Development of CO_2 Scroll Compressor for Automotive Air-conditioning Systems

Mitsubishi Heavy Industries. LTD
Nagoya R & D Center
Compressor Laboratory

Makoto Takeuchi

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Introduction

- Problems of R134a Refrigerant
- Properties of CO_2 Refrigerant
- Advantage of Scroll Compressor
- Loss Analysis of CO_2 Scroll Compressor
  (Changing Displacement Only)
- Technologies for High Efficiency
- Loss Analysis of Prototype CO_2 Scroll Compressor
- Efficiency of Prototype CO_2 Scroll Compressor
- Conclusions

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Problems of R134a Refrigerant

	ASHRAE Number	ODP	GWP	Safety
HFC	R134a	0	1300	Safe
HC	R290	0	<3	flammable
NH_3	R717	0	<1	Toxic
CO_2	R744	0	1	Safe

CO_2 is the most promising natural refrigerant because of its low GWP and safety.

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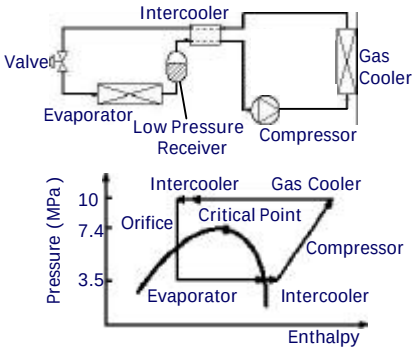
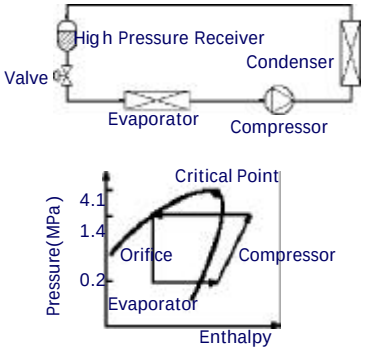
Properties of CO_2 [System]

CO_2 System



R134a System



- CO_2 cycle involves super critical pressure.
- CO_2 system is high pressure cooling cycle.
- CO_2 system has intercooler to improve the capacity and the coefficient of performance (COP).

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Properties of CO_2 [Thermophysical]

at 0?

	Latent Heat (kJ/kg)	Density of Saturated Vapor (kg/m^3)	Capacity Volume Ratio (kJ/m^3)
CO_2	232	97.6	22600
R134a	198	14.4	2860

Capacity Volume Ratio=Latent Heat × Density of Saturated Vapor

Because the capacity volume ratio of CO_2 is 8 times larger than that of R134a , displacement of CO_2 compressor is 1/8 of current R134a compressor.

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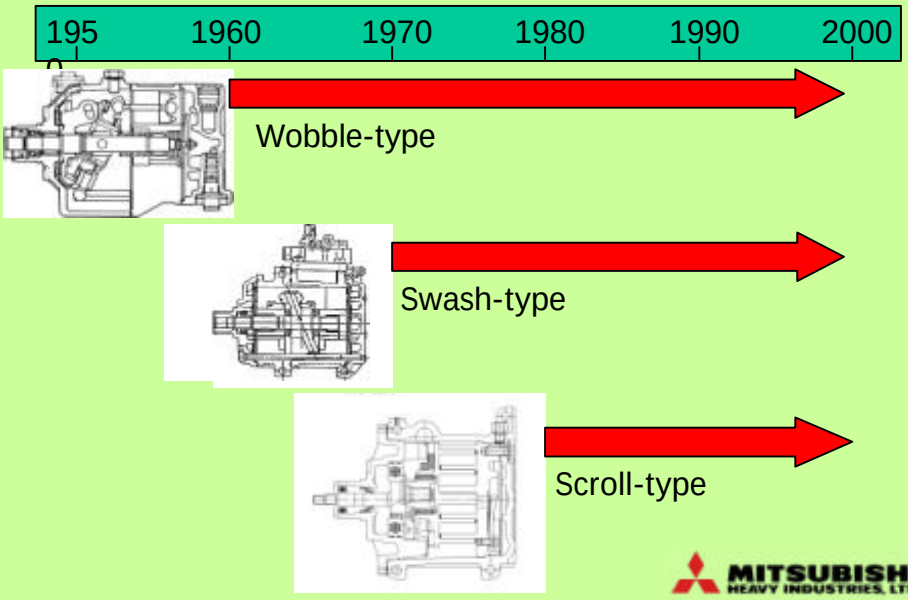
Advantage of Scroll Compressor (1)



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Advantage of Scroll Compressor (2)

1:High Volumetric Efficiency

2:Low Pressure Loss

3:Low Mechanical Loss

4:Low Noise and Vibration

Scroll Compressor for CO_2 Refrigerant

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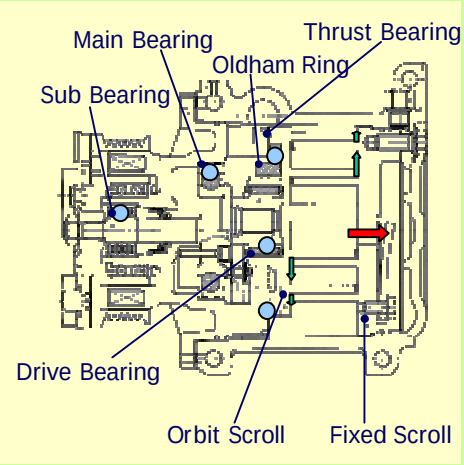
Loss of Scroll Compressor



Pressure Loss
Over Compression Loss

Indicative Loss
Leakage and Heat Loss

Mechanical Loss
Thrust Bearing Loss
Drive Bearing Loss
Main Bearing Loss
Sub Bearing Loss
Oldham Ring Loss

