BHP- Brake Horsepower, Hp or ft – lbs./sec.:
The mechanical horsepower delivered by the BHP motor shaft to the impeller (after electrical and mechanical losses). Standards of Hydraulic Institute equivalent: Mixer Input, expressed in Horsepower.

Cp - Specific Heat

D - Tank Diameter, ft.

d - Impeller Diameter, in.

d_P - Mean Particle Diameter

e - Specific Power:
Ratio of fluid output power to fluid volume

E_E - Electrical Efficiency:
The ratio of the Motor Output Power (P_P) to the Motor Input Power (P_I). The electrical efficiency changes with motor load.

Note: First convert motor input power to horsepower.

$$E_E = \frac{\text{Motor Output Power } (P_P) \text{ in HP}}{\text{Motor Input Power } (P_I) \text{ in HP}}$$

E_H - Hydraulic Efficiency:
The product of the impeller efficiency and impeller system efficiency, which is equal to the ratio of Fluid Output Power (P_P) in the system to the Brake Horsepower (BHP) supplied to the impeller.

$$E_H = E_I \times E_{IS} = \frac{P_P}{BHP} = \frac{\rho QH}{BHP}$$

E_I - Impeller Efficiency:
The ratio of the Mixer Output Power (P_o) delivered by the mixer to the Brake Horsepower (BHP).

$$E_I = \frac{P_O}{BHP} = \frac{\rho Q\left(\frac{V_J{}^2}{g}\right)}{BHP}$$

E_{IS} - Impeller System Efficiency:
The ratio of the Fluid Output Power (P_p) in the system to the Mixer Output Power (P_O) developed by the impeller:

$$E_{IS} = \frac{P_P}{P_O} = \frac{V}{V_J} \cong \frac{V}{ND}$$

E_T - Total Efficiency:
Total Efficiency, Overall Efficiency (E_O) and Wire to Water Efficiency (E_W) are interchangeable terms and equal to the product of electrical and hydraulic efficiencies.

$$E_T = E_O = E_W = E_E \times E_H$$

g - Gravitational Constant, ft./sec^2

H - System Losses, ft.:
Head losses in the system

H_o - Outside Heat Transfer Coefficient

h - Tank height, ft.

K - Thermal Conductivity of Fluid

K_L - Mass Transfer Coefficient

N - Impeller Speed, RPM:
Nominal impeller speed

N_m - Motor Speed, RPM:
Nominal motor shaft speed

P - Power, Hp or kW:
The unit of power expressed as either horsepower (Hp) or kilowatts (kW)

P_I - Motor Input Power, kW:
The electrical input power input to the motor

P_m - Motor Rated Power, Hp or kW :
The nominal rated (output) power of the motor

P_O - Mixer Output Power, Hp:
Fluid power delivered at the mixer impeller after all electrical, mechanical and impeller losses are considered.

P_p - Fluid Output Power, Hp:
Fluid power developed by the mixer in the system after all electrical, mechanical and hydraulic losses are considered.

P_{TC} - Total Power Consumption, Hp:
Input energy minus all system losses.

Q - Primary Flow or Primary Pumping Capacity, ft^3/sec:
The flow that is discharged directly from the propeller blades

Q_I - Induced Flow or Total Pumping Capacity, ft^3/sec:
The flow induced by turbulence.

Q_T - Total Flow or Total Pumping Capacity, ft^3/sec:
Primary Flow (Q) plus Induced Flow (Q_I).

SG - Specific Gravity :
Ratio of Density (ρ) of the fluid to the Density (ρ) of the Water

T - Tank Diameter, ft

T_M - Mixing Time, Minutes:
Time required to provide blending to 98% uniformity.

V - Voltage, Volts:
Nominal design voltage of the motor. Voltages that differ from the nominal voltages may require different stators or rotors.

V_a - Average Velocity, ft^3/sec:
The average of all velocities created by the mixer(s) throughout the mix tank.

V_H - Hydraulic Velocity, ft/sec:
Hydraulic velocity through the system

V_J - Jet Velocity, ft^3/sec:
Outlet flow velocity from the propeller blades.

V_m - Mixed Volume, Gallons or ft^3 :
Volume of material to be mixed.

ρ - Density, lbs. ft^3 :
Weight per volume of material

μ - Viscosity, C_P:
Measure of fluid property, which offers resistance to shear

σ **- Interfacial Tension, lbs./ ft^2**
Stress between adjacent parts

Certain fundamental equations and principles are useful when evaluating the performance for most mixing systems. These equations and principles are given below.

POWER NUMBER: Dimensionless Group Used to Quantify Impeller Power

$$N_P = \frac{Pg}{\rho N^3 D^5}$$

REYNOLDS NUMBER – Relates Inertial to Viscous Forces

$$N_{\mathrm{Re}} = \frac{D^2 N_P}{\mu}$$

FROUDE NUMBER – Ratio of Inertial to Gravitational Forces.

$$N_{FR} = \frac{ND^2}{g}$$

PUMPING NUMBER – Relates pumping rate (Q), speed (RPM) and impeller size.

