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Study on the Fuzzy Technique over Marine Air-Conditioning System

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Abstract: The marine air-conditioning is important equipment on board the ship. It created the comfortable and cosy surrounding for the crew in the working time and daily lives. The fresh air for the air condition system is essential to keep the crew watchful during the watch-keeping. What is more, the condition outside of the marine vessel is diverse, the self-adjustability of the marine air conditioning is not swift. Meanwhile, the air-conditioning unit is the main energy consumption. The reasonable operation of the marine air-conditioning can be energy-saving. The parameters of temperature and the carbon dioxide concentration in the air-conditioning room are the key factors for the air-conditioning control. Under the condition that the unit of the marine air conditioning is not altered, the fuzzy control method is applied to adjust the temperature and the carbon dioxide concentration in the air conditioned space. The fuzzy controller is designed and the program is written in this study. In this way, the comfort index is high and the energy is conserved. Compared with the general control method PID, the fuzzy control without the mathematical model is simple and precise. Taking the temperature difference, the difference variety ratio and the carbon dioxide concentration as the control parameters, the marine air-conditioning can create a cozy and comfortable space for the crew on board the ship.

Key words: Marine air-conditioning, carbon dioxide concentration, fuzzy control, mathematical, compared, consumption

INTRODUCTION

The merchant marine ship, sailing all over the world, covering the oceans water, along different sea routes, encountered various weathers and climates in her voyage (Zuperl *et al*., 2005). In order to comfort the crew in their daily lives, the marine air-conditioning create the cosy man-made climate in cabin. So, the modern ocean-going ship equips the marine air-conditioning on board. As the aim is to meet the requirement of the work and daily life, the marine air-conditioning is sorted as comfort air conditioning (Mohanraj *et al*., 2012). However, working in the cabin on board the ship, the crew may suffer the symptom such as the chest distress and dizziness, because of the increase of the carbon dioxide and the other harmful gases. That must be the lack of the fresh air in the cabin. Moreover, the marine air-conditioning system is the main electricity consumer on board. So, the energy conservation should be taken care of for the ship corporation. For the design of the marine air-conditioning system, the capital investment, the control precision and the comfort quality should be considered together as the main characters (Tashtoush *et al*., 2005).

Audited studues, design of a single input fuzzy logic controller based SVC for dynamic performance enhancement of power systems (Subramanian, 2014) explains the controller embedded with fuzzy logic circuits to check the performance of enhanced power system dynamically. Solar driven air conditioning system integrated with latent heat thermal energy storage (Ponshanmugakumar *et al*., 2014) disputes the heat generated from the air conditioning system is initialized on storage of thermal energy in a containers. Experimental investigations on the performance of a water heater using waste heat from an air conditioning system (Sivaram *et al*., 2015) investigates the storage of thermal energy transferred from the air conditioning systems.

General methods for marine air conditioning: The control objects of the basic marine aerating and cooling system are the temperature in the spaces, the relative dampness and the supply air rate. The control system is dealt with the articles above to keep the living space comfortable. The on-off control and relative control are basic strategy in the marine aerating and cooling control (Zhang *et al*., 2009). As the on-off control system just has two positions, that is on position and off position and the operation is straightforward and the changes of the controlled parameters are fairly incredible. The information and yield signs of the relative control system are corresponding and the operation is well persistent. The relative control strategy of which the control position and the control parameters are changed in corresponding way and generally connected noticeable all around the system (Linkens and Hasnain, 1991).

Fuzzy control method: As the unique condition for the marine vessels, the outside atmospheric condition changes as often as possible and the interference is different, hence, the reaction is immediately required. The fuzzy control strategy, making the provoke reaction can meet the necessity and vitality protection. The fuzzy control is the PC advanced control technique in view of the fuzzy set theory, fuzzy linguistic variables and fuzzy logic inference (Nauck *et al*., 1997). As per the individual prerequisite of the temperature, the air conveyance speed and the oxygen content, the fuzzy control instrument which is connected in the modem maritime ship can manage velocity restlessly, enhance the indoor air quality and the space comfort.

MATERIALS AND METHODS

Fresh air volume and the reasonable fuzzy control method

Fresh air volume based on the carbon dioxide concentration: The living spaces ought to be supplied certain volume of outside air for each individual in the space. So, the outside air rate for the space could be resolved on the indoor carbon dioxide fixation as indicated by the following Eq. 1:

$$GG_2 + nG_1 = GG_3 \quad (1)$$

The fresh air volume in the cabin can be derived as:

$$G = nG_1/(G_3 - G_2) \quad (2)$$

Fresh air volume based on the ventilation volume: The intake air is supplied by the air ventilating fan in the marine cooling system. Also, a portion of the air was depleted out the space continuously. The ventilating fan, blends the arrival air and the natural air at the proportion 3: 1 and conveyed to blend the aerating and cooling space through the principle air channel and the blended air is separated, cooled or warmed and dehumidified. As indicated by the vitality preservation law, the warmth air going into the space is equivalent to the volume of air that depleted the space. Equation 3 is uncovered as the takeover is expressed as:

$$MH_n + Q = MH_B \quad (3)$$

$$M = -\frac{Q}{H_B - H_n}\left(kgh^{-1}\right) \quad (4)$$

The natural air volume provided into the cooled spaces can just ensure the carbon dioxide fixation close-by, however, close to the setting point. In spite of the fact that the all the outside air volume enhances the air quality, unnecessary vitality was devoured for the point. The equilibration of the carbon dioxide in and out the space is shown as in Fig. 1 and 2. So, the base fresh air volume the space required in light of the outline standard is:

