Process Intensification: A Study of Micromixing and Residence Time Distribution Characteristics in the Spinning Disc Reactor 4

Continued:
50. A fast reaction is described as having an equal or lessor time requirement than that of the time requirement for micromixing.
51. Page 76 offers an equation for calculating the time requirement for through macromixing using a stirred tank reactor with depth approximately equal to its diameter.
52. Page 78 shares an equation that describes the time dependency of mesomixing based on feed rate and turbulence.
53. The time requirement for micromixing can also be calculated based on another equation in page 78. Micromixing time is dependent upon the rate of molecular diffusion, shear force, and laminar interaction in the fluid.
54. According to the micromixing time formula, thin film micromixing on an SDR can be achieved in 0.1- 1.0 seconds.
55. With, quote – sufficient intensive turbulence – unquote, it is possible that, quote – time constants for micromixing are likely to fall in the range of 0.1-100 ms – unquote.
56. Using know reactions with fast characteristic reaction times allows mixing analysis. The rate and efficiency of the mixing can affect the product particle size distribution which can be used as a measure of mixing efficiency.
57. Segregation index, denoted Xs, is a measure of the portion of undesirable byproducts produced in a reaction compared to the maximum number of undesirable byproducts produced without any mixing.
58. Xs will fall between 0 and 1. Zero representing perfect micromixing; 1 indicating total segregation and no mixing.
59. The micromixedness ratio measures the portion of a reactor volume that is perfectly micromixed divided by the remaining segregated volume of reactants.
60. Residence time distribution (RTD) is the, quote – probability distribution function that describes the amount of time a fluid element could spend inside the reactor – unquote. RTD is heavily influences yield and unwanted byproduct production.
61. RTD can be measured using a tracer. A tracer is an inert compound that is added to the reactant feed stream. It is either colored or radioactive but will not react with any other materials in the system. By measuring the rate of its collection, its residence time can be calculated.
62. For the primary investigation the author implements a, quote – parallel competing reaction scheme namely the acid-base neutralization coupled with the Dushman reaction – unquote. This specific reaction was selected because much of the previous work done to quantify mixing in semi-batch reactors was performed with the same setup.
63. A labeled picture of the 10 cm spinning disc reactor used for some of the investigations is shown on page 134. A mechanical drawing of the SDR is available on page 135.
64. A labeled picture of the 30cm SDR is available on page 143 and clearly shows the grooves employed on the disc for part of the investigation.
65. Using the 10cm SDR, it was shown that, quote – the segregation index (Xs) decreases consistently with increasing rotational speed – unquote, indicating better micromixing at higher disc rpm.
66. Increasing reactant feed rates was also associated with a decrease in Xs.
67. Page 191 shows a chart of disc rotational speeds along with the calculated residence times and calculated micromixing times for each trial. The residence times, while only a fraction of a second, were orders of magnitude greater than the required micromixing times.

Source: Al-hengari S. Process Intensification: A Study of Micromixing and Residence Time Distribution Characteristics in the Spinning Disc Reactor. October 2011.
https://theses.ncl.ac.uk/dspace/bitstream/10443/1771/1/Al-Hengari (12mnth).pdf

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