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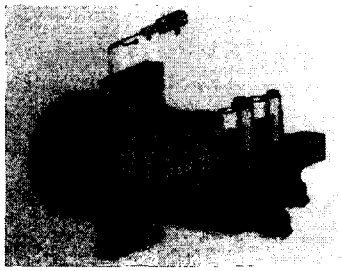
자동차 에어컨용 CO2 압축기 기술동향



이 건 호 (ghlee @ doowon.ac.kr)

2003. 12. 5

유체기계공업학회 2003 연구개발 기술발표회

두원공과대학 냉동공조과

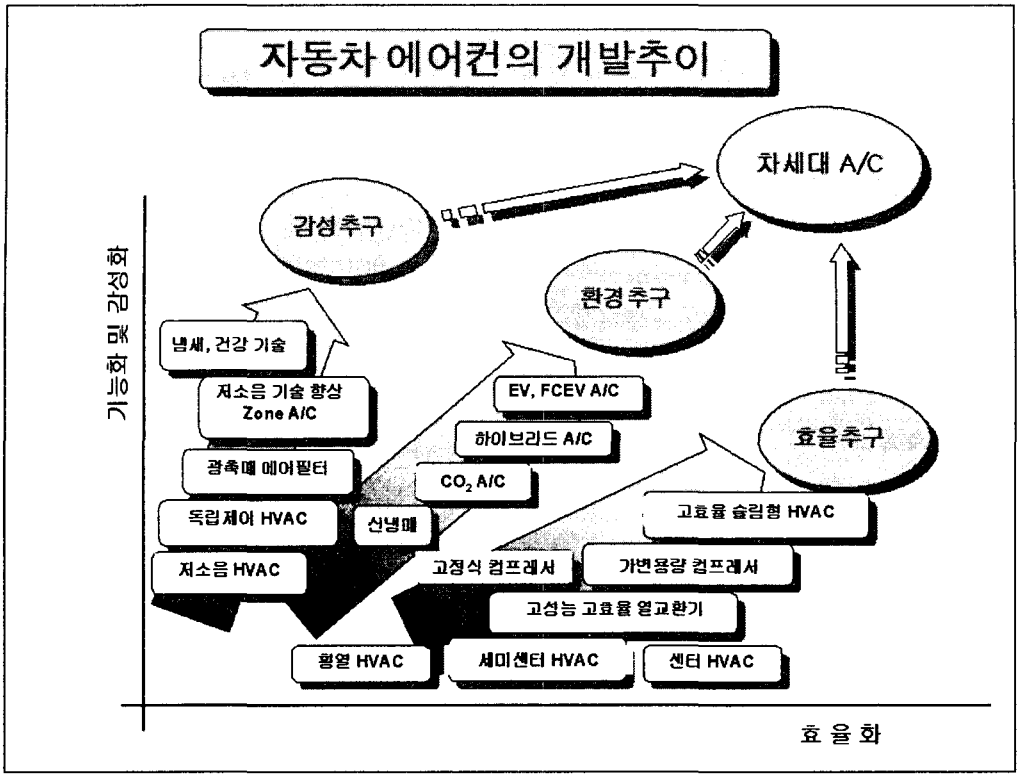
자동차 에어컨용 압축기 현황

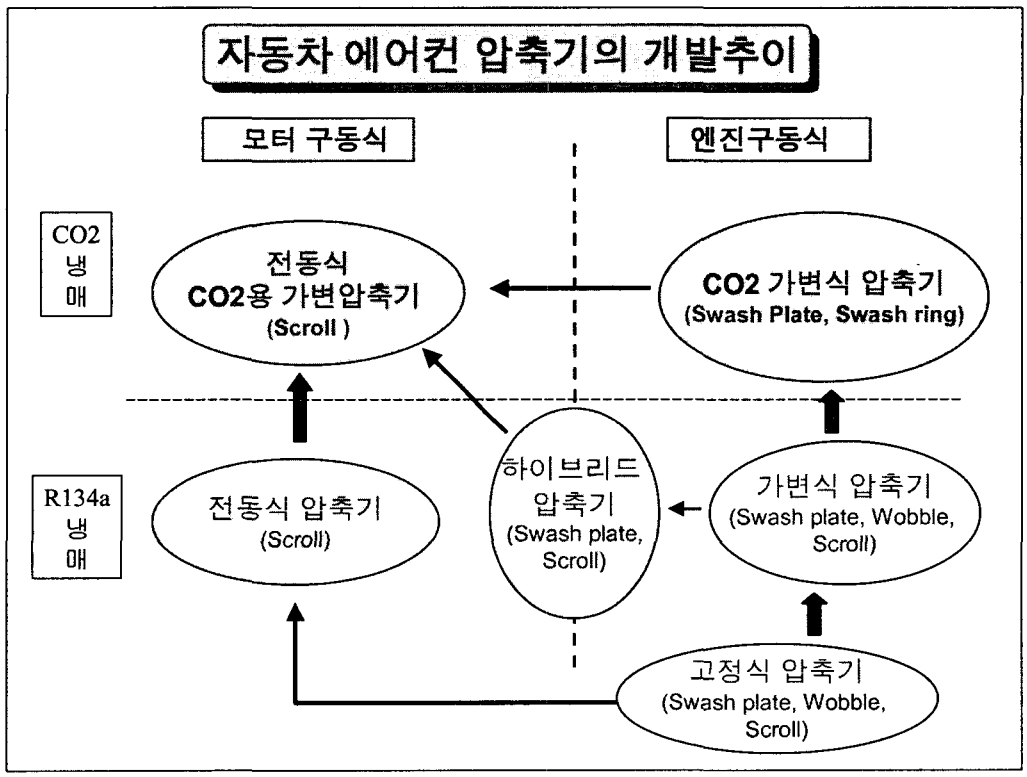
		Reciprocation type			Rotation type		
		Swash type	Wobble type	One-sided swash	Scroll type	Rotary vane type	Through vane type
	Type						
		- High reliability - Small size - Good total balance	- Suitable for variable displacement - Large torque fluctuation	- Combined the merit of swash type and wobble type - Suitable for variable Displacement	- Superior in NVH and good power saving	- Suitable for miniaturization - Low price because of simple structure	- Suitable for miniaturization - Superior to rotary vane type in reliability
Characteristics	크기, 중량	○	△	△	△	○	○
	성능	○	○	○	○	△	△
	소음 진동	○	△	○	◎	△	△
	내구성	◎	○	◎	◎	○	○
