
Research and Development of R290 Less Oil Rotary Compressor

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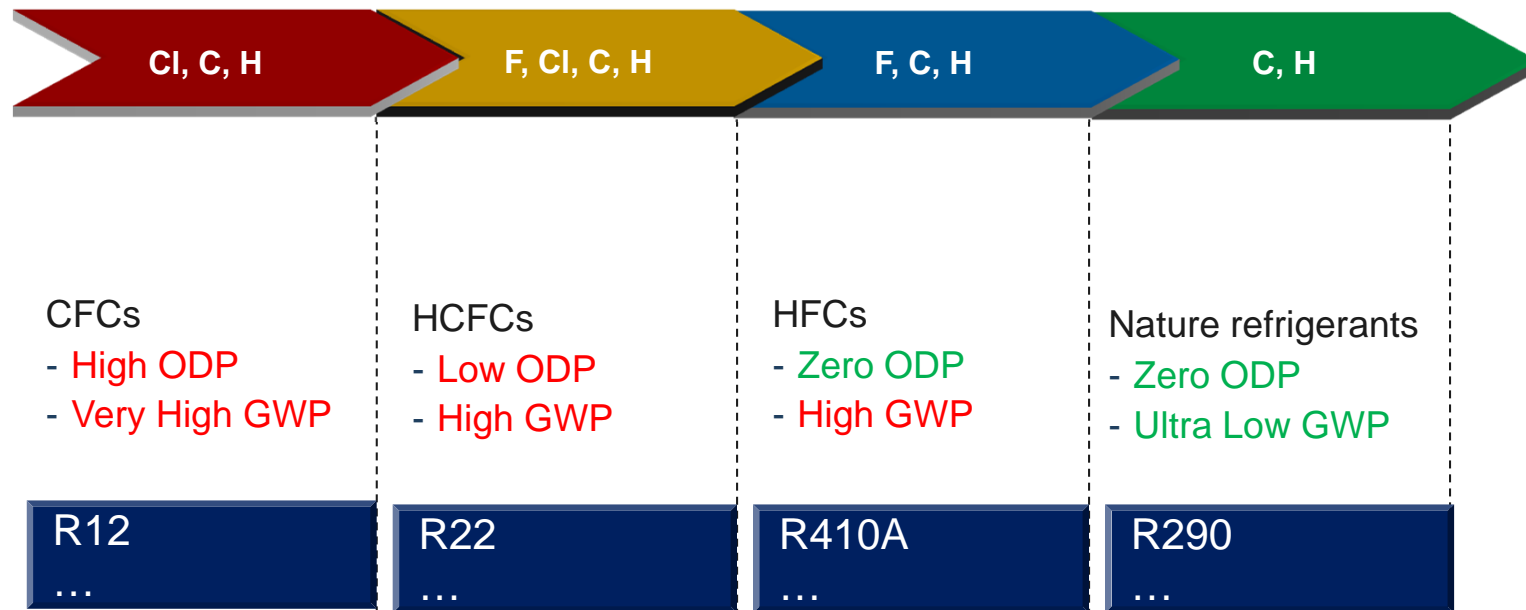
Conclusion