$$N_Q = \frac{Q}{ND^3}$$

WEBER NUMBER - Relates inertial to surface forces

$$N_{WE} = \frac{N^2 D^3}{\sigma}$$

NUSSELT NUMBER – Used in heat transfer determinations

$$N_u = \frac{hoD}{k}$$

PRANDTL NUMBER – Used in heat transfer determinations

$$N_{PR} = \frac{C_p N}{k}$$

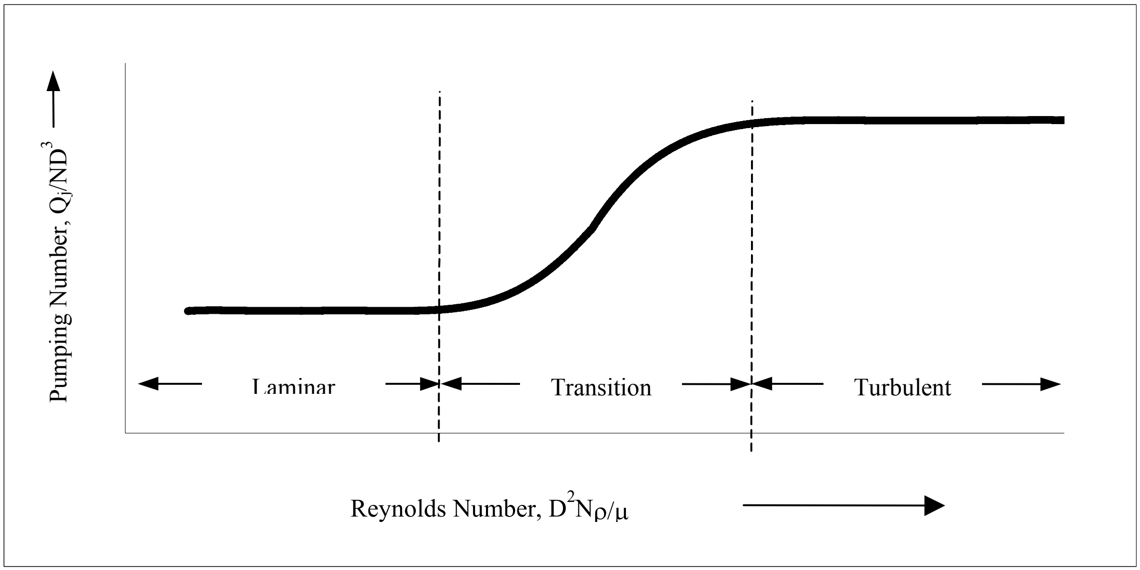
SHERWOOD NUMBER – Relates fluid and solid velocities

$$N_{SH} = \frac{K_L d_P}{D}$$

FLOW NUMBER OR PUMPING NUMBER – Dimensionless Group Used to Quantify Impeller Flow

$$N_Q = \frac{Q}{ND^3}$$

This single relation shows the effect of propeller speed and diameter on the primary flow through the propeller. From the diagram below you can see that for laminar flow (low Reynolds Numbers) Pumping Number is lower than for turbulent flow (high Reynolds Numbers) for the same propeller speed and diameter. This means that for the same propeller arrangement, lower mixing intensities are achieved in a viscous flow regime compared to a turbulent flow regime.



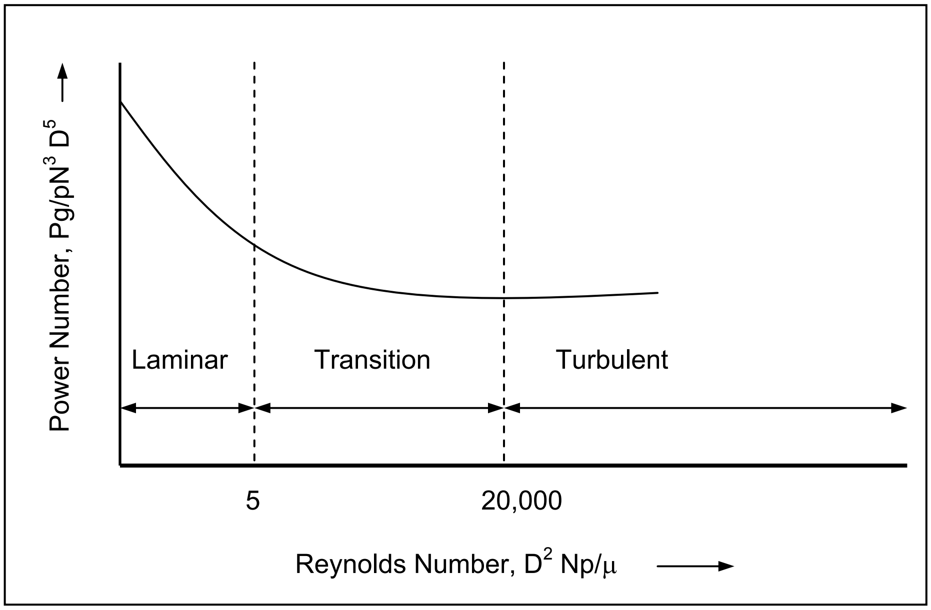
Pumping Number versus Reynolds Number

POWER NUMBER VS REYNOLDS NUMBER

For several decades It has been known that Power Number is a function of Reynolds Number for geometrically similar systems. This relationship has been extensively investigated and remains today as a fundamental relationship in propeller power determinations. This single relationship between Reynolds Number and Power Number correlates the effects of density, viscosity, rotational speed, and diameter. The Power Number vs. Reynolds Number correlation has been experimentally determined for numerous propeller types. Below is a chart that illustrates this relationship.

In all fluid flow situations, turbulent, laminar and transition regions can exist. Reynolds Number helps to define a propeller's operating regime in order to define its power behavior characteristics. In the turbulent flow regime, inertia forces dominate. In the laminar flow regime, viscous forces dominate. Between the turbulent flow regime and laminar flow regime is an area know as the transition flow regime. As the term transition implies, it is a flow regime where inertial dominated flow transforms into a viscous dominated flow as the viscosity increases.

