OPERATOR BASED THERMAL CONTROL OF AN ALUMINUM PLATE WITH A PELTIER DEVICE

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Received December 2007; revised May 2008

ABSTRACT. In this paper, operator based nonlinear control system of an aluminum plate with a Peltier device is designed by using operator theory. A model of an aluminum plate with a Peltier device is derived. The parameters of Peltier device of model are obtained by experiments. After that, operator based nonlinear temperature control system by using robust right coprime factorization is designed for the model. The effectiveness of the designed system is confirmed by simulation.

Keywords: Operator, Peltier device, Nonlinear control, Robust right coprime factorization

1. Introduction. Peltier devices have thermoelectric elements and have a specific effect called "Peltier effect", that is, one side of them has endothermic and another side has radiation when an electric current is applied. In addition, the elements have characteristics such as not generating noises and Freon gas [1,2]. However, because Peltier devices are nonlinear and also have uncertainties, the analysis and the control of this kind of devices are difficult.

In this paper, we propose a temperature control system for an aluminum plate with the Peltier element by using operator theory. Operator theory is a control theory based on an idea that a signal in the input space is mapped to the output space, and research studies in regards to the theory are conducted nowadays [3-5]. That is, an applicable robust condition is shown in [3] so that the operator based control can be applied to a broader class of nonlinear plants. Control and fault detection by using operator based design scheme are realized in [4]. Further, a method to control unstable plants with input constraints is given in [5], where the controlled plant with the input constraints satisfies the coprime factorization. The advantage of the operator based control is that the control design is relatively simple, because bounded input and bounded output stability is guaranteed. Based on the theory, nonlinear controller for the temperature control system with Peltier device is designed by using robust right coprime factorization concept. That is, for ensuring the robust stability, robust controller is considered. For obtaining the desired output tracking performance, robust tracking filter is also designed. As a result, the designed control system ensures the robust stability and the perfect output tracking.

The effectiveness of the designed system is shown by the simulation.

The contents of this paper are written as follows. In Section 2, principle of the Peltier element, modeling of the aluminum plate with the Peltier element are described. Meanwhile, problem setup is given. Section 3 describes the operator based temperature controller of the thermal process by using operator theory. In Section 4, experimental result for evaluating the Peltier element model is shown, and control system simulation is also given.