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Background

Simple review of refrigerant alternative process

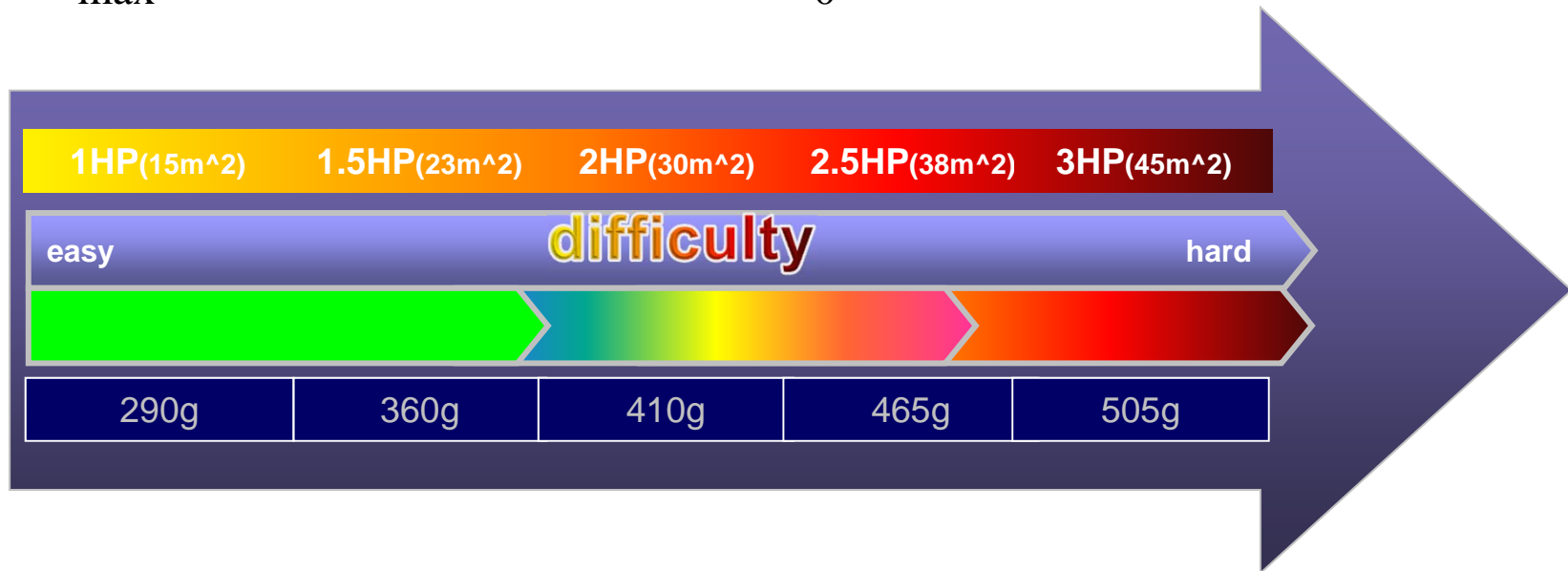




Background

The demand of R290 charge amount in RAC system should be accordant with the following equation :

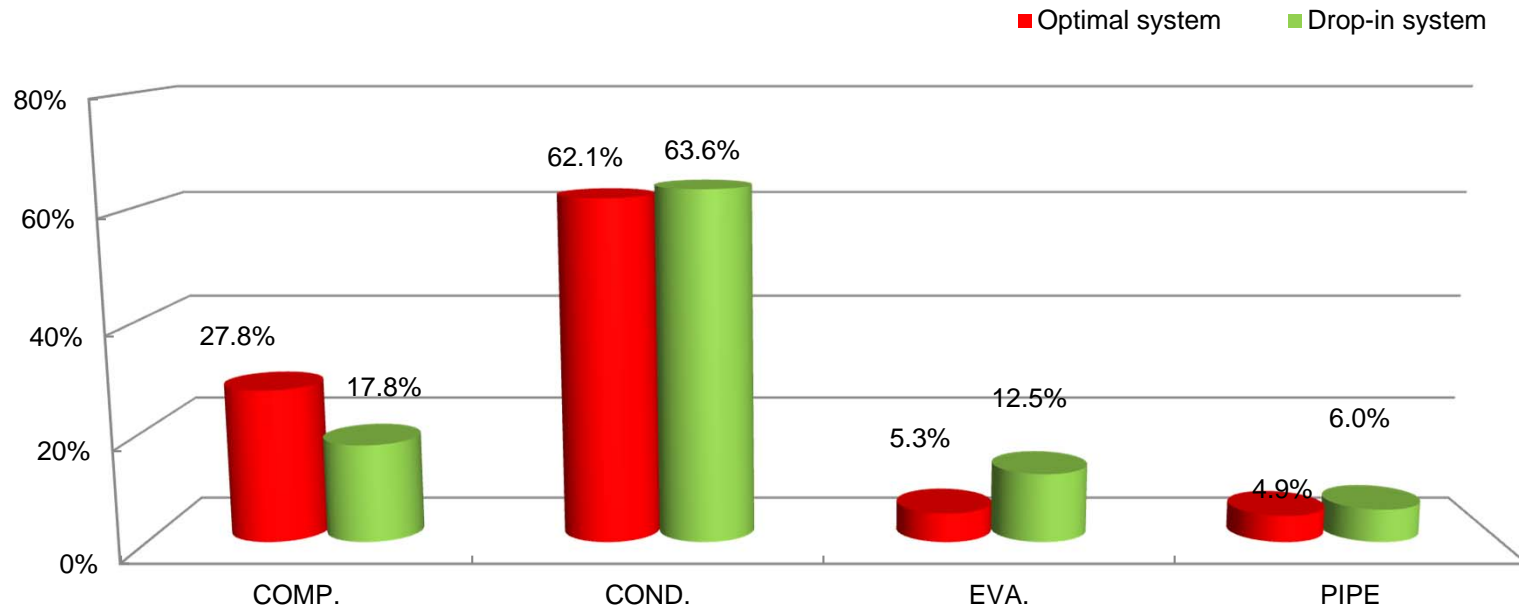
$$m_{\max} = 2.5 \times (LFL)^{(5/4)} \times h_0 \times (A)^{1/2}$$





