2014 Purdue Conferences
Compressor Engineering
Refrigeration and Air Conditioning
High Performance Buildings

Development of High Efficiency Swing Compressor for R32 Refrigerant

Yuuichi Yamamoto

Compressor Development & Engineering Group

Air Conditioning Manufacturing Division

Daikin Industries, Ltd.

Comparison of Refrigerant Properties

Table 1

	R410A (50%-R32, 50%-R125)	**R32**
GWP*1	2088	675
Theoretical COP (ratio to that of R410A)	100%	102%
Density (ratio to that of R410A)* 2	100%	72%
Molecular weight	73	52
Discharge temperature *2	85°C	101°C

*1. IPCC4

*2. operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃)

Comparison of Refrigerant Properties

Table 1

	R410A (50%-R32, 50%-R125)	**R32**
GWP*1	2088	675
Theoretical COP (ratio to that of R410A)	100%	102%
Density (ratio to that of R410A)* 2	100%	72%
Molecular weight	73	52
Discharge temperature *2	85°C	101°C

*1. IPCC4

*2. operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃)

Comparison of Refrigerant Properties

Table 1

	R410A (50%-R32, 50%-R125)	**R32**
GWP*1	2088	675
Theoretical COP (ratio to that of R410A)	100%	102%
Density (ratio to that of R410A)* 2	100%	72%
Molecular weight	73	52
Discharge temperature *2	85°C	101°C

*1. IPCC4

*2. operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃)

Comparison of Refrigerant Properties

Table 1

	R410A (50%-R32, 50%-R125)	**R32**
GWP*1	2088	675
Theoretical COP (ratio to that of R410A)	100%	102%
Density (ratio to that of R410A)* 2	100%	72%
Molecular weight	73	52
Discharge temperature *2	85°C	101°C

*1. IPCC4

*2. operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃)

Comparison of Refrigerant Properties

Table 1

	R410A (50%-R32, 50%-R125)	**R32**
GWP*1	2088	675
Theoretical COP (ratio to that of R410A)	100%	102%
Density (ratio to that of R410A)* 2	100%	72%
Molecular weight	73	52
Discharge temperature *2	85°C	101°C

*1. IPCC4

*2. operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃)

Overview

1. **Swing Compressor Specifications**
2. **Issues and Countermeasures**
    - i . **Efficiency**
    - ii. **Reliability**
3. **Conclusion**

Overview

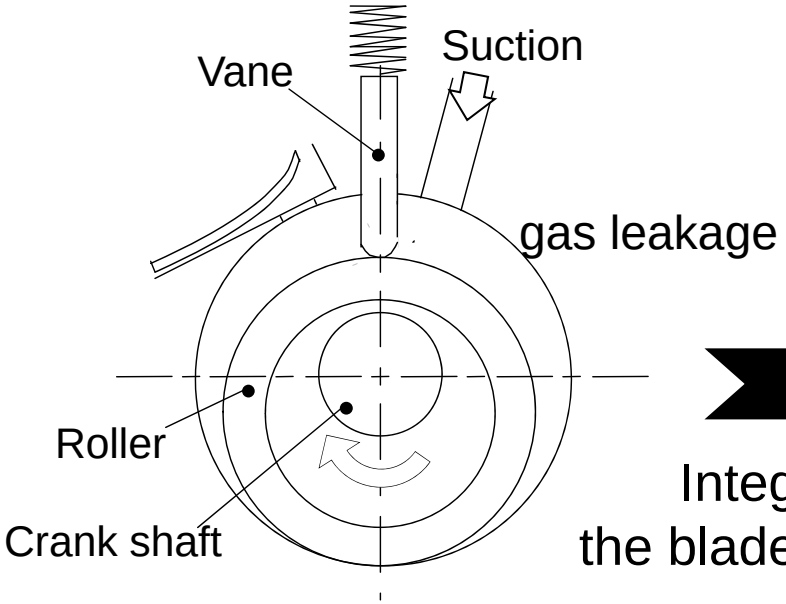
1. **Swing Compressor Specifications**
2. **Issues and Countermeasures**
    i . **Efficiency**
    ii. **Reliability**
3. **Conclusion**

1. Swing Compressor Specifications

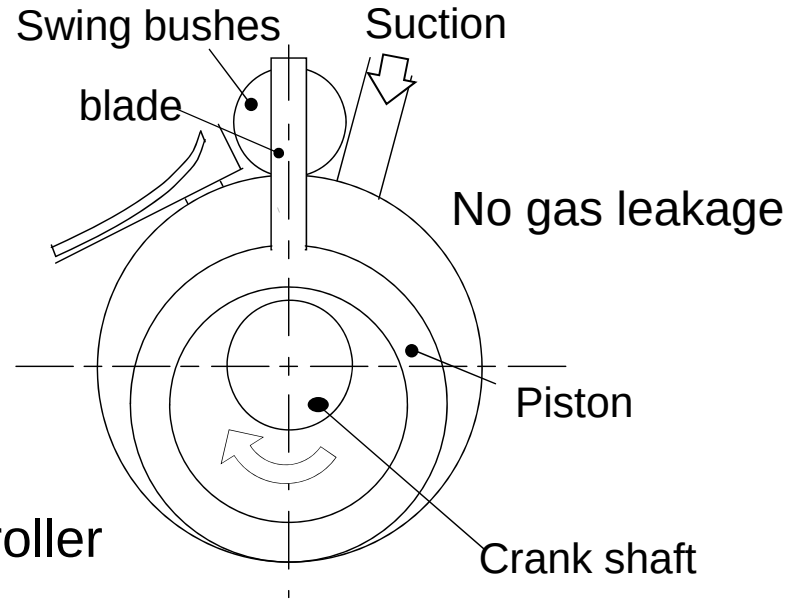
Swing compressor feature:

- **No gas leakage between the blade tip and the roller**

Rotary compressor



Swing compressor



Integrated
the blade and roller

Figure 1

Advantage of Swing Compressor

- **Volumetric efficiency is higher than rotary compressor**
- **This tendency is the same for R32**

