

MIXING 101

Remembering the Basics of Mixing

General

Mixing Technology is complex and often difficult to understand for someone not well versed in the industry. Although the technology is often related to pumping technology, it is very difficult and more abstract. For example, one can establish the required head and flow required for the process, read off the manufacturer's specifications, and select the pump model required. Simplistically put – but this is how the selection process works.

Mixer selection is much more complex because shear is required in place of head, and this requirement is much more difficult to ascertain. So, let's re-examine the basics:

1.0 Elements of Mixer Design

The key elements of Mixer Design are:

- 1.1 Process Considerations
- 1.2 Power Considerations
- 1.3 Mechanical Design

Understanding each of these elements and their effect on agitator design and operation, allows agitators to be a key to efficient Process Design.

1.1 Process Considerations

This requires matching the customers process requirements with the correct impeller design. So, based on the customers' requirements in terms of product, process requirement, blend / residence time, and Rheology, we match the impeller type, vessel design, power and speed, to arrive at an optimum selection. We need to match the impeller output in terms of flow and shear, with the process requirement. A flocculation process, for example, does not relate well to high shear.

1.2 Power Considerations

Once the process aspects of the mixer design are finalized, it is necessary to optimize the final design to use the power most efficiently. This could mean altering the $\frac{D}{T}$ (impeller to Tank \emptyset) ratio to produce the same process result at reduced power. The price to pay will be Torque, which could require larger gearboxes, using lower power. This is a trade off between operating cost and capital cost, often requiring input from the customer.

1.3 Mechanical Design

Once the agitator design is complete, in terms of process, and the agitator design has been optimized for efficient operation, we can advance to the mechanical design of a mixer which provides long operating life and minimum downtime. This means providing a mechanical design which is strong enough to prevent premature failure without being excessively strong and overly heavy. Mixers should have a mechanical life of 20 years. The key to efficient mechanical design is understanding the forces acting on the mixer. Mixers are dynamic machines with fluctuating loads and forces. Shafts are usually over hung with no lower support.

The forces acting on the shaft, concentrated around the mounting base, are:

- Axial load and thrust
- Bending moment
- Torque

Special consideration must be also be paid to Critical Speed which is the first natural harmonic of the shaft and impeller systems.

Material, shaft length, bearing centers, impeller weight and quantity, are critical factors in determining the critical speed, relative to the operating speed. For safe mechanical design, mixers should not operate with 75% of first critical speed. For critical speed ratios in excess of 40% the lower impellers should be fitted with stabilizing fins.

Summary

It is not sufficient to design an agitator for efficient process operation. It must also be mechanically reliable and efficient in terms of power usage.