

Compressor Tests with Low GWP Refrigerants for Air Conditioning

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brand products

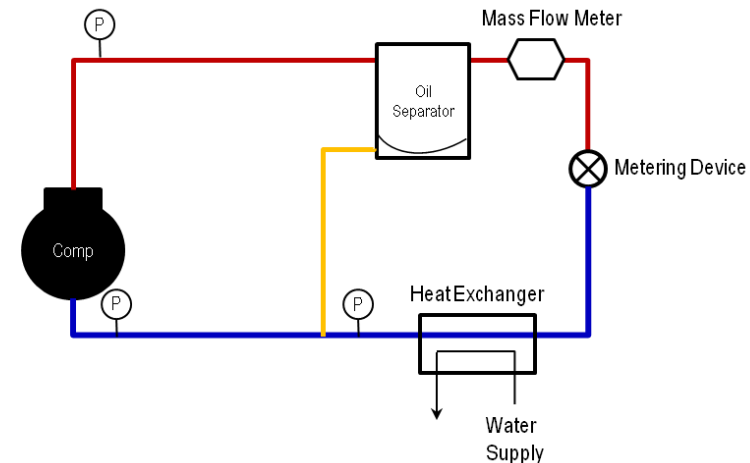

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Test Procedure and Compressor Description

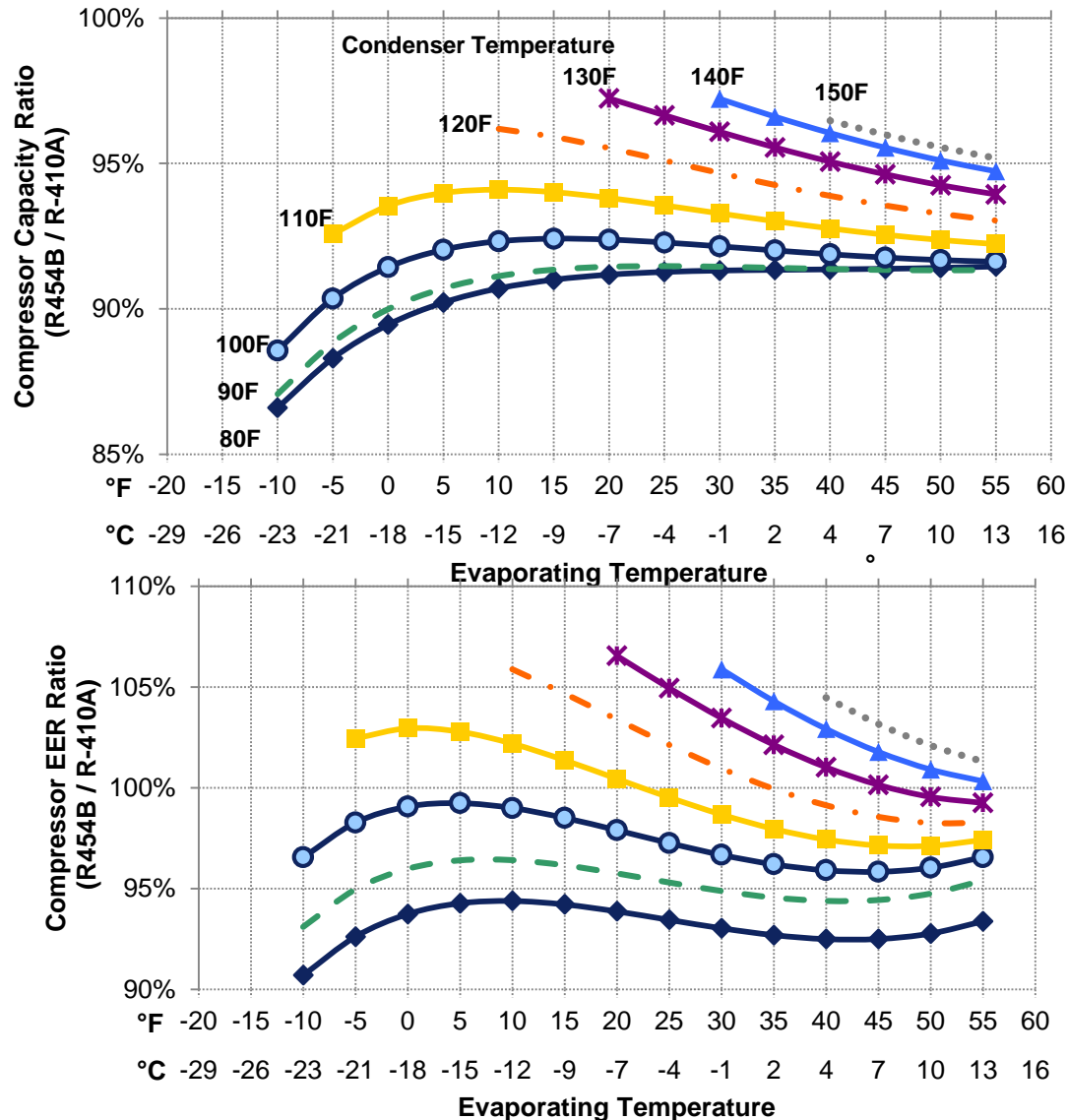
- (2) LGWP Refrigerant Alternatives Tested As Drop-In With Emerson Compressors:

