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Why Dynamic In-Line Mixing?

General Mixing Categories:

One approach to mixing problems is the simple ***mixing tank***, which involves placing the product in a tank and then inserting some kind of rotary mixer. Mixing continues until the product quality is acceptable. A more sophisticated approach is to install a mixing device into a pipeline and then cause the product to flow through that pipeline. Such a device is called an ***in-line mixer***.

Whereas the mixing tank setup offers few options, the in-line mixer solution can be further divided into two broad sub-categories:

- static (or passive) in-line mixing
- dynamic (or active) in-line mixing

The remainder of this article will focus on the benefits of in-line mixing.

Types of Products:

The only real requirement for applying in-line mixing to a product is that the product must be able to flow through a pipeline. Although this eliminates dry powders from consideration, it does include a wide range of commercially important products that are classified as:

- emulsions
- dispersions
- suspensions.

Because of the nature of the above product types, in-line mixers are often referred to as ***wet mixers***.

Static or Dynamic?:

A static in-line mixer is not powered and has no moving parts. It simply alters the flow pattern of the product by placing baffles in its path. Although static in-line mixing can be superior to tank mixing in some situations, it lacks many of the advantages of dynamic in-line mixing and we will not discuss the static process further. It will become clear that most of the benefits discussed here are not available with a static mixer.

Dynamic in-line mixers are usually powered by an electric motor and contain one or more mixing elements that perform a rotary motion about the axis of the flow path. The specific design of this ***mixing chamber*** (see Figure 1) distinguishes one in-line mixer from another. It is this aspect of in-line mixer design that presents the greatest opportunity for optimizing the mixer's performance for a given product.

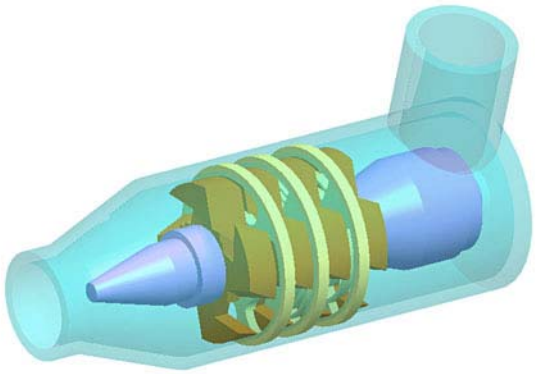

Figure 1: In-Line Mixing Chamber

Processing Goals:

To understand the advantages of dynamic in-line mixing, one must grasp what happens to an emulsion, dispersion, or suspension that is processed with such a mixer. Mixing is usually applied to improve one or more of the product's bulk physical properties, such as:

- stability
- viscosity
- texture
- color
- flavor

However, improvements in these bulk properties only reflect changes made on a microscopic level. Such changes usually include one or more of the following:

- particle size reduction
- particle deagglomeration
- particle blending/homogenization

These essential microscopic changes do not come easily. There is an energy threshold that must be met in order to achieve these objectives. In many cases, that threshold cannot be reached with a tank mixer or a static in-line mixer - only a dynamic in-line mixer is up to the task.

Processing System Advantages:

In addition to providing the raw energy required, dynamic in-line mixers offer a variety of processing system advantages. They permit control of the processing system in the following areas:

- repeatable results
- reliable performance
- reduced processing time
- versatility

With in-line mixing, one is assured that the entire product batch will flow through the mixing chamber and receive exactly the same level of processing. Thus, the results achieved for one batch of product will be precisely repeated for every subsequent batch. With a tank mixing system, where the energy is greatest right at the mixing blades and falls off as the distance from the mixer increases, such repeatability is impossible.

Top-of-the-line dynamic in-line mixers are designed to be simple and rugged machines (see Figure 2). These mixers convert the electrical energy of the motor into rotary mechanical energy in a manner that involves a minimum of components and maintains the factory setup with little or no effort on the part of the end user. Furthermore, these mixers permit easy disassembly and reassembly by the end user for routine cleaning. A well-designed in-line mixer is a totally reliable device that will provide years of service with a minimum of system down time. Just be sure to choose a model that offers such user-friendly features.

Figure 2: Dynamic In-Line Mixer

By its very nature, a tank mixing system requires an extended processing time to ensure that the entire batch of product receives the minimum required level of processing. This is because the energy provided by the mixer is not uniform throughout the tank. One must wait and hope that eventually the entire batch will find its way to the mixing blades so that the necessary changes in physical properties can occur. There is no such limitation with a dynamic in-line mixer. As soon as the entire batch of product has flowed through the mixer, one can be 100% certain that all of the product has received the needed processing. It is typical for a tank mixing process that took hours (or days) to take only minutes (or hours) with a dynamic in-line mixing system. Such an enormous reduction in processing time greatly increases the profitability of that product.

Processing System Advantages (cont.):

Dynamic in-line mixers offer unparalleled versatility in system integration. The discharge of the in-line mixer can either be directed to a collection point for a continuous, one-pass process or it can be directed back to the feed tank to create a multi-pass, recirculation process. In addition, with a full-featured in-line mixer, the speed and configuration of the mixing elements are easily modified to fine-tune the mixing process. This capability is invaluable in a system that must process multiple products or for products that are susceptible to variations in raw materials. The ability to quickly and easily vary the applied shear level from very low to very high in a precisely-controlled manner to suit the needs of the moment is just not possible with either a *tank* mixing system or a *static* in-line mixing system.

Stephen Masucci
Technical Director

Bematek Systems, Inc.
12 Tozer Road
Beverly, MA 01915
1-800-BEMATEK (236-2835)
1-978-927-2179
www.bematek.com