(164) The Characteritstics of Agitated Mixing of Mechanical Stirring Vessel Investigated by Water Model Test

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1. Introduction

Various external desulphurization processes of hot metal have so far been proposed. The method using an impeller is one of such processes, which is reported by Japan Patent Publication, No. 42-12343 (1967). The characteristics of agitated mixing of KR Vessel has been studied by means of water model test.

2. Results of experiment

(1) Flow model

The rotating radius of forced vortex r_c, may be calculated by Reynold's number. The equation of thier relation is:

$$r_c/r_1=Re/(10^3+1.6Re)$$

Reynold's numbers observed and calculated are greater than 10 000, and the value of r_c is almost a constant.

The relation of hollow depth of liquid and revolution rate w or Reynold's number is shown as following:

$$H=0.06w^{1.99}$$

or

$$H=0.06(1.3\cdot10^{-4}Re)^{1.99}$$

(2) Height of liquid surface

The relation of height risen in agitated vessel and revolution rate w or Reynold's number is shown as following:

$$H=6.6\cdot10^{-3}.w^{1.99}$$

or

$$H=6.6\cdot10^{-3}(1.3\cdot10^{-4}Re)^{1.99}$$

(3) Efficiently agitated surface

The ratio of r_c/r_1 is great, the efficiently agitated surface will be small. The value of r_c/r_1 equal to 0.70, then the efficiently agitated surface is:

$$S=(1-r_c/r_1)100\%=30\%$$

(4) Imported mechanical energy

Because of rotating of impeller, the liquid mainly produces rotating flow in circle direction with impeller. So it gives force acting on impeller is small, the power necessary for agitating liquid is small, it means imported mechanical energy is small. The results on observation and calculation are treated, and give the equation as following:

$$P=(1.35n-110.4)^3$$

or

$$P=1.67\cdot10^{-3}Re-110.4$$

(5) The distribution of Reynold's stress

In agitated vessel, the Reynold's stress of fluid along radial direction is calculated. It shows this stress at impeller tip range is more bigger, with radius increase, its value decrease rapidly.

(6) Centrifugal force of solid powders floating

The centrifugal force of solid powders at near r_c region are more bigger. While radial distance is greater than r_c, its centrifugal force is inversely proportional to that of the radial distance r^3.

3. Conclusion

Because the liquid produces rotating flow in circle direction in KR Vessel, all fluid particles almost move concentrically round the axis. Solid powders are withdrawn in liquid, which depth is about equal to the hollow height of liquid surface. They are dispersed between the region of r_c and impeller tip, and rejected along radial direction, then floated. At above rejecting region, they are taken circle motion on withdrawing-rejecting-withdrawing. Therefore, KR Vessel can be called a mixing device of a "partial mixing, withdrawal, shear type in radial direction".

REFERENCES

1) Japan Patent Publication: No.42-12343, (1967).
2) S.Nagata: Mixing, Principles and Application, (1975).
3) I.Yama: Chemical Engineering, 20(1956), No.12, 688.