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## Visualization and Quantification of Oil Behavior inside Rotary Compressor

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**Key Words:** Rotary compressor( ), Oil behavior( ), Quantification( ), Flow visualization technique( 가 )

### Abstract

A quality of a refrigeration cycle and a reliability of a compressor can be reduced if a refrigerant including excessive lubricating oil is exhausted from the compressor. Thus, the analysis of the oil behavior inside the compressor is required to prevent the problem. A tested rotary compressor with visualization windows has been manufactured in this study to investigate the oil behavior using developed visualization techniques. The oil behaviors at various operating conditions have been quantified to obtain the relationship with the outlet pressure inside the compressor. Also, the effect of the operating conditions on the quantity of the exhausted oil from the rotary compressor has been investigated using the visualization technique.

### 기호설명

$I$

$I_{avg}$

$M$

$N$

$Q_I$

$Q_O$

$Q_R$

가 (2,3)

1.

가

(1)

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\*\* DA RC

Housing

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가

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가

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. Fig.2 Test Model  
. Test Model

Generator Heating  
Regulator Circulator

. Test Model  
80mW Ar-Ion

2.

80mW

. Test Model  
Ar-Ion

2.1 Test Model

가

가

2.2 가

Rotary Compressor

Fig.3

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가 가

Fig.4

가 가

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가

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가

가

가

Test Model

Test Model Fig.1

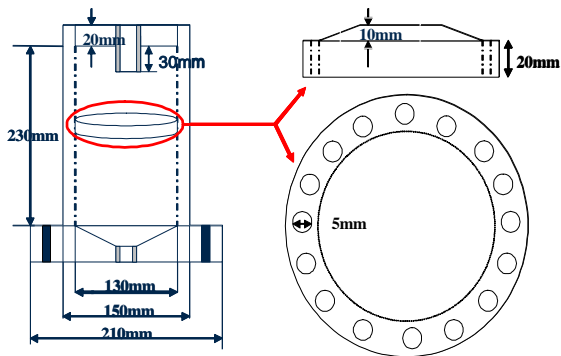


Fig.1 Layout of test model

가

가

60bar

0.2mm

Polymer Film 가

1,2

640 X 480

8bit(0~255)

