UCDAVIS
Western Cooling Efficiency Center

CASE STUDY
October 2019

PERFORMANCE TESTING OF R-466A: A LOW GLOBAL WARMING POTENTIAL ALTERNATIVE REFRIGERANT

KEY NUMBERS

5-10% increase in refrigerant charge

65% less GWP

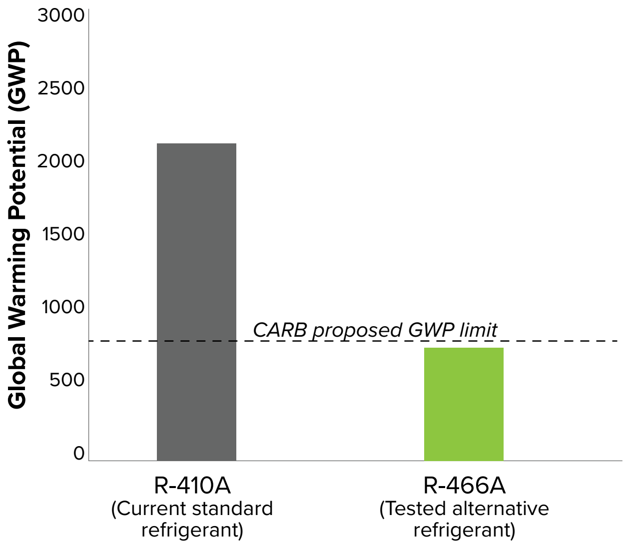
5% average reduction in capacity

<2% average reduction in COP

"The retrofit R-466A refrigerant provided similar performance to R-410A while having a lower GWP."

PROBLEM

Refrigerants used in vapor-compression air conditioners and heat pumps have a high global warming potential (GWP). Environmental regulations require that alternative solutions be developed with lower GWP. In general, there is a trade-off when choosing alternative refrigerants between performance, GWP, and safety. There is a significant effort underway to identify a refrigerant that is design-compatible with R-410A equipment, the prominent refrigerant used in unitary air conditioning equipment in the U.S. This project evaluates a refrigerant developed by Honeywell, R-466A, that reduces GWP beyond that of the industry standard R-410A, while reportedly maintaining similar performance and safety.



OBJECTIVE

The Western Cooling Efficiency Center (WCEC) tested the cooling performance of a unitary heat pump with R-410A and with a new, low GWP R-466A refrigerant. Researchers tested the heat pump equipment in cooling mode at six outdoor air conditions from 75°F-115°F using R-410A to obtain a baseline and repeated the tests after a drop-in replacement with the R-466A refrigerant. The cooling tests measured the total capacity, total system power, and coefficient of performance (COP) of the heat pump to determine what impact the new refrigerant had on the system's performance.

PROCEDURE

To assess the performance of the new refrigerant, researchers instrumented and tested a 4-ton Trane RTU (model #WSC048E3). Prior to testing, the unit was outfitted with an adjustable TXV to accommodate variation in system pressures for the two different refrigerants. The unit was initially charged to the manufacturer's specification with 9.0 lbs of R-410A, which produced 11.4 F of subcooling and 11.2 F of superheating. A drop-in test was then performed with R-466A. To charge the unit with R-466A, researchers started with an initial charge of 9 lbs and incrementally added refrigerant until the subcooling approached what was measured for R-410A. Ultimately, after adding 9 lbs 10 oz of R-466A the subcooling was measured to be 12.4 F. Once the subcooling agreed, the thermal expansion valve was adjusted until the superheat agreed with a final value of 13.2 F.

Table 1: Laboratory test conditions

Test	Outdoor Air Dry Bulb (F)	Indoor Air (DB/WB(F)
0	75	(80/67)
1_1	82	
1_2	82	
1_3	82	
2	85	
3_1	95	
3_2	95	
3_3	95	
4	105	
5	115	

Once charged, the RTU was placed in an environmental control chamber which allowed control of the indoor and outdoor air's dry bulb and wet bulb temperatures. Researchers instrumented the RTU so its performance could be quantified according to the ANSI/AHRI Standard 210/240 and compared at each test point. A total of ten cooling tests were performed for each refrigerant (Table 1). All ten tests used the same indoor air conditions (80°F/67°F dry bulb/wet bulb) and a nameplate air flowrate of 1600 CFM was maintained over the evaporator coil with a minimum external static pressure of 50 Pascal.

RESULTS

Total Capacity and Power Draw

Total capacity for both the baseline and retrofit refrigerant followed similar trends. The capacity for both refrigerants decreased with increasing outdoor air temperature as expected. **The capacity of R-466A was slightly lower than R-410A at all test conditions with an average reduction of 5%.** The reduced capacity was more prominent at lower outdoor air conditions with a 6% reduction in capacity as compared to a 4% reduction at the higher outdoor air conditions (Figure 1). The sensible heat ratio was consistent between the two refrigerants.

Total power draw for the unit was slightly lower for R-466A with an average reduction of 4%. There was a larger reduction in power draw at the hotter outdoor air temperature conditions with a 6% reduction as compared to a 2% reduction at the lowest air temperature.

