm)	Net Weight oz. (kg)		
					KY	PP	SS
46550-1/4—	1/4	3/16 (5)	3 (76)	1-1/4 (32)	.51 (.01)	.51 (.01)	—
46550-3/8—	3/8	5/16 (8)	4-1/16 (103)	1-11/16 (52)	—	1 (.03)	9.9 (.28)
46550-3/4—	3/4	3/8 (10)	6-3/8 (162)	3 (76)	—	2.8 (.08)	24.5 (.69)
46550-1-1/2—	1-1/2	9/16 (14)	10 (254)	4-1/2 (114)	—	10.2 (.29)	73.5 (2.1)



Mini Tank Mixing Eductor

Compact design maximizes liquid circulation and agitation

Benefits

- For use in applications with lower flow rates
- Entraines three to five times more solution than pumped solution as it passes through the eductor/diffuser
- Circulation is six times greater than using pipe holes or agitation with air
- Flow-through chamber minimizes clogging
- Compact design simplifies mounting and is ideal for small tanks
- Ideal for use in paint booth pre-treatment, etching and plating tanks
- Color-coded by flow size for quick identification (polypropylene only)



Specifications

Materials: Polypropylene. PVDF and other similar materials optional

Inlet Conn. (in.): 1/4 NPT or BSPT (M)

Effective Flow Field: 3" to 24" of flow per second (7.6 to 61 cm of flow per second)

Dimensions: 1-5/8" x 11/16" (length x outside dia.) (40 x 17 mm)

Ordering Information

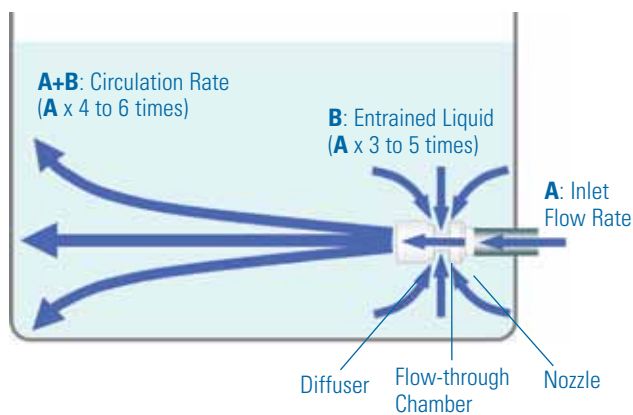
Mini Tank Mixing Eductor

46550	—	1/4	ME	—	1.5	—	PP
Model No.		Inlet Conn.	Mini-Eductor Designation		Nozzle Size		Material Code

Other materials available upon request. BSPT connections require the addition of a "B". Example: B46550 – 1/4 ME – 1.5 – PP.

How the Mini Tank Mixing Eductor works

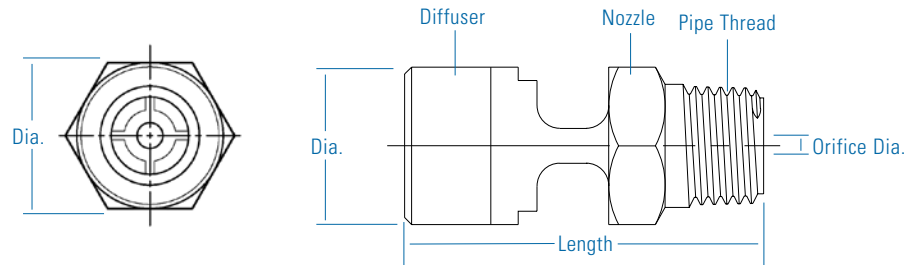
Pressurized liquid is pumped through the eductor. As liquid exits the diffuser at high velocity, surrounding solution is entrained in the open flow-through chamber. The combination of pumped flow and pulled flow significantly increases circulation.