	Variable displacement	△	◎	◎	△	△	△
Compressor suppliers	DENSO	★	★	★	★		
	Sanden		★	★	★		
	Calsonic		★	★			
	zexel	★	★	☆			
	Mitsubishi				★		
	Seiko						
	Delphi	★	★	★			
	Visteon	★		★	★		
	Annual production rate in 2000	44% 16.19 million/year	24% 6.83 million/year	8% 2.94 million/year	11% 4.05 million/year	13% 4.78 million/year	

Not suitable for variable displacement

★ : under running

☆ : under developing


자동차 에어컨의 개발추이
차세대 A/C
감성추구
환경추구
효율추구
기능화 및 감성화
냄새, 건강 기술
저소음 기술 향상 Zone A/C
광촉매 에어필터
독립제어 HVAC
저소음 HVAC
신냉매
EV, FCEV A/C
하이브리드 A/C
CO_2 A/C
고정식 컴프레서
고효율 습림형 HVAC
가변용량 컴프레서
고성능 고효율 열교환기
평열 HVAC
세미센터 HVAC
센터 HVAC
효 율 화

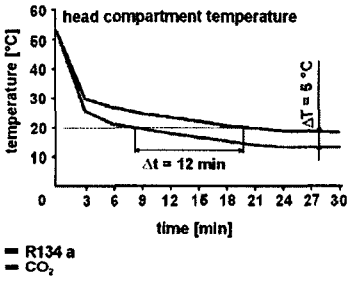

자동차 에어컨 압축기의 개발추이
모터 구동식
엔진구동식
CO2 냉매
R134a 냉매
전동식 CO2용 가변압축기 (Scroll)
CO2 가변식 압축기 (Swash Plate, Swash ring)
전동식 압축기 (Scroll)
하이브리드 압축기 (Swash plate, Scroll)
가변식 압축기 (Swash plate, Wobble, Scroll)
고정식 압축기 (Swash plate, Wobble, Scroll)

Why CO2 ?