R290 distribution in RAC system

Refrigerant distribution in RAC system





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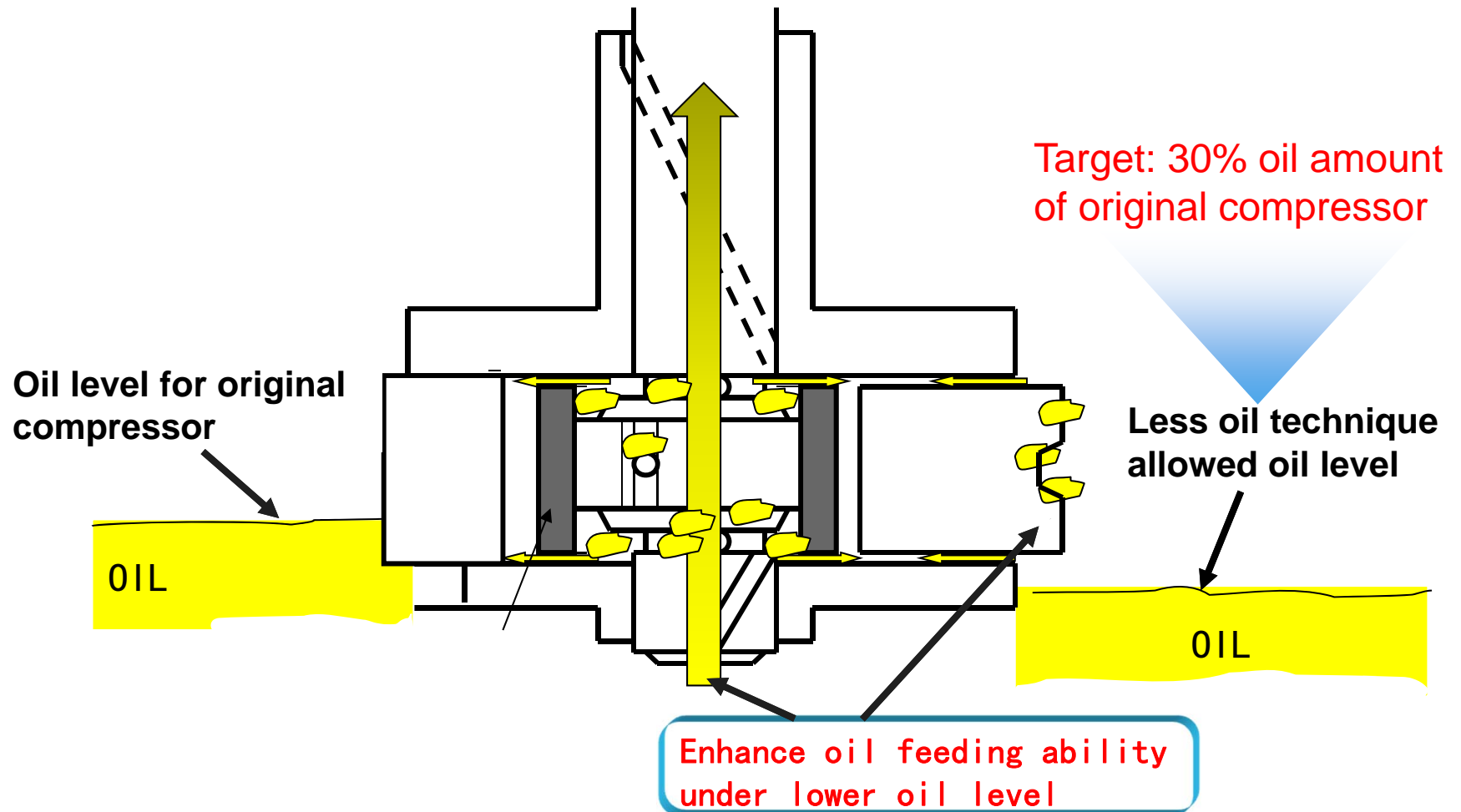
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Concept of less oil rotary compressor