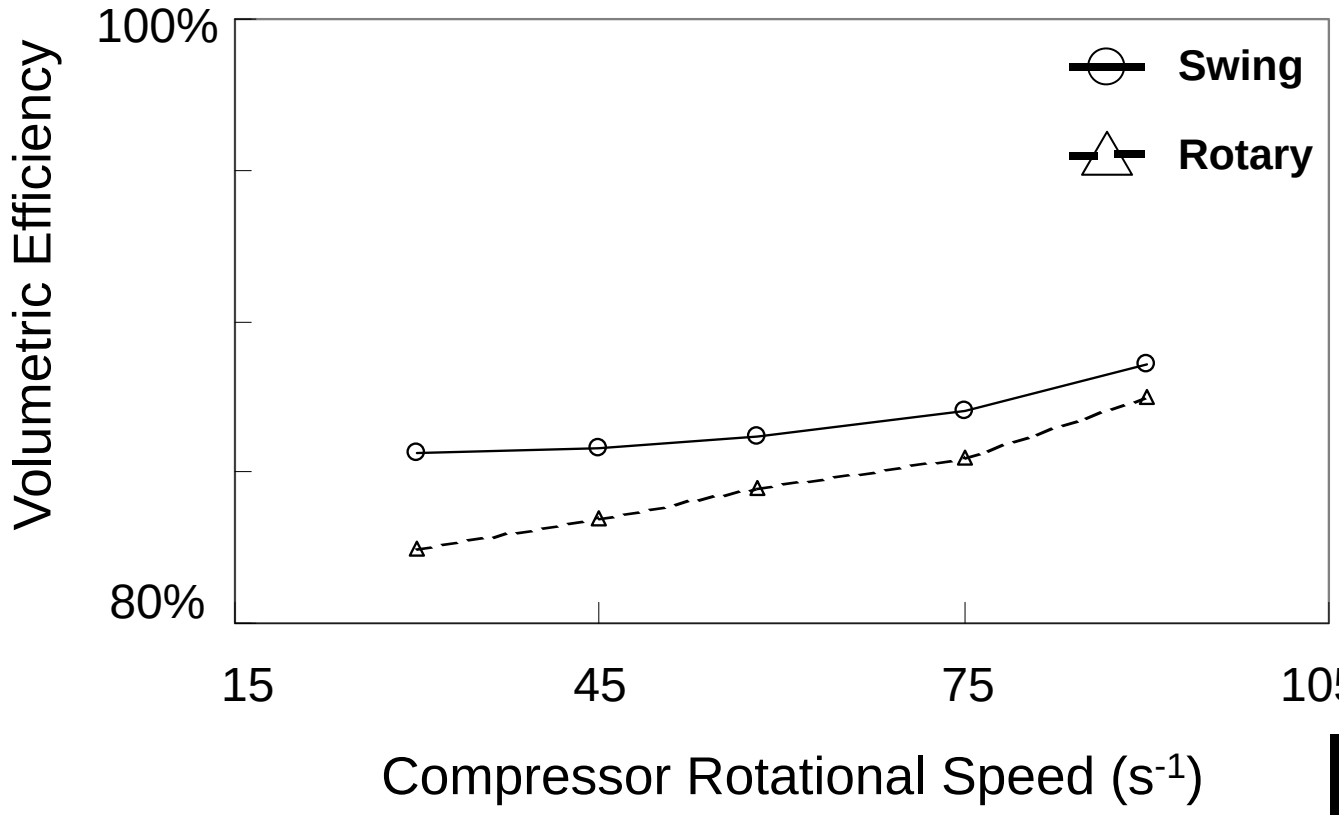


Figure 2

Overview

1. Swing Compressor Specifications
2. **Issues and Countermeasures**
    - i . **Efficiency**
    - ii. Reliability
3. Conclusion

Issues with Efficiency

- **Improvement estimation was 8.2 points**
- **Actual measurement was not as much as we expected**
- **Reasons: the leakage & increase in overheating loss**

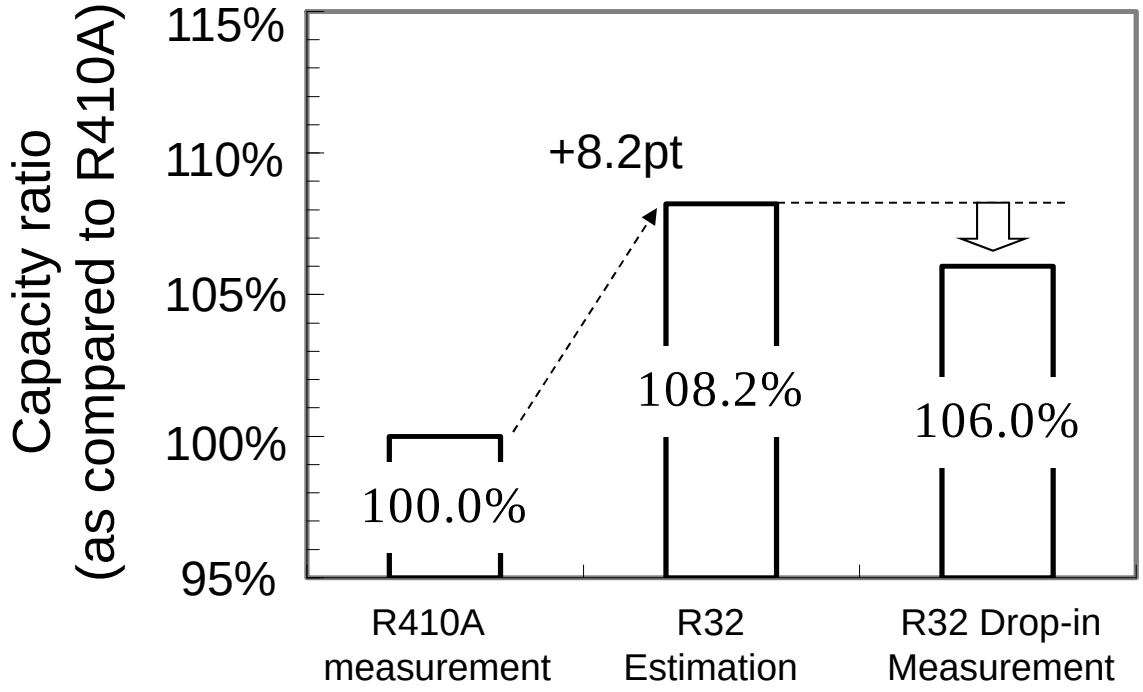


Figure 3

・Operating an R410A swing compressor with R32 and oil newly developed for R32

Countermeasures to Efficiency Issues

Heat-Insulating Structure

- **Created spaces above & below the compression chamber**
- **Discharge gas does not flow in these spaces**