Performance Data

Nozzle No.	Color Code*	Flow Rate	Inlet Liquid Pressure psi (bar)							
			10 (.5)	15 (1)	20 (1.5)	25 (2)	30 (2.5)	35 (3)	40 (3.5)	50 (4.0)
46550-1/4ME-1.5-PP	Orange	Inlet Flow Rate gpm (l/min)	.31 (1.0)	.38 (1.4)	.43 (1.7)	.49 (2.0)	.53 (2.2)	.57 (2.4)	.61 (2.6)	.68 (2.8)
		Circulation Rate gpm (l/min)	1.9 (6.2)	2.4 (8.8)	2.7 (10.8)	3.1 (12.5)	3.4 (14.0)	3.6 (15.4)	3.9 (16.7)	4.4 (17.8)
		Effective Flow Field** in. (cm)	3.0 (7.6)	4.0 (10.2)	5.0 (12.7)	6.0 (15.2)	7.0 (17.8)	7.5 (19.1)	9.0 (22.9)	12.0 (30.5)
46550-1/4ME-2.0-PP	Green	Inlet Flow Rate gpm (l/min)	.56 (1.8)	.69 (2.6)	.79 (3.1)	.89 (3.6)	.97 (4.0)	1.0 (4.4)	1.1 (4.8)	1.2 (5.1)
		Circulation Rate gpm (l/min)	2.7 (8.6)	3.3 (12.3)	3.8 (15.0)	4.3 (17.2)	4.7 (19.4)	5.0 (21.3)	5.4 (23.1)	6.0 (24.6)
		Effective Flow Field** in. (cm)	5.0 (12.7)	9.0 (22.9)	10.0 (25.4)	10.5 (26.7)	12.0 (30.5)	15.0 (38.1)	16.0 (40.6)	17.0 (43.2)
46550-1/4ME-2.5-PP	Blue	Inlet Flow Rate gpm (l/min)	.86 (2.7)	1.1 (4.0)	1.2 (4.9)	1.4 (5.7)	1.5 (6.4)	1.7 (7.0)	1.8 (7.5)	2.0 (8.2)
		Circulation Rate gpm (l/min)	3.2 (9.9)	4.0 (15.2)	4.7 (19.1)	5.3 (22.1)	5.9 (24.7)	6.4 (27.3)	6.9 (29.5)	7.8 (32.3)
		Effective Flow Field** in. (cm)	8.0 (20.3)	10.0 (25.4)	11.0 (27.9)	12.0 (30.5)	15.0 (38.1)	16.0 (40.6)	17.0 (43.2)	21 (53.3)
46550-1/4ME-3.0-PP	White	Inlet Flow Rate gpm (l/min)	1.3 (4.2)	1.6 (5.8)	1.8 (7.1)	2.0 (8.3)	2.2 (9.3)	2.4 (10.2)	2.6 (11.0)	2.9 (11.7)
		Circulation Rate gpm (l/min)	4.7 (15.3)	5.8 (21.6)	6.7 (26.4)	7.5 (30.7)	8.2 (34.5)	8.9 (37.7)	9.5 (40.7)	10.7 (43.6)
		Effective Flow Field** in. (cm)	11.0 (27.9)	13.0 (33)	16.0 (40.6)	17.0 (43.2)	20 (50.8)	22 (55.9)	22 (55.9)	24 (61)

* Color coding available for polypropylene material only. ** Effective Flow Field is defined as 1' (30 cm) of flow per second.



Dimensions

Nozzle No.	Inlet Conn. (in.) NPT or BSPT (M)	Orifice Dia. in. (mm)	Length in. (mm)	Dia. in. (mm)
46550-1/4ME-1.5 _	1/4	.059 (1.5)	1-5/8 (40)	11/16 (17)
46550-1/4ME-2.0 _	1/4	.079 (2.0)	1-5/8 (40)	11/16 (17)
46550-1/4ME-2.5 _	1/4	.098 (2.5)	1-5/8 (40)	11/16 (17)
46550-1/4ME-3.0 _	1/4	.118 (3.0)	1-5/8 (40)	11/16 (17)

Air Induced Tank Mixing Eductors

Powerful bubbling action improves cleaning efficiency, tank agitation without compressed air