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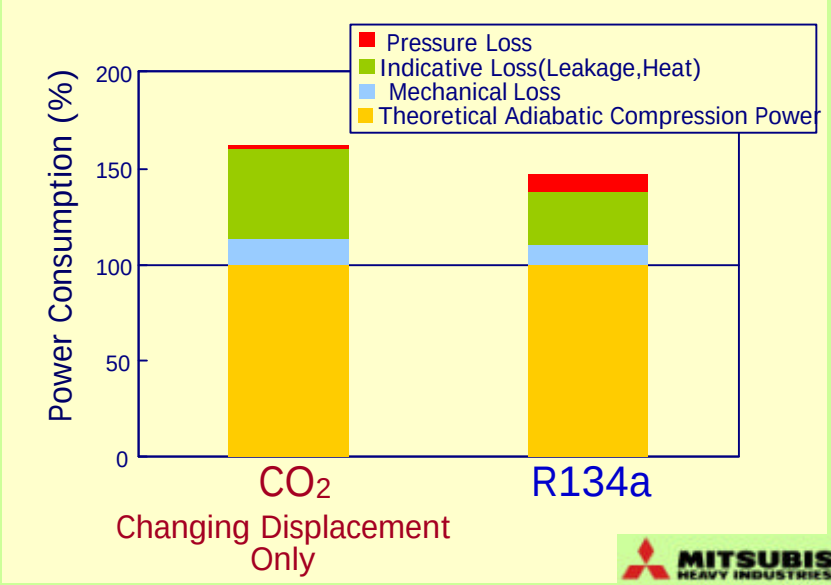
Loss Analysis of CO_2 Scroll Compressor



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Technologies for High Efficiency

- Improvement of Indicative Loss

  ⇩

  Tip contact mechanism is applied to prototype CO_2 scroll compressor

- Improvement of Mechanical Loss

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  Thrust rolling bearing is applied to prototype CO_2 scroll compressor

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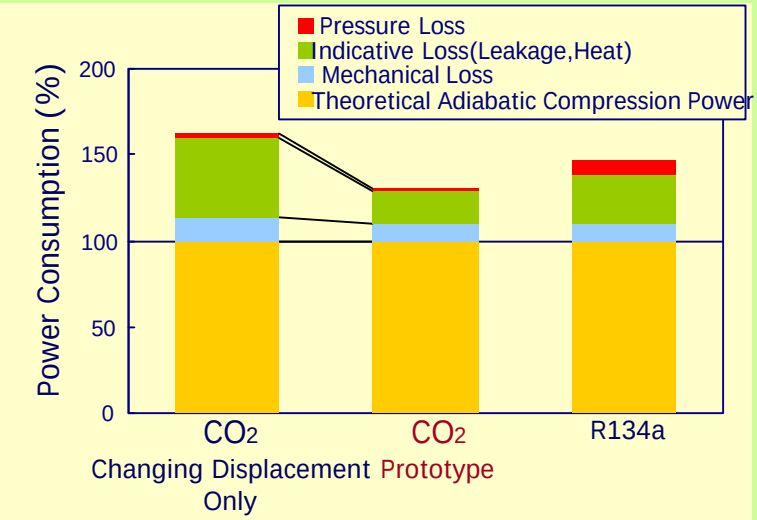
Loss Analysis [Prototype]



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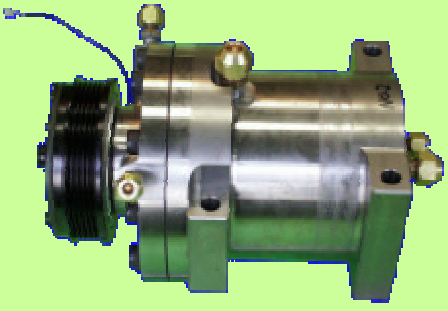
Prototype CO_2 Scroll Compressor



	CO2 Prototype	Current (R134a)
Diameter (mm)	f 135	f 125
Weight (kg)	23	6
Displacement (cm^3)	13	105

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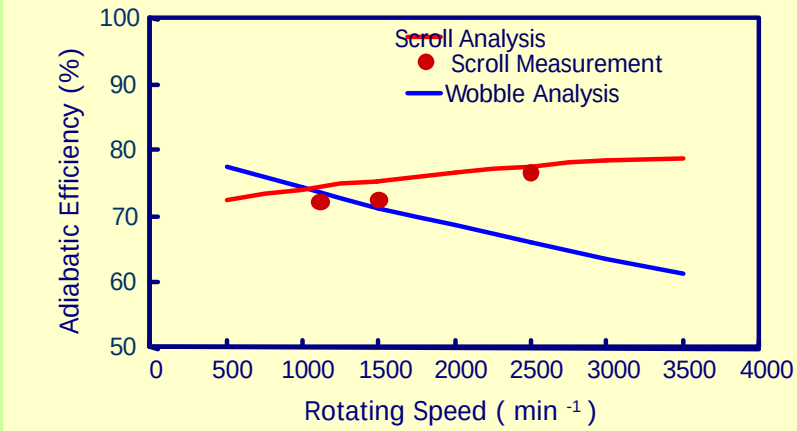
Efficiency of Prototype CO_2 Scroll



Scroll has higher efficiency especially in high speed because of no suction valve and less pressure drop.

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Conclusions

- Tip contact mechanism and thrust rolling bearing are applied to prototype CO_2 scroll compressor for improvement of efficiency.

- Prototype CO_2 scroll compressor achieved high efficiency.
  (Adiabatic Efficiency = 76%)

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