Herrick Laboratories PURDUE UNIVERSITY

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Refrigeration and Air Conditioning
High Performance Buildings

Development of a New Dual-Cylinder Rotary Compressor for VI System

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PURDUE UNIVERSITY

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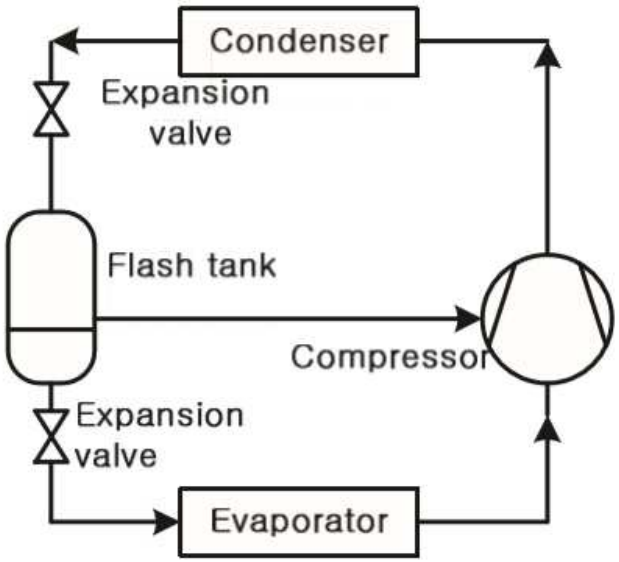
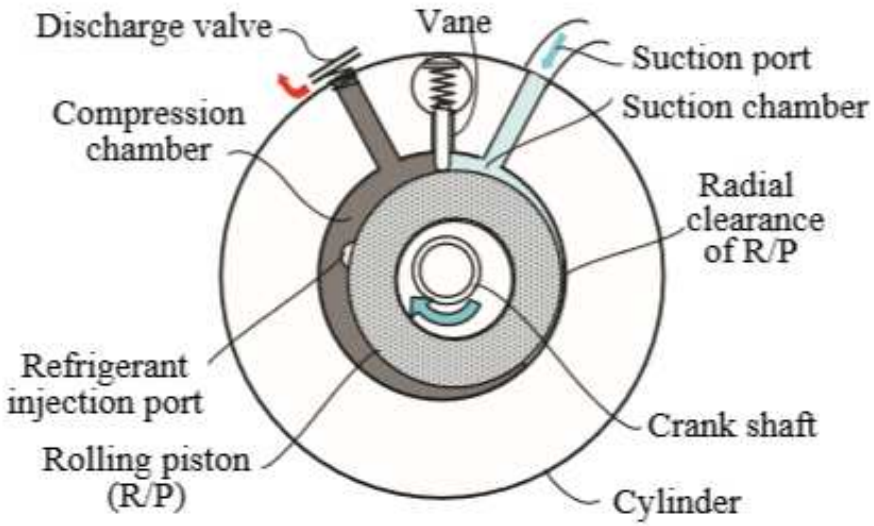
INTRODUCTION

- Vapor injection compression cycle's superiority over non-injection cycle has been well known
- VI system produces the high heating/cooling capacity, and its power consumption is less than the non-injection system.

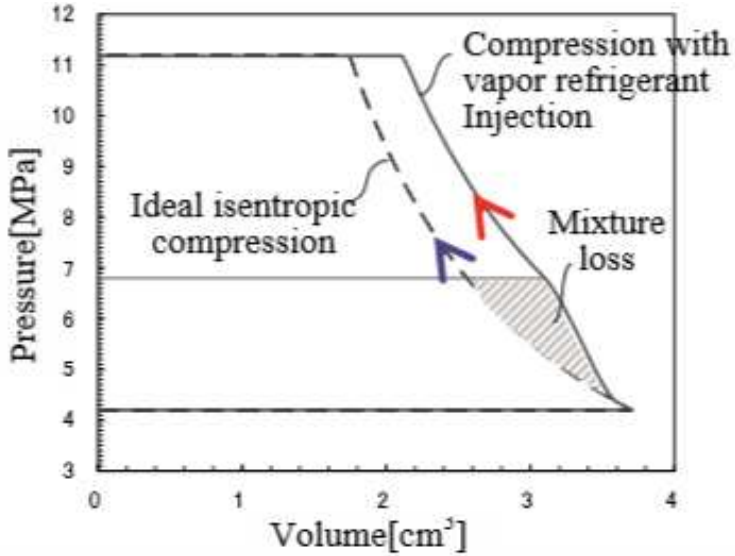


INTRODUCTION

- Unfortunately, other problems arise, such as mixture loss on refrigerant injection into the compression chamber (Sekiya *et al*., 2005, Tetsuhide *et al*., 2008)