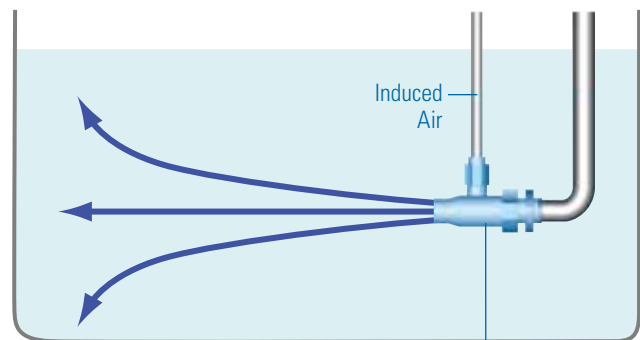
Air induced tank mixing eductors are available in three capacities with liquid inlet flow rates up to 3.0 gpm (12.1 l/min) and standard or wall-mount installation.

Benefits

- Circulated liquid flow is combined with induced air to generate small air bubbles that improve operational efficiency
 - Air bubbles provide an added scrubbing action when used for plating, dip cleaning or parts cleaning
 - Air bubbles elevate tank particulate and encapsulate debris for easier filtration of tank solution when used for mixing and agitation
- Unique injector design creates a wide 30° to 50° angle for added coverage and capture of particulates
- Easily change flow rates using interchangeable orifice plates (stainless steel models only)
- Ideal for use in dip cleaning, metal particulate carry off and liquid agitation

How the Air Induced Eductor works

Liquid flow from two orifices combines with air drawn from outside the tank to produce a powerful flow.



Air and liquid piping provided by customer.

Nozzle

Specifications

Liquid Flow Rate Range: 0.82 to 3 gpm (3 to 12.1 l/min)

Materials: PVC and stainless steel

Installation Types:

Standard hook-up or wall-mount

PVC models are for wall-mount installation only

Liquid Inlet Conn. (in.):

3/8 NPT or BSPT (F) for stainless steel models

1/2 NPT or BSPT (F) for PVC models

Air Inlet Conn. (in.): 1/4 NPT or BSPT (F) – All models

Ordering Information

Air Induced Tank Mixing Eductors

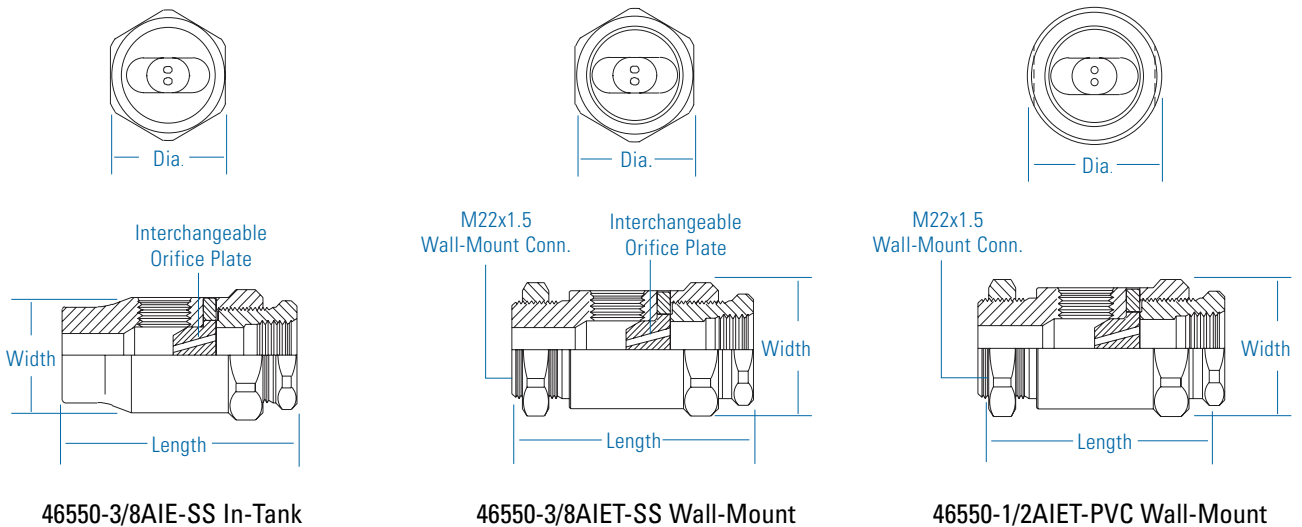
4	6	5	5	0	–	3	/	8		A	I	E		T	–	1	0	–	S	S
Model	Inlet	Eductor	Installation	Capacity																Material
No.	Conn.	Type	Type																	Code

