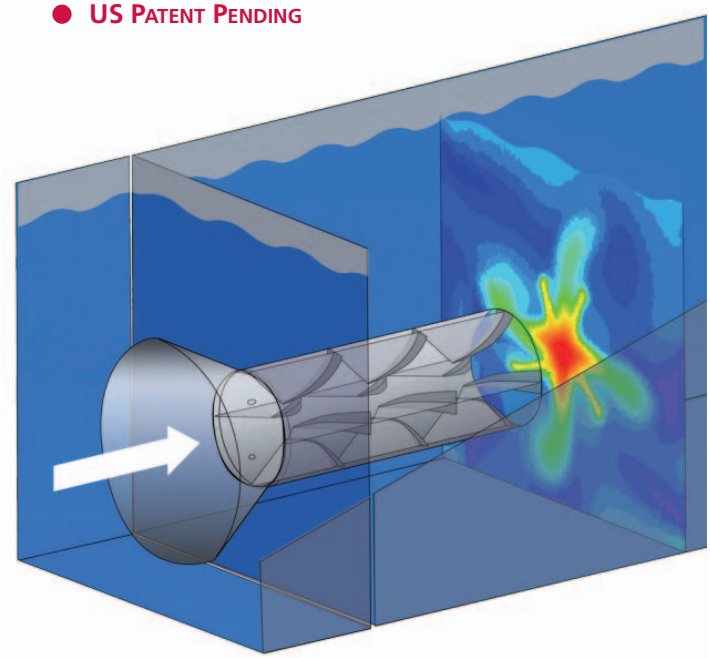
Model 4000 Series Mixer

WESTFALL

● US Patent Pending

Westfall Model 4000 Leading Tab Low Head Mixer Excels in Open Channel Applications



Alden Research Laboratory Inc. tested the performance of the three-stage Westfall 4000 mixer for use in open channel applications, to determine the mixer's effectiveness in achieving low CoV (coefficient of variation) – optimal mixing, with as little pressure loss as possible. Two configurations were tested: one with inlet and diffuser cones and one without.

Alden reported that the mixer "will work very well as an open channel mixer in either configuration tested. The low pressure loss characteristics are very desirable for pressure limited operation, and the raked angles prevent fouling." In addition, "the mixer tabs break up any swirling flow, which at high velocities or low submergence depths could cause air-entraining vortices to form, which would reduce flow rate."

The Testing Set-up

A 36-inch diameter mixer was tested within a 10-ft by 10-ft channel used for water treatment. The 8'-1-3/4" long mixer was integrated into a bulkhead across the channel that directs any water flowing down the channel through the mixer. The mixer pipe inlet was flush with the bulkhead*. The mixer centerline was placed at the midpoint of the channel's span, 4-ft off the channel floor. The inlet is 10-ft upstream of the mixer and the outlet is 30-ft downstream.

The mixer was tested with and without inlet and diffuser outlet cones. The inlet cone is 2'-0" (0.667 D) long with an included angle of 40°. The outlet cone is 4'-6" (1.5D) long with an included angle of 10°.

Save Money and Operate "Green"

Because the mixer requires no electric connections, you will save significantly on the installation, operation and maintenance. And of course, the energy savings are good for the environment as well as your budget.

Flow Rate

Velocity at the inlet was 6,342 gpm (9.13 MGD) at 60°F. Only one water flow rate was tested because previous testing has determined that the mixer performs similarly at different flow rates if the flow is turbulent (Re>4,600).

Chlorine Injection

Chlorine solution was injected into the mixer through two injection ports at the mixer inlet plane, upstream of the 12 o'clock and 6 o'clock mixer tabs. It was injected at such a rate that it would result in 982-ppm in the channel (6.23gpm), though it could be mixed at a lower rate with similar results.

If Reducing Pressure Loss is Paramount, Use Inlet and Diffuser Cones

The inlet and diffuser cones reduced mixer pressure loss by 32% at a given flow rate, or increased flow rate by 18% at a given head loss. 52% of the decrease in pressure loss is attributable to the inlet cone, and 48% to the diffuser. According to Alden, "The diffuser reduces energy loss of the flow through the mixer by limiting the turbulent momentum transfer with the bulk fluid as it slows and expands the flow." This "reduces the energy available for mixing once the flow exits the diffuser." Without the inlet cone, pressure loss is greater as there is a large separated flow region at the walls in the first stage of the mixer; whereas with the inlet cone, the flow remains attached to the mixer walls throughout. The K value using inlet and diffuser cones is 2.0.