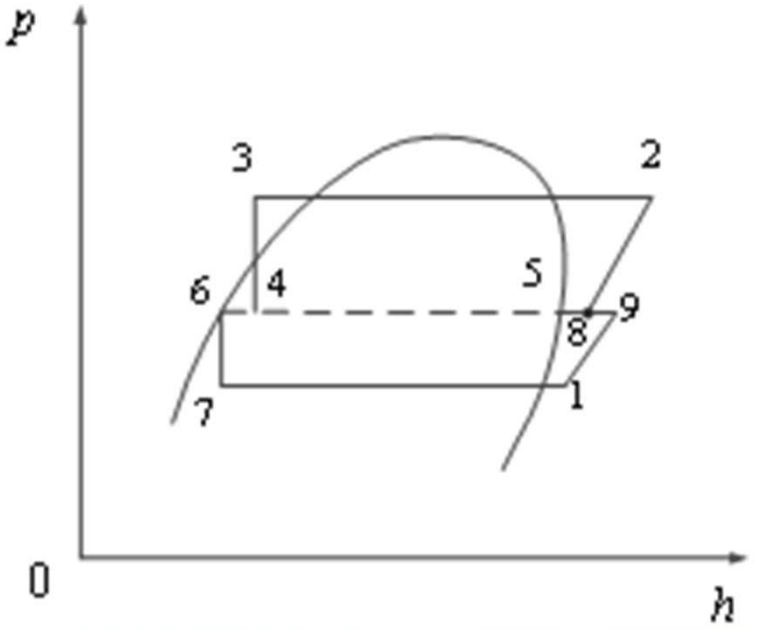
Structure of rotary compression mechanism in single type cylinder with refrigerant injection



P-V diagram in cylinder of single rotary compressor with vapor refrigerant injection

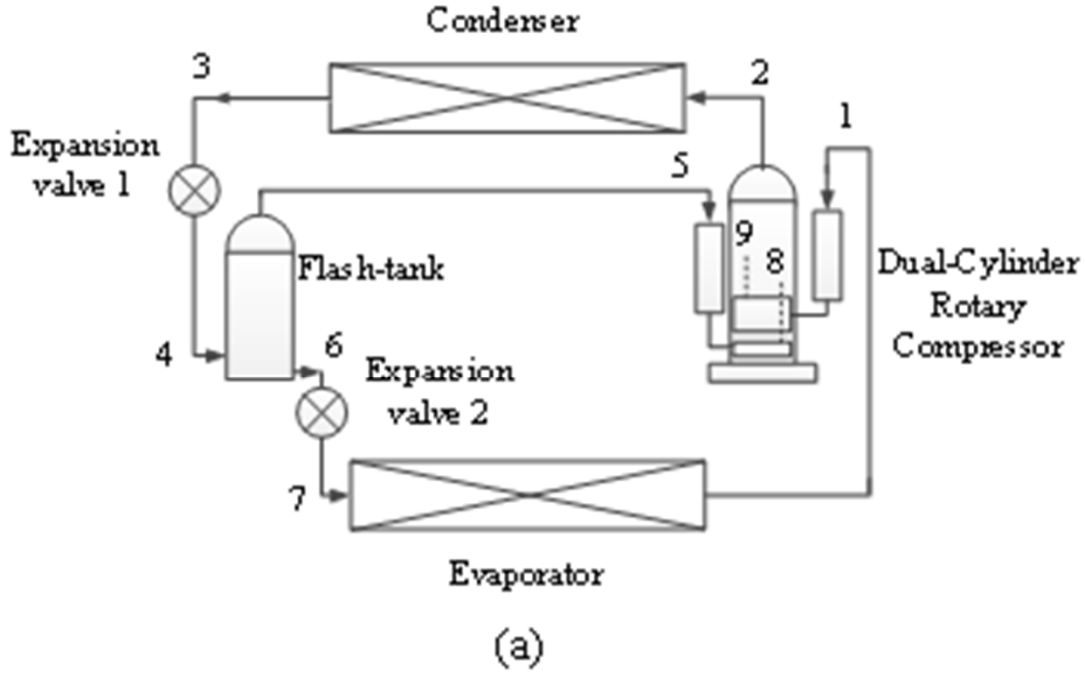
INTRODUCTION

- Another solution for the two-stage compression cycle is the use of a two-stage compressor, because most of the gas is compressed two times, the indicated power increases because of its two times exhaust process.

