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Advanced Mixing Technologies

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Tech. Note No. 101

ADMIXER™ THEORY OF OPERATION

The Admixer™ geometry has been computer designed for optimal performance and reproducible manufacturing techniques. The unit will completely blend, disperse, react or heat two or more fluids in a short length of pipe. To achieve these results, the mixer relies on the principles of radial momentum transfer, flow division and inertia reversal. These transport mechanisms combine to eliminate concentration, velocity and thermal gradients. While many geometrical shapes have been used to create homogeneous flow, the degree of energy and mixing efficiency has been inadequately addressed. By using an elliptical or helical shape, smooth transitions are possible and no energy is wasted in back mixing. Triangular risers are used to connect the angled elliptical shapes to prevent eddy dissipation at the element edges.

THE ADMIXER™ PRINCIPLE

Fluids proceed axially through the line in a flow regime defined by the degree of turbulence. Turbulence is characterized by the dimensionless Reynolds number, and specifies the ration of inertial forces to viscous forces. Laminar flow is defined as having no turbulence, i.e. Nre < 500, transitional flow as 500 < Nre < 2000 and fully developed turbulent flow as Nre > 2000.

The Three mixing actions described below work independently or together, depending on the flow regime present. In addition, pipeline velocity plays an important role in the degree of uniformity achieved due to its influence on shear, and thus mass transfer. See Tech Note 102 for more information on velocity.

I. FLOW DIVISION

When in laminar flow, two or more fluids will remain adjacent to each other indefinitely unless disrupted. By inserting mixing elements, the fluids are divided and reoriented 180° before the next element. This process proceeds geometrically to produce fluid layers of fine proportions that insure complete mixing. The number of divisions produced is approximately equal to a value of 2E where E=Number of elements.

II. RADIAL MOMENTUM TRANSFER

When in laminar flow, two or more fluids will remain adjacent to each other indefinitely unless disrupted. By inserting mixing elements, the fluids are divided and reoriented 180° before the next element. This process proceeds geometrically to produce fluid layers of fine proportions that insure complete mixing. The number of divisions produced is approximately equal to a value of 2_E where E=Number of elements.

Momentum is transferred to adjacent film layers. The directional components of the momentum correspond to the shape of the resistance, i.e. the element.

This fluid layer momentum transfer continuously forces material to rotate about its hydraulic center mass at the pipe wall and element centerline transfer positions constantly to effect homogeneity. This momentum transfer in the radial plane eliminates the parabolic velocity profile normally seen in open pipe flow, and approaches true plug flow. Plug flow insures that all materials being processed are undergoing equivalent residence time treatment.

III. INERTIA REVERSAL

Throughout the fully turbulent flow zones, fluids encounter a dramatic directional change at the inter-element connection. As the mixing elements change from left-hand to right-hand orientation, the rapid reversal at the interface enhances the mixing effect. Opposing forces of inertia come into play, creating intense localized microturbulence at minimal energy expense.

SYNOPSIS

Knowing the basic flow phenomena involved in static Mixing leads to an understanding of static mixing principles. To apply this basic understanding in more detail another technical report is available. Ask for Admix Tech. Note # 102: "Sizing the Admixer™ Static Mixer and Sanitary Static Blender".