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608-238-6001 [TEL]

greg@cruisingreview.com [Email]

process-intensification-green-chemistry

Cruising Review

Process Intensification for Green Chemistry

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As environmental regulations become more stringent there is an ever-growing need for chemical processes that produce less environmental impact.

PDF Version of the webpage (first pages)

1. As environmental regulations become more stringent there is an ever-growing need for chemical processes that produce less environmental impact.
2. One concept that can be applied to reduce environmental impact is process intensification: quote – a strategy that aims to achieve process miniaturization, reduction in capital cost, improved inherent safety and energy efficiency and often improved product quality – unquote.
3. Ultrasonic and radiation energy sources are a couple of examples of ways certain processes can be intensified.
4. Process intensification also offers the benefit of reducing the volume of potentially hazardous compounds required for a reaction.
5. Another primary goal of intensified process design, quote - is to move away from batch processing to small continuous reactors, the latter giving more efficient overall operation – unquote.
6. Intensified reactors that are now under development or in use include, quote – spinning disc reactors (SDRs), HEX reactors, oscillatory baffle reactors, microwave reactors, microreactors, cross- corrugated membrane reactors and catalytic plate reactors – unquote.
7. Use of these designs may offer the ability to use significantly higher reactant concentrations, take advantage of intensified mixing kinetics, or allow for better thermal control.
8. Intensified reactors also offer significant improvement in heat and mass transfer, two of the most common process limiting considerations in process design.
9. The Spinning Disc Reactor (SDR) involves combining reactants on the top of a thermally controlled spinning disc inside an environmentally controlled reactor. As the reactants are forced outward via centrifugal force the mixture forms, quote – highly sheared thin films – unquote, capable of extremely high heat and mass-transfer rates.
10. Thin film formation also encourages micro-mixing further improving reaction efficiency.
11. The reaction surface of the disc can be smooth, channeled, or rough depending on the desired residence time and specific reaction requirements.
12. The author describes a trial in which an SDR was used to perform polymerization of styrene and required approximately one third of the time required by the standard batch process.
13. Microreactors are another design offering the benefits of an intensified process. These are reactors machined to a very small scale and high tolerance. Small amounts of reactants are mixed, quote - within submillimeter scale channels – unquote, providing excellent heat transfer and a tightly controlled reaction environment.
14. Flat sheet membrane and cross-corrugated membrane flow cells also offer intensified process benefits through better heat transfer allowing reactions to progress more rapidly.
15. Membrane reactors also offer the benefit of engineered selectivity; they may be designed to allow certain reactants or catalysts to pass but selectively block byproducts improving the overall efficiency and reducing environmental waste products.
16. The primary benefits of process intensification are reduced reaction times - leading to reduced energy requirements, reduced solvent volumes – leading to a reduction in resource requirement, and less downstream processing – leading to less waste.
17. While many of these processes are currently in use, adoption needs to become more