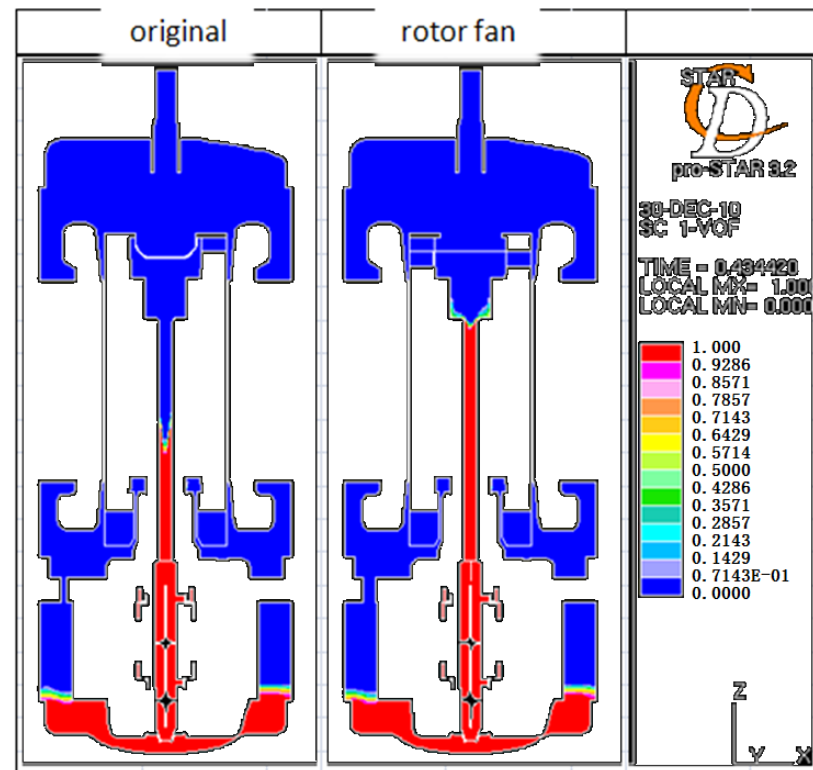




Oil feeding structures

Rotor fan structure

- To improve oil feeding to the shaft and upper bearing.
- The rotor fan structure makes the pressure decrease of the shaft oil pump outlet, so that the pressure difference of the shaft oil pump system increase
- This structure can enhance the oil pump efficiency and oil supply height.