Other materials available upon request. BSPT connections require the addition of a "B". Example B46550 – 3/8 AIE T – 10 – SS. "T" indicates wall-mount connection. No code required for in-tank type eductor.

Performance Data

Nozzle No.	Flow Rate	Inlet Liquid Pressure psi (bar)				
		15 (1)	20 (2)	30 (3)	40 (4)	60 (5)
46550-3/8AIE-5-SS 46550-3/8AIET-5-SS 46550-1/2AIET-5-PVC	Liquid Flow Rate gpm (l/min)	.82 (3.0)	.92 (4.2)	1.10 (5.0)	1.30 (5.6)	1.50 (6.2)
	Induced Air Flow Rate scfm (NI/min)	.11 (3.0)	.15 (7.0)	.24 (9.0)	.34 (15.0)	.54 (20)
46550-3/8AIE-7-SS 46550-3/8AIET-7-SS 46550-1/2AIET-7-PVC	Liquid Flow Rate gpm (l/min)	1.10 (4.1)	1.30 (5.7)	1.50 (7.0)	1.70 (7.8)	2.10 (8.6)
	Induced Air Flow Rate scfm (NI/min)	.14 (4.0)	.18 (7.0)	.28 (10.0)	.37 (16.0)	.57 (22)
46550-3/8AIE-10-SS 46550-3/8AIET-10-SS 46550-1/2AIET-10-PVC	Liquid Flow Rate gpm (l/min)	1.70 (6.3)	1.90 (8.6)	2.30 (10.0)	2.50 (11.1)	3.0 (12.1)
	Induced Air Flow Rate scfm (NI/min)	.24 (6.0)	.35 (17.0)	.60 (32.0)	.88 (42.0)	1.50 (48)

The flow rate table is based on the following specifications: Depth of eductor from water surface: 8" (220 mm).
Induced Air Side: 5/16" (8 mm) I.D. tubing. Max. Length = 20" (500 mm).



Dimensions

Nozzle No.	Air Inlet Conn. (in.) NPT or BSPT (F)	Nozzle Dia. in. (mm)	Length in. (mm)	Width in. (mm)
46550-3/8AIE-SS	1/4	1-1/16 (27)	2-3/16 (55)	1-3/64 (26.5)
46550-3/8AIET-SS	1/4	1-1/16 (27)	2-3/16 (55)	1-3/64 (26.5)
46550-1/2AIET-PVC	1/4	1-1/16 (27)	1-31/32 (50)	1-3/16 (30)

Mounting Accessories

Specifications

	37235 Adjustable Ball-Type Assembly	38625 Hinged Split-Eyelet
Inlet Conn. (in.):	1/4, 3/8, 1/2	NA
Pipe size (in.):	NA	1-1/4, 1-1/2
Materials:	Polypropylene (PP)	Polypropylene (PP)
CP20582 Threaded Ball: Accepts 1/4" and 3/8" (M)	Required	Required
Eductor: 1/4" and 3/8" sizes only	Model 46550*	Model 46550*

*See pages 6 and 7 for eductor ordering information.

See data sheets 37235-2 and 38625 for more information.

Ordering Information

37235 Adjustable Ball-Type Assembly

37235 + CP20582 - 1/4 - PPB

Assembly No.	Threaded Ball	Inlet Conn.	Material Code

38625 Hinged Split-Eyelet

38625 + CP20582 - 1-1/4 - PPB

Assembly No.	Threaded Ball	Pipe Size	Material Code



37235 Adjustable Ball-Type Assembly



38625 Hinged Split-Eyelet

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