Compressor	R454B (DR-5A)	R447A (L41-2)
3-ton AC Scroll	✓	
10-ton AC Scroll		✓

- Both Tested With Current POE 3MA 32cst Oil
- Tested Multiple Points Within The Operating Envelope Of Each Compressor To Create Regressions Of Mass Flow, Capacity & Power Coefficients
 - Standard Emerson Facility Instrumentation and Accuracy
 - Per AHRI Standard 540 (Dew Point Based) and 15F Subcooling / 20F Superheat
- Compared Regressed Data Versus Published R-410A

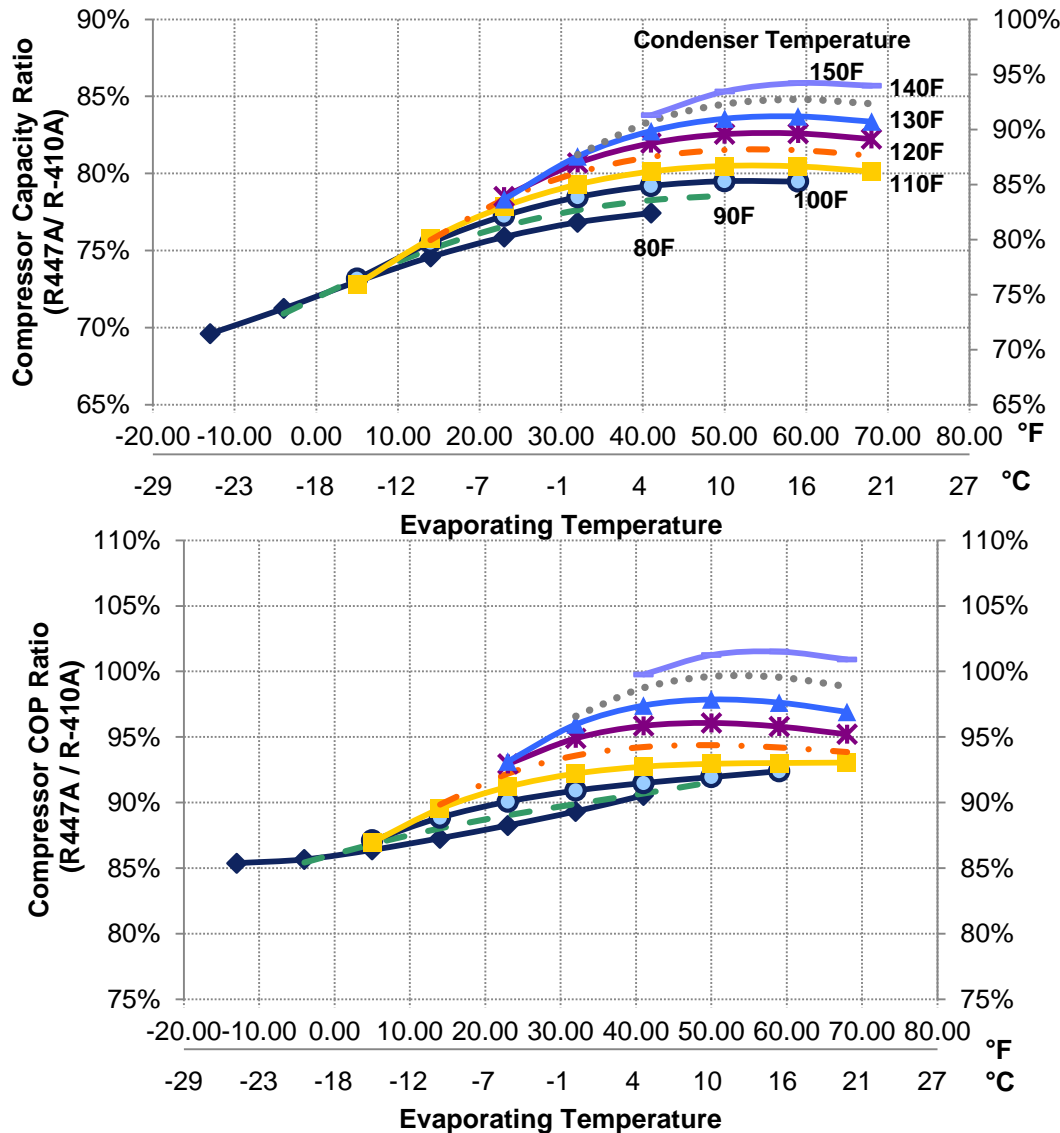


R-454B Drop-In Tests in a 3-ton AC Scroll Compressor



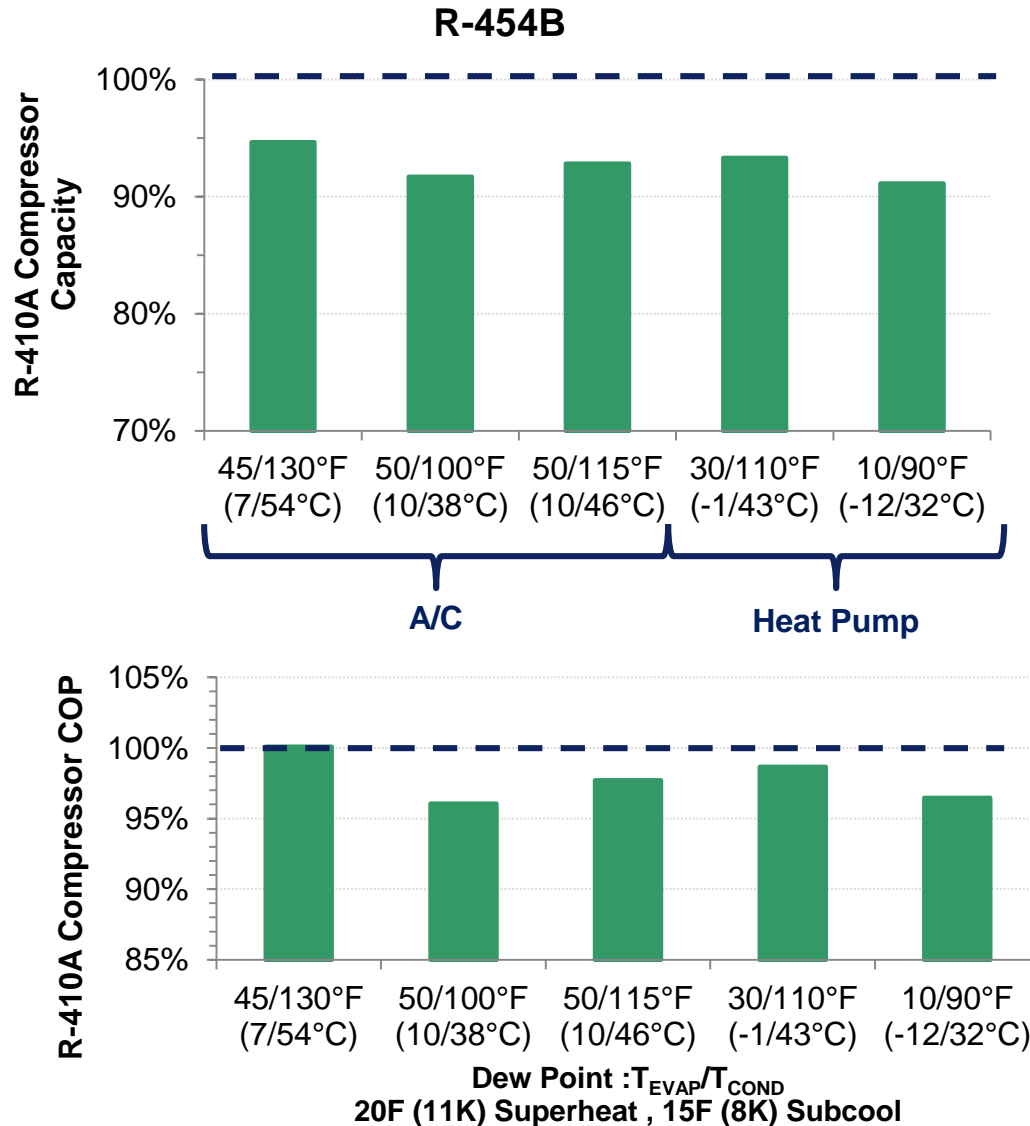
- **R454B** Compressor Performance VS. R410 Behaves Nonlinearly Depending on Te/Tc
- Relatively Better At Higher Tevap and Higher Tcond
- Performance As Expected Based On Properties
- Performance Ratio Lower Than Seen In AREP System Tests Due To Testing At Dew-Point and Other System Effects