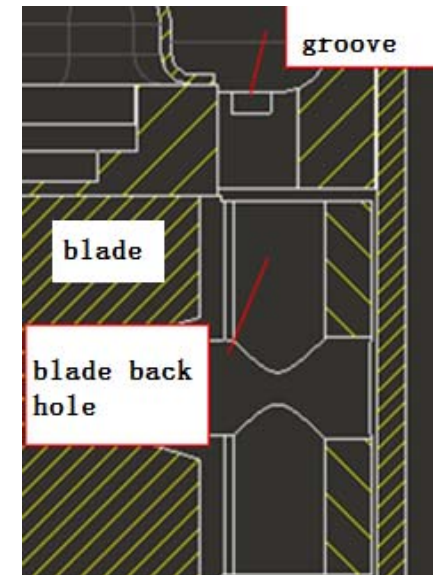
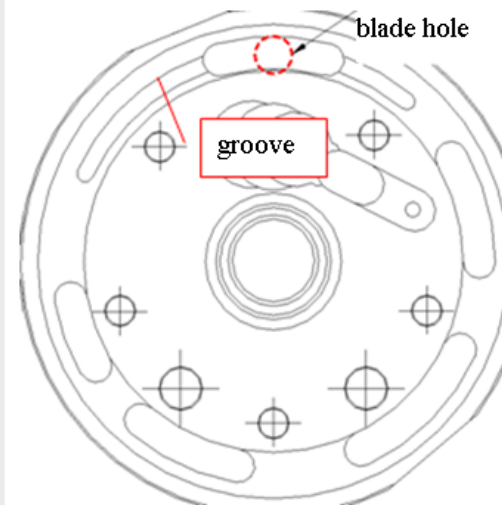




Oil feeding structures

Oil collecting groove

- To improve blade lubrication by increase the oil amount through the blade surface.
- A groove is manufactured on the upper bearing to collect oil and lead the oil flow to the blade back hole
- To achieve equivalent lubricate status to the original compressor.



Oil collecting groove on the upper bearing



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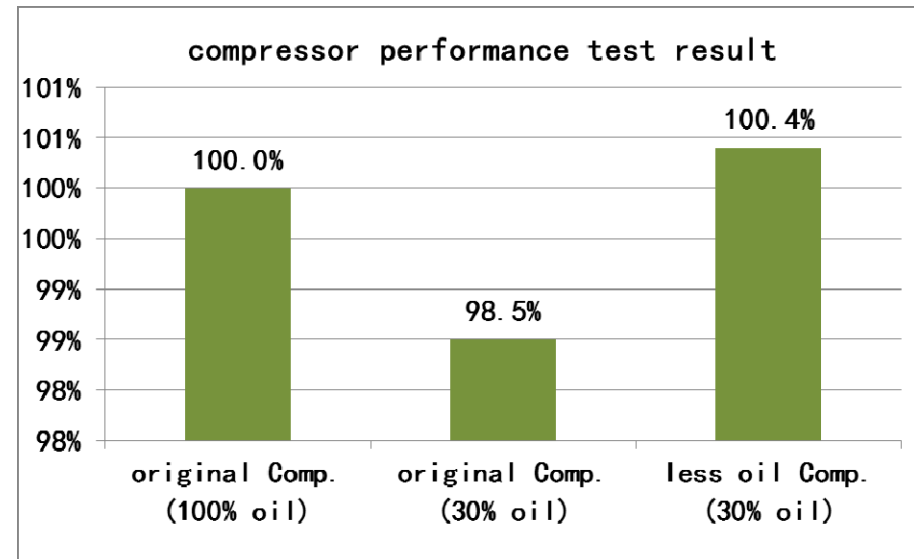
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Performance test - compressor

Compressor performance

- The 100% is original compressor result with normal oil charge amount
- The less oil compressor with 30% oil charge amount obtained 0.4% higher efficiency.
- The efficiency of the original compressor with 30% oil charge is 1.5% lower than the base.