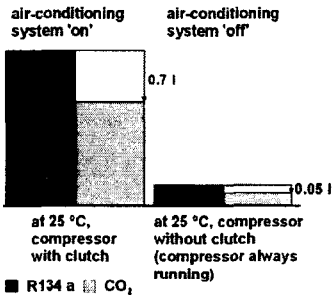
name	HCFC (R12)	HFC (R134a)	CO_2 (R744)
ozon damage	yes	yes	no, it is natural gas
global warming potential	GWP = 8100	GWP = 1300	GWP = 1
CO_2 emissions from operation	2600 kg / car	2600 kg / car	1800 kg / car
CO_2 GWP-equivalent over service life	8100 kg / car	1300 kg / car	0,5 kg / car
Σ	10700 kg / car	3900 kg / car	1800,5 kg / car

banned in 1990 — 2005 due to technical advantages

냉방성능곡선

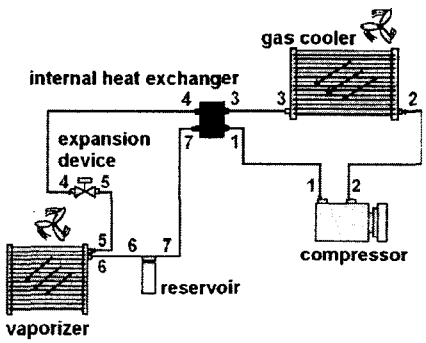


연료소비량

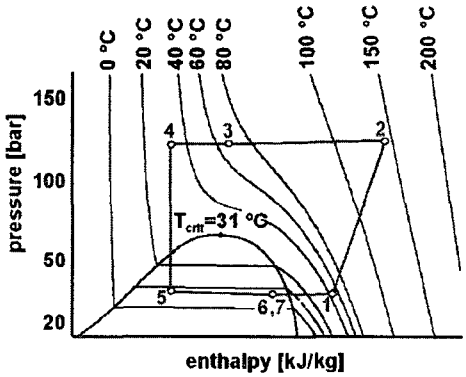


자동차용 CO2 에어컨 시스템

구성도



P-h 선도



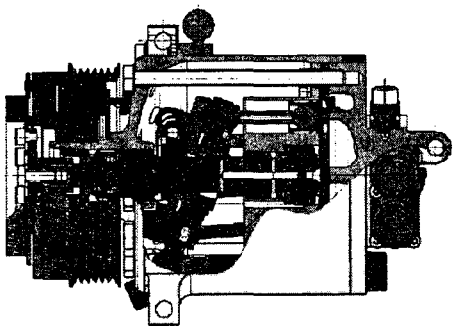
압축기 운전조건

압축기 회전수	흡입압력	토출압력	과열도(압축기 전)
700 - 8,000 rpm	3.38 MPa	12.0 MPa	5 – 15 °C

Sanden/Luk CO2 압축기

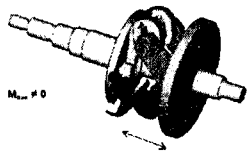
Wobble Type

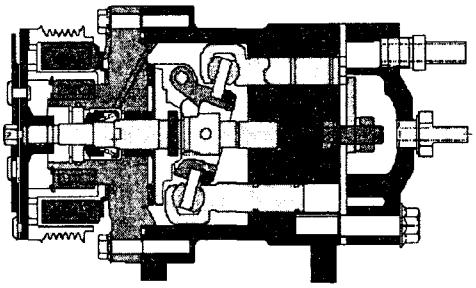
- 30 cc – 36 cc 급
- R134a 160 cc 급과 동급



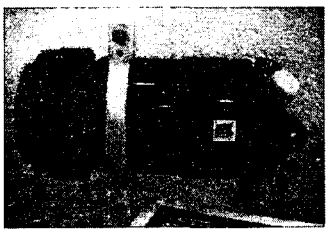
Swash Plate Type

- 30 cc 급



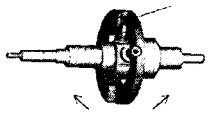


Swash Ring Type



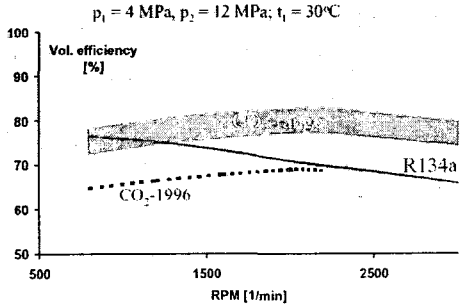
● Specification

Typel	Variable displacement	
Swept volume	26 cc	31 cc
No. of cylinder	4	5
Mass flow	0 – 350 kg/h	
Speed	600 ~ 11,200 rpm	
Max discharge Pressure	13.5 Mpa (Burst Pres. 45.0 Mpa)	
Max. crankcase Pressure	11.0 Mpa (Burst Pres. 33.0 Mpa)	
Inlet Temperature (T_1)	-40 ℃ ~+170 ℃	
Dimension	100 mm	
Weight	5.5 kg	