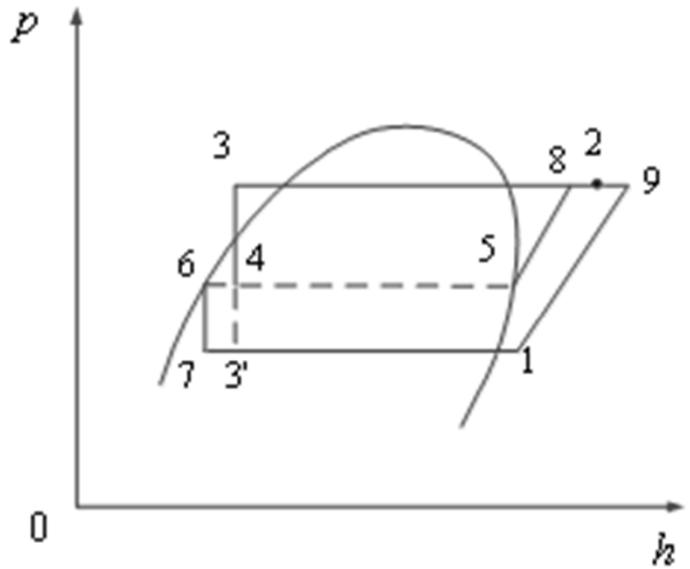


MODEL OF THE NEW VI SYSTEM

- The gas from the flash-tank will be compressed independently



(a)



(b)