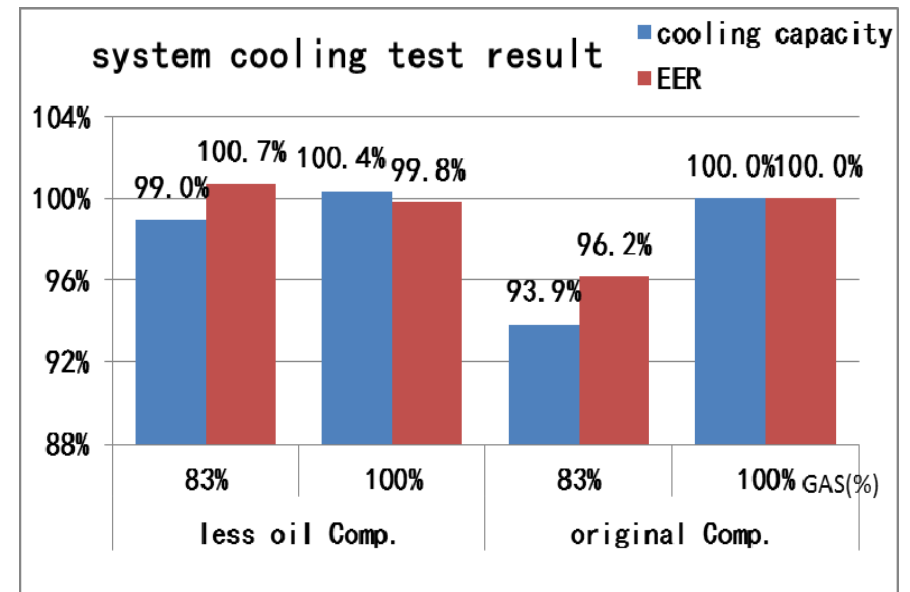
Compressor COP result



Performance test – RAC system

System cooling performance

- Under the cooling condition, the less oil system only needed 83% charge amount can achieve equivalent performance of the base
- When changed R290 charge amount from 100% to 83%, the less oil system has better performance stability
- We can use the less oil technique to help system satisfy the standard easier or to achieve more safety with lower R290 charge .



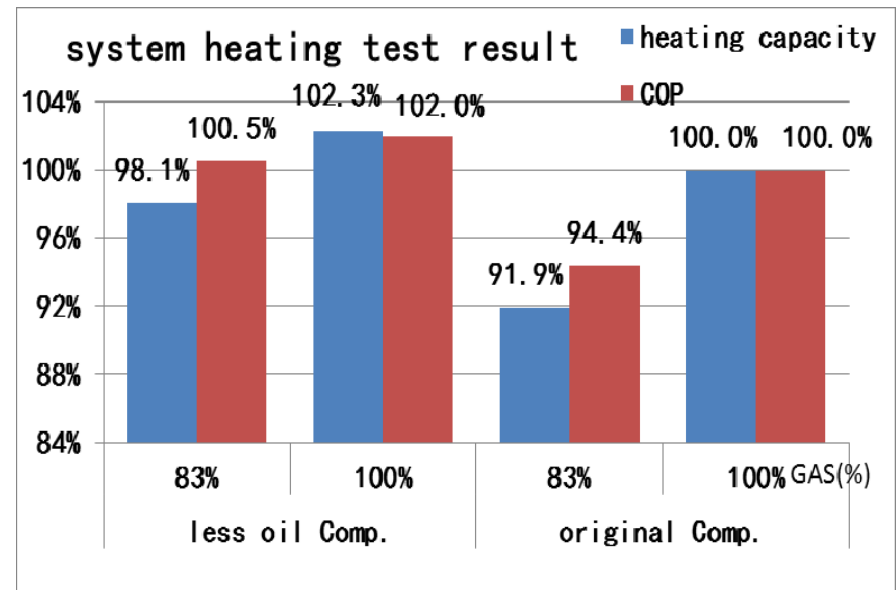
System cooling EER result



Performance test – RAC system

System heating performance

- The less oil R290 system shows better heating performance.
- Under the heating model, we can either choose 83% charge amount to obtain acceptable performance or get about 2% higher EER by use more R290.
- The heating performance of the original system shows more severity than cooling performance along with the decrease of R290 charge amount



