Introduction to Mixing Technology

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Date: 5th July, 2009

What is Mixing, Blending?

“Mixing is the process of thoroughly combining different materials to produce a homogenous product”. The mixture is generally a combination of dissimilar materials, e.g. Coal Ash and Cement are blended in specified ratio to produce Pozzocrete cement. In other cases, a chemically homogenous material may be mixed to produce a uniform lot of a desired weight/volume with consistent particles size distribution, color, texture, other required attributes, e.g. Metal Powders produced in 1 ton batch size are blended to a homogenous lot size of 4 tons (or pre-specified quantity) .

The terms "Mixing" and "Blending" are often used interchangeably; but technically they are slightly different. Blending is a process of combining materials; however, blending is a relatively gentle process compared to mixing. In terms of the phase of material, blending is the process of solid-solid mixing or mixing of bulk solids with small quantity of liquid. The terminology mixing is more closely associated with liquid-liquid, gas-liquid, and viscous materials. For the scope of this article and those to follow, we will use the terms "mixing" and "blending" interchangeably.

Mixing and Blending are the most demanding unit operations in the chemical process industries. Industries such as pharmaceutical and foods also rely heavily on mixing and blending technology. Some common examples are as follows:

Chemical Process Industry: Mixing and blending of specialty chemicals, explosives, fertilizers, dry powdered detergents, glass or ceramics, and rubber compounds.

Pharmaceutical Industry: Blending of Active Ingredients of the drug with excipients like starch, cellulose, lactose.

Food industry: Preparation of Cake Mix, Spices, Flavors

Importance of Mixing Technology

Mixing is a critical process because the quality of the final product and its attributes are derived by the quality of the mix. Improper mixing results in a non-homogenous product that lacks consistency with respect to desired attributes like chemical composition, color, texture, flavor, reactivity, particle size.

The wide variety and ever increasing complexity of mixing processes encountered in industrial applications requires careful selection, design and scale up to ensure effective and efficient mixing. Improved mixing efficiency leads to shorter batch cycle times and operational costs. Today's competitive production lines necessitate robust equipment that are capable of fast blend times, lower power consumption, equipment flexibility, ease of cleaning and a gamut of customized features. In addition to blending components, many modern mixers are designed to combine different process steps in a single equipment, e.g. coating, granulation, heat transfer, drying, etc.

A mixer is no longer a generic production tool, but a critical and decisive business tool. This is because profitability and competitive advantage are dependent upon subtle improvements in Product Quality through gains in mixing performance and efficiency. A recently published handbook on industrial mixing estimates the cost of poor mixing to be as high as US $ 100 million/yr

Types of Mixing Equipment

Mixing equipments are classified based on the type of materials being mixed. The three main classifications of the mixing equipment are as follows:

1. Blenders: Mixers for Solid-Solid Blending

Considering the myriad of industrial operations requiring blending of bulk solids, there is a wide range of blender technologies available. Depending on the principle, mechanism of mixing, blenders are classified as follows:

- ***Tumbler Blenders*** *:* Double Cone Blender, V-Blenders, Octagonal Blender
- ***Convective Blender:*** Ribbon Blender, Paddle Blender, Vertical Screw Blender
- ***Fluidization Blenders / Mixers****:* Plow Mixer, Double Paddle Mixer (Forberg Mixer)

Photograph 1: V-Blender

2. Agitators: Mixers for Liquid-Liquid, Liquid Gas Mixing

A variety of process functions like blending miscible liquids, contacting or dispersing immiscible liquids, dispersing a gas in a liquid, heat transfer in agitated liquid, suspension of solids in liquids, etc. are carried out in agitated vessels by rotating impellers. The impellers are classified into two types, axial and radial, depending on the angle that the impeller (also known as agitator) blade makes with the plane of impeller rotation.

- ***Axial Flow Impellers:*** The impeller blade makes an angle of less than 90° with the plane of impeller rotation. As a result the locus of flow occurs along the axis of the impeller (parallel to the impeller shaft)
  e.g.: Marine Propellers, Pitched Blade Turbine

- ***Radial Flow Impellers:*** The impeller blade in radial flow impellers is parallel to the axis of the impeller. As a result, the radial-flow impeller discharges flow along the impeller radius in distinct patterns.
  e.g.: Flat Blade Turbine, Paddle, Anchor

Photograph 2: Agitated Vessel

3. Heavy Duty Mixers: Mixers for Viscous, Pasty Materials

For high-viscosity materials, the mixing regime changes from one in which turbulence dominates (as in liquid agitators) to one in which viscous drag forces dominate. Moreover, some materials exhibit Non-Newtonian behavior. A *non-Newtonian fluid* is a *fluid* whose flow properties are not described by a single constant value of viscosity. Therefore mixing of such material requires special heavy duty mixers. These include:

- **Double Arm Mixers**
- **Planetary Mixers**
- **Dual and Triple Shaft Mixers**

The operation of the mixing equipment may be batch or continuous depending upon the required production capacity, product quality, pre and post mixing equipment, type of mixer, etc.

Photograph 3: Double Arm Mixer

Further Discussions

The purpose of the present article was to introduce the reader the basics of the mixing technology. This article is the first among the complete series of articles that shall focus on "Mixing Technology". The articles to follow shall discuss in detail the following topics:

- **Design and Construction of Mixers**
- **Selection of Mixers for Different Applications**
- **Case Studies of Improvements in Mixing through innovations in Mixer Design**

The articles shall focus on the practical aspects and applications of the mixing technology as relevant in today's competitive environment.

About the Author **-** Jayesh R. Tekchandaney is the Technical Director of Unique Mixers & Furnaces Pvt. Ltd (www.uniquemixer.com). He has over 12 years of experience in the selection and design of Industrial Mixing Equipment. His company offers the complete range of Mixing Equipment, besides mixing consultation and testing facilities. Tekchandaney holds a B.E. in Chemical Engineering from Bombay University, and a M.S. in Industrial Engineering from The Pennsylvania State University, USA. He also earned a Diploma in Business Management from Narsee Monjee Institute of Management Studies, Bombay.

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