Jacket Temperature Control of a Batch Reactor Using Three Different Temperature Levels

Miklós Gábor Balaton, Lajos Nagy, Ferenc Szeifert*

Department of Process Engineering, Faculty of Engineering, University of Pannonia, 8200 Veszprem, Hungary

balatonm@fmt.uni-pannon.hu

Abstract

In the pharmaceutical, fine chemical, polymer and food industry, where high value-added products are manufactured, insufficient control might produce off-grade products. This can cause significant financial losses, or in the pharmaceutical industry, it can result in an unusable batch. In these industries, batch reactors are commonly used for the manufacturing of intermediate and final products. The control of these reactors is essentially a problem of temperature control. In the industry, an increasing number of heating-cooling systems utilizing three different temperature levels can be found. Although they are advantageous from an economic point of view, it makes the control more complicated. A pilot unit of such a system can be found in the authors' laboratory, which contains a monofluid thermoblock with

* Corresponding Author Tel.: +36-88-624-295.

E-mail address: balatonm@fmt.uni-pannon.hu (M. G. Balaton)

three different temperature levels. It is a useful experimental facility to test control algorithms for industrial use.

This paper describes a split-range algorithm that can be used as part of the jacket temperature controller in the case of a thermoblock containing three different temperature levels. The main problem from the control point of view is that the sign of the gain of the controlled object changes depending on the relation of the jacket and the actual feed temperature of the jacket recirculation loop. The main purpose of the split-range algorithm is to maintain the sign of the gain of the controlled object unchanged thus, avoiding control instability. This solution ensures that the controller utilizes all three temperature levels, especially the medium level with lower energy consumption. The algorithm was tested with simulation, and for the jacket temperature controller, a constrained PI controller was used. The parameters of the controller were identified by numerical optimization. The resulting jacket temperature controller extended with the split-range algorithm was validated on the pilot system. The same set-point profile was used for simulation and for the test measurement; this was designed to cover the entire temperature range of the system and to contain drastic changes, constant and ramped sections. Both in the case of simulation and the test measurement, good control performance was achieved; the controlled variable followed the set-point with small error both in the case of ramped and constant set-points.

Keywords: batch reactor, split-range, monofluid thermoblock, temperature control