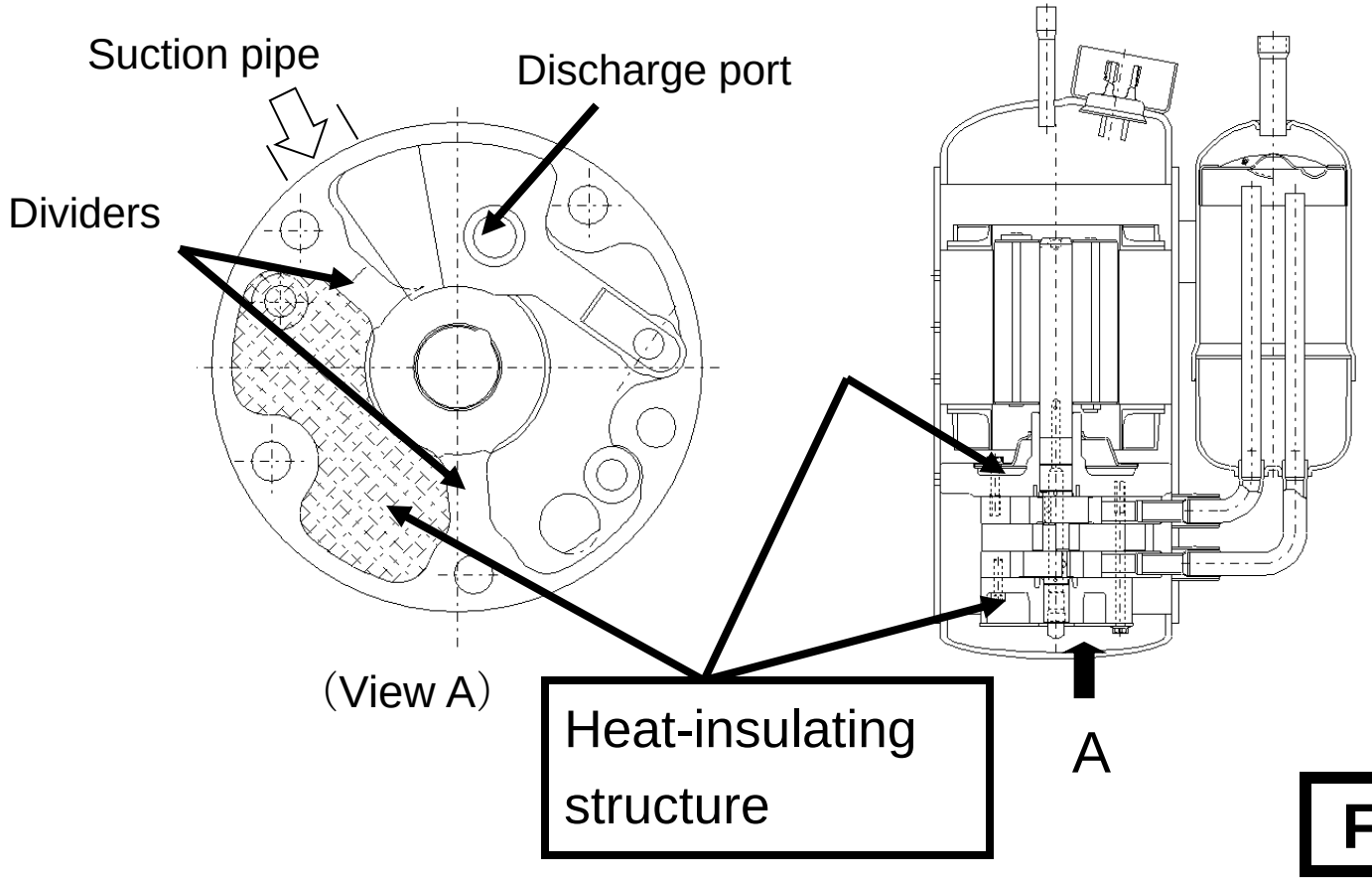


Figure 4

Evaluation of Heat-Insulation

- **The transfer of heat can be minimized**
- **Improvement: 0.7 points**

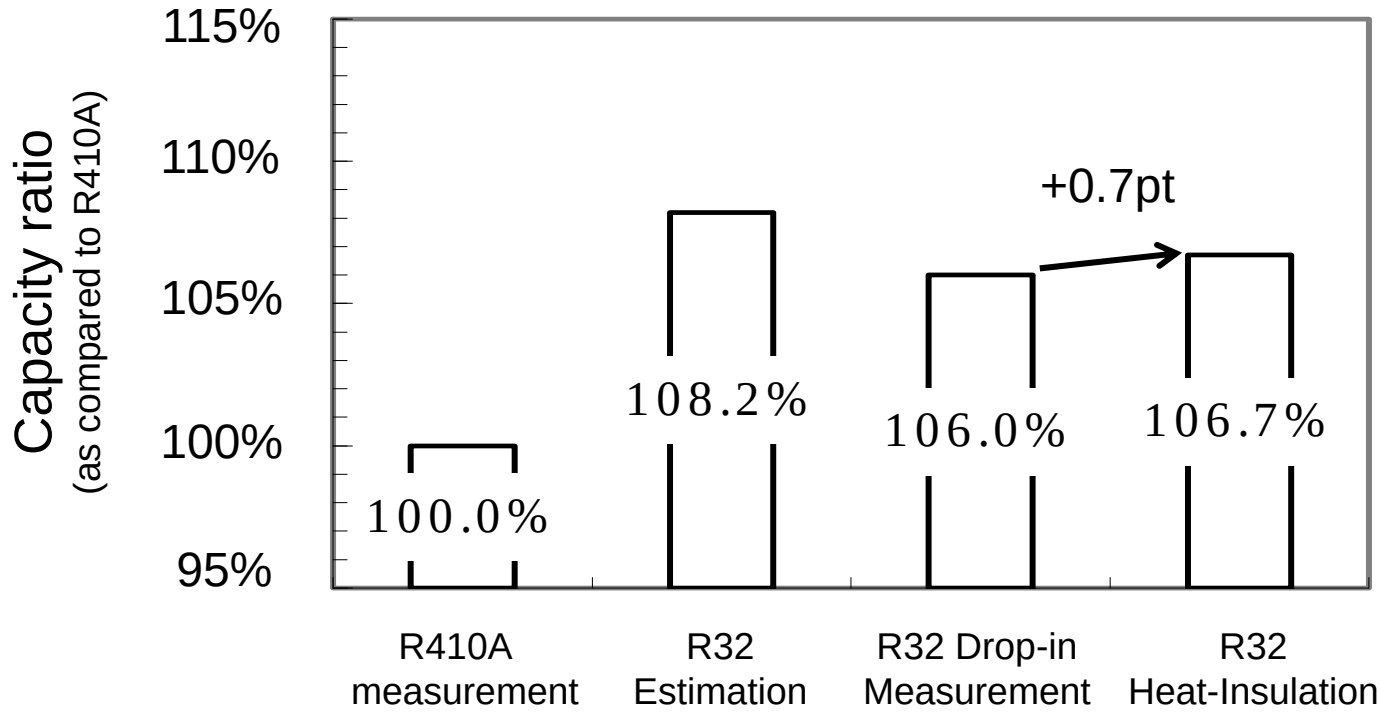


Figure 5

Optimization of the Port Diameter:

Volumetric efficiency

- **Smaller port diameter reduces the dead volume**
- **Improvement in volumetric efficiency**

