

Mixer Selection

General Considerations

Mixer selection is determined by the process requirements and the vessel configuration being used. Many variables must be considered. A primary concern is fluid movement or turnover rate and the power necessary to accomplish this. Determine clearly the type of mixing involved – liquid blending, solid suspension, dissolving, absorption, extraction, reaction, heat transfer, etc.

Degree of agitation (mild, medium, vigorous, violent)

The amount of agitation is usually determined by the purpose and end result of the mixing operation. Impeller location, type, speed and fluid properties are the most important factors to consider the achieving the appropriate degree of agitation.

Viscosity of liquids or slurries, specific gravity, settling rates of solids, dissolving rates, corrosive characteristics, volatility, etc., are important properties to determine mixer selection, type and speed of impeller, and required horsepower.

Viscosity is the “thickness” of a liquid or its ability to flow. The common unit of measure is centipoises. Viscosity of most liquids varies inversely with temperature.

The viscosity of Newtonian fluids such as water remains constant, regardless of agitation. Viscosity decreases in thixotropic fluids such as vegetable oil. Viscosity increases with dilatant fluids such as clay. Highly viscous materials require the increased torque of higher horsepower mixers or reduced gear mixers.

Mixers are defined in terms of horsepower, speed and torque. Speed is measured in revolutions per minute (RPM), while torque is the rotational force delivered by the mixer in inch-pounds or inch-ounces. Speed, torque and horsepower are related by the following equation:

$$\text{Torque} = \frac{\text{HP} \times 63025}{\text{Rpm}}$$

Low speed mixers generally provide much higher torque capability for a given horsepower. The higher the torque capability of the mixer, the greater the turnover rate the mixer is capable of.

The amount of horsepower needed depends on the volume, viscosity and size of impeller to provide complete mixing.

The diameter of the propeller or impeller also affects torque load on the mixer. The power needed to rotate a propeller is related to its diameter and speed.

A small increase in speed and especially impeller diameter will cause a great increase in the power required for a mixing operation.

High vs. low speed

Speed changes increase or decrease power assuming a constant impeller size and pitch

High speed (1150 – 1750 RPM) for light liquids such as aqueous solutions.

Intermediate speed for liquids of medium viscosity such as varnishes, medium oils, syrups, etc.

Low speed (35 – 420 RPM) for the following conditions:

1. When the mixture is thin, viscous or slippery, so that small high-speed propellers tend to channel rather than propel the entire mass into circulation.
2. When the mixture contains particles such as crystals sliced fruit, or other solid food, which would be broken up by a high-speed propeller.
3. When the mixture is of a foamy nature, and such foam is undesirable.
4. When colloids which are harmed by high speed mixing are to be treated. Mild and cream are typical of these colloids.

A low speed mixer carries a large impeller or propeller; a high speed mixer carries a small impeller.

Small diameter impellers are used at higher speed for maximum shear.

Large diameter impellers are used at lower speeds for maximum pumping capacities.

Single vs. dual impellers (propellers)

Impeller size and pitch effect power output. The same power level can be maintained with either single or dual impellers. At equal volume, the vessel shape will determine the use of single or dual impellers.

Single impellers are used in vessels with $Z/T \leq 1$.

Dual impellers are used in vessels with $Z/T \geq 1.5$ (Z/T = tank height to tank diameter ratio).

Dual impellers are also recommended when dry materials that are difficult to wet out are added to the mixture. The upper impeller is located on the shaft below the surface of the liquid to create a slight vortex. The vortex will draw down the powder or solids and be mixed more thoroughly by the lower impeller.