Short Communication (T-1)

EXPERIMENTAL STUDIES ON EFFECT OF CUT IN THE BAFFLE ON POWER CONSUMPTION

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ABSTRACT

Experimental studies on effect of baffle cut on power consumption using standard Turbine agitator has been presented here. Modification was done by introducing V cut in the baffle. The power consumption for the agitated vessel fitted with standard plain baffle is higher than that of the cut baffle.

Key Words : Agitated vessel, Power consumption, Turbine agitator, Baffle cut

INTRODUCTION

Agitators are used widely for Fermentation, Effluent treatment and other various Chemical and Biochemical Engineering applications namely mixing of miscible and immiscible fluid, dispersion of gas in liquid, suspension of solids in liquid as it is done in hydrogenation of oils. A wide variety of agitators are used for different applications of mixing and agitation. Among these turbine type agitator is used widely for dispersing gas into liquid, which is very much required in fermentation and effluent treatment application. In the early 1970s, researchers recognized that the angle of impeller blade, vessel geometry, baffle were plays the major role in agitated vessel and postulated that an impeller with more baffle can perform better in terms of power consumption. Since then, impellers with angle of blades have been discarded, and the 6-blade disk turbine impeller with 4- baffle has become the most popular impeller. The power consumption depends on the geometrical parameters of the agitator, baffles and vessel. The power curves for different agitators working in the vessel equipped with standard baffles (i.e. baffle length L is equal to liquid height H in the vessel) were reported by Joanna Karcz, Marta Major, 1998. This paper presents the experimental on effect of V in the baffle on the power consumption in the agitated vessel with standard Turbine agitator for water system.

MATERIAL AND METHODS

Technical details of agitated vessel

Agitated vessel of inner diameter $D = 0.3$ m, filled with the fluid up to height $H = D$
and fitted with equally spaced four baffles of width $B = 0.1D^{2/3}$. The agitator is a standard Turbine type with the diameter one-third of tank diameter. The baffle is modified by introducing V cut in the baffle. Experiments were performed for vessel fitted with four equally spaced plain baffles, with four equally spaced V baffles and two V cut baffles fitted in opposite directions.

![Fig. 1: Arrangement of baffles in the agitated vessel](image)

(a) Plain baffle (b) Cut baffle

**Experimental setup and procedure**

The experimental setup used for the present study is shown in **Fig. 2.** It consists of agitated vessel with equally spaced four baffles, turbine agitator attached to the shaft of a single phase electrical motor. The motor assembly with agitator is fixed to a stand by movable frame so that the height of the agitator can be varied to the required level. The electrical motor is connected to a voltage regulator, which is used to vary the speed of motor. The voltage regulator is connected to wattmeter to measure the power consumption during mixing. The wattmeter is connected to the single phase A-C power supply. The non-contact infrared RPM sensor is used to measure the speed of an agitator$^{4,5}$.

To start with, the agitated vessel is filled with fluid to a height equivalent to diameter of the tank. The plain turbine agitator is fixed on to the shaft and the agitator assembly is placed in the vessel centrally so that the location of the agitator is placed at a height which is equivalent to the diameter of the agitator from the bottom of the tank. The agitator is allowed to rotate at a particular speed by adjusting a voltage with the help of speed regulator and the power consumption for the particular run was noted with wattmeter after a steady state. The speed of agitator was varied with speed regulator and the power consumption for each run was noted. Experiments were performed by fixing four equally spaced plain baffles, with four equally spaced V baffles using water as working fluid.
Calculation of power and Reynolds number

The power number and Reynolds number were calculated using the following relations

Power Number \( (N_p) = \frac{P \cdot g_c}{n^3 \cdot D_a^5 \cdot \rho} \)  \hspace{1cm} (1)

Reynolds Number \( (Re) = \frac{n \cdot D_a^2 \cdot \rho}{\mu} \) \hspace{1cm} (2)

Where \( P \) is power required for running agitator in Watt

\( n \) is speed of agitator in revolution per second

\( D_a \) is diameter of the agitator in m

\( \rho \) is density of the fluid in kg/m\(^3\)

\( \mu \) is viscosity of the fluid in Pa.s

\( g_c \) is gravitational constant taken as 1kg m/N s\(^2\)

RESULTS AND DISCUSSION

Experimental power consumption for three different types of baffles is depicted in Fig.3. It is observed from Fig.3 that the power consumption for the agitated vessel fitted cut baffles is less than of vessel fitted with plain baffles for the range of Reynolds number studied. This may be due to the reason that cuts introduced in the baffle produces less shear in fluid mixing during agitation leading to decreased power consumption.
CONCLUSION

1. Experimental studies on power consumption in an agitated vessel fitted with four equally spaced plain baffles, with four equally spaced V baffles were presented using water and Glycerol.

2. The power consumption for plain baffle is higher than the V cut baffle.

3. These cut baffles can be effectively used for Fermentation, Effluent treatment, and other various Chemical and Bioprocess Engineering applications.

Nomenclature

- $B$: width of the baffles, m
- $D$: inner diameter of the agitated vessel, m
- $D_a$: diameter of the agitator, m
- $H$: liquid height in the vessel, m
- $L$: length of the baffle, m
- $n$: agitator speed, $s^{-1}$
- $P$: power consumption, W

Power number = $P / n^3 D_a^5 \rho$

Reynolds number = $n D_a^2 \rho / \mu$

Greek letter

- $\mu$: dynamic viscosity of the liquid, kg/ms
- $\rho$: liquid density, kg

REFERENCES


