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著者(和文)	林鍾何
Author(English)	Jongha Lim
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	林 鍾何		

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指導教員（主）： Academic Supervisor(main)	只野 耕太郎
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

In this thesis, a pneumatic booster valve with energy recovery (PBV-R), which is an improved version of pneumatic booster valve (PBV) that has been used to boost compressed air for decades, is developed. Since the Expansion Cylinder has an energy recovery function, PBV-R is expected to be improved in terms of energy efficiency than PBV. The purpose of this thesis is mainly to improve energy efficiency of PBV-R. To do that, firstly, we carry out experimental validation. Secondly, we investigate the relationship between geometric parameters and energy efficiency of PBV-R. Lastly, on the basis of the results, we design and make a prototype of PBV-R and evaluate how much energy efficiency increases compared with a manufactured PBV.

In Chapter 1, we introduce background that too much energy consumption occurs in the industry in Japan, especially in pneumatic systems. Thus, the law of Japan, Kyoto Protocol and Paris Agreement encourage that mankind has to make effort to reduce energy consumption. Under the background, several researches have been carried out to develop technologies of energy saving in pneumatic systems. Among all, applying PBV to plants is considered as one of the simplest and most effective method that reduces the energy consumption. Furthermore, PBV-R has been proposed and the it has been numerically validated that the energy efficiency of PBV-R is greater than that of PBV. However, the performance of PBV-R has not been experimentally proved yet, although numerical simulation is usually inaccurate in fluid mechanics. Therefore, we set up the purpose of this thesis as experimental validation and development of PBV-R.

In Chapter 2, we designed a pneumatic circuit and set up an experimental apparatus for investigating the performances between PBV method and PBV-R method, e.g. energy efficiency, boost ratio and effective consumption rate. firstly, the energy efficiencies of PBV-R method were up to 8% greater than PBV method. Secondly, the boost ratios of PBV-R method were up to 17% greater than that of PBV method. Thirdly, effective consumption rates of PBV-R method are up to 5% greater than those of PBV method. Fourthly, we confirmed that the high-pressure air that was supposed to be exhausted in case of PBV method was partly reused in PBV-R method. Furthermore, we investigated how much energy is recovered and reused by an expansion cylinder. To do that, we defined “recovery ratio” and investigated at each area ratio. As a result, we found that there exists the area ratio that maximizes recovery ratio at each supply pressure.

In Chapter 3, we investigated the performances under different geometric parameters, e.g. area ratio and stroke length. To do that, we designed and set up a new experimental apparatus that can change all air cylinders. As a result, firstly, we found that if stroke length is constant, there exists specific area ratio that maximizes energy efficiency, boost ratio and effective consumption rate at different supply pressure. Secondly, we found that if area ratio is constant, energy efficiency and effective consumption rate tend to increase as stroke length

increases, while boost ratio does not change at all stroke lengths except 25 mm stroke length. Although, according to the previous studies, stroke length does not affect energy efficiency of PBV-R, the experimental results were different from the previous study. Thus, we investigated the factor that reduces the energy efficiency and we assumed that one of the biggest reasons is considered as dead volume. We carried out calculation of energy efficiency of PBV-R with consideration of dead volume and the results indicates that dead volume rate has a large effect on energy efficiency of PBV-R. This conclusion can explain the reason that PBV-R with shorter stroke length shows smaller energy efficiency.

In Chapter 4, Since it is considered that there exists optimal stroke length that makes energy efficiency of PBV-R higher and expense of manufacturing lower, we investigated the optimal stroke length by evaluating cost. On the basis of the evaluation and the results in previous chapters, we designed and produced a prototype of PBV-R, and carried out the experiment for comparing the performances of the prototype and those of a manufactured PBV(VBA20A). The maximum energy efficiency of the prototype was 63.9 percent, which is up to 10.5 percent greater than VBA20A. Furthermore, according to a calculation, we found that if PBV-R is applied to the whole industry in Japan, 0.4 percent of annual electricity energy consumption in the entire industry can be saved and reduce 4,100 kiloton of carbon dioxide emission annually.

In this thesis, firstly, we carried out experimental validation of PBV-R. Secondly, we determined the relationship between geometric parameters and energy efficiency of PBV-R. Lastly, we designed and made a prototype of PBV-R and evaluated how much energy efficiency increases compared with a manufactured PBV.