APPLICATION CONSIDERATIONS FOR PROPELLERS USED IN FLUID MIXING

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GENERAL INFORMATION

The use of 3-bladed marine propellers for mixing dates back more than 60 years. The propeller is still one of the most efficient mixing devices known in the industry. It produces high flow at minimal power consumption.

Propeller mixers are highly effective in blending, dispersion, solids suspension and heat transfer applications. Prop R Mix can provide limited application guidelines, however for a new application or a unique process, we recommend you consult with a mixer manufacturer for a complete mixer sized to your specific requirements.

A number of years ago mixer manufacturers developed a "high efficiency" hydrofoil impeller that is used on many portable and side-entry mixers today. Compared to a propeller, the main advantage of a hydrofoil is its lighter weight. Pumping rates and horsepower consumption of propellers vs. hydrofoils are virtually the same for any given speed. Above 20" in diameter the hydrofoil configuration offers advantages in cost and lighter weight - critical for shaft design considerations. Below this size, the propeller is highly effective in almost all processes. In highly viscous applications, a propeller will provide proper mixing that a hydrofoil can not do.

TERMINOLOGY

The following are often used terms in describing propellers:

Pitch - Defines the angle of the blade and its relationship to the diameter of the propeller. For industrial applications either a square pitch or steep pitch (sometimes referred to as "super pitch") is used. In terms of pitch ratios, the above are often referred to as 1.0 and 1.5 pitch respectively.

Generally a 1.5 or steep pitch prop will produce 50 to 75% higher flow than a square pitch. However, it requires twice the horsepower for a given shaft speed.

Hand - Propellers are either "Left Hand" or "Right Hand." When the propeller is viewed from the blade edge or its side, the blade is angled upward to the left (Left Hand) or upward to the right (Right Hand).

In 95% of industrial mixing applications, a left-handed propeller is used in conjunction with the mixer shaft turning clockwise (viewed from the motor end). This creates a downward flow to produce optimal tank turnover or mixing. If the motor is wired to run counter clockwise the pumping direction is upward. In a limited number of applications, such as draft tubes, this is desirable. A right hand propeller performs just the opposite - upward for clockwise rotation and downward for counter-clockwise rotation.

APPLICATION CONSIDERATIONS

When selecting a propeller for mixing applications there are several factors to consider:

- The Mixing Process
- Degree of Agitation
- Shaft Speed
- Viscosity
- Specific Gravity
- Power Requirements
- Propeller Diameter
- Tank Configuration

DEGREE OF AGITATION - There are three general categories of mixing or agitation levels.

Mild - A tank turnover rate of one to one and a half per minute.
Medium - Most common. Two to three tank turnovers per minute.
Violent - Over four tank turnovers per minute.

A mixer can be compared to an open centrifugal pump. At a given speed and propeller size, a fluid flow is produced and can be measured in GPM (Gallons Per Minute) as a pumping rate or in terms of tank turnovers per minute. The pumping rate increases dramatically with the speed and propeller diameter. It is important to keep in mind that changing either of these factors dramatically effect your power or motor horsepower requirements. See below.

HIGH SPEED VS. LOW SPEED

Mixers are typically supplied with direct drive motors running at 1750 RPM (high speed) or gear driven versions with output shaft speeds of 170 - 420 RPM (slow speed).

Small propellers (2" to 8" dia.) running at high speed are for light liquids in small batches (25 - 300 gallons) and for dispersions where a higher degree of shear is required to break up particles, crystals or other solids.

Larger propellers (8" and up) running at slower speeds are used when higher flow is necessary to the process, or the mixture is thick (viscous). This combination is also effective when there are solids in the solution that need to be suspended. When foaming is undesirable, or colloids are present, a larger prop rotating at slow speed will limit the problem.

EFFECTS OF SPECIFIC GRAVITY (DENSITY) AND VISCOSITY

Specific gravity and viscosity do not directly effect the propeller selections, rather the power required. Power requirements increase directly with specific gravity. Viscosity is resistance to flow. It effects power draw in the laminar region only. Generally, the more viscous the material becomes, the application requires larger propellers rotating at lower speeds.

POWER REQUIREMENTS

Motor horsepower is affected exponentially by shaft speed and propeller diameter. The horsepower requirement is proportional to a change in speed to the third power and the change in propeller diameter to the fifth power. For example, if speed is increased 50%, the mixer would need a motor three times as large as what was used for the original diameter prop. If the propeller diameter was increased 50% and speed remained constant, the power requirement is seven times greater. In practical terms, a typical .25 HP gear driven mixer is supplied with a 10" propeller. If a 15" diameter prop were substituted, a 2.0 HP motor would be necessary.

Prop R Mix can provide flow rates and horsepower consumption for given propeller diameters if you are uncertain what the application requires.

SINGLE VS. DUAL PROPELLERS

Generally, when the vessel's height is equal to or less than its diameter or width, one propeller provides satisfactory mixing. When the height exceeds 1.5 times the diameter or width, two propellers are recommended.

If the application calls for adding powders, or crystals that are difficult to wet out, a second propeller positioned on the shaft to create a small vortex just below the surface will be very effective to wet out the material and prevent agglomeration (lumping). The lower prop does the majority of the mixing.

PROPELLER POSITION AND SHAFT ANGLE

The most effective mixing is accomplished in a tank with three or four equally spaced vertical baffles mounted on the tank walls. The mixer is then located on center with the propeller approximately one diameter off bottom, i.e., a 10" propeller should be 9 - 12" off the tank bottom. Flow direction should be directed downward.

When baffles are not used, the mixers should be mounted in a position to place the shaft on a 10 - 15° angle off-vertical and angled the same degree to the right of its centerline, again with the prop approximately one diameter off bottom and the flow directed downward.

There are exceptions to the above parameters. If your application is not a direct replacement for an existing propeller, Prop R Mix strongly recommends reviewing your application with a mixer manufacturer.

For additional information call or write us.

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Propellers for Industry

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