Global Optimization of Process Networks through the IDEAS approach

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The continuous improvement of computer technology, combined with progress in process modeling and simulation capabilities, have enabled the analysis of process networks (flowsheets), and have minimized the use of pilot plants. Despite the progress, current process flowsheeting technology has few synthesis capabilities. Over the last few decades, the pursuit of flowsheet synthesis through numerical optimization has invariably led to process flowsheet optimization formulations that are nonlinear or mixed integer nonlinear programs (NLP's or MINLP's) most instances of which cannot be solved globally within realistic timeframes.

The Infinite DimEnsionAl State-space (IDEAS) conceptual framework represents a paradigm shift which establishes that chemical process nonlinearities need not be manifested at the flowsheet optimization level, but rather can be fully accounted for prior to optimization. The resulting mathematical formulations feature feasible regions that are defined by linear constraints, albeit in an infinite dimensional space. Furthermore, for large classes of objective functions, the resulting process network optimization formulations are infinite dimensional linear programs (LP's), whose finite dimensional approximations can be solved to global optimality in a timely manner.

The power of the IDEAS framework is illustrated on a number of optimal flowsheeting problems, such as Mass Exchange Network Synthesis, Attainable Region Identification for reactor (CSTR, PFR, RTD, batch) networks and general process networks, Power Plant Synthesis, Reactive Distillation Network Synthesis, and Azeotropic Distillation Network Synthesis.