In turbulent flow, mixing is relatively easy requiring minimum energy to mix the fluid. In laminar flow, fluids have higher viscosities requiring additional energy to mix the fluid.



Power Number Versus Reynolds Number

AFFINITY LAWS

When dealing with a narrow range of operating conditions the effect of density and viscosity are negligible. If only a single fluid and mixer impeller size (D = constant) is involved, the Pumping and Power Number equations can be reduced to:

$$N_Q \propto \frac{Q}{N} \quad \text{and} \quad N_P \propto \frac{P}{N^3}$$

this leads to the following relationships:

$$Q \propto N$$

$$P \propto N^3$$

When holding the impeller speed and fluid density constant, the following relationships emerge from the Pumping and Power Number equations, provided the impeller area term proportional to D^2 is eliminated.

$$Q \propto D$$

$$P \propto D^3$$

Therefore, for geometrically similar impellers the following affinity laws can be developed:

For D and ρ constant

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$

For N and ρ constant

$$\frac{Q_1}{Q_2} = \left(\frac{D_1}{D_2}\right)^3$$

$$\frac{P_1}{P_2} = \left(\frac{D_1}{D_2}\right)^5$$

These Affinity Laws can be used to illustrate the effect that a change in propeller speed and/or diameter will have on mixing, helping to predict the performance of similar mixers.

SHEAR AND FLOW

From the Diagram below it is easy to see that large impellers running at slow speed have more circulation flow and less head (shear) than do small impellers running at high speed at the same power level.

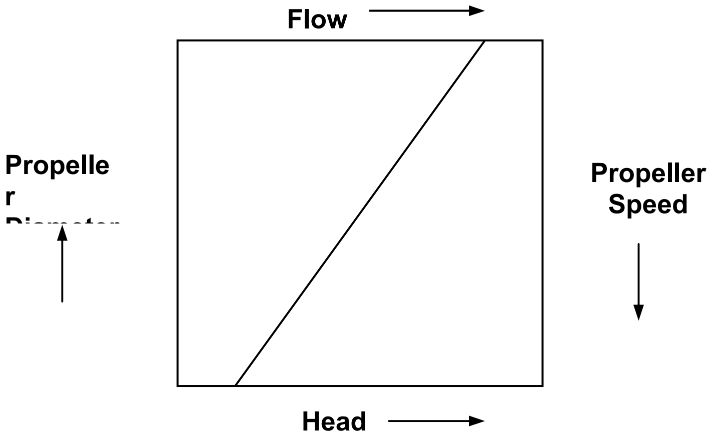


Diagram A

Every mixing process has its own dynamic response requirement for shear rate and pumping capacity. The propellers provided on ABS' submersible mixers have been designed to cover a larger variety of process requirements. An even wider range of propeller styles is available for use with the SCABA top and side entry mixers for use in applications not possible with the submersible line. Diagram B illustrates the relative flow-head requirements of some typical mixer applications.

Heat transfer
Solid - Liquid Suspension
Liquid - Liquid Blending
Solids Dissolving
Gas - Liquid contacting
Liquid - Liquid Blending
Solid Dissolving
Gas - Liquid Contacting
Solids – Liquid Dispersion
Liquid – Liquid Dispersion
Gas – Liquid Dispersion

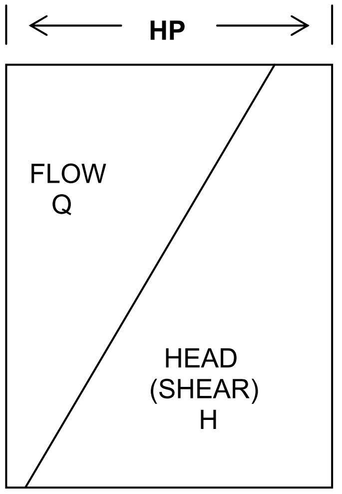


Diagram B

AGITATION INTENSITY

Often the terms agitation and mixing are used interchangeably. However, to understand the dynamics involved, it is important to understand the difference between agitation and mixing. Agitation is the process whereby motion is induced, fluid circulated, and a specific flow pattern is created in a process tank. Mixing is the process of random distribution of two or more separate phases. Some examples of mixing are blending of two fluids, suspension of a solid in a fluid, and dispersion of a gas in a fluid.

In processes where the reaction time is very slow, the mixing intensity and shear forces produced by a mixer have little effect on the reaction rate or product. Mixing in these types of processes is known as macromixing. Average velocities are important in these types of processes. The blending of miscible low viscosity fluids is an example of these types of processes. They are the easiest types of fluids to mix, take very little time to mix, and require the lowest energy levels.

The basis for quantifying the dynamic response for blending and motion is bulk fluid motion. The quantification of bulk fluid motion is known by several names: “Agitation Intensity”, “Agitation Scale”, “Scaba Number”, “ChemScale”, etc. Each involve a scale, usually 1-10, which is related to bulk fluid velocity (V_b) or to surface velocity (V_s).

By definition: $$V_b = \frac{Q}{A}$$

Where: Q = Fluid flow in the tank or basin, ft^3/min
A = Fluid flow cross section, ft^2

Using the above equation and quantifying the agitation intensity in a scale of 1-10 using a bulk velocity range of 6-60 ft/min, the following equation is obtained:

$$A_I = \frac{V_b}{6}$$

Table 1 defines the typical agitation intensities needed for only a few flow sensitive applications. The agitation intensities needed and definition of results for blending miscible fluids and suspending solids is shown in Table 2 and 3.

