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A study on the Performance test of swash plate compressor in vehicle

Seo Hyun Sang

Lead author, Division of Mechanical and Automotive Engineering,
Kongju National University (KNU), 275, Budae-dong, Cheonan-si, Chungcheongnam-do 330-717, South Korea
youranycall@naver. com

Haeng Muk Cho

Corresponding author, Division of Mechanical and Automotive Engineering,
Kongju National University (KNU), 275, Budae-dong, Cheonan-si, Chungcheongnam-do 330-717, South Korea
hmcho@kongju. ac.kr

Abstract
In this study, the effects of the compressor for the air conditioning system on the fuel economy were experimentally investigated in an actual automobile. Performance tests were conducted on the compressor calorimeter according to the number of cylinders of the variable cylinder swash plate type compressor, the performance and characteristics of the compressor by number of piston in each cylinder. Performance of the compressor is proportional to the number of revolutions of the compressor, and inversely proportional to the compression ratio. Power consumption is the number of cylinders you us a trend similar to the difference between the 5 individual compressor performance, power consumption and compressor is small, but seven individuals, in the case of individual compressor cylinder number 6 shows the low power consumption. Therefore, the number of six individual cylinder compressor with low power consumption, is the best compressor in terms of fuel economy.

Keywords: Compressor, Variable Swash Plate, Fuel Economy, Automobile, COP

1. Introduction
In the auto industry of today, there are a number of conditions to be considered and various studies are made on how to cut fuel consumption. For instance, there are studies on the improvement of an auto engine and the reduction of wind resistance in order to cut fuel consumption. The reduction of fuel consumption is very critical for consumers of the auto industry of today, but there is another factor receiving a lot of attention lately and that is 'Convenience'. To cope with such demand, the auto industry also has emphasized the car system that requires a low level of fuel consumption while offering a pleasant and convenient driving experience. Also, the auto industry currently works on the development of an air-conditioning system that could not only offer pleasant air in the car, but also be eco-friendly to accomplish the market's demand for prevention of global warming. A refrigerant for the auto air conditioning system, for instance, is one of gases inducing global warming. Exhaustion of fuel resources and concerns for global warming have brought significant changes to the auto industry, in turn having great ripple effects on the auto component industry. At the time of writing, the most important concerns of the auto component industry are fuel consumption saving and efficiency of the compressor of the auto air conditioning system. There is a huge demand on the compressor, but the auto component industry of South Korea heavily relies on import since core technologies of the compressor have not been secured. Only by the early 2000s, the auto industry of South Korea started to concern on a swash plate type compressor and at the early stage of the development of a swash plate type compressor, the auto industry only focused on the improvement of its durability, which unfortunately came to be unsuccessful since power consumption of such swash plate type compressor affects engine output, in turn deteriorating a level of power consumption. Since then, the auto industry has worked on the design approach of a swash plate type compressor to improve conditions of the automobile and only recently, it has started to study on the improvement of efficiency of the compressor in depth. [1]
This study aims to reveal factors that affect performance of a swash plate type compressor by studying performance of the compression under various environmental conditions and actual driving conditions while varying the number of cylinders and the maximum discharge capacity of a swash plate type compressor. The performance of a swash plate type compressor is measured using a calorimeter.

2. Structure and Features
A variable swash plate type compressor is a compressor energy than fixed to automatically control the angle of the swash plate the structure variably moving the swash plate by the pressure in the circuit and compression piston that moves inside the stationary compressor is different from that used in the current car air conditioning system, holding less advanced compressor efficiency is also good. The piston is tilted by the rotation of the swash plate inclination angle of the swash plate by reciprocating a reciprocating piston compressor for movement with the tilt angle of fixed swash plate compressor which is fixed changes in the variable capacity swash plate type compressor for controlling a representative. A variable swash plate type compressor has a wide operation range, is characterized in that it is relatively durable compared to other compressor.

Fig. 1 is Boundary of Variable swash plate for automotive compressor. [2] Fig. 2 is ECV (main control valve) location in variable capacity compressor. [3]

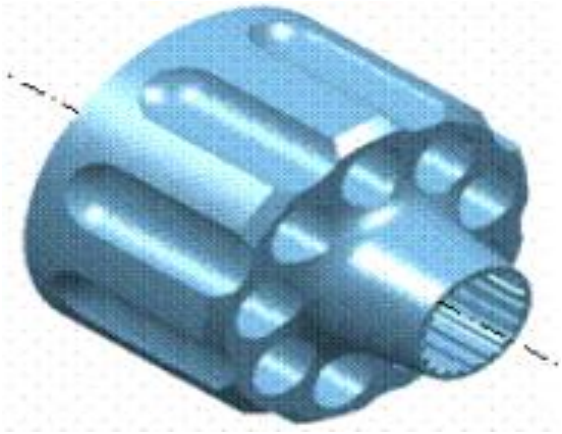

Fig. 1 Boundary of Variable swash plate for automotive compressor [2]