R-447A Drop-In Tests in a 10-Ton AC Scroll Compressor



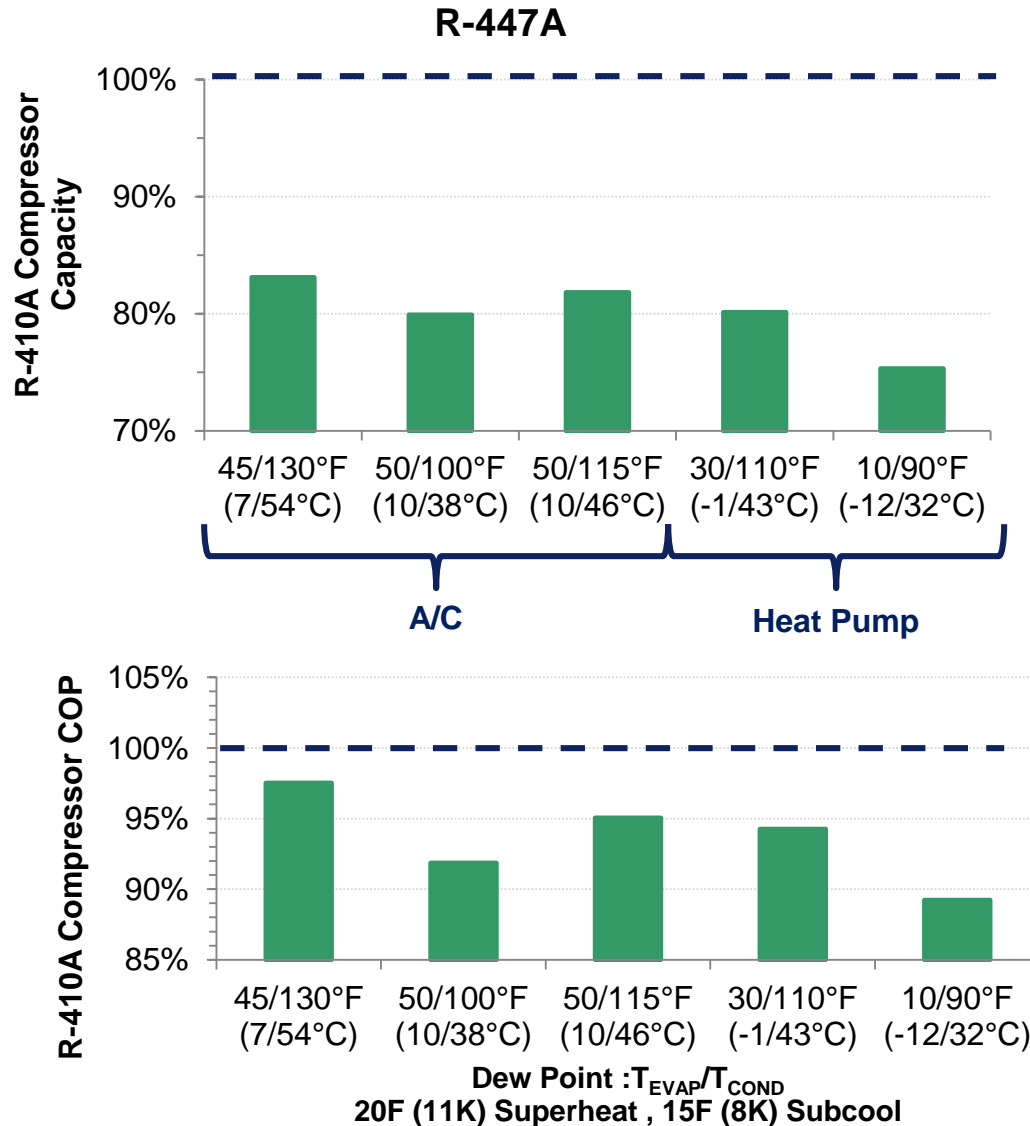
- **R447A Performance Lower Than R454B As Expected From Properties**
- **Compressor Performance VS. R410 Behaves Nonlinearly Depending on Te/Tc, Much Worse At Lower Tevap H/P Conditions**
- **Relatively Better At Higher Tevap and Higher Tcond**
- **Performance Ratio Lower Than Seen In AREP System Tests Due To Testing At Dew-Point and Other System Effects**

R-454B in a 3-ton AC Scroll Compressor At Key A/C and H/P Conditions



- **R454B** Compressor Capacity was 5-10% Lower than R-410A
 - Slightly Lower Capacity Partly Due To Dew-Point Condition (2.5F Glide)
- **R454B** Compressor COP was 0-5% Lower than R-410A
- Performance Better At Higher Condensing Temp