Table 1
Flow Sensitive Applications

Agitation Intensity	Application	Industry	Process	Classification
< 1	Crude Oil Storage	Petroleum	Suspend bottom sludge & water	Suspension
<= 1	Equalization	Water Treatment	Prevention of concentration surges	Blending
1	Fuel Additive	Petroleum	Blend Miscible Additives	Blending
1 – 2	Brew Kettles	Brewery	Fermentation	Gas Dispersion
2	Syrup Storage	Sugar & Starch	Keep syrup blended uniformly	Blending
2 – 3	Pigment Suspension	Paint	Maintain pigments in suspension	Suspension
2 – 3	Lime Slurry Storage	Water Treatment	Maintain 0-20% solids in suspension	Suspension
2 – 3	Polymer Storage	Polymer	Keep polymers emulsified	Blending or Suspension
2 – 4	Starch Converter	Sugar & Starch	Enzyme conversion (dissolving)	Suspension
2 – 5	Clay Storage	Ceramics	Maintain clay in suspension	Suspension
3	Feed or Holding	Paint	Maintain uniformity during holding	Blending or Suspension
3	Sugar Dissolving	Sugar & Starch Pulp & Paper	Dissolve dry sugar to produce syrup	Suspension
3 – 4	Clay Storage	Ceramics Pulp & Paper	Maintain suspension of clay	Suspension
3 – 4	Lime Slurry Storage	Water Treatment	Maintain 20-30% solids in suspension	Suspension
3 – 8	Blend Tanks	Adhesives	Blending ingredients	Suspension
3 – 10	Flash Mixing	Water Treatment	Rapid mixing of chemicals	Suspension
4 – 5	Lime Slurry Makeup	Water Treatment	Suspension of 0-20% slaked lime	Suspension
6 – 7	Lime Slurry Makeup	Water Treatment	Suspension of 20-38% slaked lime	Suspension
6 – 8	Starch Cooker	Pulp & Paper	Prepare starch for coating	Suspension
6 – 10	Blunger	Ceramics	Breakup and suspension of clay	Suspension
6 – 10	Thin & Tint	Paint	Blend paint base, vehicle and pigments	Blending
6 – 10	Rubber Cement	Adhesives	Cutting and dissolving	Suspension
6 – 10	Emulsion Polymerization	Polymer	Monomer emulsion formation with stabilizers	Blending or Suspension
8 – 10	Lime Slaking	Water Treatment	Conversion of Ca O to Ca $(OH)_2$	Suspension
8 – 10	Bulk Polymerization	Polymer	Polymer is molten or soluble in monomer	Blending or Suspension

Table 2
Agitation Intensity for Blending Miscible Fluids

Agitation Intensity	Sp. Gr. Difference	Viscosity Difference Ratio	Suspend Trace Solids (<2%)	Surface Motion
1 – 2 Mild	< 0.1	< 100 : 1	No	Flat but moving
3 – 6 Medium	< 0.6	< 10,000 : 1	Settling Rates up to 4 ft/min	Rippled at low viscosities
7 – 10 Violent	< 1.0	< 100,000 : 1	Settling Rates up to 6 ft/min	Surging at low viscosities

Table 3
Agitation Intensity for Suspension of Solids

Agitation Intensity	Application Definition	Dynamic Response Description
1 – 2	Requires low solids suspension to achieve the process results.	All solids at the design settling rate are in motion. Moving fillets that are suspended occasionally.
3 – 5	Typically used for dissolving Solids.	All solids at design settling rate suspended completely off the tank floor. Uniform solids suspension to 1/3 of the fluid height. For slurry drawoff at low exit nozzle elevations.
6 – 8	Solids approach complete uniformity.	Uniform solids suspension to 95% of the fluid height. For slurry drawoff up to nozzle elevations of 80% of fluid height.
9 – 10	Maximum practical solids uniformity.	Uniform solids suspension to 98% of the fluid height. Overflow slurry drawoff.

BLENDING

Consider applications where the reaction does not occur until the molecules of two or more materials come into contact with each other. The reaction rate is dependent on the mixing intensity, and mixing time is long when compared to the reaction time. Mixing in these types of processes is known as micromixing, in contrast to macromixing discussed earlier. In micromixing, the addition point is extremely important and will affect the ratio of mixing versus reaction time. At the microscale level, mixing is controlled by molecular diffusion (D_m, ft^2/s). This allows the use of Kolmogoroff's microscale of turbulence (t_k) equation.

$$t_k = \left(\frac{v^3}{e}\right)^{0.25}$$

Where: t_k = eddy size microscale of turbulence, ft

v = kinematic viscosity, ft^3/sec

e = energy dissipation rate per unit mass or power per unit mass

$$e = \frac{gP}{\rho V}$$

g = Gravitational acceleration, ft/sec^2

P = Power, ft-lb/sec

ρ = Density, lb/ft^3

V = Volume, ft^3

Eddy sizes range from 10 to 100 microns and mixing time can be quantified by the equation below.

$$t_m = \frac{{t_k}^2}{D_m}$$

Where : Dm = molecular diffusivity, ft^2/sec

Mixing times can be simulated in the laboratory if the proper scaling techniques are used. However, laboratory simulations will yield shorter mixing times due to higher turbulence levels when other mixing criterion is more important than mixing time.

SOLIDS SUSPENSION

The suspension of solids is a very common mixing application. The suspension uniformity is dependent on the mixer performance, solids properties, fluid properties, solids concentration, and tank or basin geometry. Complete off bottom suspension is the most common requirement requested. Off bottom suspension is achieved when no solids remain in a fixed position on the tank floor for more than one second. This is also known as the “one second criterion” and is defined as the mixing intensity needed to achieve complete suspension.

