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Applying rotary jet heads for mixing and mass transfer in a forced recirculation tank reactor system

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Abstract

An approximation to an ideally mixed tank reactor can be obtained by vigorous stirring with mechanical mixers. For an aerated reactor the gas dispersion contributes to the mixing process. Mixing can also be achieved by recirculation of a portion of the liquid through either an internal or an external loop.

In this study, we determine mixing times in water and CMC solutions and oxygen mass transfer coeffcients in water for a tank reactor system where a small fraction of the total liquid volume is rapidly circulated through an external loop and injected through the nozzles of rotary jet heads at 1–9 bar gauge pressure into the bulk liquid. Liquid feed can be added to the bulk volume or it may be injected into the pressurized recirculation loop. Gas is always fed to the recirculation loop, and the heat of reaction is removed in a plate-type heat exchanger inserted in the recirculation loop. The system has a very simple design with no internal baffles or heat exchange area, and between batches the rotary jet heads are used for cleaning in place.

Mixing time decreases and mass transfer increases with increasing circulation flow rate. For nozzle diameters between 5.5 and 10 mm and with one or two rotary jet heads, it is shown that a remarkable saving in power input for a fixed mixing time or mass transfer coeffcient can be obtained by using a large nozzle diameter and two rather than one rotary jet heads.

At the experimental conditions of the study the system is scaleable by simple formulas, and the power input to achieve a certain mixing time is proportional to the bulk liquid volume.

Keywords: Mixing; Mass transfer; Power input; Recirculation reactor; Scale-up; Rotary jet head