

INDCO Industrial Mixers – A Basic System Design Primer

INDCO, INC. PROVIDES A WIDE RANGE OF MIXERS, STIRRERS AND DISPERSERS FOR APPLICATIONS UP TO APPROXIMATELY 5,000 GALLONS. IN ORDER TO ASSIST YOU WITH THE SELECTION OF THE IDEAL MIXER FOR YOUR APPLICATION THE FOLLOWING GUIDE TO MIXING SYSTEM DESIGN BASICS IS PRESENTED:

Most industrial mixing system applications involve blending low-viscosity liquids or liquids with soluble solid materials through agitation. For these applications, there are time-tested quantifiable calculation methods INDCO engineers utilize to assist you with sizing your mixer and selecting the appropriate impeller. As viscosity increases or less soluble material is utilized applications become more challenging. Analytical models are still useful with the added experience of our staff to ensure that desired process results are achieved.

Definition of Mixing: The intermingling of different materials (liquid, gas, solids) to produce a homogeneous mixture (Wikipedia.com). Specifically, the change in relationship of two theoretical “particles” occurs in the “zone of attrition”, the highly turbulent region at the impeller’s trailing edge.

All industrial mixing applications consist of a combination of flow and shear. The selection of impellers and speeds are made with this in mind based on the desired properties of the final mixed product. The ideal mixing system design also includes vessel geometry, mechanical, electrical and customer operating considerations.

Material Flow: Material flow in mixing is the quantified liquid movement in the vessel resulting from impeller pumping capacity. INDCO engineers calculate pumping capacity in units including tank turns per minute, bulk fluid velocity and agitation scale. Each impeller type (marine style impeller, hydrofoil, axial flow turbine, etc.) has a unique pumping number. Marine style propellers and hydrofoils are examples of high pumping impellers. Material flow pattern is the visualization of how and where the material moves throughout the vessel and is influenced by the relationship between impeller and vessel dimensions, not simply by batch volume. A large impeller rotating slowly and a small impeller rotating fast may have equal pumping capacities but will provide significantly different flow patterns.

Shear: The technical definition of fluid shear is the change in velocity gradients along the profile of the impeller. Shear rate is a characteristic of the impeller design or type. Shear stress which provides fluid “micro-mixing”, stretching of liquid “particles” at the impeller or dispersing of gas bubbles is the product of shear rate and fluid viscosity. Dispersion blades, homogenizers and rotor-stator designs are examples of high shear mixers.

How INDCO works with you: By utilizing some key information INDCO customer service representatives and engineers can help you confidently design a successful mixing process. The following is a list of important information to provide when working with us:

- Batch Volume(s) including minimum and maximum desired batches if applicable.
- Vessel dimensions (diameter, overall height, liquid depth) and geometry (flat bottom, cone bottom, etc.)
 - Material properties
 - o Initial ingredient and final product viscosities
 - “Water-like”, “similar to honey”, etc. can also be helpful

- o Specific gravity or weight per gallon of ingredients
- o Corrosive or flammable properties
- o Solubility of solids and concentration used
- Desired process outcome (blended liquid, solids suspension, etc.)
 - Process description
 - Sequence of ingredient addition
 - Processes successfully used for small-scale or pilot batches

Theoretical Design: Using the information provided INDCO personnel will first determine the optimal theoretical design, i.e. the combination of impeller type, size and speed in relationship to the vessel to provide the required material flow and flow pattern for the application. At this point the required horsepower (motor size) and torque (gear reducer) are determined.

Role of the Reynolds Number: Reynolds Number in fluid dynamics is defined as the ratio of a liquid's dynamic to inertial viscosity in parallel planes under shear. More simply, it is an indication of how easily liquids flow or resist flow at the impeller. Our engineers will calculate the mixing Reynolds number for your application to assist them with impeller type and size selection. Low Reynolds numbers resulting from high viscosities generally result in selection of larger impellers paired with gearboxes for maximum surface area contact and increased torque.

Practical Design: When the impeller type, horsepower and torque to provide the desired flow pattern and agitation are defined, the detailed mechanical design can be accomplished. Considerations to achieve this step include shaft length and diameter selection based on operating stress and critical speed avoidance. Critical speeds are rotational speeds at which natural frequency vibration is present. All rotating equipment has multiple critical speeds at which this vibration occurs. Mixer engineers calculate critical speeds based on the rigidity of mounting method, distance between support bearings, shaft length and diameter and weight of the impeller(s). Industrial mixers are generally designed such that the operating range needed to provide the desired process result is not within 40% of a critical speed. It is common to quickly run a mixer through a first critical speed in order to reach the designed operating range.

Shaft and impeller material selection is based on the properties of the materials in the mixture. The most commonly used alloy is 316 stainless steel. Final decisions to configuring the optimum mixing system include those relative to the production environment and the operational needs of customer personnel. Air or electric motors are chosen based on available services. Gear reducers, if applicable, come in many configurations. Options for motors and gear drives include finishes for indoor, outdoor or sanitary washdown industrial mixer applications.

INDCO offers hundreds of standard industrial mixer models each available customized to your unique process requirements. Our engineers are directly available to assist you with the selection of the industrial mixer or sanitary mixer that meets your requirements. INDCO, Inc. is located at 4040 Earnings Way, New Albany, IN 47150. **Call us at (800) 851-1049.**