A measure of the suspension difficulty is the solids settling rate in low viscosity fluids. Activated sludge, paper stock and biological solids all have solids settling rates below 1 ft/min. As a result equal fluid motion can control the above processes.

When the concentration of solids increases, the mixing application changes from one of suspending free settling solids in a low viscosity Newtonian fluid to blending in an elevated viscous non-Newtonian fluid. Hindered settling of solids causes this transformation and the mixer selection becomes more difficult. Each application should be evaluated individually and a rheological test performed unless previous experience with similar materials has been gained.

Applications having a free settling solids velocity rate greater than 1 ft/min and solids concentrations up to 40% by weight are difficult mixing problems. Mixer selection for these processes should be approached with caution. Otherwise, the mixer will be either undersized or oversized. A very conservative approach to obtain complete suspension in these applications is to size the mixer based on the required power per unit weight, which is proportional to the mixers transmitted critical shear stress on the wetted surface area in the tank, mixer speed, impeller diameter, and hydraulic radius.

$$\frac{P}{V\rho}\,\alpha\,\frac{t_{cr}ND}{\rho R} \quad \text{and} \quad R = \frac{V}{S}$$

Where:

P = Power

V = Volume

ρ = Density of slurry

σ = Shear stress

N = Mixer speed

D = Impeller diameter

R = Tank hydraulic radius

S = Wetted tank surface area

It is important to know the critical shear stress required to keep solids in complete suspension when the tank dimension and volume along with mixer speed and impeller diameter are known. Critical shear stress is a function of the following slurry properties.

1. Fluid density difference (D_p)
2. Particle diameter (d_p)
3. particle settling velocity (v_t)
4. Fluid viscosity, μ
5. Slurry concentration, C_w

For slurries having low viscosity fluids such water, solids having settling rates greater than 1 ft/min, and solids concentrations of no greater than 10% by weight, the following equation can be used to define the relationship between critical shear stress and concentration.

$$\frac{t_{cr}}{\Delta\rho_s d_p} = X(C_w)^{0.5}$$

Where: X = 3.16 for circular tanks
X = 4.42 for rectangular tanks

The thrust (F) necessary for just suspending the solids is:

$$F = t_{cr}S = X(C_w)^{0.5}\Delta\rho_s d_p S$$

MIXING TIME

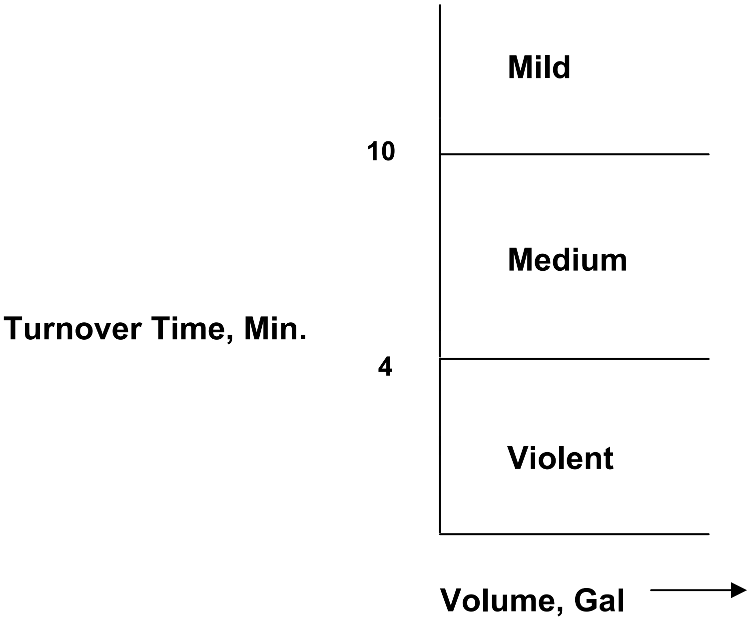
Another criteria often used in determining the performance of mixed systems is the turnover rate (Q/V_M) the turnover time (V_m/Q) and the number of turnovers t_m x (Q/V_m), where t_m is the mixing time.

Tests have shown that the mixing time is equal to 3 times the turnover time.

$$t_m = 3\frac{V_m}{Q}$$

Simply stated, this means three tank turnovers are needed to completely blend the contents. This is normally the criteria used and generally found in literature for blend time estimates.

Turnover time can be equated to agitation intensity. Below is a diagram that can be used to quantify mixing intensity into three categories.



MIXING CLASSIFICATION

	Liquid/Liquid Blending	Solids/Liquids Suspension	Gas/Fluid Dispersion	Solids/Liquid Dispersion	Liquid/Liquid Emulsion
Process Variables	Volume Density Viscosity	Volume Density Solids Settling Velocity	Volume Density Gas Velocity	Volume Density Viscosity	Volume Density Viscosity
Desired Process Result	Blend time, Heat transfer Rate, Reaction rate.	Dissolution rate Suspension rate	Reaction rate Gas-absorption rate	Dispersion Rate, solids concentrate	Emulsion rate, Emulsion stability
Primary Mixing Classification	Fluid motion	Fluid motion	Shearing Force	Shearing Force	Shearing Force
Secondary Mixing Classification			Fluid motion	Fluid motion	Fluid motion
Process Examples	Neutralization, Paint blending, Chemical makeup, Polymerization of soluble ingredients, Fish farming, De-icing applications.	Pulp suspension, Metallurgical suspension, Coal-slurry suspension, Sludge holding, Digesting mixing, Flocculation, Lagoon cleaning, Manure suspension.	Neutralization, Hydrogenation Aeration	Clay, Powder paint, Calcium carbonate (Limestone)	Mayonnaise, Cosmetics, Milk, Lubricating oils

SIZE ESTIMATES

The following fundamentals can be used to estimate mixer sizes:

1. Equal torque provides equal mixing performance.

2. Equal Impeller Tip Speed provides equal torque/volume and consequently, equal bulk fluid velocity.

3. Equal power per volume provides equal mass transfer.

4. Heat transfer coefficients are proportional to power per volume to an exponent (exponent varies with impeller design).

