

# SENSITIVITY ANALYSIS APPLIED TO REACTIVE SYSTEMS FOR IMPROVING CONTROL PERFORMANCE

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**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

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