Solid-Liquid and Gas-Liquid Mass Transfer in “NX Mixer”

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Introduction

NX Mixer has been developed by Japan Chemical Engineering & Machinery Co., Ltd. based on the anchor impeller applied to low viscosity liquid, where two original baffles were installed on the vessel wall. NX Mixer type1 has retreating bottom blades under the anchor. NX Mixer type2 has a double helical ribbon around the shaft

The mass transfer volumetric coefficient $K_L a$ for heterogeneous system is one of the most important factors on the design of mixer, as the mass transfer through the interface is frequently the rate-controlling step. Thus solid-liquid and gas-liquid mass transfer coefficients in an agitated vessel with NX Mixer were measured.

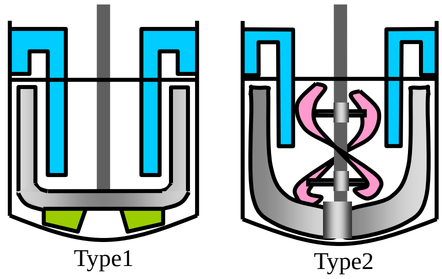

Fig.1 Schematic diagram of NX Mixer

Solid-liquid mass transfer under aeration

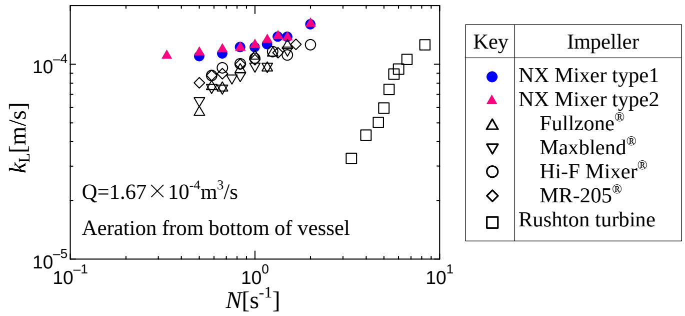

Fig.2 Effect of rotational speed on solid-liquid mass transfer coefficient

When the gas was sparged from the vessel bottom, k_L of NX Mixer was larger than that of the other impellers in the range of low impeller rotational speed. Because the anchor part of NX Mixer was set up with narrow clearance between the vessel bottom and the impeller tip, the solid particles were suspended easily. In addition, the sparged gas from the vessel bottom helped to suspend the particles.

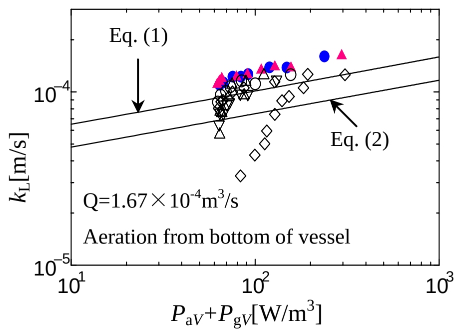

Fig.3 Effect of power consumption on solid-liquid mass transfer coefficient

The correlations of Levins and Glastonbury (1972) and Hiraoka *et al.* (1990) were shown in Figure. 3.

Levins and Glastonbury (1972)
$$\frac{k_L d_p}{D} = 2 + 0.50\left(\frac{d_p{}^4 P_V}{\rho \nu^3}\right)^{0.203} Sc^{1/3} \qquad (1)$$

Hiraoka *et.al.* (1990)
$$\frac{k_L d_p}{D} = 0.45\left(\frac{d_p{}^4 P_V}{\rho \nu^3}\right)^{0.193} Sc^{1/3} \qquad (2)$$

NX Mixer and the other large impellers have almost the same solid-liquid mass transfer coefficient at the same power consumption per unit volume.

Gas-liquid mass transfer

All the experimental data of $K_L a$ were correlated with Eq. (3) by Hiraoka *et al.* (2001) based on the correlation by Nishikawa *et al.* (1981a,1981b) in the Reynolds number range of Re_d>270.

$$K_L a = (K_L a)_a + (K_L a)_g \qquad (3)$$

$$(K_L a)_a = 0.039\mu^{-1/3}\sigma^{-2/3}D^{1/2}P_{aV}$$

$$(K_L a)_g = 0.12 P_{aV}{}^{0.12} P_{gV}{}^{0.70}\mu^{-0.25}\sigma^{-0.6}D^{0.5}$$

where $(K_L a)_a$ and $(K_L a)_g$ mean that by aeration and that by agitation, respectively. $K_L a$ calculated with Eq. (3), $K_L a$(cal), was compared with the experimental data, $K_L a$(exp). Because those of large impeller were not correlated with Eq. (3), the agitation part of Eq. (3) was modified by Eq. (4). $K_L a$ of the large impellers including Maxblend® can be correlated within the experimental error of ±30%, as shown in Fig. 4.

$$(K_L a)_g = 0.009 P_{aV}{}^{0.12} P_{gV}{}^{1.36}\mu^{-0.5}\sigma^{-0.6}D^{0.5} \qquad (4)$$

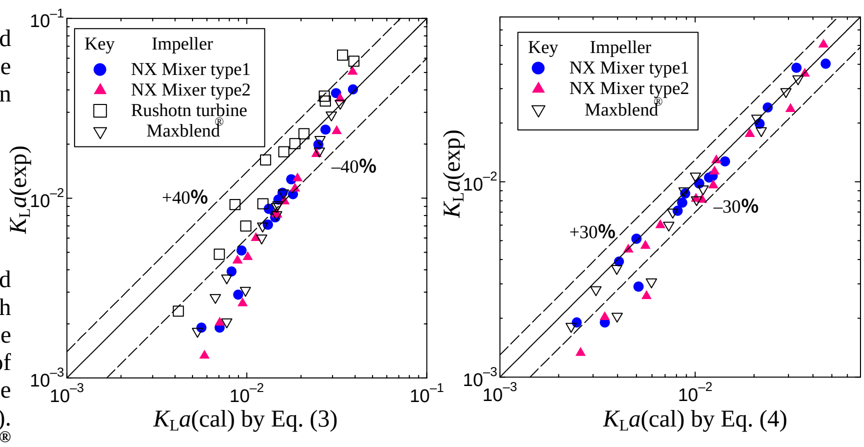

Fig. 4 Comparison of mass transfer coefficient calculated from Eq. (3) and Eq. (4) with experimental data.