# PFS VENTURI-MXR

IN-TANK EDUCTOR MIXING SYSTEMS

## WHO WE ARE

For over 40 years, Primary Flow Signal (PFS) has been a leading resource for design, engineering, and manufacturing of venturi meters. PFS now offers the next generation in venturi-based tank mixing, the **Venturi-MXR**. Fluid dynamics, specifically the Venturi Effect, is used as the foundation for mixing. Venturi effect, based on the Bernoulli Principle, describes how pressure drops as velocity increases in a narrow section of pipe, such as nozzle, and is the foundation for tank agitation or mixing by the Venturi-MXR.

## HOW THE VENTURI-MXR WORKS

1. The driving force for the mixing system is the fluid entering trough the nozzle and is called the motive.
2. The motive may be recirculated process fluid, a secondary process fluid, steam, or a gas.
3. The unique geometry of the Venturi-MXR limits exposure of he now high velocity and low-pressure motive fluid to the surrounding tank liquid, entraining, or pulling in, only a calculated amount so the combined flow can be slowed to maximize the total fluid's momentum in the what is called the Discharge Jet.
4. The discharge jet performs work in your tank to facilitate your goal for mixing.

| Common Goals for Mixing: | Applications: |
|---|---|
| **Suspend solids** | · Less settling maximizes usable volume, moves more material to processing, and reduces waste |
| **Blend liquids** | · Dissolve solids with process<br>· Mixing or combining chemicals to achieve homogeneity |
| **Temperature Stabilizing** | · Return heated or cooled liquid to tank and achieve desired process temperature |
| **De-stratify liquids** | · Storage tanks and basins with liquids that separate at some rate of time |
| **Aeration & Heating** | · Introduction of a secondary gas to mix, blend, or act as a catalyst within a process, and directly inject steam |

## ADVANTAGES OF VENTURI-MIXERS

- Controlled level of shear when mixing, with low shear being the most common
- Accelerated tank turnover, commonly moving five times the amount of fluid pumped
- Efficient aeration and direct steam heating with smaller bubbles sizes than spargers
- Low-shear mixing and liquid entrainment can accelerate chemical reactions, leading to faster blending times, decreasing chemical usage and more cycles per operation time.
- Low-shear mixing is safer for sensitive processes, such as live cell cultures, enzymes, and complex compounds saving them from the damaging force of blade mixers, increasing process viability.
- Greater process temperature control, returning cooled or heated liquid through the venturi and entraining liquid can save 50% to 75% of the normal circulation time.
- No moving parts inside the process, leading to very little or no maintenance.

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# VENTURI-MXR APPLICATIONS BY INDUSTRY

| MIXING GOAL | INDUSTRIES | Refining | "Chemical Processing" | "Process & municipal water treatment" | Storage: Tanks, Terminals, Ships | "Hygienic Processes" |
|---|---|---|---|---|---|---|
| | Suspend Solids | ☑ | ☑ | ☑ | ☑ | ☑ |
| | Blend / Mix Fluids | ☑ | ☑ | ☑ | ☑ | ☑ |
| | Temperature Stabilizing | ☑ | ☑ | ☑ | Rare | ☑ |
| | Aeration | Rare | ☑ | ☑ | Rare | ☑ |
| | De-stratifying layers | ☑ | ☑ | ☑ | ☑ | ☑ |
| | Heating | ☑ | ☑ | ☑ | Rare | ☑ |

## SOLUTIONS

Your goal for mixing will require different performance parameters and installations to maximize success of the installation. The most common parameters of performance are turnover time and discharge jet length, referred to as “jet length.”

## TURNOVER TIME

Turnover time (turns) is the time required for an equivalent to the total volume of liquid to pass through the mixing system one time. Process conditions, such as temperature stabilization or a homogenous state may require multiple “turns” of the process. Blending, mixing, temperature stabilization, and de-stratifying layers often use turnover time as a main factor. The number of units will vary based on the goal for mixing, turnover time required, and specific solution identified.

## DISCHARGE JET

The jet length is applied to suspend solids, blend or mix fluids, promote temperature stabilization, de-stratify layers, and is a key factor to ensure that all the system contents move through the venturi-based mixing system. While aeration and heating by direct steam injection are impacted by jet length as well, the values will differ greatly from the table due to the compressibility of the motive and the resulting susceptibility to unique process conditions. The jet length is shown as a maximum distance at which the flow from the Venturi-MXR will have impact on the process. Generally, this is when the flow velocity drops below a foot per second in water applications. These values are shown in the table.

