Agitated Vessel

The design of agitated vessel is of two parts: (i) process design, (ii) mechanical design

Process design mainly involves choosing the impeller types and calculating the power required for agitation. The impeller creates a flow pattern in the system, causing the liquid to circulate through the vessel. The most common types of impellers are: propeller, paddle, and turbine.

Propellers:
These are high speed impellers (350 – 1500 rpm), creating mainly axial flow currents. Propellers rarely exceed 18 inch diameter. Axial flow currents are needed for solid-fluid mixing.

Paddles:
These have 2 or 4 numbers of flat blades. Some times they are pitched, but more often they are vertical. They operate at slow to moderate speeds (20 – 150 rpm).

Turbines:
These are similar to paddles, but with a smaller impeller diameter than paddles.

Baffles:
In an unbaffled vessel the tangential flow currents create a vortex at the surface of liquid. To prevent this baffles are attached to the side of the vessel.

Power required for agitation
It is a function of rpm of impeller, viscosity of fluid, density of fluid, dimensions of vessel and impeller. It is related by the dimensionless form as:

$$N_p = f(N_{\mathrm{Re}}, N_{\mathrm{Fr}})$$

where

$$N_p = \frac{P}{n^3 D_a^5 \rho} \quad ; \quad N_{\mathrm{Re}} = \frac{n D_a^2 \rho}{\mu} \quad ; \quad N_{\mathrm{Fr}} = \frac{n^2 D_a}{g}$$

P = power required for agitation
n = rotational speed of impeller
D_a = diameter of impeller
ρ = density of fluid
μ = viscosity of fluid

For baffled vessels, Power number (N_p) does not depend on the value of Froude number (N_{Fr}), and it is only a function of Reynolds number (N_{Re}).

Empirical correlations and charts are available with the dimensional groups to get N_p, from which power required for agitation is calculated. This required power is supplied by means of electrical drive / gearbox assembly and transmitted to the vessels by the impeller attached with the shaft coupled to the drive.

The mechanical design of agiated vessel is calculated as per pressure vessel design codes such as ASME Section VIII Division 1 or IS 2825.