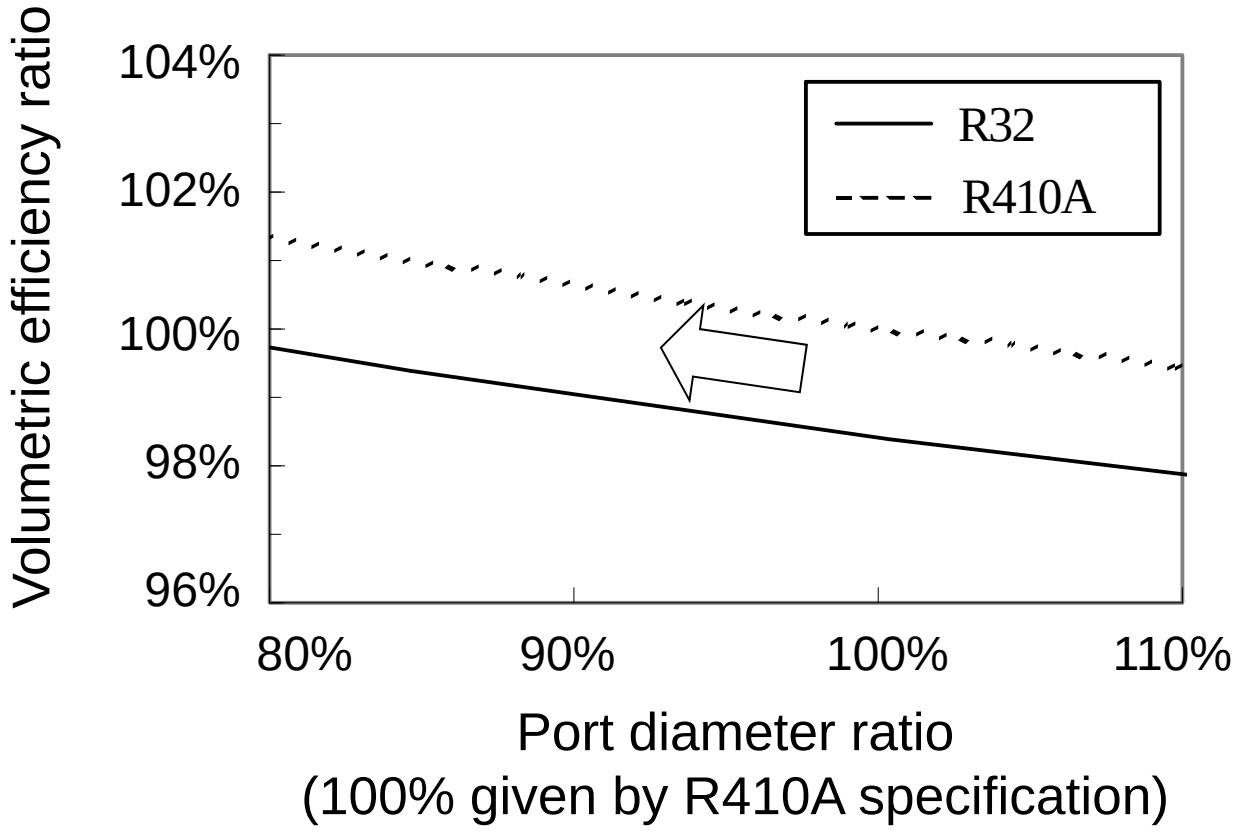


Figure 6

Optimization of the Port Diameter:
Indicated efficiency

- **Smaller port diameter increases the flow resistance**
- **Increase in pressure loss**

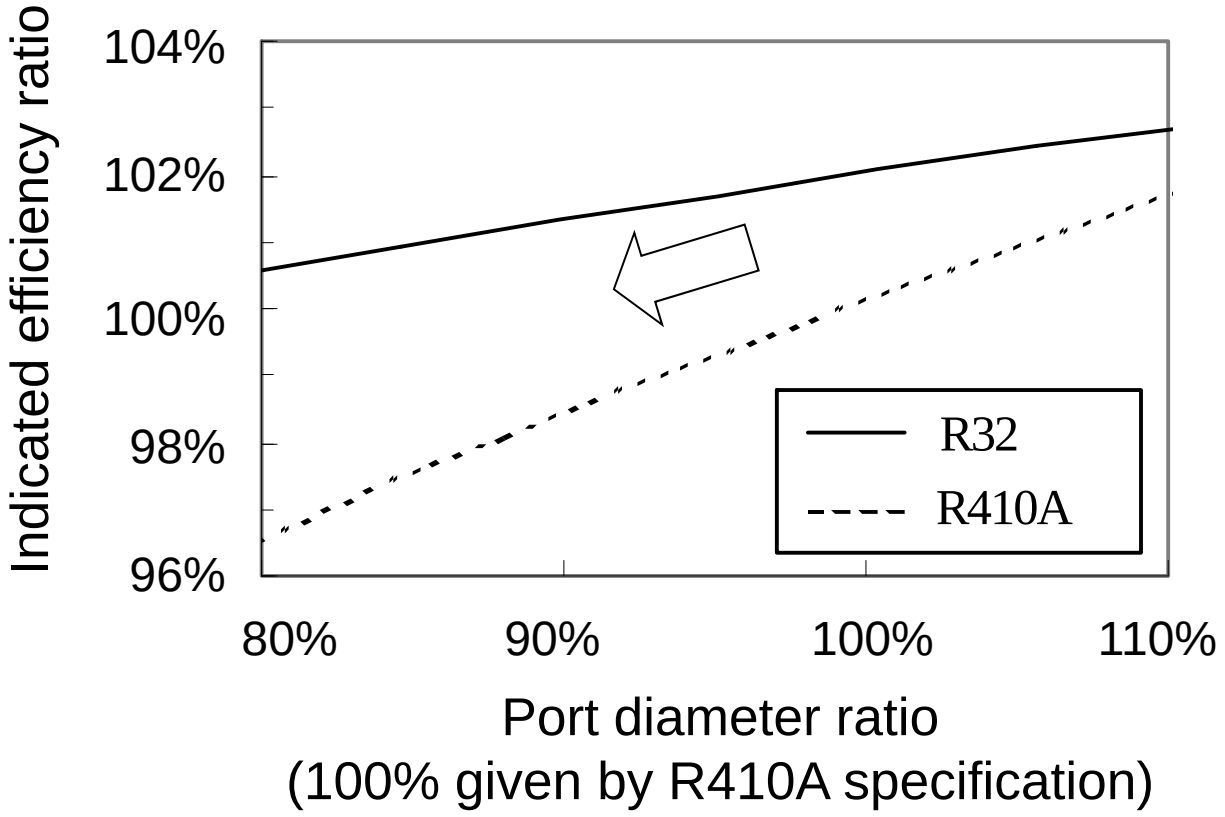


Figure 7

Countermeasures to Efficiency Issues

Optimized the port diameter

■ **Reducing the port diameter by 10% improves efficiency by 0.7 points in the case of R32**