CCD

XC-55

, 3

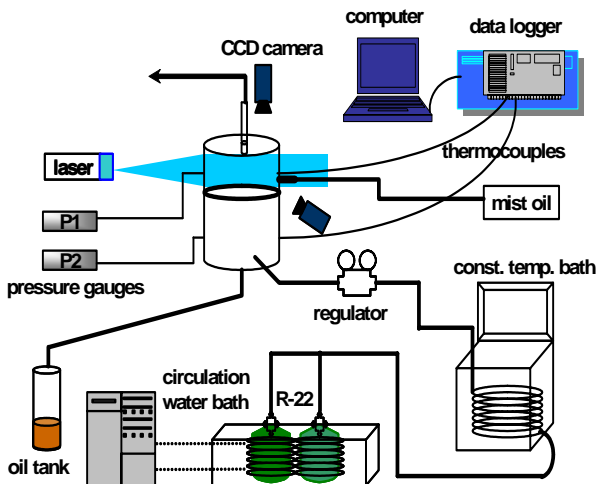


Fig.2 Experimental setup for test model

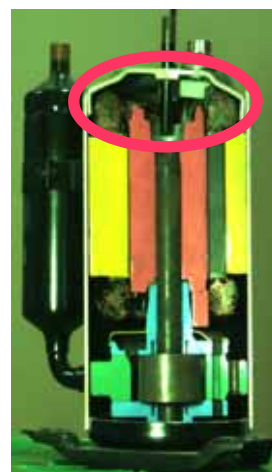


Fig.3 Cross-sectional view of rotary compressor



Fig.4 Quartz for visualization of rotary compressor



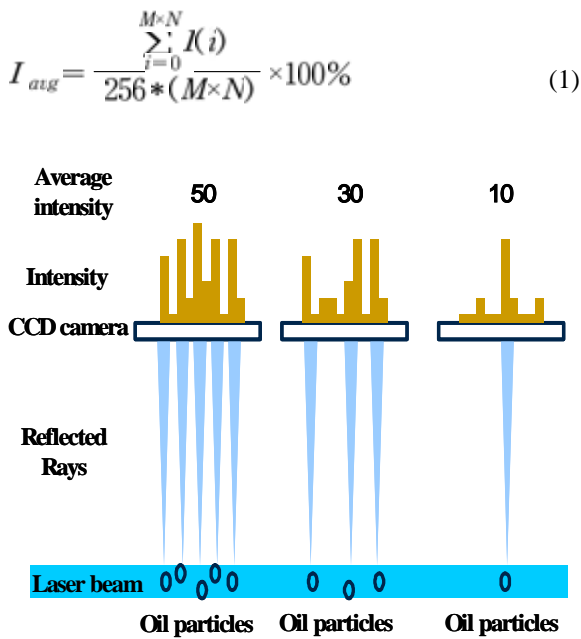
(a) Top view (b) Side view  
**Fig.5** Photographs of rotary compressor with visualization windows

1024 X 768 가 HR70C

3.

3.1

가  
 Laser Sheet  
 CCD  
 Fig.6  
 가  
 (1)



**Fig.6** Principle of quantification of intensity

윗 식에서 M, N은 평균값을 구하기 위한 영상 pixel의 행과 열의 개수를 나타내며, 8bit의 최대 밝기는 255이다.

3.2 Test Model

Test Model

Table 1 4가  
 Cylindrical Lens  
 Sheet

(2)

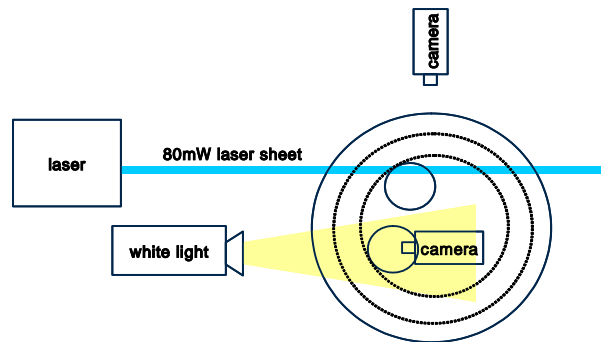
$$Q_O = Q_I - Q_R \quad (2)$$

3.3 가 Rotary Compressor

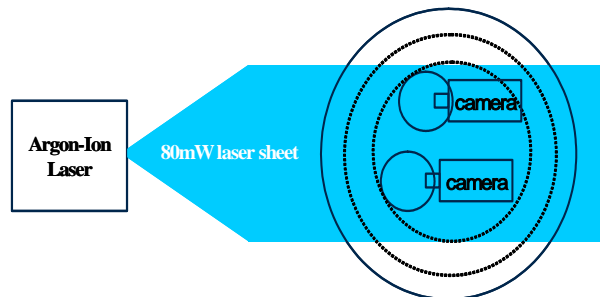
3 . 1

Intensity , 2

Intensity , 3  
 Intensity  
 Fig.7 1 , 1



**Fig.7** Schematic diagram for Exp.I (Top view)



**Fig.8** Schematic diagram for Exp.II (Top view)

Laser Sheet  
 Fig.8  
 CCD  
 15mW  
 4.

4.1 Test Model

Table 1 Average Intensity Test Model  
 Test Model

**Table 1** Average intensity with inserted refrigerant and discharged oil

Condition	1bar,77	2bar,77	1bar,57	2bar,57
Inserted R22	4.06kg	6.6kg	4.12kg	6.22kg
Exhausted Oil	7ml	10ml	2ml	7ml
Average Intensity	5501.7	8849.9	2864.5	6686.2

**Table 2** Average intensities with various conditions

	Inlet T ( )	Outlet T ( )	Outlet P (bar)	I <sub>avg</sub> of Top view	I <sub>avg</sub> of Side view
Condition1	26.3	89.3	11.8	53.09	60.10
Condition2	30.0	90.6	11.9	53.20	60.48
Condition3	29.6	95.6	13.1	56.43	60.78
Condition4	30.0	106.1	16.2	60.73	64.86
Condition5	30.1	123.6	20.7	75.32	76.32