| PSID | Characteristic | "Unit Size" | 3/8 | 3/4 | 1 1/2 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 10 | Pump Flow | gpm | 7.1 | 15.4 | 30.9 | 61.8 | 142 | 247 |
| | Total Flow | gpm | 35.5 | 77.2 | 154 | 309 | 710 | 1,235 |
| | Jet Length (1) | feet | 4.6 | 6.6 | 10 | 15 | 21 | 33 |
| 20 | Pump Flow | gpm | 10.0 | 21.8 | 43.7 | 87.3 | 201 | 349 |
| | Total Flow | gpm | 50.2 | 109 | 218 | 437 | 1,004 | 1,747 |
| | Jet Length | feet | 9.4 | 14 | 21 | 31 | 44 | 69 |
| 30 | Pump Flow | gpm | 12.3 | 26.7 | 53.5 | 107 | 246 | 428 |
| | Total Flow | gpm | 61.5 | 134 | 267 | 535 | 1,230 | 2,139 |
| | Jet Length | feet | 13 | 19 | 28 | 42 | 60 | 94 |
| 40 | Pump Flow | gpm | 14.2 | 30.9 | 61.8 | 124 | 284 | 494 |
| | Total Flow | gpm | 71.0 | 154 | 309 | 618 | 1,420 | 2,470 |
| | Jet Length | feet | 18 | 26 | 39 | 58 | 82 | 128 |
| 50 | Pump Flow | gpm | 15.9 | 34.5 | 69.0 | 138 | 318 | 552 |
| | Total Flow | gpm | 79.4 | 173 | 345 | 690 | 1,588 | 2,762 |
| | Jet Length | feet | 23 | 33 | 49 | 73 | 104 | 162 |
| 60 | Pump Flow | gpm | 17.4 | 37.8 | 75.6 | 151 | 348 | 605 |
| | Total Flow | gpm | 87.0 | 189 | 378 | 756 | 1,740 | 3,025 |
| | Jet Length | feet | 32 | 46 | 68 | 101 | 143 | 223 |
| 70 | Pump Flow | gpm | 18.8 | 40.8 | 81.7 | 163 | 376 | 654 |
| | Total Flow | gpm | 88.5 | 192 | 385 | 770 | 1,770 | 3,078 |
| | Jet Length | feet | 39 | 56 | 83 | 123 | 175 | 273 |
| 80 | Pump Flow | gpm | 20.1 | 43.7 | 87.3 | 175 | 402 | 699 |
| | Total Flow | gpm | 90.0 | 196 | 391 | 783 | 1,800 | 3,130 |
| | Jet Length | feet | 45 | 65 | 97 | 144 | 205 | 320 |
| 90 | Pump Flow | gpm | 21.3 | 46.3 | 92.6 | 185 | 426 | 741 |
| | Total Flow | gpm | 91.0 | 198 | 396 | 791 | 1,819 | 3,164 |
| | Jet Length | feet | 51 | 74 | 110 | 163 | 232 | 362 |
| 100 | Pump Flow | gpm | 22.5 | 48.8 | 97.6 | 195 | 449 | 781 |
| | Total Flow | gpm | 92.3 | 201 | 401 | 803 | 1,846 | 3,210 |
| | Jet Length | feet | 59 | 85 | 126 | 187 | 266 | 415 |
| 110 | Pump Flow | gpm | 23.6 | 51.2 | 102 | 205 | 471 | 819 |
| | Total Flow | gpm | 93.2 | 203 | 405 | 810 | 1,864 | 3,241 |
| | Jet Length | feet | 66 | 95 | 141 | 209 | 297 | 463 |
| 120 | Pump Flow | gpm | 24.6 | 53.5 | 107 | 214 | 492 | 856 |
| | Total Flow | gpm | 94.2 | 205 | 410 | 819 | 1,884 | 3,277 |
| | Jet Length | feet | 73 | 106 | 157 | 233 | 331 | 516 |
| 130 | Pump Flow | gpm | 25.6 | 55.7 | 111 | 223 | 512 | 891 |
| | Total Flow | gpm | 95.3 | 207 | 414 | 828 | 1,905 | 3,314 |
| | Jet Length | feet | 82 | 119 | 177 | 263 | 374 | 583 |
| 140 | Pump Flow | gpm | 26.6 | 57.8 | 116 | 231 | 531 | 924 |
| | Total Flow | gpm | 96.5 | 210 | 419 | 839 | 1,929 | 3,355 |
| | Jet Length | feet | 91 | 132 | 196 | 291 | 413 | 644 |

**(1)While "Penetration Depth" most accurately describes one flow within a second, it can mislead the intent within a three-dimensional system, so we will simply refer to this distance as the "Jet Length."**

Solutions may consist of single or multiple units. Examples showing various goals for mixing and tank sizes are available with Computational Fluid Dynamics (CFD) analysis. Fluid properties, unique tank or basin geometry, additional equipment, and pump supply (pressure and flow) all impact potential mixing system solutions. Custom solutions can be modeled and then verified by PFS engineers using CFD analysis prior to advancing projects. Consult factory for details.

## VENTURI-MXR TECHNICAL DETAILS

- **Sizes:** 3/8” through 3” Cast standard, Bar stock optional
  4” and larger fabricated
- **Standard materials:** Carbon steel and 316 / 316L SS
- **Optional materials:** Metals and plastics, including Alloy 20, Hastelloy, Monel, PTFE (Teflon®), PVC (CPVC), PVDF (Kynar®)


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