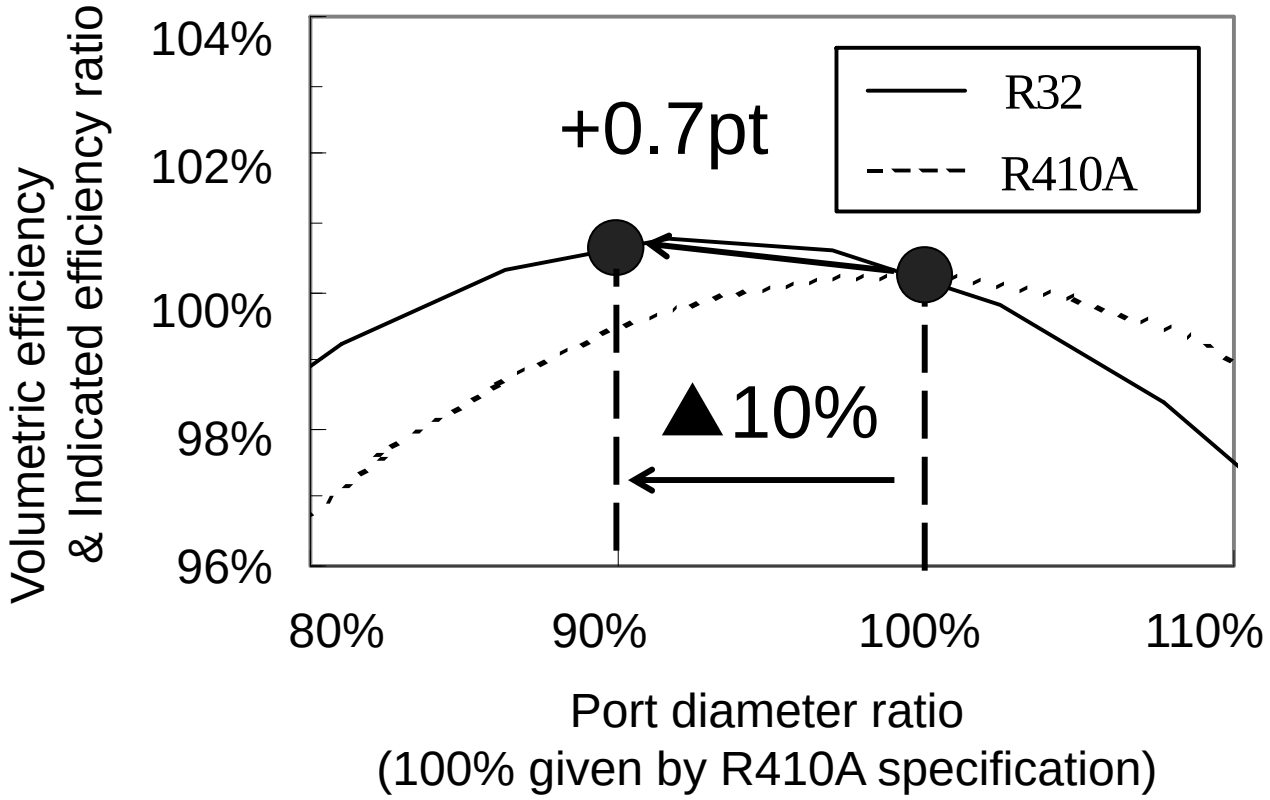


Figure 8

Performance After Modifications

- **The COP of R32 was 101.2% compared to R410A**
- **Higher energy saving using R32**

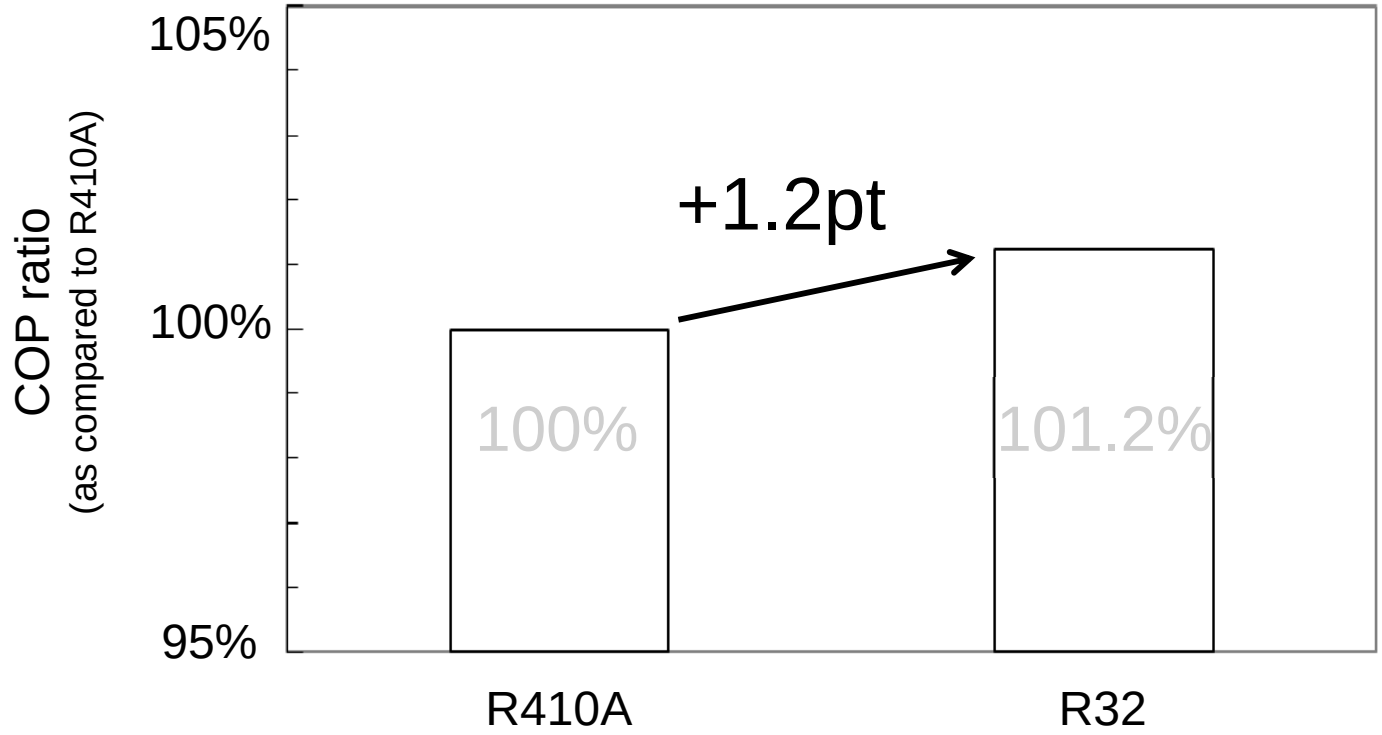


Figure 9

Overview

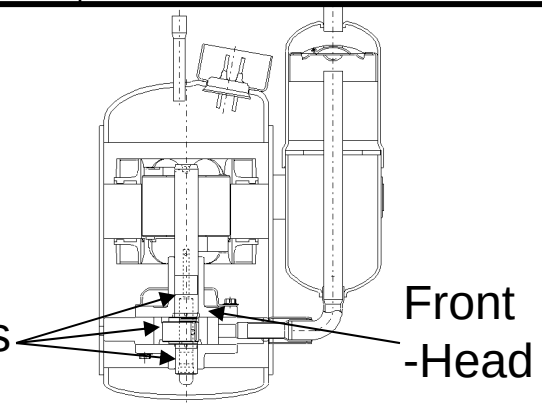
1. Swing Compressor Specifications
2. **Issues and Countermeasures**
    i . Efficiency
    ii. **Reliability**
3. Conclusion

Results of Reliability Test

Table 2 Drop-in Test Results

Parts	Lubricating type	Results	
Journal bearings	Fluid lubrication	Good	No damage
Front head face	Boundary lubrication	Not Good	Surface roughness