5. Specific power $e = P_P/V_M$ is often used as a criteria for determining mixer size. Using specific power will normally result in a mixer that will provide the desired mixing effect, but will also result in mixers that are oversized for the application. For this reason, specific power should only be used as an estimating tool. Below is a table of typical specific power requirements for some mixer applications (taken from V.M. Uhl):

Operation	Power Requirement
Blending vegetable oils	1hp/100,000 lb (0.4kW/100,000 kg)
Blending gasoline	0.3 hp/1000 bbl (0.014 kW/m^3)
Clay dispersion	10-12 hp/1000 gal. (1.9-2.2 kW/m^3)
Fermentation (pharmaceutical	3-10 hp/1000 gal. (0.6-1.9 kW/m^3)
Suspension polymerization	6-7 hp/1000 gal. (1.2-1.3 kW/m^3)
Emulsion polymerization	3-10 hp/1000 gal. (0.6-1.9 kW/m^3)
Solution polymerization	15-40 hp/1000 gal. (3-7.8 kW/m^3)

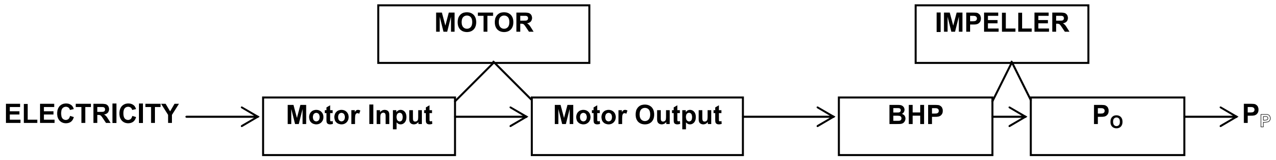
Use of these specific power values should be restricted to estimated mixer sizing only, but are adequate for use during the feasibility stage of a project. Your ABS application engineer can provide you with the optimum mixer size that will provide the performance needed for your application.

OPERATING COST

All systems require an input energy source in order to develop output energy. The output energy is a function of input energy minus all system losses. Thus, the relationship between input and output energy can be expressed as the **Total Power Consumed (P_{TC})** by the system. For mixers, the input energy is normally the electrical motor input power, and the output energy is normally the liquid flow, expressed as Fluid Output Power (P_P). The **Total Efficiency** (E_T) of the system is extremely important because it is inversely proportional to the operating costs of the mixer. In other words, the higher the **Total Efficiency** of a mixer the lower its operating costs will be. Over a long time period this cost reduction can exceed the initial equipment costs.

The formulas required to determine electrical, hydraulic and **Total Efficiency** were shown in Terminology section.

The flow diagram below illustrates the conversion of electrical input power to system Fluid Output Power (P_P).



$$\frac{Output}{input} = E_E$$

(Electrical)

$$\frac{P_P}{BHP} = E_H$$

(Hydraulic)

$$E_E \times E_H = E_T$$
$$E_E \times E_I \times E_{IS} = E_T$$
$$E_E \times E_I = E_T$$

(Combined Motor & Mixer)

SUBMERSIBLE MIXER DESIGN STEPS:

1. Obtain information about the process and application.
2. Select a mixer that will provide the dynamic response needed for the process and application.
3. Select mixer location and position to provide maximum mixer performance and create smoothest possible running condition.

All three of the above steps are equally important and need to be executed correctly in order to get a good submersible mixer installation. Often times step three does not get the attention it needs which can lead to poor mixing results. Proper positioning will result in a well-mixed tank that has minimal losses and an even distribution of shear forces and velocities throughout the entire tank. The following is a list of general location recommendations that apply to submersible mixers.

- To achieve maximum performance the flow approaching the mixer should produce minimum disturbance. This is accomplished by evenly distribution of the approaching flow around the mixer restricting air from entering the propeller area. To prevent vortexes in the propeller area the approaching velocities should not be excessive.

- Restrictions or obstructions close to the propeller should be avoided.

- The mixer's jet flow could transmit unbalanced loads to the propeller. Obstacles in front of the propeller may set up reflected waves that can cause unbalanced loads on the propeller.

- Minimum submergence levels should be observed. Vortexes cause unbalanced loads on the mixer propeller.

- To prevent unbalanced propeller loads, the minimum distance a propeller blade tip should be located from a tank sidewall or floor is one half the propeller diameter.

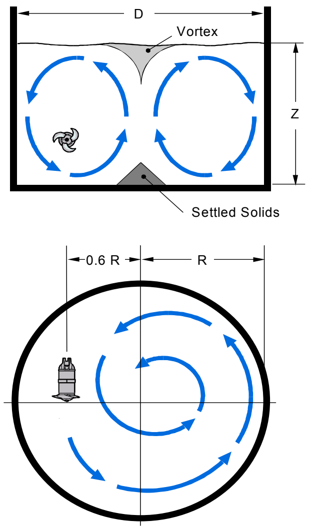
- Mixers used in combination with aeration equipment, such as in oxidation ditches, should be isolated from the aeration system. It is recommended that the suction side be kept clear of diffusers a distance equal to one to two times the liquid depth and the discharge side be kept clear a distance equal to one to three time the propeller diameter.

