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Some Considerations of Mutual Coupling in Multivariable Processes

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Abstract *- Couplings of multivariable processes is common problem in industry. Because of that defining of multivariable interactions is very important for appropriate utilization of PID control in multivariable processes. Present paper involves research of this interaction within process with two inputs and two outputs and definition of interaction measures (indexes). These indexes are derived using process response, i.e. process quality indicators and named partial interaction indexes. Investigation has been supported by simulations because of its flexibility in forming coupled and separated control loops. By comparing responses of these loops, under the same other parameters of the system, mentioned indexes are derived. Before analysis, mathematical model of flow tank, where water from two channels with different temperatures is mixed, has been formed.*

Key words: *Multivariable process, coupling, partial interaction indexes*

I INTRODUCTION

Complexity of multivariable (MIMO) processes stems from mutual coupling between more inputs and outputs. Mutual coupling causes interaction in these processes. There is even interaction between outputs in some cases. Therefore, the appropriate control of these processes is more difficult to achieve than in the process with one input and one output (SISO). According that, there is a need for compensation of interaction during tuning of chosen type of PID controller and in that way in functioning of the process. This fact enlarges significance of determination of interaction measure which is expressed through the interaction indexes.

Research presented in this paper contains consideration of mutual coupling within process with two inputs and two outputs. Evaluation of interaction indexes was carried out based on comparison of step responses of process in two cases: one in coupled control system and the other in separated control loops for single output. Better said, interaction indexes have been determined by analyzing some of process quality indicators in time domain, but without using Relative Gain Array (RGA) as in [1]. Theoretical background for utilization of RGA is derived and explained in [2]. Present survey is attempt to obtain as obvious as possible measures of process interactions through their quantification. Therefore, the interaction indexes are decomposed per individual quality indicators of process response and because of that they named as partial interaction indexes. That should be guide for synthesis of regulators in decentralized and centralized concept of control.

II PROCESS OF INTEREST

A. Process description

This research was performed by considering flow tank where two separate inlets of water (Q_1 and Q_2) with different temperature are taken as its inputs. Level h and temperature t are controlled outputs here. Flow rates in inlet pipes are manipulated variables. Changing the flow rate at any valve simultaneously influences on the level and the temperature in the tank. Purpose of this process is mixing water from two sources to get water on outlet with constant flow rate and desired temperature. Level has to be controlled in order to enable sufficient fluid volume for its appropriate mixing. This kind of tank was taken into consideration as represent of numerous processes in industry where different fluids are mixed to get output product with desired temperature, concentration, density, etc. Scheme of the flow tank with accompanying labels is shown in Fig.1.

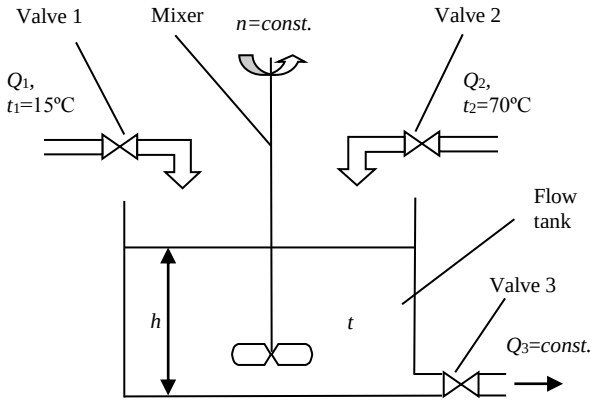

Fig. 1. Schematic display of flow tank

Where Q_1 and Q_2 are flow rates through the valve 1 and valve 2, respectively. Flow rate through the valve 3 (which is on/off valve) is marked with Q_3. Temperatures of water in first and second inlet are labeled with t_1 and t_2, respectively. The reservoir is open and has the shape of cylinder with a basis area of 0,1 m^2 and a height of 1,2 m.

Reference values (set points) that should be tracked are: for level h_r=1 m and for temperature t_r=30 °C.