THERMODYNAMIC ANALYSIS

- The refrigerating capacity in evaporator is

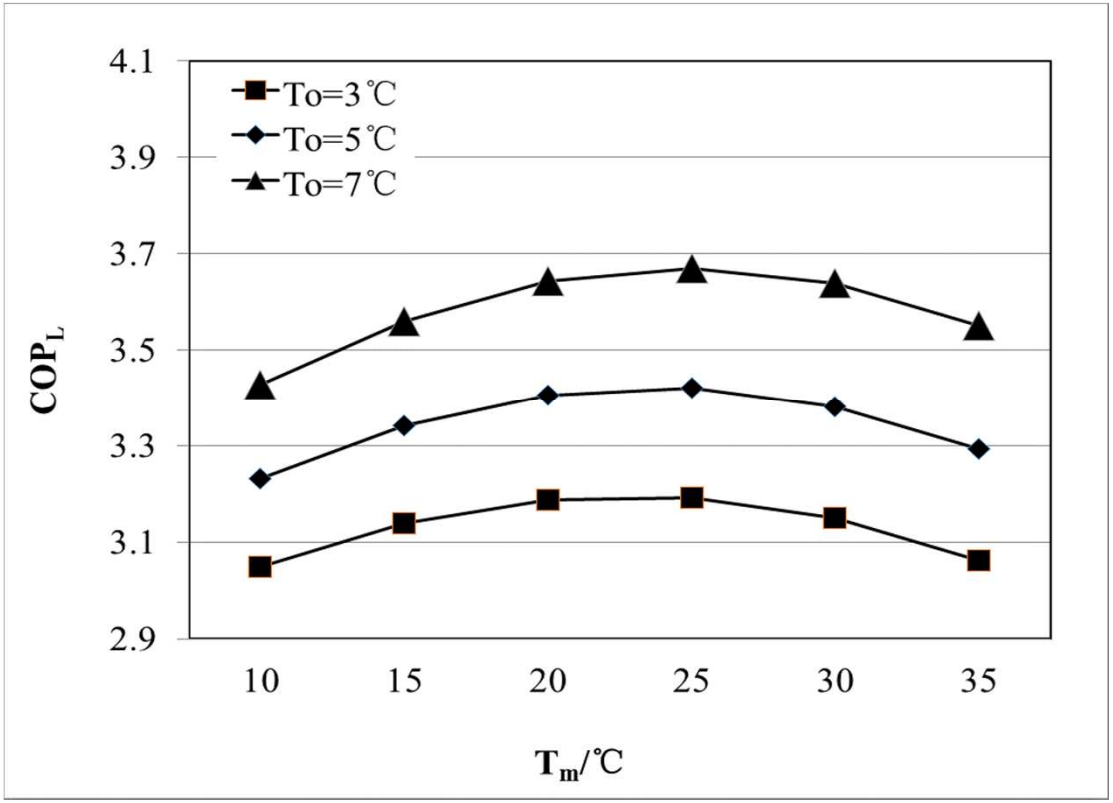
$$q_o = h_1 - h_7$$

- The cooling COP of the new VI system is

$$\mathrm{COP_L} = \frac{q_o}{w_{1-9} + w_{5-8}}$$

THERMODYNAMIC ANALYSIS

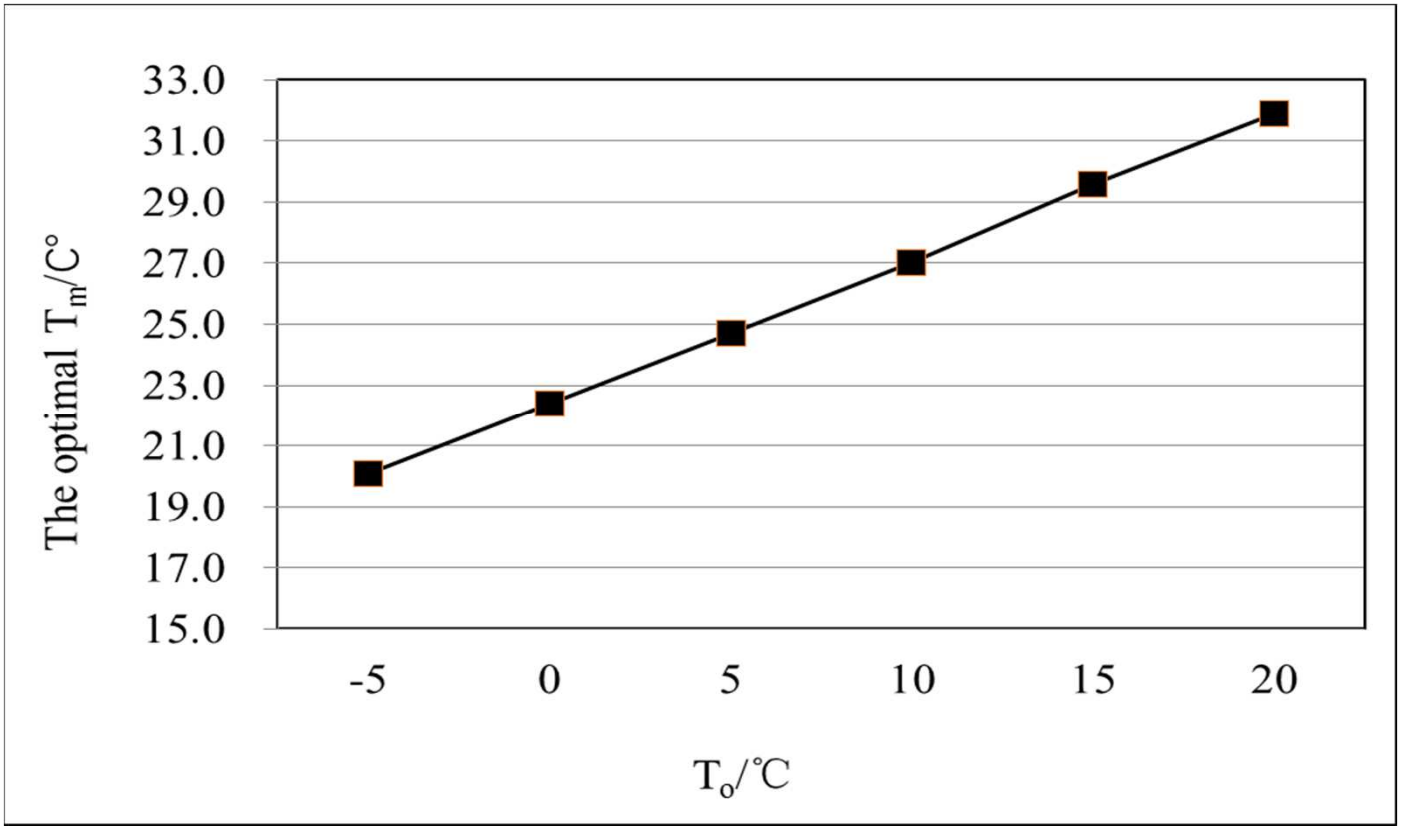
- The variation of COP_L with T_m(temperature of flash tank)



