

***A CO₂ Refrigerant System
for Vehicle Air-
Conditioning***

**NISSAN /
ZEXEL**

Phoenix Alternate Refrigerant Forum
June,28----July,1 Phoenix, AZ

**A CO₂ Refrigerant System for Vehicle Air-
conditioning**

Outline

- ZEXEL Activities for Environment Protection
- '99 Model of CO₂ System
- Result of Vehicle and Bench Tests
- Tasks to be Solved
- Conclusion

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Introduction

ZEXEL Activities for Environment Protection

- ZEXEL was quick to complete change over from CFC to HFC in '94.
- Development of energy saving A/C Systems for vehicles.
- R&D on New Environmentally Safe Refrigeration Systems
 - CO₂, HC, Stirling, Zeolite, etc .
- < December - '97 Kyoto Protocol >
- '98 Phoenix Forum (with '98 Model - first basic trial system)

NISSAN B14

- '99 Phoenix Forum (with '99 Model)

NISSAN A32

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Target of CO₂ '99 Model

Conditions: EVA 35.-70%, GCL 35.

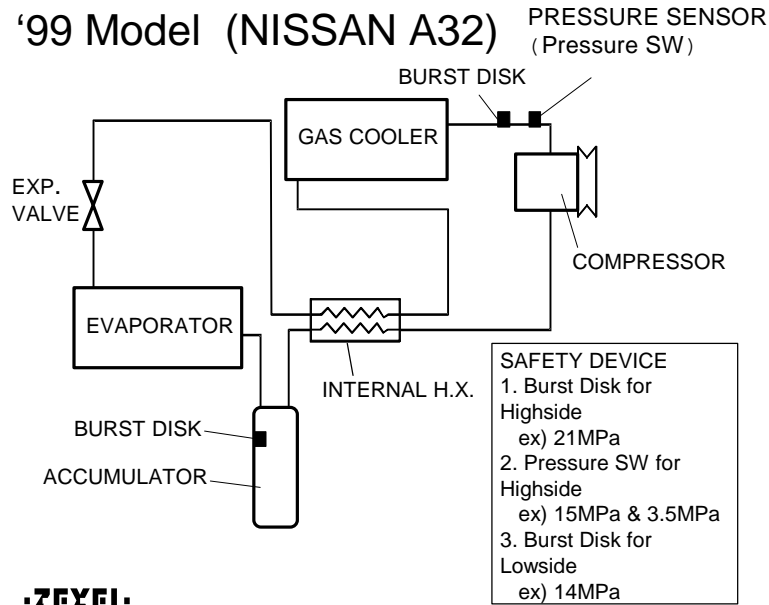
- | | <u>Target</u> | <u>ref. R134a</u> |
|----------------------|---------------|-------------------|
| • Cooling Capacity : | 1.1 | 1 |
| • System COP : | 1.2 | 1 |
| • Weight : | 1.2 | 1 |
- Same Comfort as R134a System

Bench mark system: NISSAN A32

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'99 Model (NISSAN A32)



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Modifications '98 version -> '99 version

- Compressor
22 cc --> 28 cc
- Heat Exchangers
Gas-cooler : 0.18 m² --> 0.25 m²
Evaporator : 0.041 m² --> 0.055 m²
- Improved Control
EXP/V : invariable throttle --> high pressure control
COMP. : fixed --> variable

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Vehicle Performance Result

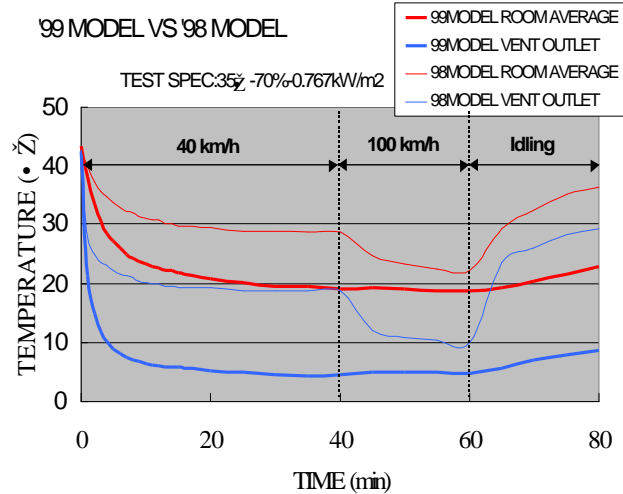
- Comparison of '99 and '98 Model
- Comparison with R134a system

