

### Process Intensification: A Study of Micromixing and Residence Time Distribution Characteristics in the Spinning Disc Reactor 3

Continued:

31. The first thin films studied were those produced by allowing liquid to flow down inclined or vertical walls. Much of this original work influenced the more recent move to centrifugally created thin films.
32. As with rotationally created thin films, the gravity generated thin films exhibited, quote – superior rates of heat and mass transfer which were linked to the strong mixing characteristics of the surface waves – unquote.
33. Page 55 of the study provides equations to calculate many aspects of idealized SDR thin film creation: average maximum shear rate across the disc surface, film thickness based on radial position, average film thickness, and mean residence time of the fluid on the disc.
34. The Coriolis force causes the thin film to move more slowly than the disc due to its force in the opposite direction of the rotating disc. If the centrifugal force is much greater than the Coriolis force it is understood that the Coriolis force can be described as negligible.
35. Previous work concluded that Coriolis and Inertial forces are, quote – only significant at a small distance from the distributor – unquote, the location near the axis where the reactants are being deposited onto the spinning disc.
36. In SDR's with relatively large radius, quote – the simple centrifugal model is sufficient to describe the flow – unquote.
37. The equation for determining Reynolds number for thin film on a rotating disc can be found on page 57. Reynolds number describes a ratio of the internal forces of a fluid to the viscosity of the fluid.
38. Reynolds number can help to determine the type of liquid flow present on different parts of a spinning disc: smooth laminar, wavy laminar, or turbulent.
39. Smooth laminar flow is associated with Reynolds numbers less than 16. At the other end of the spectrum, Turbulent flows are associated with Reynolds numbers in excess of 1,000.
40. Studies reviewed by the author investigated the effect of reactant flow rate and disc rotational speed. It was found that both have a significant impact on the type and location of ripples / disruptions formed in the thin film.
41. Critical flow rate is a term that has been developed to describe the minimum reactant flow rate required to allow proper thin film formation. Break down in thin film formation significantly reduces the heat and mass transfer capacity of the system.
42. One study determined that the addition of, quote – mechanically machined grooves ... on the disc surface – unquote, significantly improved the heat transfer performance of the system.
43. It was also determined that disc rotational speed is the most significant factor in determining mass transfer rate.
44. In an experiment using an SDR to polymerize styrene, Boodhoo and Jachuck, demonstrated that the resulting product was produced more quickly and was of better quality in terms of a tighter particle size distribution than styrene produced by a continuously stirred reactor.
45. According a device that intends to offer throughout mixing of reactants must two crucial abilities: it must prevent areas of stagnation and it must create high shear forces. The SDR offers both characteristics.
46. Mixing occurs at three scales: macromixing, mesomixing, and micromixing.
47. Macromixing occurs, quote – on a scale greater than the minimum eddy size – unquote. It is the overall blending that increases visual homogeneity.
48. Mesomixing occurs, quote – on a scale roughly comparable with the size of the reactant feed pipe – unquote, and more finely mixes than macromixing.
49. Micromixing occurs on a molecular scale and exists at a size smaller than the minimum eddy size. This level of mixing is required for chemical reactions characterized by high rates of reaction.

**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 \(12mth\).pdf](https://theses.ncl.ac.uk/dspace/bitstream/10443/1771/1/Al-Hengari%20(12mth).pdf)

**Review by:** SP