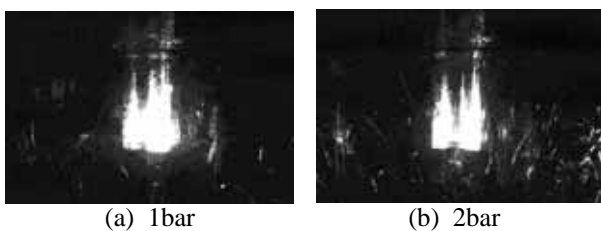


Fig.9 Oil behaviors by inlet pressure

Intensity Test Model  
 Fig.9 CCD

4.2 Rotary Compressor

Figs.10, 11 P-h

Table 2

Intensity  
 Intensity가 가 가  
 Intensity가 가 Test Model  
 Intensity가 Test Model  
 가 가

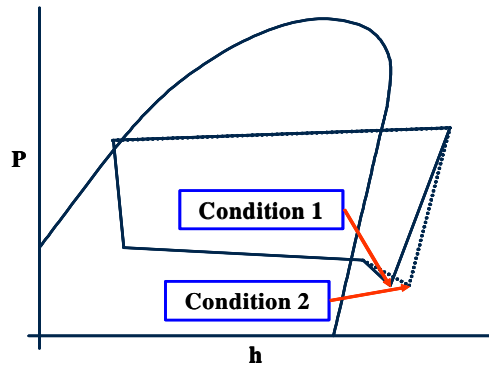


Fig.11 Cyclic chart of Exp.I for conditions 1 and 2.

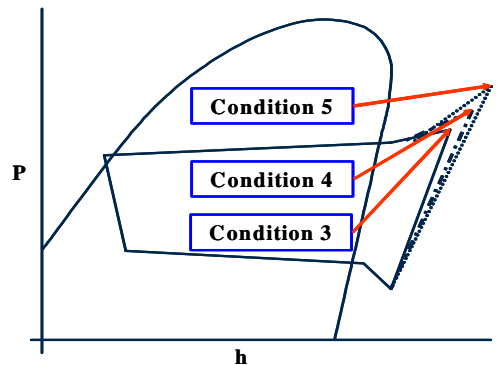
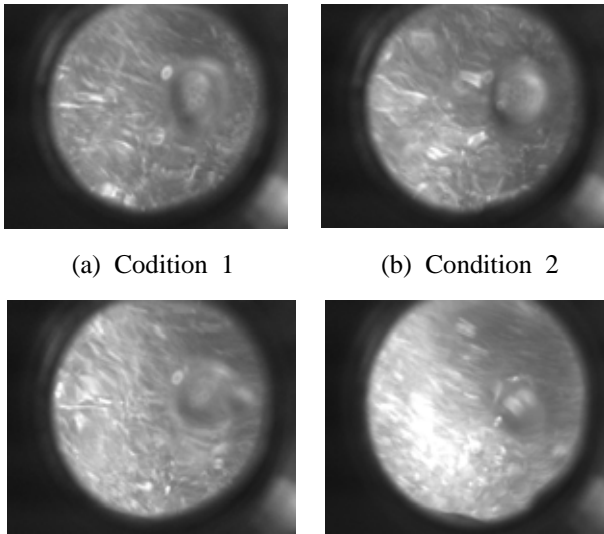


Fig.11 Cyclic chart of Exp.I for conditions 3, 4 and 5.



