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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
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The industrial compressible fluid, especially the flammable gases has been paid more and more attention in the energy source supply system in the past twenty years. For example, methane or so-called natural gas, propane, and hydrogen are all cleaner than the conventional fuel. The self-actuated pressure control system without the electrical components such as the gas governor unit is widely used in the city gas supply system for anti-explosion. There are many pressure control problems in this equipment because the system lacks the electrical controlled circuit.

In this thesis, in order to solve the nonlinear problems caused by the square characteristics flow resistance of orifice in the pressure control system, a method using porous material whose flow rate characteristics is linear was proposed to improve the characteristics of the pressure control system and pilot valve system in chapters 2 and 3. On the other hand, a simulation model of the parallel pilot valve system was proposed to analyze the dynamic characteristics of the gas governor unit in chapter 4. Finally, for the application of the hydrogen pressure control system, the differences of the pressure response with various gas properties were investigated in chapter 5. The contents of each chapter are summarized as follows.

In chapter 1, four common industrial gases, air, methane, propane, and hydrogen, and some pressure control technologies of them are introduced. We showed the disadvantages of the square characteristics of the flow resistance in the pilot valve system in terms of the pressure vibration problems. The purposes and structure of this thesis are illustrated.

In chapter 2, a method by using porous materials is proposed for improving the characteristics of a gas pressure control system called pneumatic RC circuit. A static characteristics experiment with a porous material and an orifice is performed to confirm their *P*–*Q* characteristics. Then, the mathematical model of the pneumatic RC circuit is established, and the simulation is carried out by MATLAB. A frequency response experiment is also performed to estimate their dynamic responses. The experimental results are in close agreement with the simulation results. In the case of a pneumatic RC circuit with a porous restriction, the curves of the pressure gain and phase difference in the frequency response experiment are invariable with respect to changes in the amplitude of the input pressure. However, they are variable in the case of a pneumatic RC circuit with an orifice, because of

the nonlinear flow rate characteristics of the orifice.

In chapter 3, the new method employing porous materials is examined for improving the characteristics of the pilot valve system in the gas governor unit. A test pilot valve is manufactured, and a frequency response experiment is performed in this test system to estimate its dynamic response with porous material and orifice. In the frequency response experiment, the gain and phase difference of the diaphragm chamber pressure P_d remain constant with changes in the amplitude of the input vibration because of the linear flow characteristics of the porous material. As a result, the control pressure is not affected by the changes in the amplitude of the input vibration. However, the control pressure changes in the case of the orifice because of its nonlinear characteristics. Therefore, porous materials can be used in the pilot valve system instead of an orifice to improve its dynamic characteristics by making it to be a linear system easily. And the invariable flow resistance will help engineers to choose the restrictions more easily in designing the pilot valve system.

In chapter 4, a simulation model of the parallel pilot valve system was proposed to analyze the dynamic characteristics of the gas governor unit. A static experiment is carried out to confirm the static characteristics of the pilot valve and to find the relationship of the downstream pressure and the pressure inside the pilot valve. The simulation results indicate that the parallel pilot valve system owns a composite dynamic characteristics of these two pilot valves. It will possess the stability of the main pilot valve and the quick response of the sub pilot valve, simultaneously.

In chapter 5, in the application of the hydrogen station and the design of the pressure control system with different gases, the properties of gas need to be carefully considered. Two dynamic pressure response experiments with a pneumatic resistance capacitance system and a pipe are performed to verify the effect of the gas constant of various gases on the pressure response speed. The pressure response speed of hydrogen is 3.82 times that of air in a pneumatic resistance capacitance system. The pressure response speed in a pipe with hydrogen is much faster than that with the other three gases, and a large pressure vibration does not easily occur because of its small molecular weight. In contrast, propane has a large molecular weight. The research findings can be applied in the design and manufacture of different gas systems and equipment, particularly in the application of the hydrogen.