- Operating an R410A swing compressor with R32
- Oil was a newly developed for R32
- Condition: High load and High discharge gas temperature

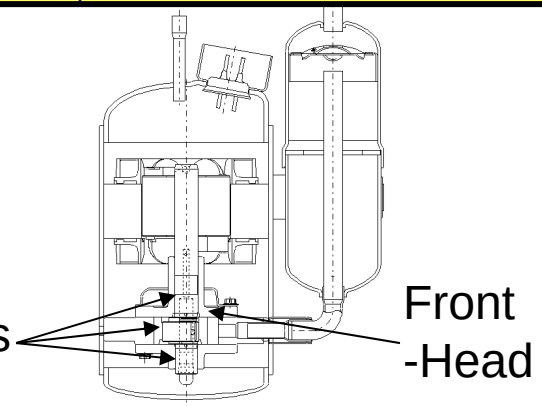


Results of Reliability Test

Table 2 Drop-in Test Results

Parts	Lubricating type	Results	
Journal bearings	Fluid lubrication	Good	No damage
Front head face	Boundary lubrication	Not Good	Surface roughness

- Operating an R410A swing compressor with R32
- Oil was a newly developed for R32
- Condition: High load and High discharge gas temperature



Damaged Section

- **No metal wear, but an increase in surface roughness**
- **Rear head face: No damage nor change in roughness**

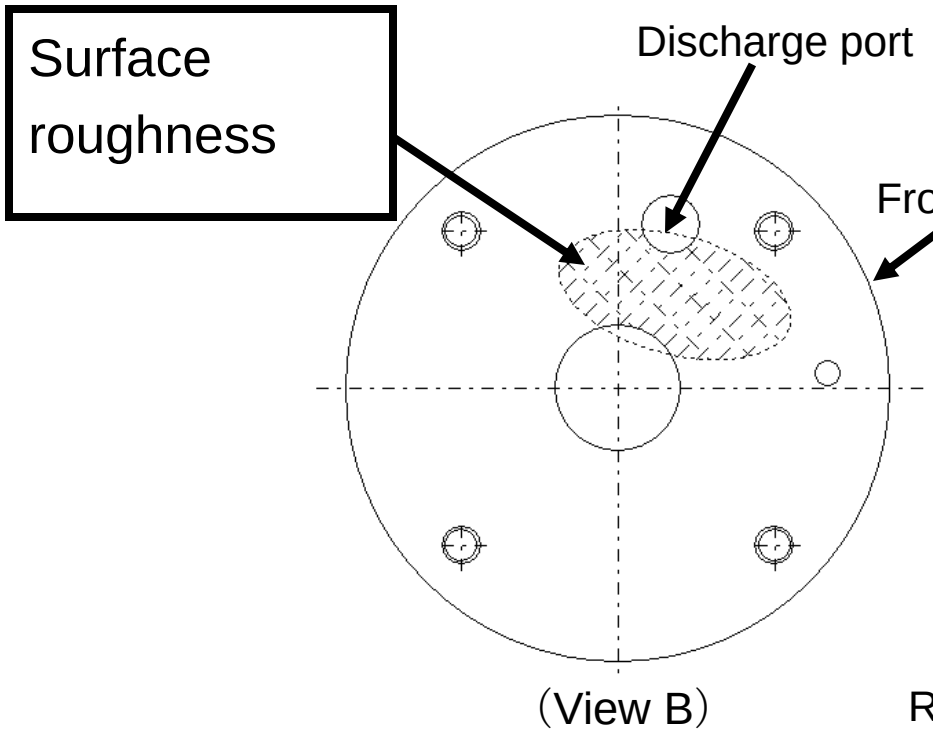


Figure 11

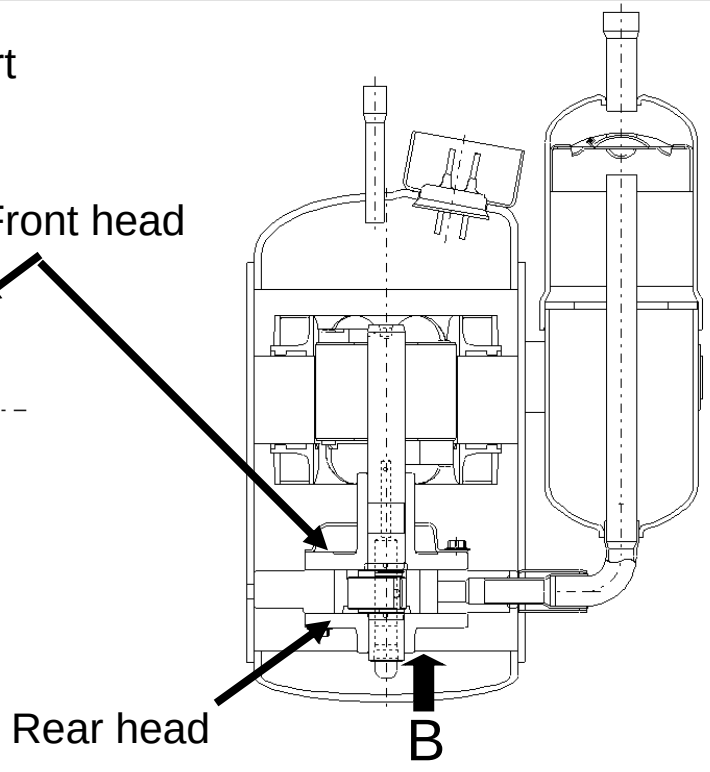


Figure 10

Original Shape of the Piston

- **Seal length of the upper and lower sides are different**
- **Piston was pressed upward**

