# Development of Air Supply System for Wearable Robot -Effectiveness of Hollow Cylindrical-shaped Variable Volume Tank

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## Ⅰ. Abstract

Air supply systems for the pneumatic power assist devices are required to have portability. Conventional air supply systems have employed constant volume tanks. If a small constant volume tank is used in order to downsize the system, inner pressure of the tank drops significantly when compressed air is supplied to the actuator. In this study, a hollow cylindrical-shaped variable volume tank is developed as a solution to this issue. This paper describes the effect of decreasing pressure drop based on the pneumatic energy characteristics when compressed air is stored in the developed hollow cylindrical-shaped tank. We also explain the feasibility of achieving the desired energy characteristic at high pressure by multi-layering the tanks to increase outer pressure.

## Ⅱ. Results & Discussion

Figure 1 shows the overview of the hollow cylindrical-shaped variable volume tank. This proposed tank is made of elastomer, which expands by increasing inner pressure and accumulates part of inflow energy as elastic energy. Figure 2 shows the measurement results of the energy characteristic of the hollow cylindrical-shaped variable volume tank. Figure 3 shows the energy characteristics of the constant volume tank. Elastic energy can be converted into compressed air energy when air is supplied to the actuator. Therefore, the pressure drop in the tank can be decreased compared to the conventional constant volume tank. The hollow cylindrical-shaped variable volume tank is compact as the initial inner volume is small. Moreover, it contributes to reducing remaining energy in the tank after compressed air is supplied to the actuator. These characteristics of the hollow cylindrical-shaped variable volume tank lead to low energy consumption of the entire air supply system.

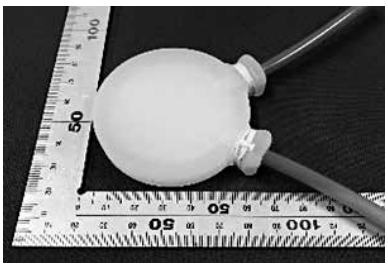

Figure 1. Hollow cylindrical-shaped variable volume tank

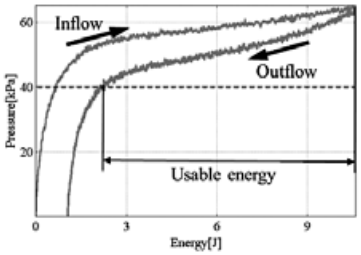


Figure 2. Energy characteristic of hollow cylindrical-shaped variable volume tank

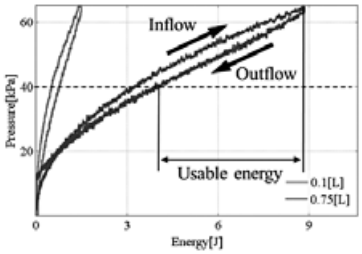


Figure 3. Energy characteristics of constant volume tank

In addition, a multi-layered tank is proposed to improve energy characteristic. Figure 4 shows the structure of the multi-layered tank. The inner tank is inserted between two outer tanks. The expansion of inner tank is restricted by increased pressure between inner and outer tanks. Figure 5 shows the energy characteristics when the outer tank is pressurized.

It is confirmed from the result that the value of relaxation-pressure and the amount of stored energy in the tank can be increased.

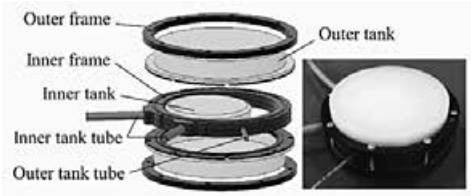


Figure 4. Multi-layered variable volume tank

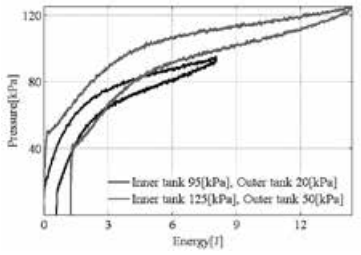


Figure 5. Energy characteristics of multi-layered variable volume tank

## Ⅲ. Conclusion

In this paper, the structure and characteristics of the hollow cylindrical-shaped variable volume tank were described. In addition, the multi-layered variable volume tank composed with cylindrical-hollow ones was proposed. The experimental results indicated that the relaxation-pressure value and the amount of stored energy in the tank can be increased. These results lead us to the conclusion that the multi-layered hollow cylindrical-shaped variable volume tank can contribute to the realization of portable energy-saving air supply systems.