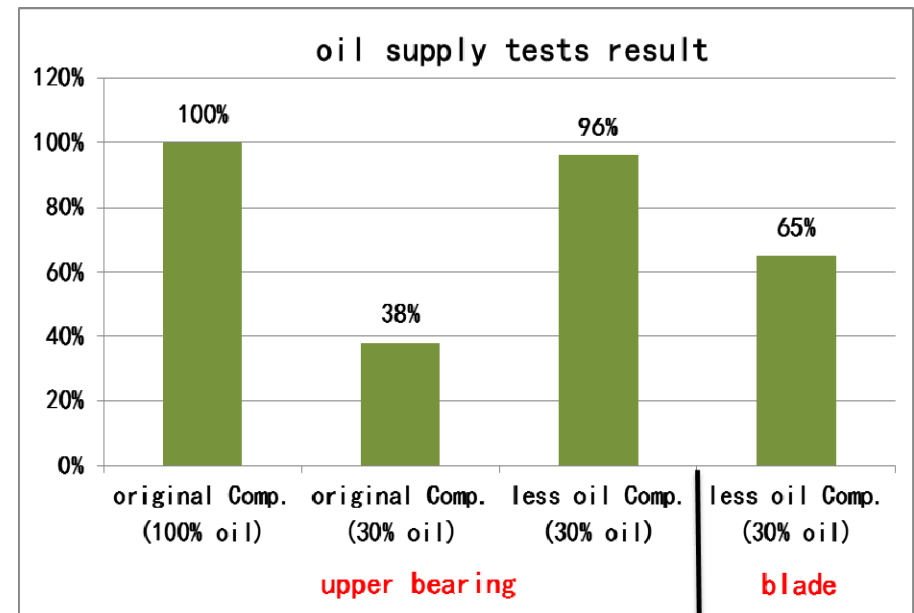
System heating COP result



Reliability test – oil feeding test

Oil feeding test

- To make sure the lubricate state of moving parts.
- The oil supply tests include upper bearing test and blade test
- The result of upper bearing test reflects the rotor fan function while the result of blade test reflects the oil collecting groove function
- Both the upper bearing test and blade test results of the less oil compressor were as good as original compressor