$$M_g = M/4\rho\left(m^3 \times h^{-1}\right) \quad (5)$$

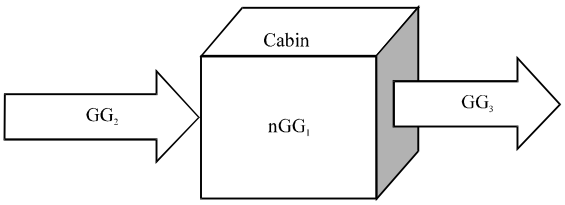

Fig. 1: Equilibration of carbon dioxide

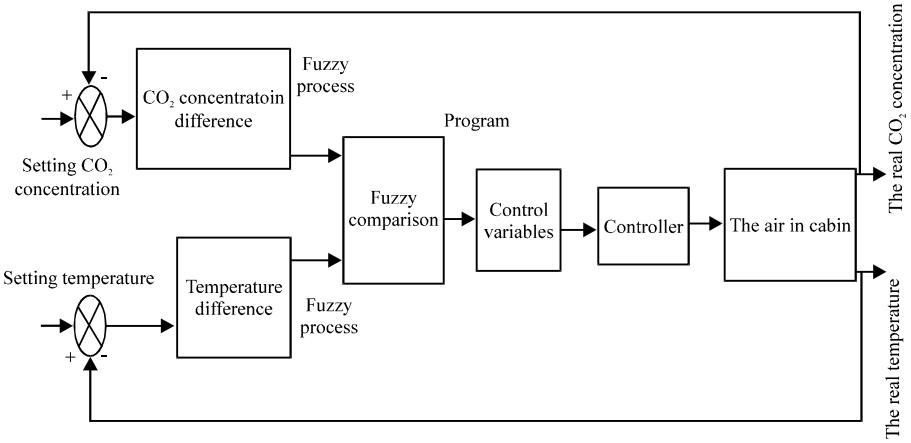

Fig. 2: Fuzzy control principle

The reasonable control of the fresh air rate and the principle: The grouping of the carbon dioxide which is the gas produced by the men's breath and the other contaminations, demonstrates the freshness of the air. In this way, in the fundamental ventilating space for the team working or the living in the spaces, keeping the carbon dioxide fixation under control which means the other tainting or unsafe gas under control. As the carbon dioxide fixation process noticeable all around the space is somewhat enormous and difficult to change, taking it as the control parameter is inclined to neutralize the exoteric obstruction, making the system dependable.

Keeping in mind the end goal to modify the natural air rate by the carbon dioxide focus, the carbon dioxide fixation sensors are fitted inside the spaces in the programmed control system. These sensors respond immediately to the carbon dioxide presence, to change or control the open level of the air entryway and check the rate of the natural air that is conveyed into the spaces. The fuzzy control principle is outlined in Fig. 2.

In the programmed control system, the carbon dioxide fixation vacillation brought about by the team movements inside the spaces or the number of air changes. The distinctions with the setting make the sensor send the signal to the controller. The controller leads the actuator to do change as indicated by the signal from the sensor. In this manner, the natural air volume which provided by the marine aerating and cooling system to the spaces, is about the same with which the ventilating space required. The incite change is maintained, the cool or warmth vitality utilization decreased and the vitality preserved.

RESULTS AND DISCUSSION

Design of the fuzzy controller: The fuzzy controller, taking the two fold information channel, the carbon dioxide and temperature as the control parameters and their disparities vary the rate. The volume proportion as the carbon dioxide focus to contrast or the outline temperature as the setting an incentive to contrast which control the air entryway open degree to modify the natural air volume. The fluffy control process was enlightened in Fig. 3.

The air entryway open degree of the inlet flap or slide system either pneumatic or hydraulic operated is taken as the control action. The greater the open degree is, the all the more natural air enters the spaces and more rapidly the carbon dioxide concentration diminished. The CO_2 fixation was communicated in rate and the numerical esteem was little. So, in the change by the information factors, the genuine fixation esteem was constantly

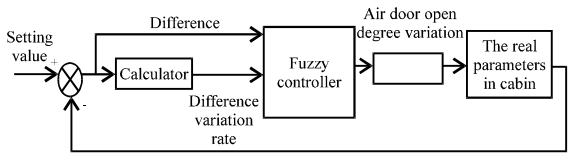

Fig. 3: Fuzzy control process

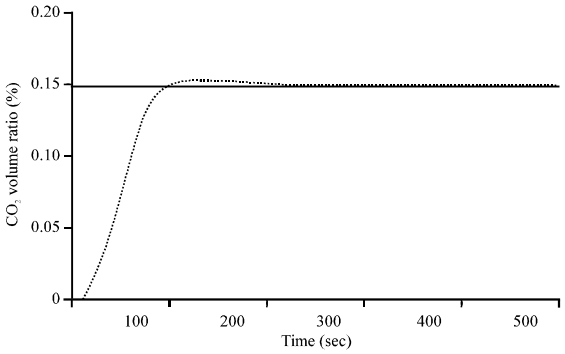

Fig. 4: Fuzzy controller response curve

opened up by 10 times (Fig. 4). The consequence of the reviews demonstrated that the ordinary fuzzy variable is appropriate to depict the fuzzy origination in this examination.

CONCLUSION

The fuzzy control innovation is without the exact mathematic demonstration, however, with the basic control program system, it could achieve the perfect execution of the marine cooling and air conditioning.

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