Coefficient of Performance

The COP for both the baseline and retrofit refrigerant followed similar trends with outdoor air temperature. As the outdoor air temperature increased, the COP for both refrigerants decreased (Figure 2). **The COP for R-466A was approximately 3% lower for the lower temperatures (75, 82, 85, and 95 °F) and 1% higher at the hottest two temperatures (105 and 115 °F) with a 2% reduction on average.**

Figure 1: Total Capacity and Total Power versus Outdoor Air Temperature

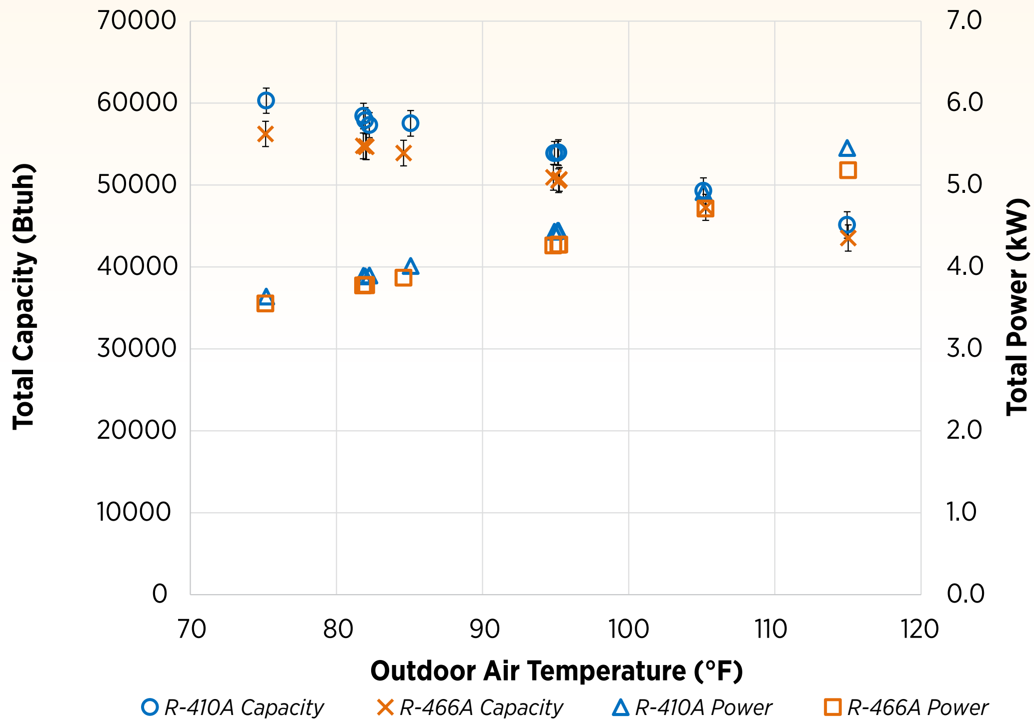
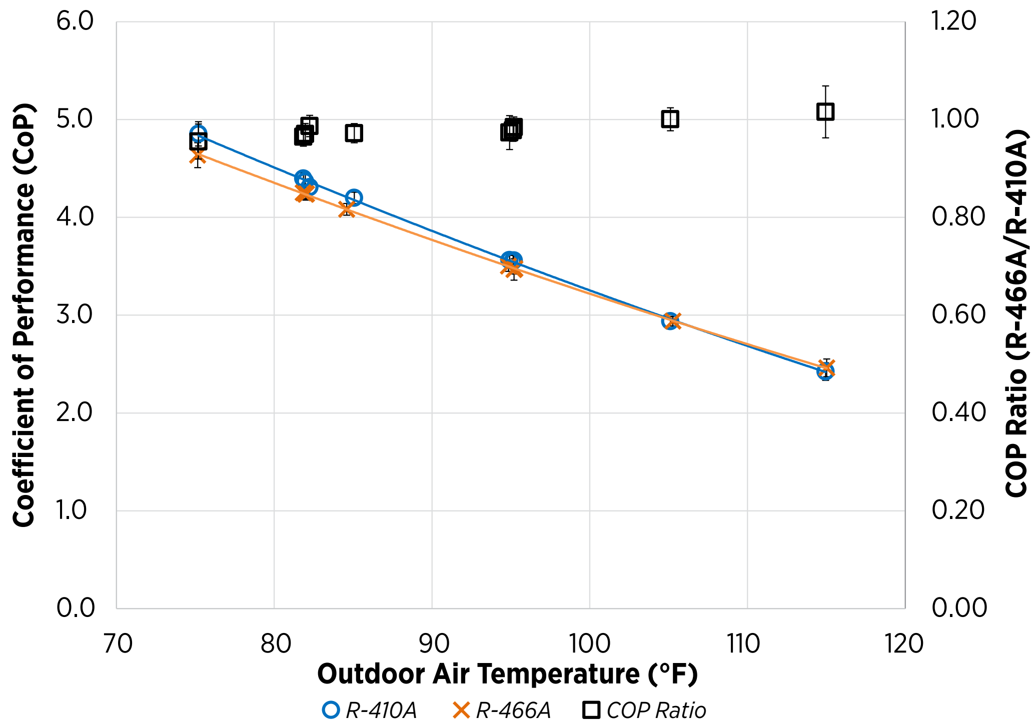


Figure 2: Coefficient of Performance versus Outdoor Air Temperature



CONCLUSION

Equipment operating with R-466A refrigerant achieved slightly lower capacity and had lower total power draw in each test performed. There was a 5% reduction in capacity on average across all test temperatures and a 2% decrease in efficiency. **To optimize performance, this efficiency drop could be minimized through more extensive tuning of the system.** Overall, the R-466A refrigerant performed similarly to R-410A and the slight reduction in performance needs to be weighed against the significantly reduced GWP value.

Given the relatively low GWP and fair performance, R-466A should be considered as a possible replacement for R-410A. There has been some concern about the durability of the refrigerant with existing equipment that can result in breaking down of the molecule. These durability issues need to be investigated further before a firm recommendation can be made.

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PROJECT CONTACT

Derrick Ross
dsross@ucdavis.edu

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