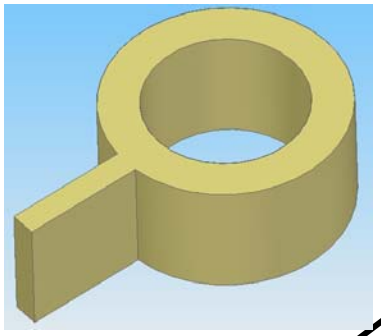
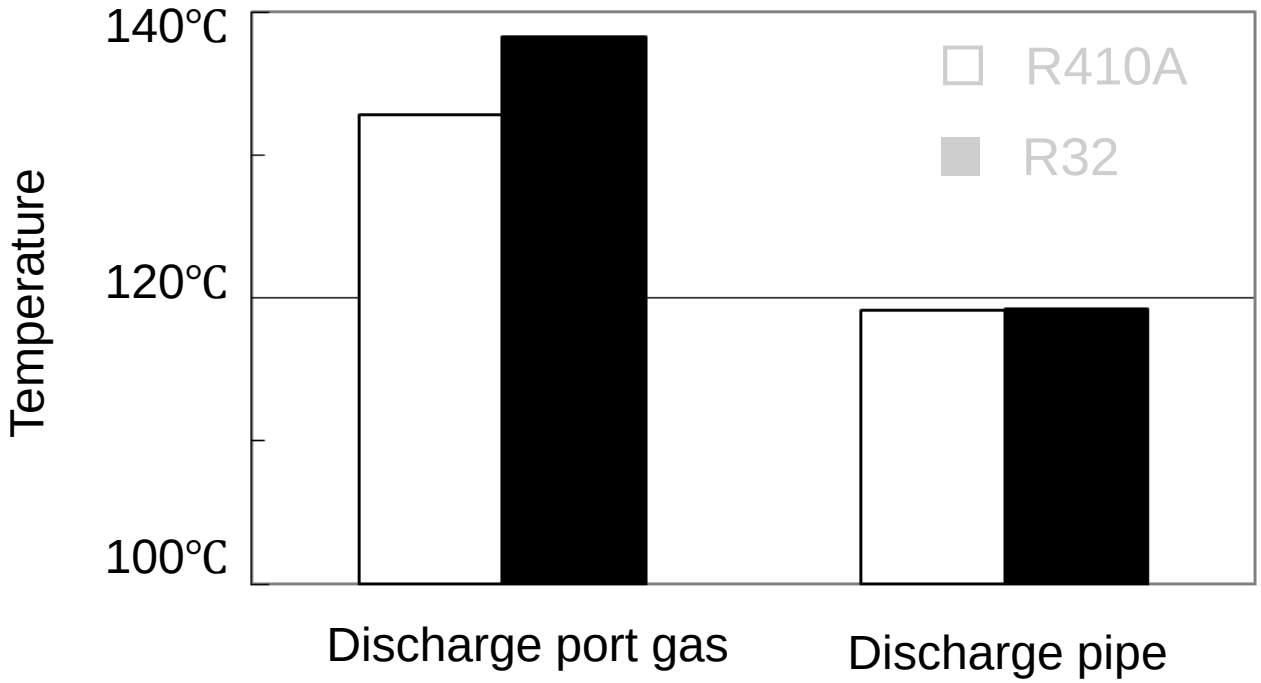


Figure 12

Comparison of the Internal Temperature

- **Discharge port gas temperature is higher for R32 than R410A**
- **Heat generated by sliding motion could not be dissipated sufficiently**



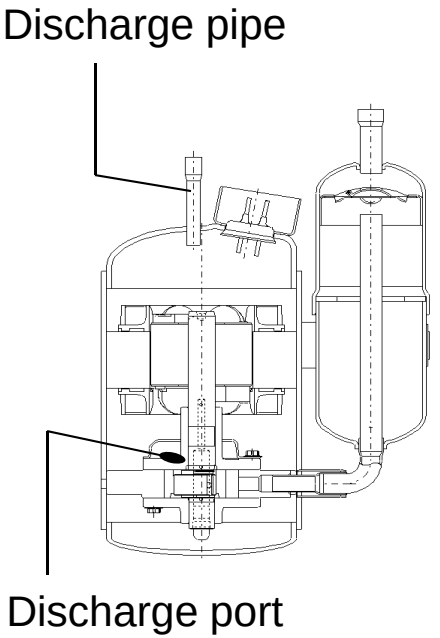
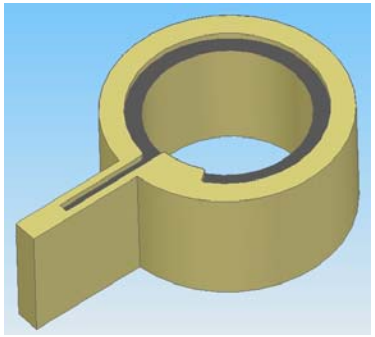
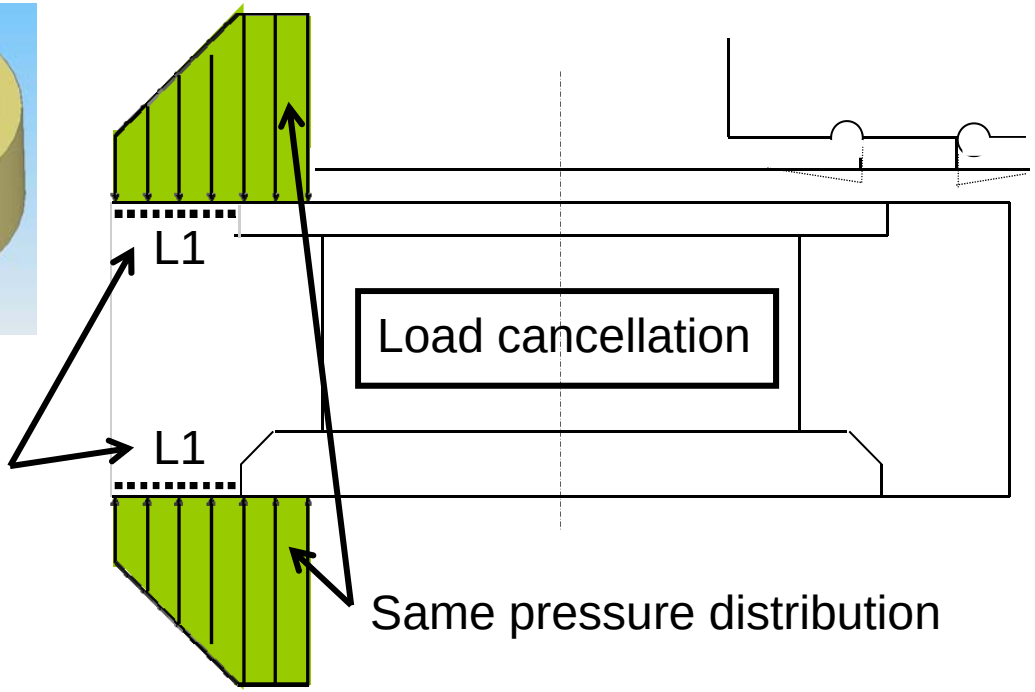


Figure 13

Modification of the Seal Length

- **Seal length of the upper and lower sides are same**
- **Pressing load was cancelled**





