

Auxiliary Brake Apparatus by Air Compression and Release for Stop of Heavy FCV Regenerative Brake (6th Report)

- Proposal of the Rotary Vane Type for compact Design -

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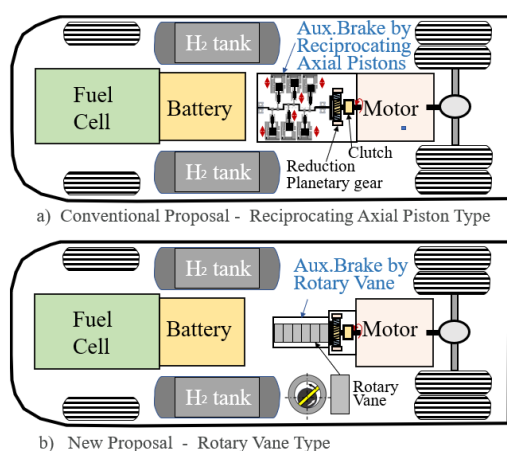


Fig.1 Mounting Method of Auxiliary Brake

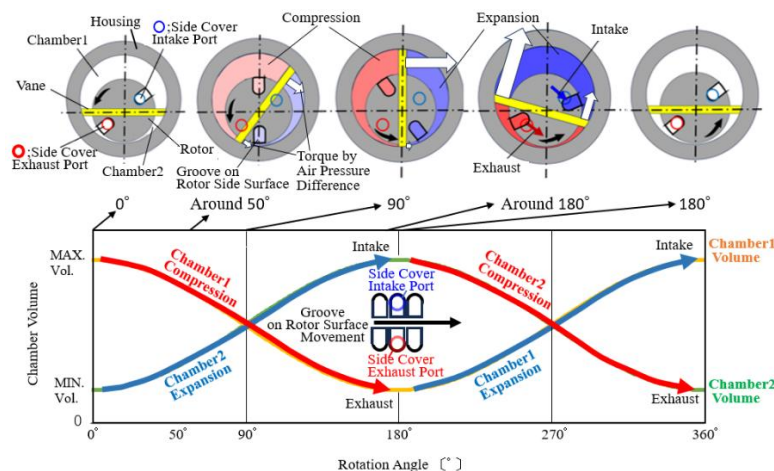


Fig.2 Operating Principle of Rotary Vane Type Auxiliary Brake

Fuel cell vehicles (FCVs) are considered a promising option for the electrification of heavy-duty trucks. However, because fuel cell trucks typically have limited battery capacity, their batteries can easily reach full charge. Consequently, during long, steep descents, the battery may become fully charged, preventing regenerative charging and leading to a loss of regenerative braking capability. To address this issue, we proposed a simple auxiliary brake system utilizing air compression and release in our previous reports (Reports 1 through 5). While the auxiliary brakes proposed in those earlier reports generated braking force through air compression and expansion resistance, their reliance on reciprocating pistons necessitated a mechanism to convert rotational motion into reciprocating motion—as illustrated in Fig. 1(a)—posing a significant challenge regarding compactness and simplicity. Therefore, in this study, we undertook the development of a rotary-vane type auxiliary brake that accepts rotational motion directly as input, as shown in Fig. 1(b). Fig. 2 illustrates the operating principle of the proposed rotary auxiliary braking device. Compression (positive pressure) and expansion (negative pressure) are generated by the vanes; the resulting pressure difference produces braking torque on the longer vane and driving torque on the shorter vane. Since the braking torque exceeds the driving torque, the device generates a net braking torque. Additionally, intake and exhaust occur automatically when air passages machined into the rotor's side face align with intake/exhaust ports (indicated by blue and red circles) in the side cover; this continuously expels heat generated by power absorption and replaces the air, preventing the device from overheating. A conceptual diagram of this intake/exhaust mechanism is shown near the 180-degree position. As illustrated, the system generates high braking force through repeated compression and expansion cycles in two air chambers—occurring twice per revolution (every 180 degrees). To clarify its fundamental characteristics, a scaled-down prototype with a rotor diameter of 40 mm and a height of 45 mm was fabricated, and its performance was evaluated experimentally.

Fig. 3 presents the braking power measurement results at a rotational speed of 180 rpm. The blue bars represent braking power, while the brown bars represent the total air chamber volume; experimental results for a previously proposed reciprocating two-stage compression model at 180 rpm are also included for comparison. As shown, the newly proposed rotary vane type performs two compression and expansion cycles per revolution; this allows it to achieve a braking power of 30 W—comparable to the 32 W achieved in the study reported in the fifth paper—with a relatively small air chamber volume. Furthermore, because the mechanism for converting motion to a reciprocating type is eliminated and the air chamber size can be reduced, the design proves promising in terms of achieving a compact footprint.

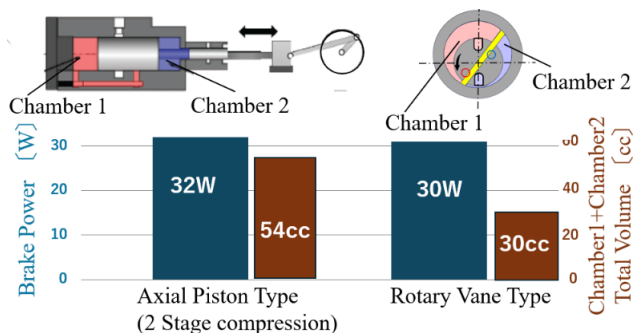


Fig.3 Comparison of Braking Power at 180 rpm