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LETTER TO EDITOR

REPLAY TO COMMENTS ON *FLOW CHARACTERISTICS OF AXIAL HIGH SPEED IMPELLERS* (CHEM. PROCESS ENG., 2010, 31, 661)

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The comments made by Professor Joshi are a most welcome addition to the findings presented by us (Fořt et al., 2010). We agree that many valuable studies in the past dealt with experimental investigation of turbulent velocity field in stirred systems with axial high-speed impellers. Therefore it would be highly desirable to present a comprehensive comparison of the efficiency of various types of impellers, especially for their optimum design for processes in chemical and biochemical industries. Nevertheless in such a comparison it should be taken to consideration the quality and reliability of experimental data, because both chosen experimental techniques and selected independent variables (position of impeller, viscosity and density of agitated liquid, etc.) have to be well defined and comparable in all investigated stirred systems.

Blending process in mechanically agitated system can be described under turbulent regime of flow of agitated liquid by simple equation (Grenville and Nienow, 2003)

$$Po^{1/3} n\Theta_I \left(\frac{D}{T}\right)^2 = C \tag{1}$$

where constant C in Eq. (1) depends on the degree of homogeneity

$$I(\Theta) = \frac{\langle c(\Theta)\rangle - c_0}{c_\infty - c_0} \tag{2}$$

The power number describing the dimensionless impeller power input P is defined as

$$Po = \frac{P}{\rho n^3 D^5} \tag{3}$$

Quantities c_0 and c_∞ express the initial and final concentration of the dissolved matter in an agitated batch, respectively, and quantity $\langle c(\Theta)\rangle$, depending on time Θ, is defined as an average value of the concentration in the whole volume of the agitated batch, except for the volume of the tracer. When a few (*e.g.* conductivity) probes are sited in representative locations of a pilot plant mixed batch, difference of their signal does not depend for higher values of quantity I on time Θ (Grenville and Nienow, 2003), and the average concentration value $\langle c(\Theta)\rangle$ can be replaced by the measured local concentration value. Fořt and Jirout (2011) tested the value of parameter C published by Grenville and Nienow (2003)

$$C = 5.20 \pm 10\%,\ I = 0.95 \tag{4a}$$

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*Corresponding author, e-mail: Ivan.Fort@fs.cvut.cz and for 14 various tested axial flow impellers they experimentally verified conditions of validity of constant C in Eq. (1):

$$C = 5.20 \pm 10\%, I = 0.98 \tag{4b}$$

Thus the change of parameter I in Eq. (4b) in comparison with value of this parameter in Eq. (4a) results in the longer blending time about 30%. Recently Liu (2011) confirmed the finding that calculation of the blending time strongly depends on the position of the conductivity probe(s) with respect to the positions of the inlet tube where the tracer of liquid is put to the charge. Therefore it seems that exact definition of the most efficient impeller for blending process without precise knowledge of the mechanism of addition of the tracer, not quite clear from data in literature, is inadequate. Therefore we were able to compared only 14 geometries of stirred systems (agitators) following our own experiments.

Energetic efficiency of impeller

$$E_p = \frac{N_{Q_p}^3}{Po} \tag{5}$$

and total energetic efficiency of impeller

$$E_t = \frac{N_{Q_t}^3}{Po} \tag{6}$$

are directly proportional to the hydraulic efficiency of impeller (Fořt, 2011). Then from the knowledge of the power number, flow rate number N_{Q_p} and total flow rate number N_{Q_t} it is possible for geometric similar systems under turbulent regime of flow of agitated liquid to compare the energetic as well as the hydraulic efficiency of axial flow impellers. We compared in our study (Fořt et al., 2010) only these impellers for which we had our own consistent experimental data; *e.g.* only for one of them (6-blade down pumping pitched blade impeller – pitch angle α = 45°) the scatter of presented N_{Q_p} data was approx. ±15%. Then, again, careful analysis of published data should be made before comparison of their efficiency. As far as the criterion for settlement of the hydraulic efficiency of tested impellers, we preferred quantities defined by Eqs. (5) and (6) and not quantities N_{Q_p}/Po and N_{Q_t}/Po mentioned in commented Article, because our terms correspond to the real physical quantities. Moreover, our conclusions can be confirmed by means of results of experiments carried out with tested down pumping four curved blade impeller of high solidity ratio TX335 exhibiting the lowest critical impeller speed for off-bottom suspension among compared axial flow impellers.

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