Bench mark system: NISSAN A32

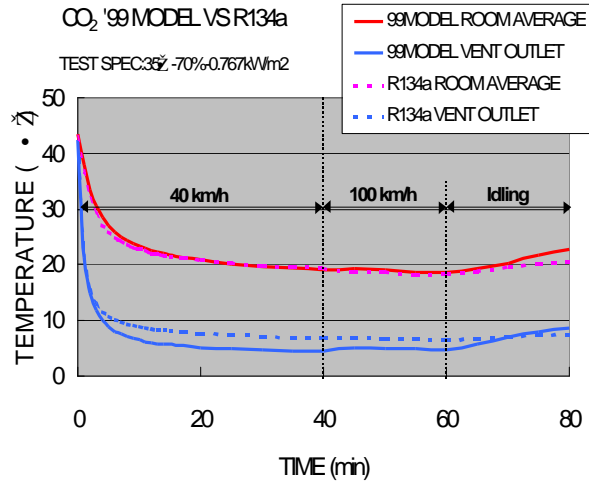


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Vehicle Performance



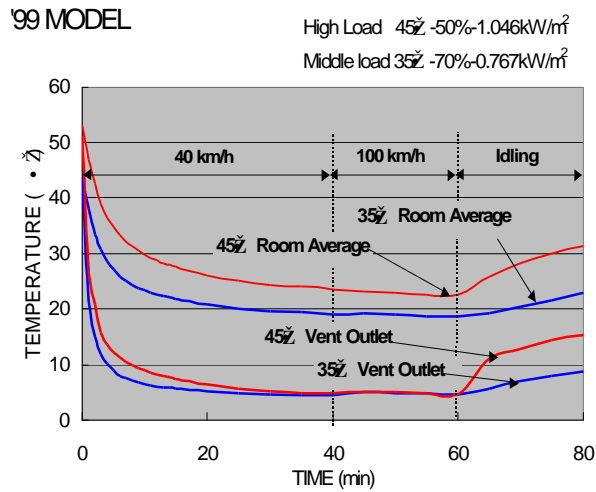
A CO₂ Refrigerant System for Vehicle Air-conditioning Vehicle Performance



SAN A32

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A CO₂ Refrigerant System for Vehicle Air-conditioning Vehicle Performance



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The Result of Vehicle Performance

- Cooling performance was greatly improved compared with '98 Model.
- Competitive with R134a system except idling conditions.
- Performance of high load conditions has to be improved.

Bench mark system: NISSAN A32

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On Test Bench

- Comparison of '99 and '98 Model
- Comparison of CO₂ with HFC134a System
- COP vs. Cycle load

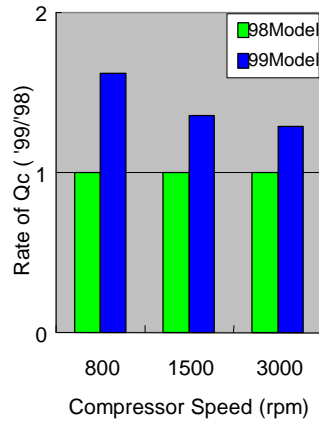
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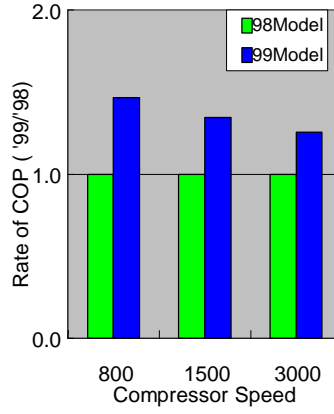
System Performance on Test Bench

Comparison of 99/98 Model Condition EVA 35 - 70% GCL 35

Comparison of Cooling Capacity



Comparison of COP

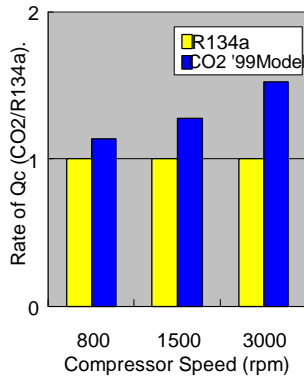


A CO₂ Refrigerant System for Vehicle Air-conditioning

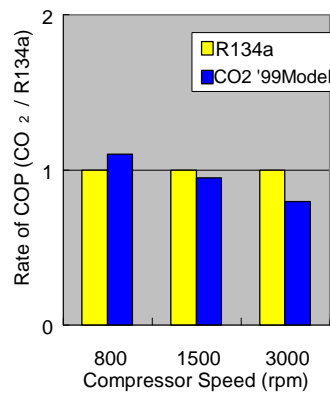
Comparison of CO₂ and HFC134a System

Condition EVA 35 - 70% GCL 35

Comparison of Cooling Capacity

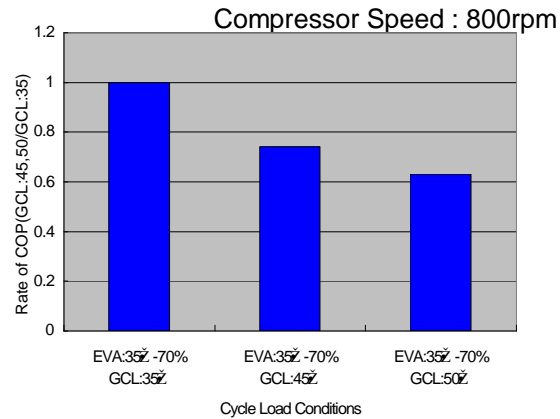


Comparison of COP



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Comparison of Cycle Load Conditions



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Experimental Result of Bench Testing

- Great improvement in cooling capacity and COP compared with '98model.
- System performance improved up to R134a system under the low and middle cycle load conditions.
- However, COP depression under the high cycle load conditions.

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Target and Result of CO₂ '99 Model

Conditions: EVA 35.-70%, GCL 35.

	<u>Target</u>	<u>Result</u>	<u>ref. R134a</u>
• Cooling Capacity : 1	1.1	1.1	
• System COP : 1	1.2	1.1	
• Weight : 1	1.2	1.5	

Same Comfort as R134a System

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Tasks to be Solved

- Improvement of COP under the high cycle load.
- Reviewing target conditions.
- Reduction of system weight.
- Development of safety devices.
- Hose, etc .
- Establish new service infrastructure for CO₂.

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Conclusion

- An influence of COP drop under high load conditions is concerned with car application.

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