- If the mixer location is restricted such that they must me located close to each other, a divergence angle of 25^{o} minimum should be used to prevent the two jet streams from merging into one, reducing the overall mixing performance of the mixers.

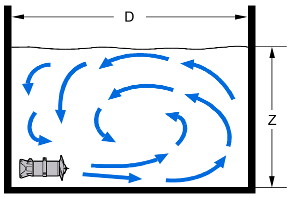
- The mixer's output jet stream should be pointed in the direction of the tank flow to obtain optimum mixing performance.

MIXER POSITIONING RECOMMENDATIONS

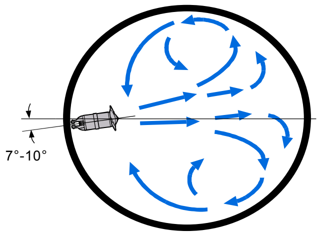
Round Tanks

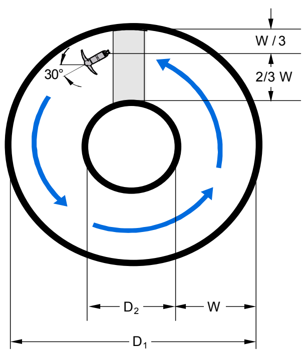


The rotating flow pattern is the simplest flow to create and produces high flow velocities quickly. Installations of this type are shown at left and below. It is effective in mixing materials with high solids concentrations and incorporating dry solids. In applications containing heavy solids, a deposit of settled solids may exist at the center of tank.



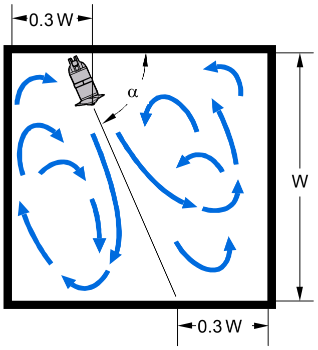
In round tanks having a liquid level between 0.3 and 1.0 times the tank diameter, complete mixing and solids suspension can be achieved when the mixer is located as shown at left and below, angled to the left of the tank center line 7 – 10^{o}.



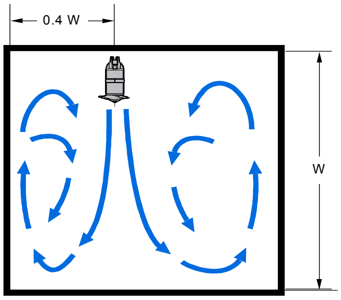


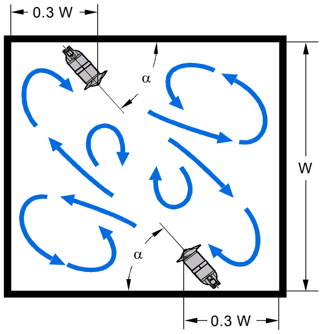
Locating and orienting a mixer as shown in the illustration on the left attains optimum mixing performance. If multiple mixers are required, the mixers should be installed equidistant from each other to minimize power.

Square Tanks

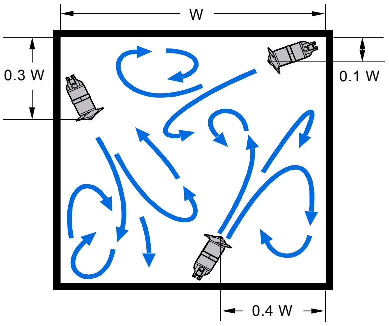


When the application mixing requirements can be met with one mixer, and the liquid level is between 0.3 and 1.0 times the width, the mixer should be located as shown in either of the first two illustrations on the left. The top illustration is the preferred orientation, but the orientation shown in the lower can also be used. Both will provide good mixing performance. The mixer should be located so the jet stream will not encourage short circuiting between the inlet and the outlet.





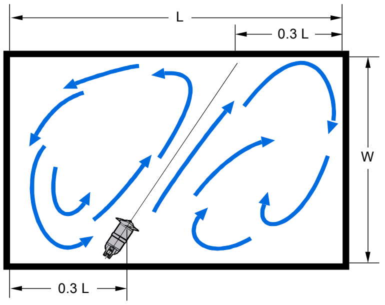
For applications requiring more than one mixer to provide the mixing requirements the mixer should be located as shown in either of the last two illustrations on the left. The mixers should be located and oriented so their jet streams are not directed at each other.