(condensing temperature, T_k, of 45℃, evaporating temperature, T_o, of 3℃, 5℃, 7℃ under cooling condition)

THERMODYNAMIC ANALYSIS

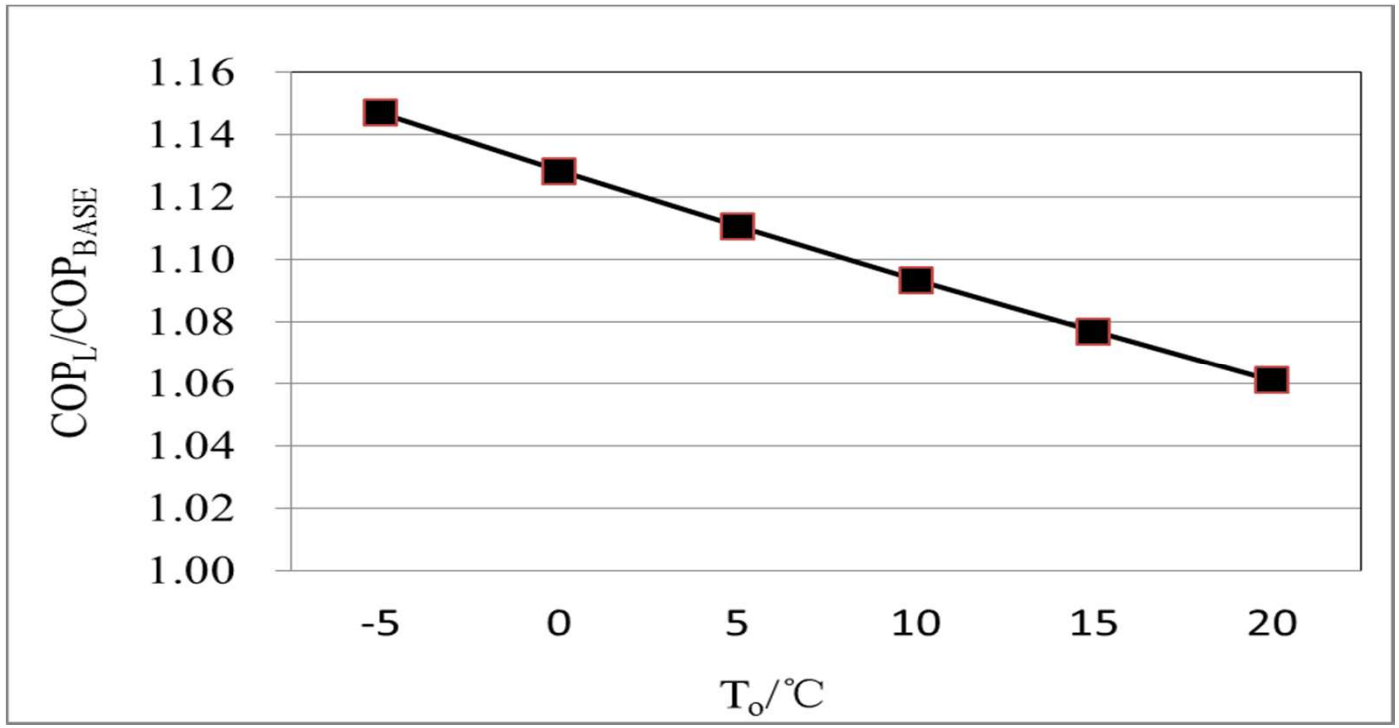
- The variation of the optimal T_m with T_o



(condensing temperature, T_k, of 45℃, the superheat = 5℃ and the sub cooling = 5℃)

THERMODYNAMIC ANALYSIS

- The variation of COP_L/COP_{BASE} with T_0 (under the optimum intermediate temperature T_m)



(condensing temperature, T_k, of 45℃, the superheat = 5℃ and the sub cooling = 5℃)

