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Innovative Reactors and Process Intensification

PEP Report 226A

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Abstract

Process intensification (PI) is a specific term used in regard to an industrial process for a measure, which targets at innovation or improvements in the equipment and/or manufacturing/processing systems through redesigning of the existing equipment and/or operation methodologies. In chemical industry, PI can be applied in all stages of the process such as: a) raw materials & their handling/transportation/storage; b) chemical reaction/s; c) separation step/s; d) heat-transfer system/s & heat-integration; e) product/s isolation & purification; f) product/s packaging & storing; etc., etc. Basic PI objectives include reduction in the size & number of devices, improvement in heat- and mass-transfer by advanced mixing technologies and shorter diffusion pathways, miniaturization, novel energy techniques, new separation approaches, integrated optimization, control strategies, etc. PI results in a substantially smaller, or more energy-efficient, or cleaner (less waste-producing), or safer process. These PI benefits may come in any combination. The end result is – economic savings.

This Process Economics Program (PEP) report is written on the subject of application of some of the abovementioned PI tenets in production of commercially important chemicals on industrial scales. This is an update of our previous report (PEP Report 226) that was published about 20 years ago. The current report presents technoeconomic analysis of the following three technologies.

- Methyl acetate production using a reactive distillation column system
- Synthesis gas (H_2 and CO) production using a microchannel reactors system (syngas is reckoned as an intermediate product for a Fischer-Tropsch process)
- Ethyl tertiary butyl ether based on a reactive distillation column system

Apart from above, this report also presents a technical review of various aspects of the process intensification (PI) schemes, which are important from the standpoint of application of its (PI) techniques in chemical, pharmaceutical, and bio-based industries. The same chapter also presents a description of the functional principles of innovative reactors and some other process equipment, hitherto developed, and are used in the chemical and bio industry.

Our evaluation of the above process-intensified technologies show that they offer a good amount of economic savings relative to the conventional production technologies for the three products.

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