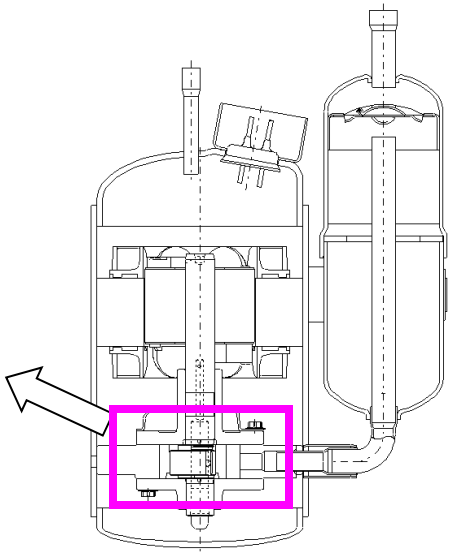


Figure 14

Effect of Countermeasures

- **This modification is ensured to have the same strength as R410A**

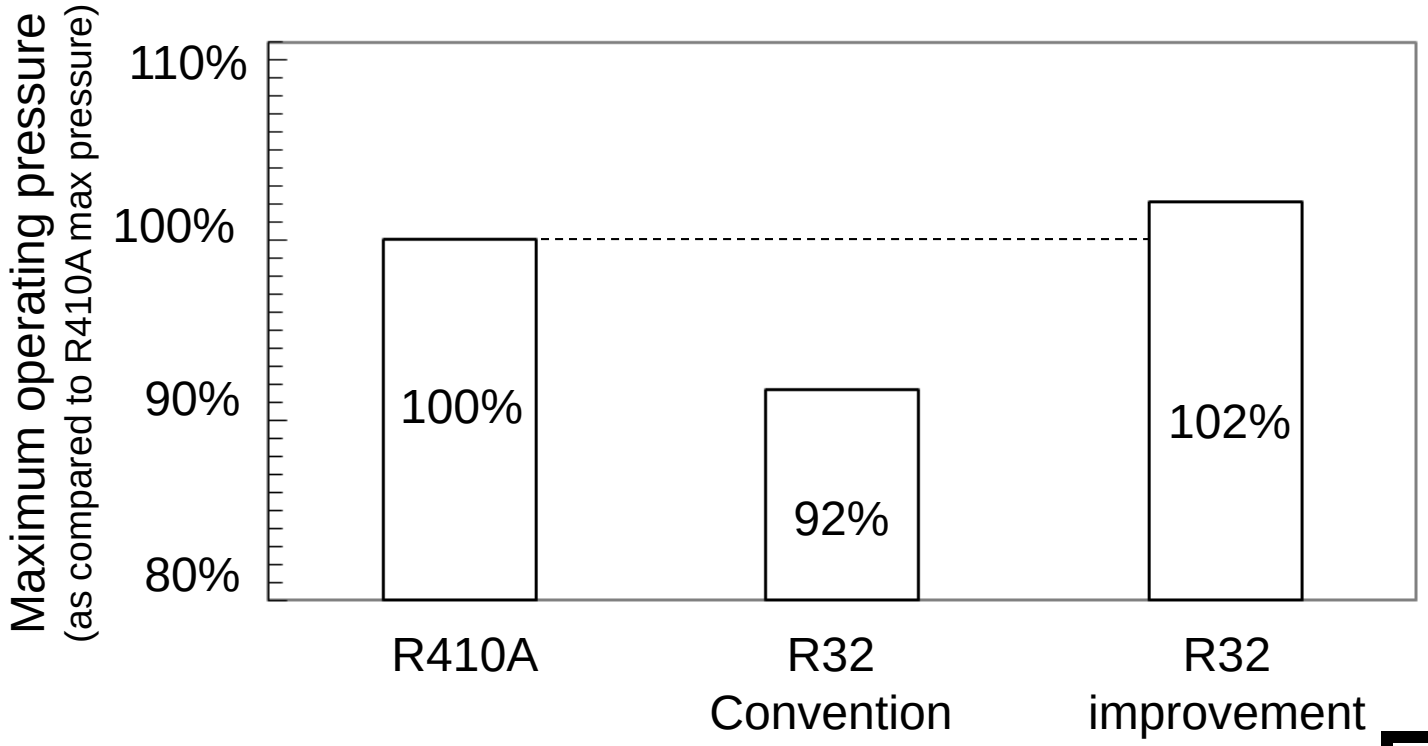


Figure 15

Conclusion

- **We achieved R32 compressors with higher COP than that of R410A compressors by optimizing the port diameter and adding a heat-insulating structure**

- **By reducing the piston pressurizing force, we achieved about the same reliability in the newly developed R32 compressor compared to that of the R410A compressor**

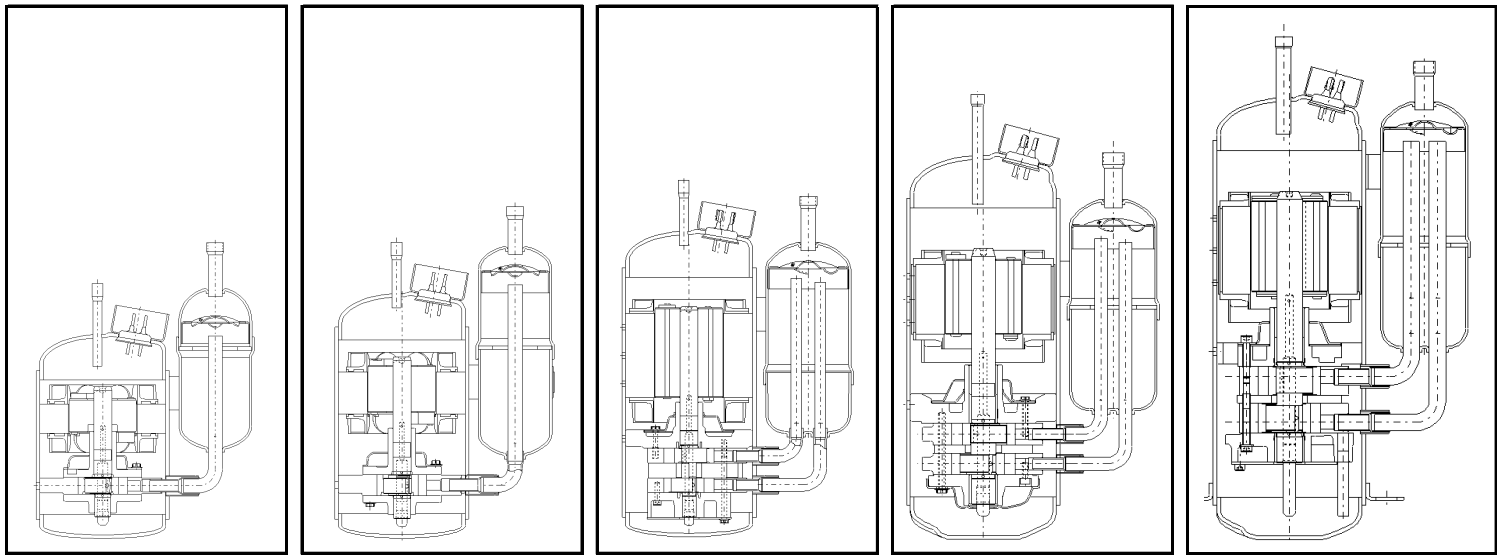
Conclusion

- We achieved R32 compressors with higher COP than that of R410A compressors by optimizing the port diameter and adding a heat-insulating structure

- **By reducing the piston pressurizing force, we achieved about the same reliability in the newly developed R32 compressor compared to that of the R410A compressor**

Conclusion

- **We applied 2 modifications to conventional R410A compressors and developed R32 compressors with a range of 2.2kW to 10kW**



Capacity*[1]	2.2 kW	2.5 kW	4.0 kW	7.1 kW	10.0 kW
Compressor Type	1 Cylinder	1 Cylinder	2 Cylinders	2 Cylinders	2 Cylinders

*1: Operating conditions (ARI standards: TC/TE/TS/TL=54.4/7.2/18.3/46.1℃,60s^{-1})

Figure 16