Appendix A: SUPPLEMENTARY MATERIAL

S.1 Calculation of reactor properties

The dimensionless number of Reynold number (Re) and power number (N_p) were calculated using equation S.1 and S.2, respectively.

$$\mathrm{Re} = \frac{\rho N D^2}{\mu} \tag{S.1}$$

$$N_p = \frac{P}{\rho N^3 D^5} \tag{S.2}$$

where, ρ is the fluid density (kg/m^3), N is the agitation speed (rev/s), D is the impeller diameter (m) and P is the impeller power (W). From equation S.2, the impeller power (P) can be calculated as:

$$P = N_p \rho N^3 D^5 \tag{S.3}$$

For preparative scale extractor, the Reynold number (Re) was calculated by equation S.1. Since the Reynold number is greater than 10000, the flow is fully turbulent.

$$\mathrm{Re} = \frac{\rho N D^2}{\mu} = \frac{878.8(12.5)(0.07)^2}{0.0022249} = 24192.8$$

S.2 Scale-up at constant power/volume (P/V)

The constant power per volume is a practical and conservative scale-up criterion which is used in equal mass transfer system. The power dissipated by the agitation system is fundamental to any mixing process since energy is needed to homogenize the vessel content, disperse immiscible phases, suspend solids, increase mass transfer and produce the desired mixing effect. As the power per volume for preparative scale and pilot scale is constant, hence:

$$\left(\frac{P}{V}\right)_{large} = \left(\frac{P}{V}\right)_{prep}$$

$$P_{large} = P_{prep}\frac{V_{large}}{V_{prep}}$$

$$\text{Since } P \propto N^3 D^5, V \propto D^3$$

$$N_{large}^3 D_{large}^5 = N_{prep}^3 D_{prep}^5 \left(\frac{D_{large}}{D_{prep}}\right)^3$$

$$N_{large} = N_{prep}\left(\frac{D_{prep}}{D_{large}}\right)^{2/3}$$

$$N_{large} = 500rpm\left(\frac{0.06m}{0.07m}\right)^{2/3} = \mathbf{451rpm}$$

S.3 Calculation of just-suspended speed, N_{js}

The just-suspended speed, N_{js} is calculated by using the Zwietering's equation (Eqn. S.4). The Zwietering's constant, S is depending on the type of impeller and it can be calculated by equation S.5. The solid effective density ($\rho_{s,eff}$) is the density of solid submerges in the liquid where pore volume is included [1,2].

Table S.1 : Parameters used in Zwietering's equation.

Parameters	Values
Zwietering's constant, S	7
Liquid mass, M_l (kg)	8.788
Liquid density, ρ_l (kg/m^3)	878.8
Liquid viscosity, μ (Pa.s)	0.002225
Liquid kinematic viscosity, ν (m^2/s)	2.53×10^{-6}
Solid mass, M_s (kg)	1.094
Solid density, ρ_s (kg/m^3)	396.67±2.08
Solid effective density, $\rho_{s,eff}$ (kg/m^3)	637.73±1.04
Solid diameter, d_p (m)	0.00025
Solids concentration, X	11.07
Pore volume, ε	0.50
Impeller diameter, D (m)	0.07
Reynold number, Re	13824.4
Froude number, Fr	0.40
Δρ (kg/m^3)	241.07±1.04
Just-suspended speed, N_{js} (rps)	7.51±0.01
Just-suspended speed, N_{js} (rpm)	450.84±0.88
where, $N_{js} = \dfrac{S(g\Delta\rho/\rho_l)^{0.45} d_p^{0.2} X^{0.13} \nu^{0.1}}{D^{0.85}}$	(S.4)
$S = \mathrm{Re}^{0.1} Fr^{0.45} \left(\dfrac{D}{d_p}\right)^{0.2} X^{0.13}$	(S.5)
$Fr = \dfrac{N^2 D}{g}$	(S.6)
$X(\%) = \dfrac{M_s}{M_T} \times 100\%$	(S.7)
$\rho_{s,eff} = (1-\varepsilon)\rho_s + \varepsilon\rho_l$	(S.8)
$\Delta\rho = \rho_l - \rho_{s,eff}$	

References

1. Atiemo-Obeng, V.A.; Penney, W.R.; Armenante, P. Solid–Liquid Mixing. In *Handbook of Industrial Mixing: Science and Practice*. Paul, E. L., Atiemo-Obeng, V. A., Kresta, S. M., Eds.; John Wiley & Sons, Inc.: New York, USA, 2004; pp. 543-584.
2. Ibrahim, S.; Jasnin, S.; Wong, S.; Baker, I. Zwietering's equation for the suspension of porous particles and the use of curved blade impellers. Int. J. Chem. Eng. 2012, *2012*, Article ID 749760, 13 pages