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Analysis on the Significance of Effects from Operational Conditions on the Performances of Ultrasonic Atomization Dehumidifier with Liquid Desiccant

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Abstract

In this work, simulations were carried out based on a L18×L8 cross-product orthogonal array to investigate the significance of the effects from inlet operational conditions on the performances of the ultrasonic atomization liquid desiccant dehumidification system (UADS), where dehumidification effectiveness was adopted as the performance indicator. Taguchi method was employed to analyze the results. It was found that though all of the inlet operational parameters revealed direct effects on the performances of UADS, the significance of their effects was quite different among which, the desiccant flow rate was the most sensible factor in improving DE while air humidity ratio exhibited the least significance. The results presented in this work may help in achieving the optimal running of the liquid desiccant dehumidification system.

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Keywords: Significance analysis; Ultrasonic atomization; Liquid desiccant; Taguchi method.

1. Introduction

Liquid desiccant dehumidification air-conditioning systems (LDAC) have attracted a great deal of attention in recent years for its great potential in energy saving of buildings [1, 2]. Numerous studies have been conducted experimentally to investigate the relationships between the operational conditions and the performances of LDAC. However, due to the complexity of the exhausting dehumidification experiments, most of the existing experimental

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investigations were just performed by means of the incomplete single factor experiment, rather than the comprehensive experiment. In view of this, this study carried out simulations based on a L18×L8 cross-product orthogonal array to investigate the significance of the operational conditions on the performances of UADS. The results presented in this work may help in achieving the optimal running of the liquid desiccant dehumidification system.

2. Methods

2.1. Taguchi Method

The Taguchi method is considered to be one of the best significance analysis methods [3]. It consists of a cross-product orthogonal array, which consists of a set of well-balanced experiments, and is able to figure out the operational conditions that are significant in improving the system's performance and reducing the fluctuation of the output of the system. The overall analysis procedure of the Taguchi method can be demonstrated briefly as Fig.1 shows [4].

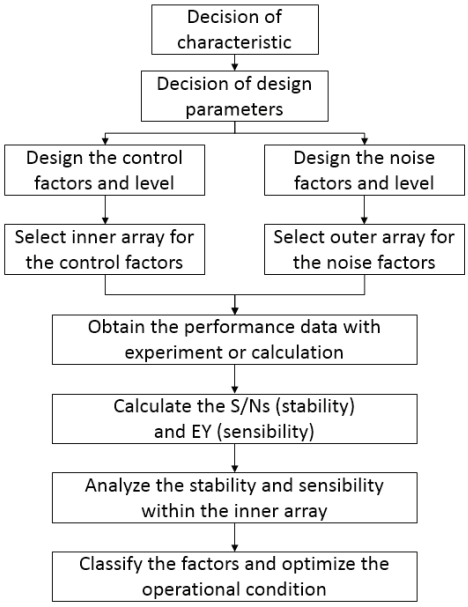

Fig. 1. Analysis procedure of Taguchi method

- Design for the cross-product orthogonal array

In Taguchi method, two kinds of the operational conditions, namely the control factors and the noise factors, are considered to have the decisive effects on the performance of one specific system. It is easy to understand that the control factors refer to the conditions that can be controlled during the running of UADS, while the noise factors stand for the fluctuation of the operational conditions which is inevitable during the dehumidification process. Both of the control factors and the noise factors were arranged into a cross-product orthogonal array as the basis of the performance tests of the system. The array was composed of two data sections, namely the inner array for the control factors and the outer array for the noise factors. In this work, six process control conditions, namely the flow rates of airstream and desiccant solution, the air inlet temperature, the desiccant inlet temperature, the air inlet humidity ratio and the desiccant inlet concentration with three levels were identified as the control factors and set in the inner array. Similarly, the outer array for the noise factors was fulfilled with a L8_2_7 orthogonal array in