(a) Condition 1      (b) Condition 2  
(c) Condition 3      (d) Condition 5

Fig.12 Captured images of Exp.I

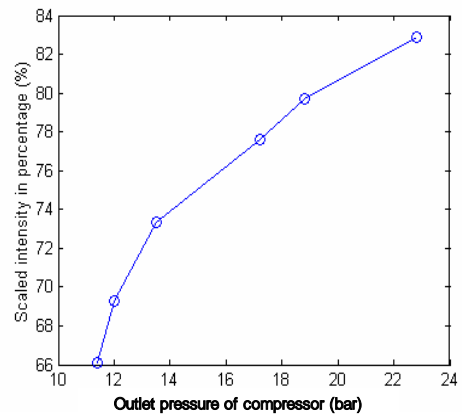


Fig.14 Average intensity of rotary compressor with outlet pressure

3

Table 3

가

가

. 3

가

Intensity

Fig.12

1

가

2

1

Intensity

Average Intensity

Figs.13, 14

가

Average Intensity

가

가

가

Intensity

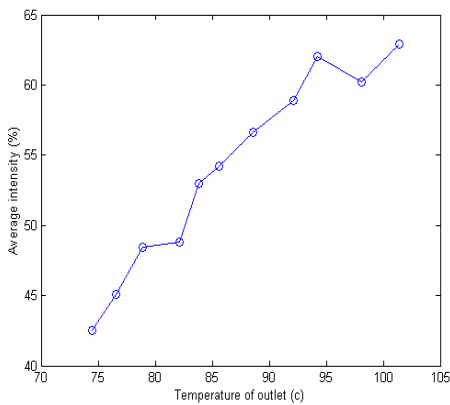


Fig.13 Average intensity of rotary compressor with outlet temperature

Table 3 Conditions for Exp.

No	Name	Parameter	$P_e$	$P_c$	$T_s$	Intensity
			$kgJ/m^2A$	$kgJ/m^2A$	$^{\circ}C$	
1	ASHRAE-T	standard	6.37	21.9	35	25.7287
2	ARI	$T_s$	6.37	21.9	18.3	26.5611
3	Ari-low suction temp		6.37	21.9	9.2	25.9153
4	A/C Cooling standard		6.93	17.64	15	28.0016
5	High condensing pressure	$P_c$	6.37	24.76	35	30.7343
6	Low condensing pressure		6.37	17.64	35	23.8782
7	High evaporating pressure	$P_e$	6.93	21.9	37.8	28.5177
8	Low evaporating pressure		5.08	21.9	27.8	22.9439
9	Ultra-Low Evaporating pressure		3.62	21.9	17.8	19.6446

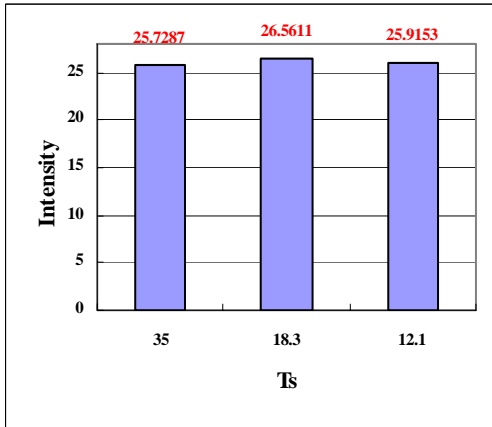


Fig.15 Average intensity of rotary compressor with inlet temperature

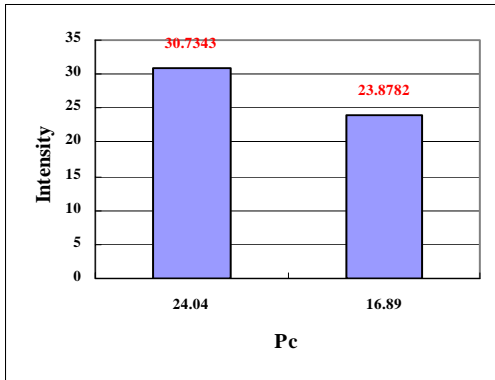


Fig.16 Average intensity of rotary compressor with condensation pressure

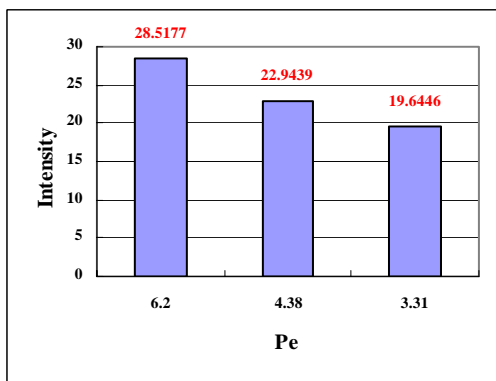


Fig.17 Average intensity of rotary compressor with evaporation pressure

Figs.15, 16

가 , Intensity 가  
1, 2  
. 3

Fig.17  
Intensity 가  
가  
5.  
가 Test Model

(1) 가 가

(2) Intensity

(3) Intensity

(4) Test

가

가 (2003-0656-900)

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