

SENSITIVITY ANALYSIS APPLIED TO REACTIVE SYSTEMS FOR IMPROVING CONTROL PERFORMANCE

José T. Manzi¹ and Heleno Bispo
Catholic University of Pernambuco – Department of Chemistry

Abstract. This paper is devoted to sensitivity analysis for nonlinear multivariable processes, particularly applied to chemical reactive systems. The presence of uncertainties or shift in the system's behavior has been investigated, based on deterministic models and also by direct application of the disturbance or uncertainty in the model. Such an approach describes the behavior of sensitivity, and since a reduction of sensitivity is desired, it can reveal how the minimum of sensitivity can be obtained. If the principal aim is concerned with process control, the results can also provide a strategy for improving performance, using the idea of fictitious smoothing reactors, meaning a partition and scheduling of variables of interest. Such a strategy can be inserted into software for process control, without additional cost or appreciable computational load.

Keywords: modeling, reactive system, sensitivity analysis, nonlinear PI

1- Introduction

Despite there being a new class of advanced controller, the PI or PID controller is still widely used in more than 95% of all control requirements for most industrial control systems. Their well-known qualities such as robustness in a wide range of industrial process with satisfactory performance, the simplicity of their structure and the low cost of implementation and maintenance are the reasons for such a long life. Due to the linear structure of PID, this class of feedback controllers cannot yield satisfactory results for some application in the industrial environment since chemical real-world processes have some degree of nonlinearity. However, to enable a controller such as this to deal with nonlinearity, efforts have been made to overcome the difficulties, using strategies which can include models of the process (Manzi and Odloak, 1998) and consequently to reduce the degrees of freedom of the system (Rivera et al., 1986), or even to implement the process control in such a way as to reduce dynamically sensitivity to disturbance.

Reactive systems have embodied structures of advanced control techniques for solving problems especially those associated with their nonlinearities, but, in practice, in view of the need to have qualified staff and the consequently increase in the cost of production, such control systems are not yet ordinarily used.

It can also be observed in industrial practice that the results obtained with the PID controller applied mainly to neutralization processes can be improved or its performance further justified, as in the case of temperature control, when sensitivity analysis is considered as a tool which can provide a better understanding of how the process responds in the presence of perturbations in the variables. For a neutralization system it is common to use a typical control strategy known as smoothing tanks. However, such a practice may not be reasonable either from the technical or economic point of view, since it can affect the plant configuration or compromise some operational conditions or the sanitary stability of the process. In this case, sensitivity analysis can contribute to improving the control performance, providing valuable insights and alternative control configurations.

For reaction temperature control, sensitivity analysis can reveal that the use of the so-called smoothing reactor is unnecessary. Such a procedure is already ordinarily applied in practice.

A review of the literature shows a widespread interest in stability analysis but relatively little has appeared on sensitivity, especially with regard to nonlinear systems. Skinskey (1973) presented a sensitivity analysis for cyclic variations in the influent *pH*, which does not reflect the fundamental details of the sensitivity. Other

¹To whom all correspondence should be addressed.

Address: Departamento de Química - Universidade Católica de Pernambuco (UNICAP)

Rua do Príncipe 526, Boa Vista, Recife - PE - Brasil - CEP: 50050-900, e-mail: jmanzi@unicap.br

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Table of Contents Sensitivity Methods In Control Theory

1. Understanding the eBook Sensitivity Methods In Control Theory
 - The Rise of Digital Reading Sensitivity Methods In Control Theory
 - Advantages of eBooks Over Traditional Books
2. Identifying Sensitivity Methods In Control Theory
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Sensitivity Methods In Control Theory
 - User-Friendly Interface
4. Exploring eBook Recommendations from Sensitivity Methods In Control Theory
 - Personalized Recommendations
 - Sensitivity Methods In Control Theory User Reviews and Ratings

- Sensitivity Methods In Control Theory and Bestseller Lists
- 5. Accessing Sensitivity Methods In Control Theory Free and Paid eBooks
 - Sensitivity Methods In Control Theory Public Domain eBooks
 - Sensitivity Methods In Control Theory eBook Subscription Services
 - Sensitivity Methods In Control Theory Budget-Friendly Options
- 6. Navigating Sensitivity Methods In Control Theory eBook Formats
 - ePub, PDF, MOBI, and More
 - Sensitivity Methods In Control Theory Compatibility with Devices
 - Sensitivity Methods In Control Theory Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Sensitivity Methods In Control Theory
 - Highlighting and Note-Taking Sensitivity Methods In Control Theory
 - Interactive Elements Sensitivity Methods In Control Theory
- 8. Staying Engaged with Sensitivity Methods In Control Theory
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Sensitivity Methods In Control Theory
- 9. Balancing eBooks and Physical Books Sensitivity Methods In Control Theory
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Sensitivity Methods In Control Theory
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Sensitivity Methods In Control Theory
 - Setting Reading Goals Sensitivity Methods In Control Theory
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Sensitivity Methods In Control Theory
 - Fact-Checking eBook Content of Sensitivity Methods In Control Theory
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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