EXPERIMENTAL RESULT

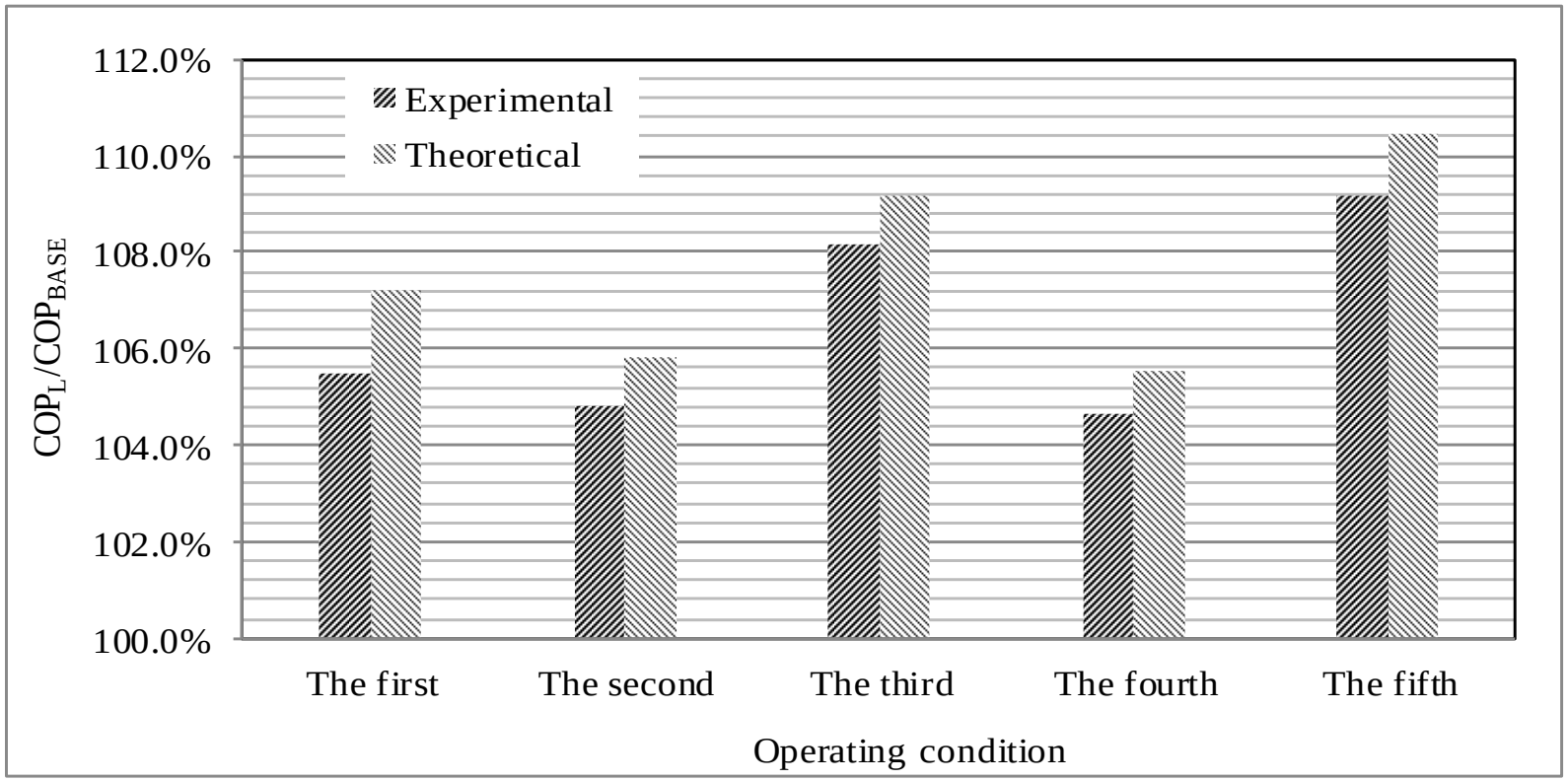
- Based on the above analysis, a new dual-cylinder compressor is designed and evaluated

- The compressor is designed based on 5 conditions

Operating condition	The first	The second	The third	The fourth	The fifth
Condensing temperature (℃)	45.6	39.6	43.6	31.5	46.5
Evaporating temperature (℃)	10.7	17.8	0.8	2.9	-4.7
Superheat (℃)	9.3	7.2	5.3	5.1	6.7
Sub cooling (℃)	6.1	1.0	7.0	4.0	9.9
Ambient temperature (℃)	35	35	35	35	35
Contribution ratio	25%	33%	13%	10%	19%

