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# Synthesis and Design of Processing Networks: Decision Making Under Uncertainty

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**Synthesis and design of processing networks: decision making under uncertainty**

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The synthesis and design of processing networks is a complex decision-making problem, consisting of the selection of raw material, product portfolio and definition of the process technologies and the process configuration. As these decisions induce large capital investments, this problem has high impact on the profitability of process industries.

The solution of this important decision making problem is challenging. It is multidisciplinary and requires cross-functional collaboration of different corporate functions (e.g. marketing, engineering, finance). Moreover, it is largely based on estimations and forecasts of future data (i.e. market prices and sizes, raw material availability and compositions etc.), whose uncertainty has to be taken into account and properly managed in the decision-making process.

Even though several solution approaches have been proposed in the literature for this class of problems, the decision-making under uncertainty still poses a number of challenges (Sahinidis, 2004), especially when the complexity of real industrial cases is considered.

In this contribution, we propose a systematic framework for synthesis and design of processing networks under uncertainty. The framework is based on a previous work dealing with decision-making (Quaglia et al. 2012), which has been extended to include uncertainty.

The key novelty of the framework is to employ a systematic approach to manage the complexity of the resulting stochastic problem (e.g. large problems with high number of uncertain parameters). The framework employs a decomposition approach, guiding the user through some preliminary steps of uncertainty characterization and mapping, prior to the formulation of the stochastic problem. These steps aim at providing a deeper knowledge of the uncertain space and of its consequences on the optimal decisions. This information is then used in order to facilitate the solution of the stochastic problem.

To this goal, the framework employs different strategies including i) variable initialization ii) search space reduction via variable bounding iii) search space reduction via inactive constraints elimination. Moreover, the generated knowledge is also analyzed to systematically generate new configurations (not included in the search space of the original problem), to hedge against uncertainty.

In order to highlight the main features of the framework, case studies from the edible oil industry and wastewater treatment are formulated and solved. The optimal processing network under uncertainty is identified, the Value of Stochastic Solution (VSS) is calculated, and strategies to manage and hedge against uncertainty are suggested and evaluated.

**References:**

N.Sahinidis, 2012, Optimization under uncertainty: state-of-the-art and opportunities, Computers & Chemical Engineering (28) 971-983

A.Quaglia, B.Sarup, G.Sin, R.Gani, 2012, Integrated business and engineering framework for synthesis and design of enterprise-wide processing networks, Computers & Chemical Engineering (38) 213-223.

**Extended Abstract:** File Not Uploaded

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