R-447A in a 10-Ton AC Scroll Compressor At Key A/C and H/P Conditions



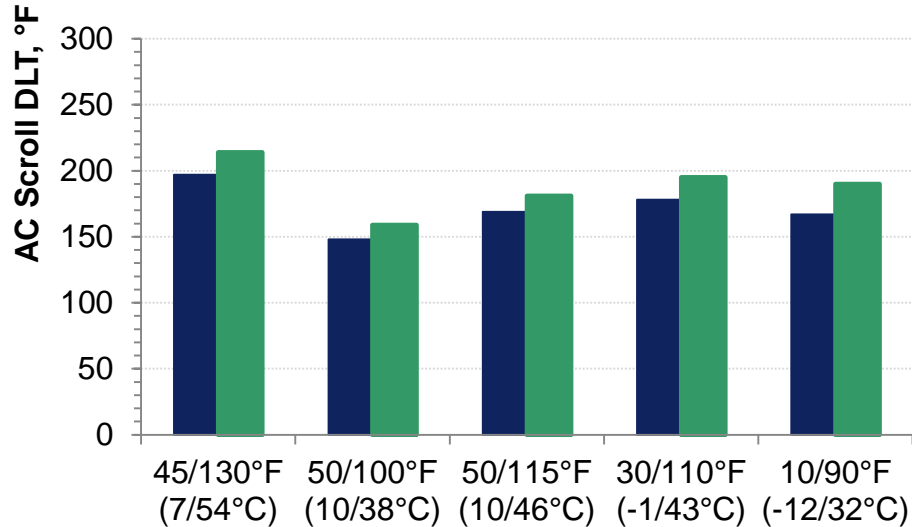
- **R-447A** Compressor Capacity was 15-25% Lower than R-410A
 - Lower Capacity Partly Due To Dew Point Condition (7F Glide)
- **R-447A** Compressor COP was 3-10% Lower than R-410A
- Performance Relatively Better At Higher Condensing Temps

Compressor Discharge Line Temperatures

(Measured 6" Downstream Of Compressor Discharge)

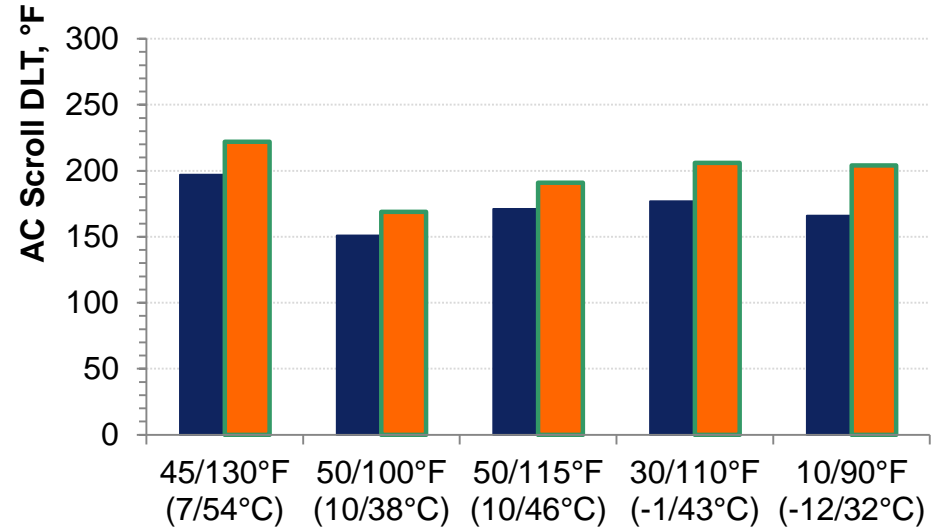
3-Ton Scroll

■ R-410A ■ R-454B



10-Ton Scroll

■ R-410A ■ R-447A



**Both Alternative Refrigerants
Have Higher, But Manageable
Discharge Temperatures**

Conclusions/Summary

- **R447A and R454B Are Feasible Candidates Among Several Low-GWP Alternatives For A/C with R454B Performance Better Than R447A**
- **Performance Follow Theoretical Properties As Expected**
- **Both Have Manageable Discharge Temperature**
- **No Oil Compatibility Issue Observed**
- **Both Are A2L Mild Flammability and Will Require Safety Standards For Commercialization**
- **Theoretical Cycle and Compressor Performance Comparisons Is Only A Part Of The Holistic Evaluation in Selecting Refrigerants; Practical Tested System Performance Such As In Low GWP AREP Program Should Be The Final Comparison**
- **For Refrigerants With High Glide, Compressor Test Results at Mid-Point Relate Better To Actual System Performance Compared To Dew-Point**