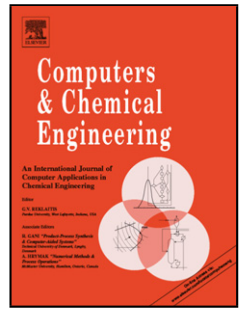

Title: Integrated design and control of chemical processes–part i: revision and classification

Author: P. Vega de R.R. Lamanna S. Revollar M. Francisco

PII: S0098-1354(14)00153-7
DOI: http://dx.doi.org/doi:10.1016/j.compchemeng.2014.05.010
Reference: CACE 4963

To appear in: *Computers and Chemical Engineering*

Received date: 11-11-2013
Revised date: 7-3-2014
Accepted date: 9-5-2014

INTEGRATED DESIGN AND CONTROL OF CHEMICAL PROCESSES – PART I: REVISION AND CLASSIFICATION

P.VEGA*, R. LAMANNA de R.**, S. REVOLLAR*, M. FRANCISCO*

* *Departamento de Informática y Automática, Universidad de Salamanca, Salamanca.*
srevolla@usb.ve, mfs@usal.es, pvega@usal.es
** *Departamento de Procesos y Sistemas, Universidad Simón Bolívar, Caracas.*
lamanna@usb.ve

***Abstract*—This work presents a comprehensive classification of the different methods and procedures for integrated synthesis, design and control of chemical processes, based on a wide revision of recent literature. This classification fundamentally differentiates between "projecting methods", where controllability is monitored during the process design to predict the trade-offs between design and control, and the "integrated-optimization methods" which solve the process design and the control-systems design at once within an optimization framework. The latter are revised categorizing them according to the methods to evaluate controllability and other related properties, the scope of the design problem, the treatment of uncertainties and perturbations, and finally, the type the optimization problem formulation and the methods for its resolution.**

***Keywords*—Process synthesis, process control, integrated design, controllability, process optimization.**

1. INTRODUCTION

The *Integrated Design and Control* is a comprehensive design methodology where the systematic analysis of plant dynamics is incorporated into the process design procedure in order to obtain a compromise solution between economic and control aspects.

In the process industry, the main objective is to deliver products which fulfil the specifications achieving the maximum economic benefit with the minimum cost. In a competitive market scenario, the plants must be operated as flexibly as possible in order to adapt satisfactorily to changes in product specifications, demand, different feed conditions and raw material quality variations. In such context, the application of appropriate process control strategies allows for the successful operation of the plants improving profitability by increasing product throughput and yield of higher valued products and by decreasing energy consumption and pollution (Edgar, 2004).

The traditional design procedure is sequential. Process synthesis is carried out first for determining the plant structure, the process parameters and operating conditions are calculated in a subsequent stage considering steady state and economic objectives and process constraints. Finally, the control system is designed to achieve the desired dynamic behaviour. A flow diagram representing the classical design procedure is shown in figure 1.

The integrated process design approach relies on the fact that the achievable plant dynamic performance is a property inherent to process design. In such sense, designing chemical processes based only on economic criterions and steady-state assumptions can lead to plants difficult to control and to operate exhibiting poor dynamic performance and unexpected behaviour under disturbances and uncertainties. The empirical overdesign as a solution to ensure resiliency and flexibility in the chemical plants is not attractive from the economical viewpoint and there is no guarantee of achieving efficient operation. Moreover, conservative design based on the worst operating conditions, may fail because the proper selection is far from trivial and seemingly logical choices can lead to systems with higher costs (Grossmann and Morari, 1983). Therefore, the integrated design philosophy can produce significant economic benefits as well as the improvement of the plant operation contemplating the important relationship between profitability and controllability by incorporating the assessment of plant dynamics from the initial steps of the process design procedure.

Figure 1. Classic Design of Processes