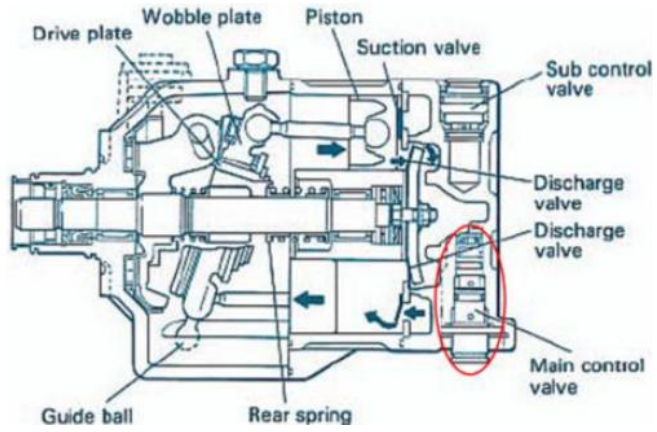

Fig. 2 ECV (main control valve) location in variable capacity compressor [3]

3. Experimental methods

For this study, swash plate type compressors, meeting a specification for domestic auto air conditioning systems, were used, and these study specimens, which were swash plate type compressors, with 5, 6, or 7 cylinders were classified by the number of cylinders and the maximum discharge capacity as shown in the Table 1. This experiment included actual automobile conditions including the scope of operation of the auto air conditioning system.

TABLE 1. Specification comparison of experimental compressors

Number of cylinder	5 Cylinder			6 Cylinder			7 Cylinder		
Displacement (cc/rev)	12	11	9	16	14	12	16	14	12

The Table 2 describes detailed conditions of the experiment. The number of rotations of a swash plate type compressor was observed at low-speed driving, medium-speed driving and high-speed driving for each driving condition.

TABLE. 2. Experimental conditions

Recolution Speed (rpm)	1200				2000				3000			
Compressor ratio (Pd/Ps)	6	7	8	9	6	7	8	9	6	7	8	9

The air conditioning capacity, power consumption and coefficient of a swash plate type compressor were measured using the following equations.

$$\Phi = Gf(hgs - hfa) + \Phi p \quad (1)[4]$$

$$HP = \frac{2\pi \times Nm \times Mtrq}{60 \times 76.04} \quad (2)[4]$$

$$COP = \frac{\Phi/860{\cdot}421}{HP/1{\cdot}3405} \quad (3)[4]$$

Equation (1) represents the performance of the compressor to heat the compressor performance of the evaporator calorimeter.
Equation (2) It represents the power consumption of the compressor by using the compressor calorimeter.
The equation (3) expresses the coefficient of a swash plate type compressor as a rate of performance and power consumption of a swash plate type compressor and it is used as a measure of efficiency.

4. Experimental results

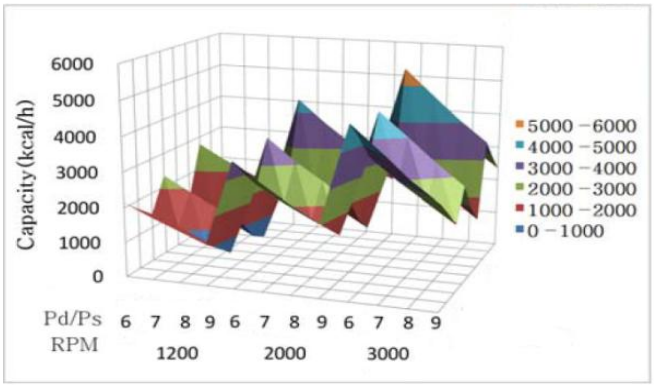

Fig. 3 Experimental result of cooling capacity

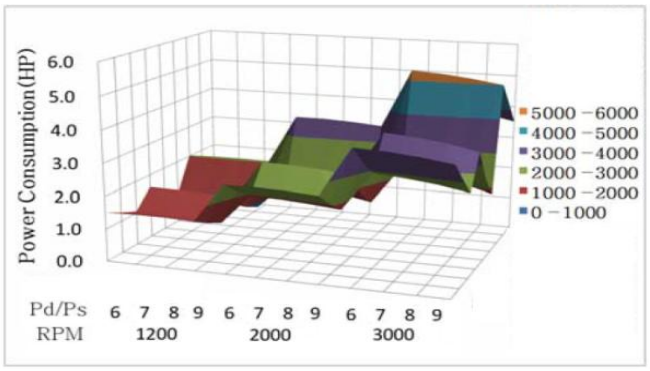

Fig. 4 Experimental result of power con-sumption

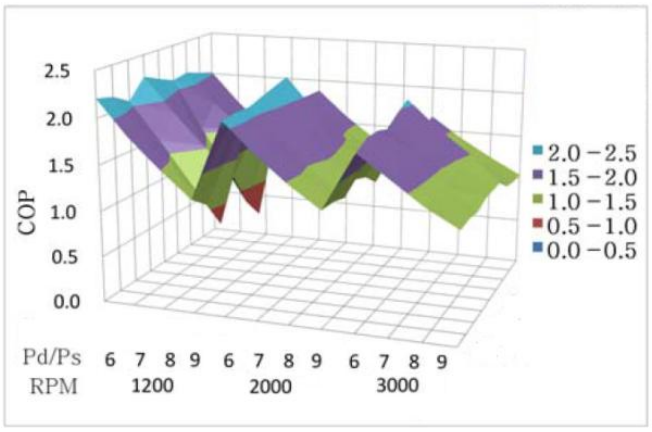

Fig. 5 Experimental result of COP

This experiment reveals that air conditioning performance of a swash plate type compressor is directly proportional to its discharge capacity and number of rotations, and inversely proportional to a rate of compression. On the other hand, power consumption of a swash plate type is not significantly influenced by a rate of compression and directly proportional to its discharge capacity and number of rotations.