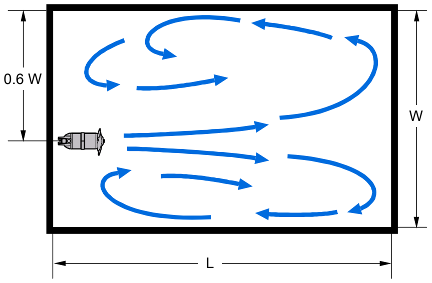
MIXER POSITIONING **RW and SB SERIES**

Dwg: DS-M01-144 **Rev:** **Date:** 8/00 **Tab** ______________ **Page** _______

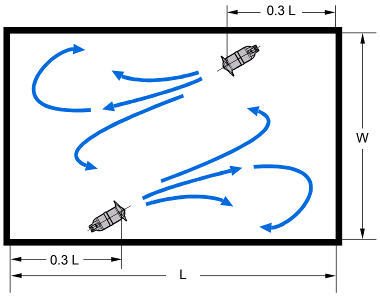
Rectangular Tanks



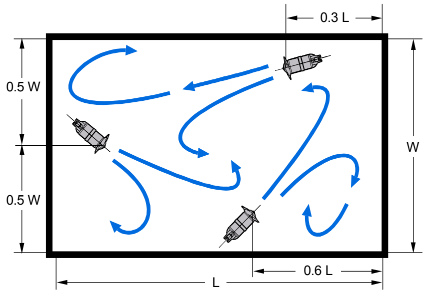
Rectangular tanks with length to width ratios that do not exceed 2.5 can be mixed with one mixer, located as shown in the illustration at left. One mixer can be used up to a length to width ratio of 5.0, but additional horsepower is needed. Therefore, two mixers should also be considered to minimize power requirements. Orientation for two or more mixers is shown below.



If the tank length to width ratio does not exceed 2.5 and the tank width is less than 5 to 8 times the propeller diameter, the mixer should be located as shown in the illustration at left.



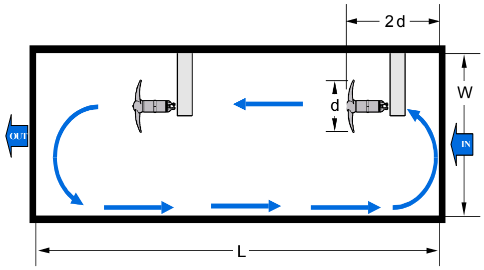
When the tank length to width ratio exceeds 5.0, multiple mixers should be used and located as shown in the illustration at left and below. As with square tanks, the mixers should be located and oriented so their jet streams are not directed at each other.



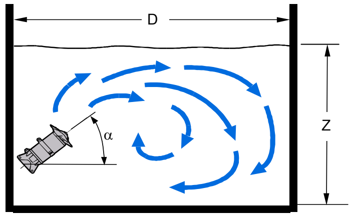
MIXER POSITIONING | **RW and SB SERIES**

Dwg: DS-M01-144 **Rev:** **Date:** 8/00 **Tab** ____________ **Page** ______

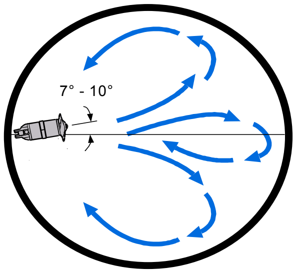
Special Applications

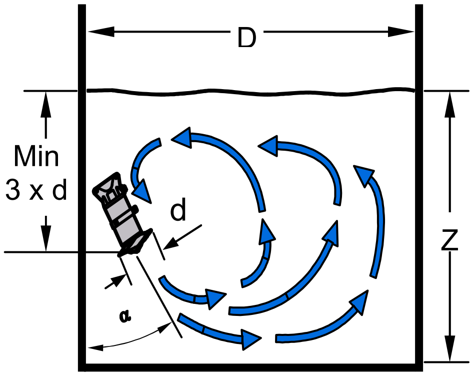


Long narrow tanks require multiple mixers installed in series.



To break up and incorporate sludge or scum layers, the mixer should be angled upward. Orienting the mixer in this way will direct the jet stream at the sludge or scum layer breaking it up and incorporating it into the tank liquid.





To incorporate solids and suspend heavy solids the mixer should be angled downward to direct the jet stream at the tank floor and to suck in solids from the surface.

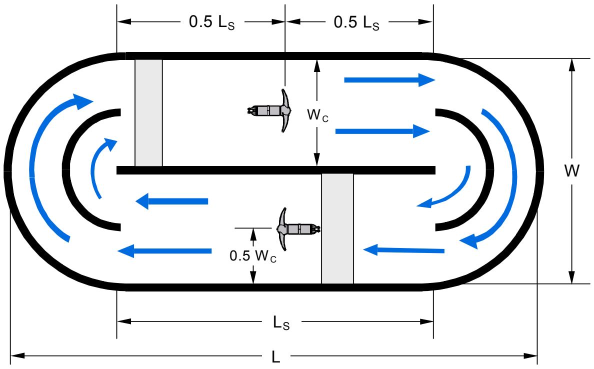
MIXER POSITIONING

RW and SB SERIES

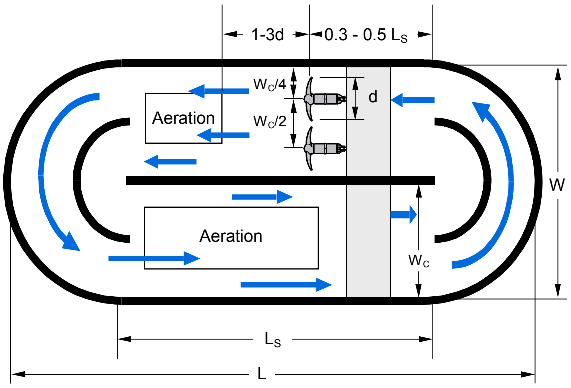
Dwg: DS-M01-144 **Rev:** **Date:** 8/00

Tab ____________ **Page** ______

Oxidation Ditches



For tanks with brush aerators, the mixers should be positioned evenly around the tank as shown in the illustration to the left. Positioning the mixers in this manner will prevent unbalanced propeller loading caused by flow turbulence.



For tanks with diffused air, the mixers should be located as shown on the illustration to the left. Positioning the mixers in this manner will prevent unbalanced propeller loading caused by air and flow turbulence.