Study of Auxiliary Brake Apparatus by Air Compression and Release for Stop of Heavy FCV Regenerative Brake

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The battery capacity of FCV is relatively small, so, though it might happen rarely, state of charge might become full on long steep downhill road ,that leads to failure of regenerative brake. And under high temperature, battery charging might not be available to avoid unallowable heat generation by the charging. To prevent such brake failure, authors propose light weight, low cost and clean auxiliary brake by utilizing air compression and release cycle system.

KEY WORDS EV and HV systems, brake control, Heavy FCV, Auxiliary Brake

The basic principal of studied auxiliary brake is shown in Fig.1. Braking force is obtained by reciprocating motion of the piston between bottom dead center(hereafter BDC)and top dead center （hereafter TDC）. Air is compressed during compression stroke immediately after BDC and resistance force caused by the compressed air generates braking force. Immediately before TDC, air exhaust hole will be opened by stroking piston seal and the air will be released. Then air pressure becomes atmospheric pressure around TDC. Immediately after TDC, the stroking piston seal will cut off the air passage between air chamber and external air again, then, expansion stroke begins. During expansion stroke, the air chamber pressure becomes lower than atmospheric pressure so that resistance force is also generated and braking force is also obtained. Immediately before BDC, air is breathed through air intake, and air chamber pressure becomes to atmospheric pressure again.

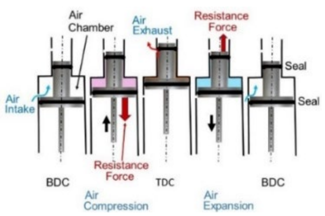

Fig. 1 Structure and principle of studied auxiliary brake

Capacity of studied auxiliary brake can be adjustable by controlling the compressed air exhausting timing. Piston stroke position where air exhaust begins is adjustable as shown in fig.2.

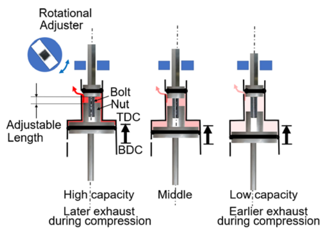

Fig. 2 Structure of brake capacity adjusting device

Bolt and nut system for exhaust timing adjustment is adopted. Bolt is connected to the smaller diameter piston, and nut is connected to the larger diameter piston. Then, the distance between smaller diameter piston and larger diameter piston can be easily changed by relative rotation between the bolt and nut. As shown in fig.2, high brake capacity can be obtained by small piston distance adjustment, and low brake capacity can be obtained by large piston distance adjustment.

Fig.3 indicates the experimental apparatus. In this study, reduced size desktop size prototype is made and tested. In general, air chamber pressure is the key for pneumatic equipment, so, in this study, behavior of the air chamber is focused and examined.

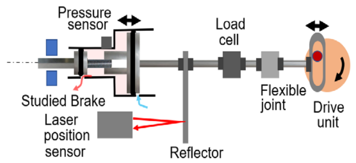

Fig. 3 Experimental apparatus

In Fig.4 behavior of air chamber pressure is shown. Red line indicates simulation and blue line indicates experiment. Simulation result using specific heat ratio κ =1.3 has been most close to experiment result.

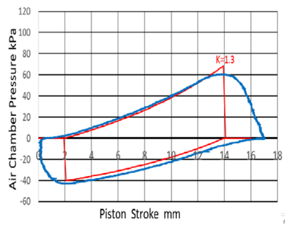

Fig. 4 comparison between simulation and experiment

Brake capacity adjustment function has been also confirmed. As shown in Fig.5, exhaust timing can be changed by the adjustment.

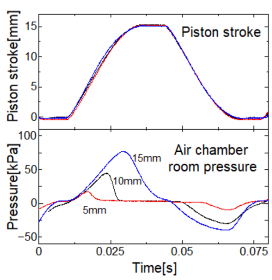

Fig.5 Pressure behavior by changing exhaust timing