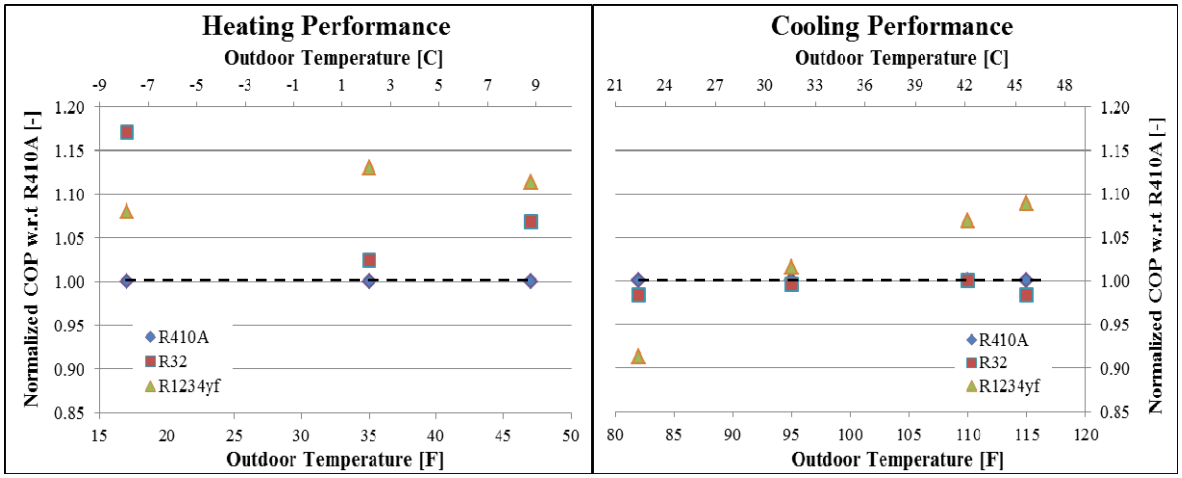


Figure 5: Normalized COP with respect to R410A for R32 and R1234yf.

The capacity for R32 cooling mode was 10% higher than R410A, especially at extreme high temperatures as shown in the right plot of Figure 6. In heating mode, the capacity for R32 was comparable to R410A. The capacity of R1234yf was about 50% lower for the entire range of outdoor temperatures and in both cooling and heating modes. It was also observed that the 1.13 kg (2.5 lb_m) of R1234yf had to be taken out from the unit during the extreme high temperature tests in order to achieve sufficient degree of superheat of at least 2°C (4°F). Thus, the charge management of R1234yf might be a challenge if R1234yf is retrofitted in R410A heat pump units for residential applications without any modification of the system refrigerant receiver.

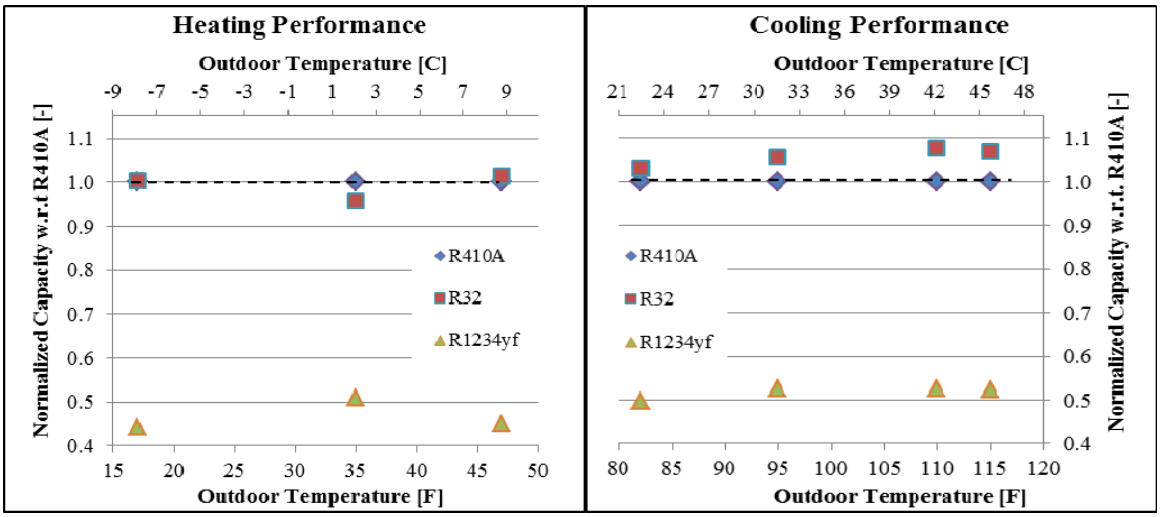


Figure 6: Normalized capacity with respect to R410A.