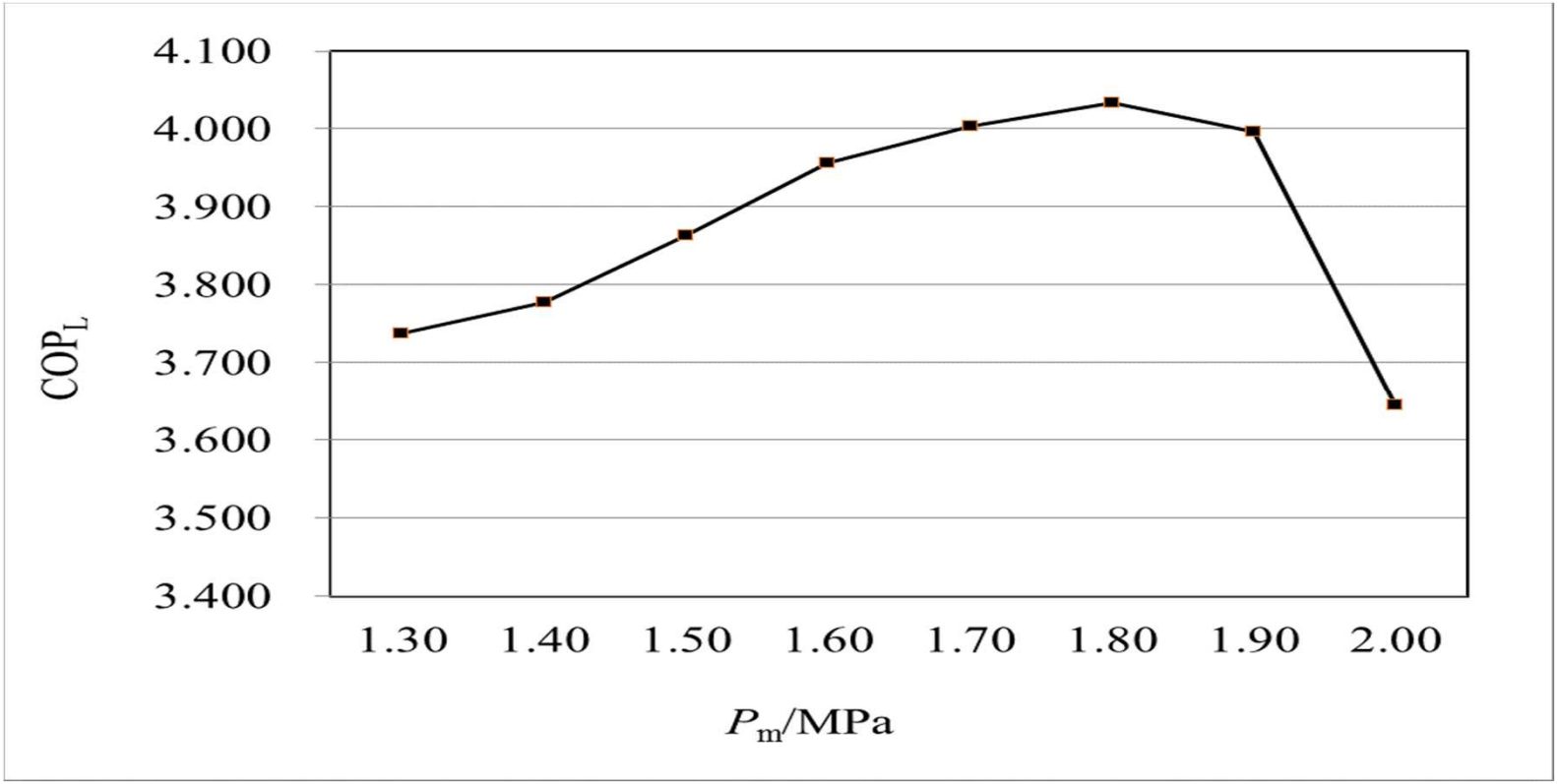
EXPERIMENTAL RESULT

- The Comparison between theory and experiment of COP_L/COP_{BASE}



EXPERIMENTAL RESULT

- The variation of COP_L with the intermediate pressure p_m about the first condition



CONCLUSIONS

- A new dual-cylinder rotary compressor for VI systems is developed and evaluated
- The cooling COP increase 4.6%-9.1% under the test conditions.
- The variations of the COP_L with the intermediate pressure p_m (pressure of flash tank) indicates that when the intermediate pressure exceeds the optimum value, the COP_L is decreased dramatically because of the suction of liquid and this should be avoided in the application.

Thank you!