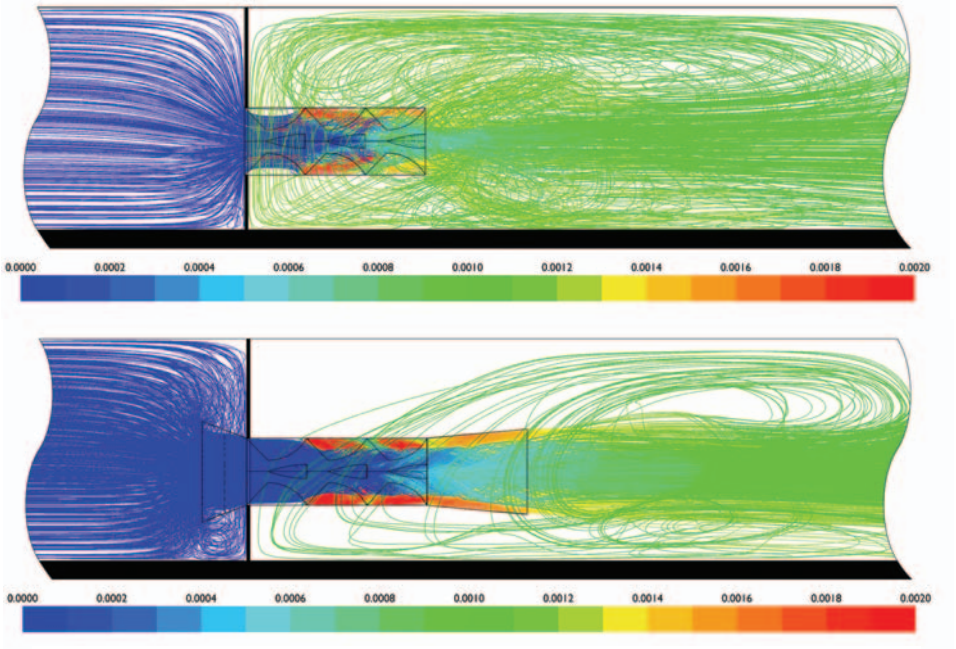
*The mixer could also be installed so that its center of gravity is in the bulkhead plane for better structural integrity, avoiding overhung loads on the bulkhead. This would also allow easier installation and recovery of the mixer. This will not change the pressure loss across the mixer with inlet and diffuser and will only slightly increase pressure loss across the mixer without the inlet/diffuser configuration.

To Balance Mixing and Pressure Loss, Use Only the Inlet Cone

Testing indicated a mixer with an inlet cone but without a diffuser cone would have mixing performance similar to the configuration that uses the mixer alone, offering the best of both parameters. The K value with an inlet cone is 2.5.

If Mixing is More Important than Reducing Pressure Loss, Skip the Cones

Both mixers offer excellent mixing performance, with very low CoV values ten mixer diameters downstream of the bulkhead (30-ft). However, the mixer without inlet and diffuser has a CoV = 0.008, better than the mixer with the inlet and diffuser which has a CoV = 0.018. The K value without the cones is 2.95.



Pathlines Colored by Volume Fraction of Injected 4000 Mixer (above) and the Inlet & Diffuser (below)

What to Do with Changeable Water Surface Elevation

If your system has water surface elevation that changes significantly with flow rate, installation needs to ensure that "the downstream end of the mixer will be submerged under all operating conditions, and the mixers should have the capacity to pass the maximum required flow at the available head without overtopping the channel," according to Alden.

Alden recommends that to satisfy both low and high flow requirements, the mixer centerline should be located approximately 1.5 diameters above the channel floor. If the channel is wide enough, "installing 4 X 18" mixers rather than 1 X 36" mixer would lower the minimum operable water level by approximately 3-ft, while maintaining the same maximum cross sectional mixer area, the same pressure loss, and the same maximum flow rate."

Bonus: Flow Rate Measurement

Alden suggests another benefit of using the mixer: "Since the pressure loss coefficient of the mixer is known, the mixer could also be used for flow rate indication by measuring the water surface elevation difference across the mixer, assuming the bulkhead is sealed adequately to the channel walls."

If you would like to download the complete report, visit our web site at westfallmfg.com/4000_mixer

Applications:

Open Channel Water Treatment for Wastewater or Potable Water

Advantages:

- No Power Consumption
- Excellent Mixing
- Accommodates Changing Water Levels and Flow Rates
- Low Permanent Pressure Loss
- Resists Fouling
- Suitable for Remote Locations
- Short Laying Length
- Minimal Maintenance Needed
- Long Service Life

Alden Research Laboratory, Inc. performed numerical simulations using the CFD software package FLUENT V6.3.26, a state-of-the-art, finite volume-based fluid flow simulation package, to calculate the three-dimensional, incompressible, turbulent flow through the pipe and around the mixer. The model geometry was developed using the commercially available three-dimensional CAD and mesh generation software, GAMBIT V2.4.6 and the computational domain generated for the model consisted of approximately 2 million hexahedral and tetrahedral cells.

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