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Residence Time Distribution Measurments in Industrial Scale Reactors with Recycle Using Radiotracer Technique

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Background of the study:
All the process industries go through a series of routine steps to produce economically viable products. The raw materials are initially made to go through a number of physical treatment blocks to be converted into the form which is conducive for the chemical reaction(s). They are then introduced to the reactors where chemical reactions take place and the products are formed. Lastly, the products are separated, purified etc. and the desired commercial grade products are obtained. Reactors, in this whole process, play most important part in any process industry and better reactor efficiency results in better product quality. The ideal reactors are: batch reactor, continuous stirred tank reactor and plug flow reactor. Recirculation reactors are a type of continuous stirred tank reactors where the mixing of the reactants is done by the turbulence created by the recirculation stream. These are employed where the installation of agitators in the reaction vessel is not desirable like bio-reactors, nuclear reactors etc. The mixing process of such reactors can be optimized by residence time distribution studies. It helps in determining the non-ideality of the reactors for instance, dead zones, channelling or short-circuiting and the extent to which it deviates from ideality. Once known, the information can be used to increase the reactor efficiency by tweaking the reactor geometry and an accurate model can be derived to describe the working of the reactor. In process industries, usually single pass conversions are low and the reactants are recycled back to the rector to achieve high overall conversion. Developing models from residence time distribution data obtained from recycle reactor are relatively complex and literature references are also scarce as the input to the system (recycle) changes to a random input.

Methodology:
Residence time distribution studies are performed by injecting a suitable radiotracer in the ethyl acetate reactor as a pulse, measuring the output signal and plotting the residence time distribution of the reactor. Bromine - 82 as ammonium bromide with a half life of 36 hours and good compatibility with the contents inside the reactor yet unreactive, was chosen to be the radiotracer. It was introduced online as a pulse input into the feed line of a recirculation reactor producing ethyl acetate via a reversible equlibirum limited esterification reaction. The reactor had recycle streams coming from two different distillation columns containing unreacted reactants.

Conclusion:
After the output concentration of radiotracer was plotted against the time, preliminary observation of the residence time distribution curves showed the presence of internal recirculation, which was obvious as the reactor worked on the principle of internal recirculation for proper mixing of contents.

Country/Organization invited to participate

India

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