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Chemineer model WVM Kenics™ Static Mixers for the water industry

Chemineer has designed and manufactured static mixers under the Kenics trade name for the water and wastewater industry for over 30 years. The first applications used the Kenics helical element KMS mixer, and this is still used widely today for pipes of 150mm diameter and less, for gas-liquid dispersion applications and where mixing is required at very low flow conditions.

Kenics KMS mixer blending dye into water.

In the early 1990's Chemineer researched, patented and introduced a novel and unique type of static mixer that generated multiple vortexes to create highly energy efficient (low head loss) radial mixing effects. This mixer, which we called the HEV™ (High Efficiency Vortex) set the standard for ultra low head loss mixing. Over the last 12 years over 1000 full scale HEV mixers with diameters ranging from 50 to 2200mm and for open channels up to 6m wide have been installed worldwide in water and waste water plants.

Kenics model HEV vortex static mixer showing position of vortex inducing elements

The Kenics WVM mixer

Our market research showed us that the Kenics HEV mixer was liked by industry for two main reasons – its low head loss and its open, non blocking structure. On the other hand, the HEV requires relatively long and expensive injectors, and is not well suited to very low flow rate conditions.

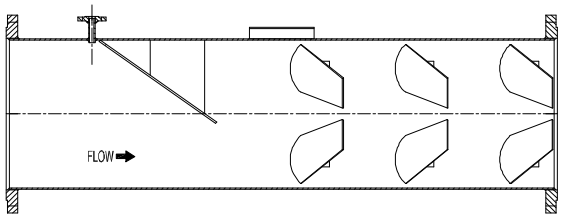
A project to build on the key advantages of the HEV but to be able to offer more a more flexible range of options more suited to differing flow conditions and with improved additive injection designs and lower construction costs was completed in 2002 and its performance validated by the BHR Group (1). The new range of mixers is called the WVM (Water Vortex Mixer). Three different WVM designs are now available. These allow the main project design parameters of length and pressure drop to achieve a certain CoV (2) within a certain time to be optimised:

Model	Pressure loss	Length to achieve mixture quality (CoV) of 0.05 (5%)
WVMA	Highest	Shortest
WVMB	Medium	Medium
WVMC	Lowest	Longest

(1) BHR Group is a world renowned research organisation specialising in many aspects of fluid mechanics
(2) CoV = Coefficient of Variation, or ó/x is the standard deviation of additive concentrations in any samples divided by the mean mixed concentration of the additive, a commonly used and quantifiable measure of mixture quality.

What does the WVM look like and how does it work?

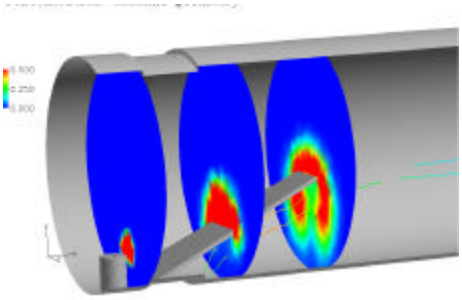
The WVM mixers consist of a simple wall additive injection point, a pre-distribution tab immediately downstream of the injection point and banks of trapezoidal shaped mixing elements. The number of banks of mixing elements varies depending on the mixture quality required for the process. The dimensions, angle of attack and spacing of the trapezoidal mixing elements varies between the WVM models A, B and C. The pre-distribution tab and the injection point design are the same for all WVM models.



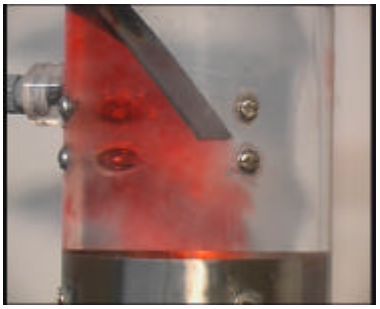
Typical WVM arrangement

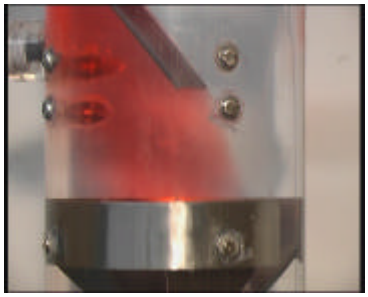
WVM pre-distribution tab

The pre-distribution tab was visually modelled and optimised in Chemineer's laboratory before being modelled again using CFM (Computation Fluid Mixing) software. Additives injected at the wall of the pipe are spread into a horseshoe shape by the pre-distribution tab :



CFM model showing distribution of additive from wall injection point





Visual modelling of the dispersion of red dye into water using the WVM pre distribution tab.

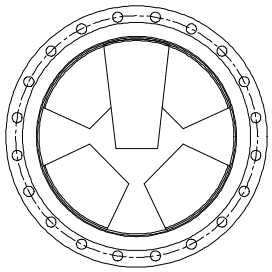
Left = Reynolds number 10,000.
Right = Reynolds number 100,000

Use of the pre-distribution tab allows the simplest of injectors to be used – either a flanged nozzle or a threaded boss to which the chemical injection line can be connected. A proprietary injection fittings with corporation cock shut off device can also be fitted to the wall mounted boss if required.

The pre-distribution tab was shown by to improve quantifiable mixture quality (CoV) by at least 10% over a wide range of flow rates compared to the use of a multihole sparger injector. The improvement in mixing at low Reynolds number (velocity 0.1 m/sec) conditions was the greatest.

WVM Mixing elements

The banks of WVM mixing elements are arranged in line with each other but off centre with respect to the pre-distribution tab. The horseshoe shaped pre-distributed additive is then caught by the tips of the first bank of WVM elements and drawn into the axially oriented spinning vortices behind them. Each element creates two vortices and each bank therefore creates eight. The successive banks maintain and intensify vortices throughout the length of the mixer and for some length downstream.



End view down WVM mixer showing position of injection boss and pre distribution tab relative to mixing elements

The pressure loss across the WVM models can be predicted by correlations developed from research carried out by BHR Group to determine friction factors for each WVM model and for a range of differing Reynolds numbers and banks of mixing elements.

Quantifiable mixture quality (Coefficient of variation or CoV) was determined during the same test programme, over the same ranges of Reynolds numbers and numbers of banks of elements, and using LIF (Laser Induced Fluorescence) techniques to measure radial homogeneity. The table below shows a length, pressure loss comparison between the different WVM models to achieve the same CoV figure of 0.05 (5%) at 3 diameters downstream from the mixer exit.

	Designs to Achieve CoV of 0.07 at 3 diameters (0.05 at 5D) for 500mm diameter mixer with v=1m/sec	
Model	**Mixer pressure loss (mm water)**	**Mixer length (m) including one injector and two flanges**
20-WVMA-3	598	1.82
20-WVMB-4	419	2.17
20-WVMC-5	208	2.98

Summary and conclusions

The Kenics model WVM product range enables Chemineer to offer individually project optimised mixers of a simpler design, having improved performance at lower Reynolds numbers and at a lower cost than was the case with the Kenics HEV mixer, with the following key features:

- ***Simple wall injection point***
- ***Optimisation of length vs. pressure drop parameters to suit the application is now possible***
- ***Improved performance at very low flow rates (0.1-0.3 m/sec)***
- ***Lower capex and opex***
- ***Test data validated by independent organisation (BHR Group)***

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