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Modeling and Simulation of Temperature Control System of Coating Plant Air Conditioner

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Abstract

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The air conditioning system is an important external condition for coating production. Effectively controlling the air conditioning system temperature could ensure the external conditions required during the production process of the coating line, thus to ensure product quality. Due to the large temperature difference change rate of outdoor fresh air at some areas, the traditional PID control method can't meet the temperature control requirements of the air conditioning system. In order to solve above problem, an actual plant air conditioning model was built based on the structure features of the truck coating plant air conditioning. An intelligent adaptive control algorithm was designed, then we performed matlab simulation on this model. Through the simulation, the experimental results show that the adaptive algorithm can meet the control requirements.

Keywords: Plant air conditioner; Adaptive; Temperature control

1. Introduction

Coating material, coating process, coating equipment and coating management are the four main elements of coating production, which complement each other. it improves the progress and development of coating process and technology together. Coating quality directly influences the product quality, considering current fierce international competition, how to improve the products' coating quality is a challenge for the major manufacturers. For solving this problem, cluster control automation of the air conditioning unit is an important condition to ensure coating quality. If the temperature of the coating plant air conditioning system could be effectively controlled, the external conditions required during the production process of the coating line could be guaranteed, thus ensure the product quality and improve international competitiveness.

In order to effectively control the temperature system of the air conditioner, firstly it's necessary to execute modeling for the control system of the air conditioner. Maxwell and other persons established the empirical model of

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chilled water coil, which is used to predict the response of every control algorithm under different gain values[1]. While Clark and other persons given the dynamic model of pipe and hot water coil[2]. Professor w.J.cai[3] and his students of Nanyang Technological University also studied modeling of HVAC system, they established a simple and accurate engineering model for cooling coil based on energy balance and heat transfer principle, which is helpful for the real-time control and optimization of HVAC system. Comparing with the cooling coil module established in Braun[4] and Rabehl[5], its simpler and no iterative operation is required. Many domestic scholars have made much contribution in this field, Zhang Huajun established a steady-state distribution model of the heat exchanger, this model considered the existence of metastable liquid area in the capillary, and the influence on heat exchange of fins shape, bank of tubes and other elements, and proven by experiment, the result is reasonable[6]. Wang Kangdi and Wang Huaixin established dynamic distribution parameter models for the refrigerant at the single-phase and gas-liquid two-phase areas of the heat exchanger respectively[7].

Generally the plant air conditioner is combined air conditioner, which has one-level or multi-level heater. Typically the control of heater of the plant air conditioner is traditional PID control. Also, there are other control methods. For example, Zhang Qianru et al. studied the characteristics of the air temperature distribution in a large space with stratified air conditioning system[8]. Li Gaojian, Nie Jianbin designed PID mathematical model and algorithm of the central air condihoning temperature control based on genetic algorithm[9]. Rehrl Jakob. and Dobbs Justin. R. presented an predicting control algorithm for heating, ventilation, and air conditioning (HVAC) systems[10]. Due to different air conditioners, many people explored different control methods for the heater of the air conditioning system.

Although many people have studied the models and control methods of air conditioning components and system, because the plants are different, the detailed requirements on equipment are different and the actual operating conditions are different for the plant air conditioning system, it's impossible to get a general model of the control system, the specified conditions must be analyzed particularly.

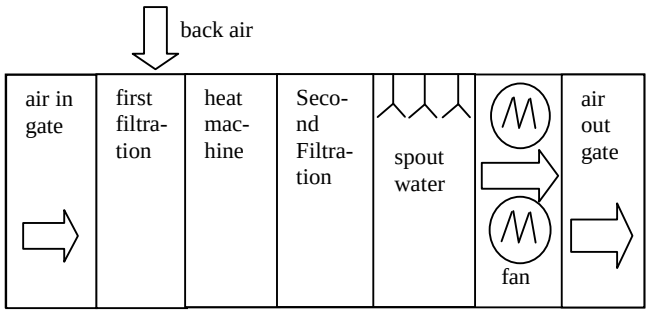
2. Structure and working principles of air conditioning system

2.1. A brief introduction of the coating plant air conditioner

There are 2 floors in the car coating plant, its length and width are 260 and 50 respectively. The total construction area of the plant is about 26000m². The first floor are machines and offices, the air conditioning system consisting of 5 big assembled air conditioning machines is on the second floor. The air is sucked into the assembled air conditioning machines, ater heating it is sended into the workshop's every parts. Normally, Air demand of the car coating plant is 280000m^3/h.

2.2. Structure of air conditioning machines

Fig. 1. Structure diagram of the assembled air conditioning



In Fig.1, we know that when the air conditioning system is working, the two fans are running, fresh air from outside enters the air conditioning system by the "air in gate". First filtration system is able to clean air, then the air