The comparison of COP several that a rate of compression exerts more influence than the discharge capacity number of rotation of a swash plate, type compressor. In other words, a rate of compression is a more critical factor of its efficiency.

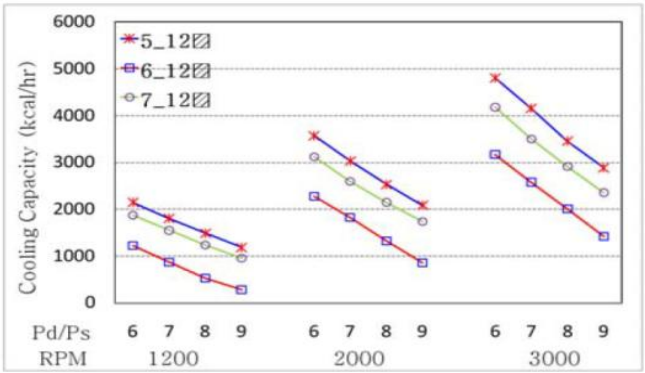

Fig. 6 Experimental comparison of cooling capacity

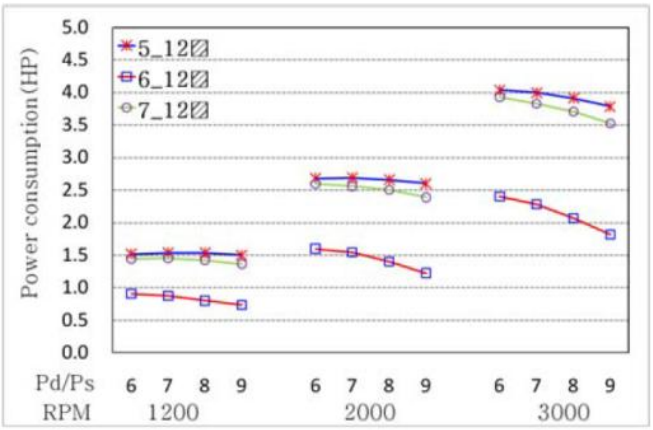

Fig. 7 Experimental comparison of power consumption

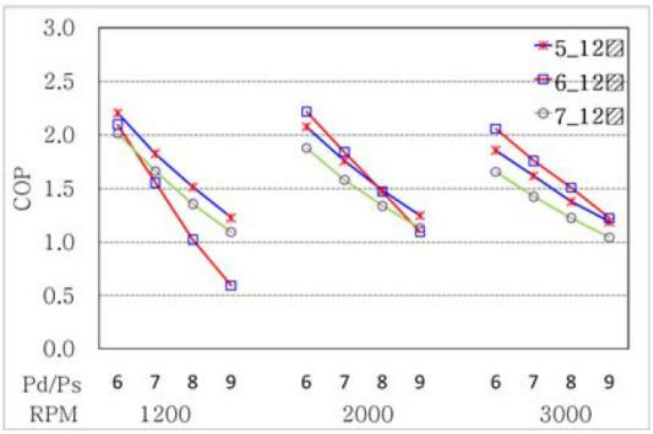

Fig. 8 Experimental comparison of COP

The comparison of swash plate type compressors with the same maximum discharge capacity, but different numbers of cylinders shows that the performance of a swash plate type compressor with 5 cylinders is the best, and followed by a swash plate type compressor with 4 cylinders and then, with 6 cylinders. It shows that the performance of a swash plate type compressor increases with the number of its rotations, but decreases with a rate of compression. Power consumption of a swash plate type compressor also shows such tendency, but there is a small difference in power consumption between swash plate type compressors with 5 cylinders and 7 cylinders and a swash plate type compressor with 6 cylinders has a relatively low level of power consumption. A swash plate type compressor with 6 cylinders has outstanding COP and it is the most effective in terms of fuel consumption since its power consumption is relatively low.

5. Conclusion

By observing performance of the compression using a calorimeter under various environmental conditions and actual driving conditions while varying the number of cylinders and the maximum discharge capacity of a swash plate type compressor, this study has made a conclusion as the following.

(1) Performance coefficients of a swash plate type compressor for both a rate of compression and the number of rotations are all within 1. 0 to 2. 0
(2) A swash plate type compressor with 6 cylinders has a low level of power consumption and outstanding performance coefficients.
(3) As for swash plate type compressors with the same maximum discharge, their performance increases with the number of rotations, but decreases with a rate of compression.

Acknowledgment

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