5th Annual AIChE Midwest Regional Conference

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Session Fr2B: 1:00pm -2:30pm, Friday February 1, 2013 (Room 007)
Smart and Intense Chemical Processes
Session Organizer: Zhijun Jai, Chart Energy & Chemicals, Inc.
Session Co-Chairs: Steve Vallee and Hani Gadalla, Chart Energy & Chemicals, Inc.

1:00pm **Smart Grid Coordination in Chemical Processes**
Donald J. Chmielewski, Illinois Institute of Technology
One aspect of the smart grid is to use a real-time price structures within electricity markets as a vehicle to mitigate source-load inequities resulting from the uncertainty associated with renewable power sources (solar and wind). Under such price structures, manufacturing facilities with an ability to change energy consumption rates can expect to capture more profit while providing the societal benefit of improving grid reliability. Although facility managers qualitatively agree with the dual benefit of adopting smart grid operating policies, they lack quantitative methods to construct these policies as well as predict revenue gains. In this paper we will illustrate the use of Economic Model Predictive Control (EMPC) as a vehicle to construct demand response policies for the flexible manufacturing application. In addition, we will propose a linear surrogate for the demand response policy, which will facilitate the development of a quantitative method to assess smart grid coordination opportunities. As an illustration of the approach a chemical processing plant will be investigated where process steam can be generated from a simple furnace or from an electric co-generation plant. In the second part of the example we will consider the additional opportunity of deferment of sub-operations based on supply-chain inventory levels.

1:30pm **Compact Heat Exchange Reactors (CHER) for Process Intensification (PI)**
Steve Vallee, Chart Energy & Chemicals, Inc.
Process Intensification (PI) is a process design philosophy to bring about dramatic improvements in manufacturing, processing, equipment size/production ratio, energy consumption, or waste reduction by the development of novel apparatuses and techniques as compared to the present state-of-the-art. This leads to substantially smaller, cleaner, and more energy-efficient technology and processes. In many conventional chemical reactors the reaction rate can be limited by heat transfer capability or mixing in the reactor, rather than the actual reaction kinetics. This results in reactors and supporting equipment that is larger than it needs to be and decreased operating efficiency. Chart's Compact Heat Exchange Reactor (CHER) combines a heat exchanger and reactor into a single device and is used to overcome heat transfer and mass transfer limitations to allow reactions to proceed at or closer to the kinetic limits. The role of heat transfer and mixing in controlling chemical reactions will be presented, as well as techniques for identifying when CHER should be considered for PI. Examples of CHER in the fine chemicals, pharmaceutical, and fuel processing fields will be shown. Chart Energy & Chemicals has been manufacturing brazed aluminum plate-fin heat exchangers for over 50 years, and brazed CHER known as FinTec® since as early as 1979. Over the last 15 years a shim-based, diffusion bonded CHER known as ShimTec® has also been developed and widely applied. Compact Heat Exchange Reactors have been constructed using aluminum, stainless steel, or specialty metals.

2:00pm **Design and Manufacture of Compact Heat Exchangers/Compact Heat Exchange Reactors**
Hani Gadalla, Chart Energy & Chemicals, Inc.
Compact heat exchangers and compact heat exchange reactors are used in industries where efficient heat transfer is necessary to achieve the requirements for unit performance, reliability and efficiency leading to Process Intensification (PI). Advantages of compact heat exchangers include high heat transfer coefficient, high surface area-to-volume ratio, and narrow approach temperatures. For the compact heat exchanger reactors, advantages include reaction control for highly exothermic or endothermic reactions, near-isothermal operations for improved selectivity and controllability, improved internal mixing and more uniformity in performance. Chart Energy and Chemicals specializes in two types of metal compact heat exchangers/heat exchange reactors: brazing and diffusion bonding. In this presentation, the two types will be compared to each other as well as to conventional exchangers and reactors. The basic exchanger design and general manufacturing steps will be presented. The performance of the units, potentially with some examples, will also be discussed.