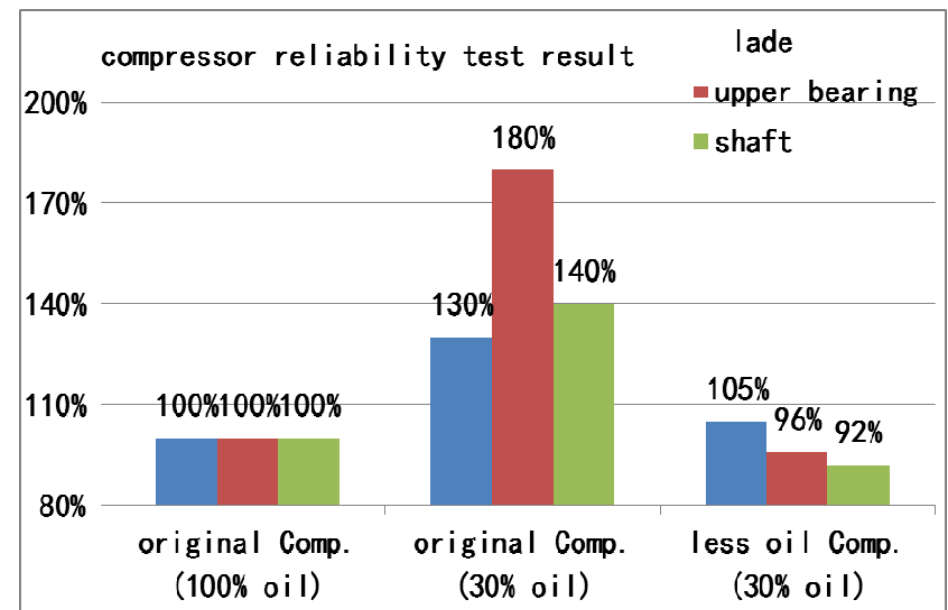




Reliability test – compressor life test

Compressor life test

- The figure only shows result of concerned parts like blade, upper bearing and shaft.
- After 1000 hours running, the wear of these parts in less oil compressor was as good as the original compressor.
- The wear apparently increased in the original compressor with 30% oil because of the bad lubrication

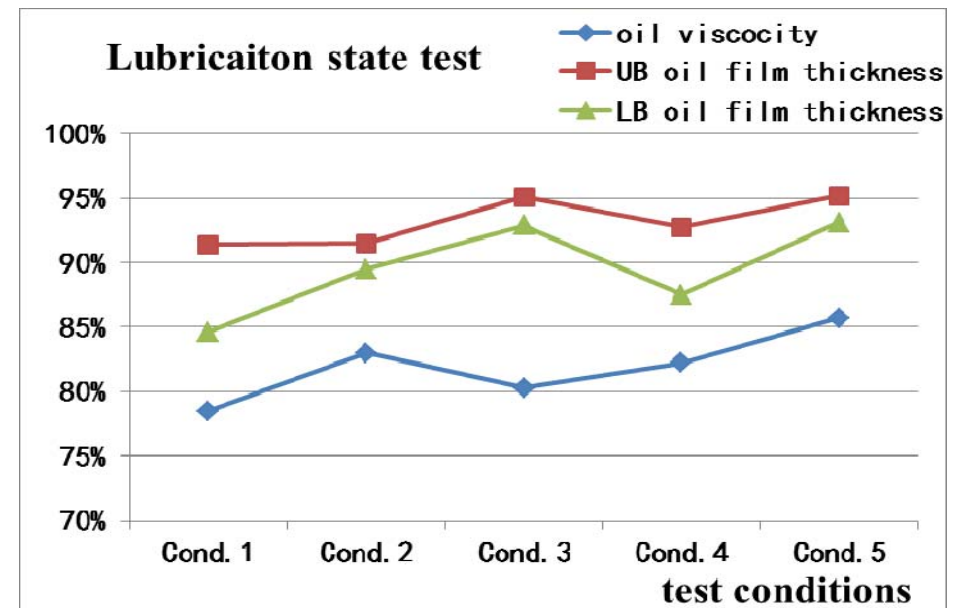




Reliability test – system test

Lubrication state test

- The 100% is original compressor result.
- The oil working viscosity has about 20% reduction while the oil film thickness dropped about 10%
- Consequently, to obtain suitable lubrication for less oil rotary compressor, it is better to choose the oil with higher viscosity or lower solubility by R290.





Conclusion

- ✓ In R290 RAC system, about 28% refrigerant stays in compressor and 62% refrigerant stays in the condenser. Since most of the refrigerant in compressor is absorbed in oil, the less oil technique is an effective way to reduce R290 in compressor and system charge amount.
- ✓ The oil supply issues of less oil compressor were presented and resolved by the oil feeding structures design. The validation tests show that the less oil compressor has good performance and reliability, it will be an important direction of R290 compressor design.
- ✓ However, the decrease of oil charge amount affects oil working viscosity and oil film thickness of compressor moving parts, the choice of lubricate oil for less oil compressor should be considered.

GMCC



Thank you !