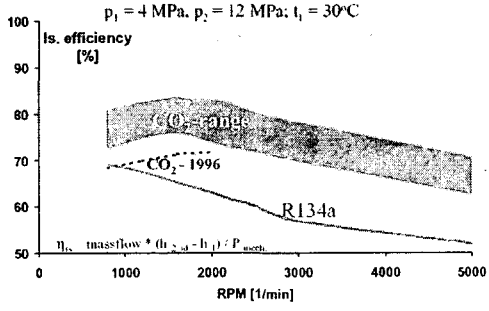
체적효율

p_1 = 4 MPa, p_2 = 12 MPa; t_1 = 30℃



압축기 효율

p_1 = 4 MPa, p_2 = 12 MPa; t_1 = 30℃



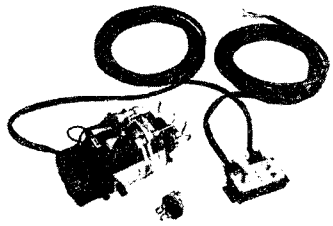
Obrist CO2 압축기

Fixed Swash Ring Type

Specification

Typel	Fixed displacement
Swept volume	Up to 42.5 cc/rev
No. of cylinder	7
Mass flow	Max 500 kg/h (at p_1=40bar, t_1=30°C, p_2=120bar)
Speed	600 ~ 3000 rpm
Inlet Pressure (P_1)	10 ~ 80 bar
Outlet Pressure (P_2)	70 ~ 140 bar
Inlet Temperature (T_1)	-40 °C ~+80 °C
Dimension	123 x 250 mm
Weight	13.5 kg

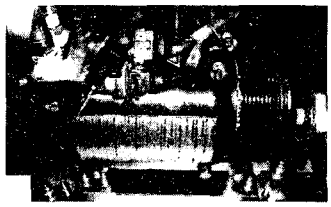
Variable Swash Ring Type

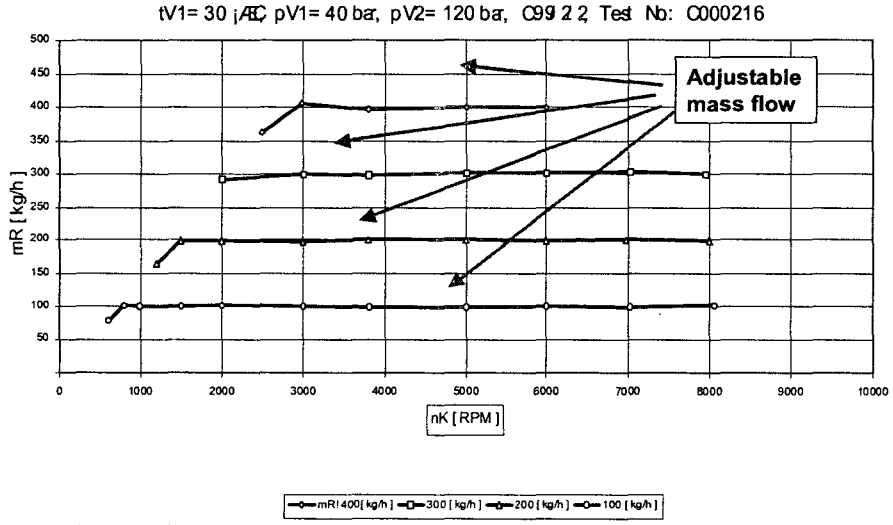


Specification

Typel	Variable displacement
Swept volume	33 cc/rev
No. of cylinder	7
Mass flow	Max 500 kg/h (at p_1=40bar, t_1=30°C, p_2=120bar)
Speed	600 ~ 8000 rpm
Inlet Pressure (P_1)	10 ~ 80 bar
Outlet Pressure (P_2)	70 ~ 140 bar
Inlet Temperature (T_1)	-40 °C ~+80 °C
Dimension	123 x 250 mm
Weight	13.5 kg

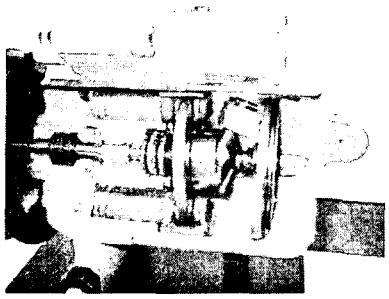
Mass Flow Rate vs. Compressor Speed of Variable Swash Ring Type





Denso CO2 압축기

가변식 압축기 (Swash Plate Type)



전동식 압축기 (Scroll Type)

•Toyota Hybrid Vehicle (4.6 cc)

Calsonic CO2 압축기