The power consumed by the compressor for R1234yf was about 48 to 60% lower than that for R410A. This was due to lower refrigerant flow rates and lower pressure ratios of R1234yf. With R32 the compressor power was 7 to 9 % higher than the baseline with R410A. The compressor performances are discussed by analyzing the difference of suction vapor specific volume of the refrigerants and the thermal efficiencies of the compression process during the actual experiments. These data are shown in Figure 7 for various outdoor temperatures. During the unit run with the original TXV, the suction specific volumes for R1234yf measured from the pressure and temperature data taken at the compressor suction port, were about 45 to 60% higher than R410A. R32 specific volumes were about 35 to 40% higher than R410A. The thermal efficiency of the compressor, normalized with respect to R410A, was generally higher for R32 and lower for R1234yf. It was also observed that the discharge temperatures for R32 was higher than for R410A, especially for the extreme high temperature tests as shown in the right plot of Figure 8. The discharge

temperature of the compressor with R32 was about 20°C (37.2°F) higher that R410A at AHRI A cooling conditions and up 30°C (54.6°C) at extreme high temperatures. For R1234yf the discharge temperature was always lower than R410A and the data in Figure 8 show the difference in discharge temperature of R1234yf and R32 with respect to R410A for a broad range of outdoor temperatures.

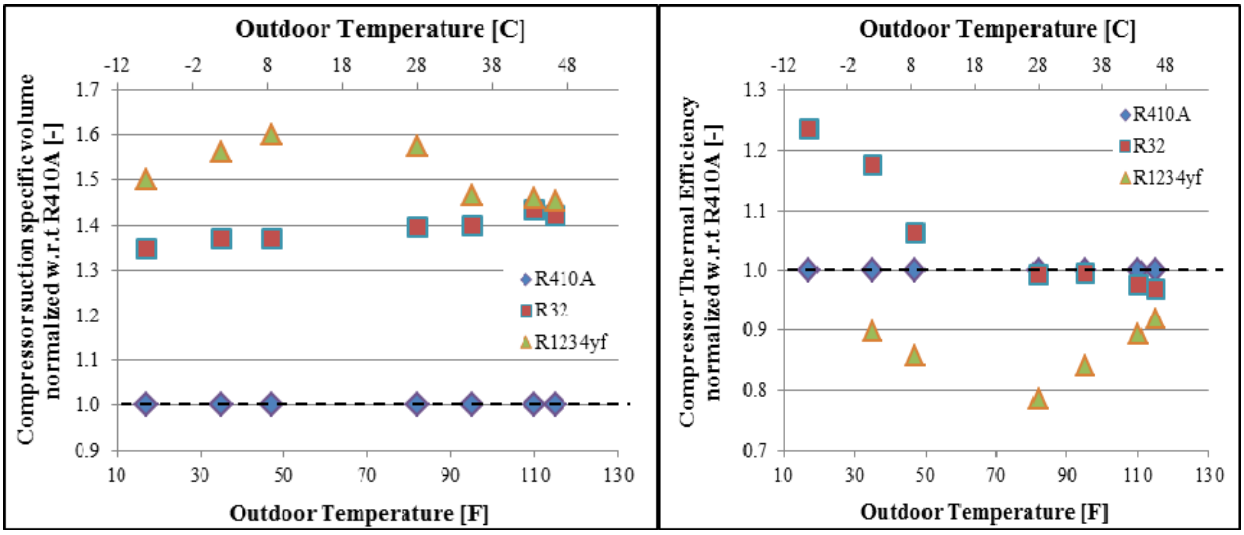


Figure 7: Compressor suction specific volume and thermal efficiency for R410A (baseline), R32, and R1234yf

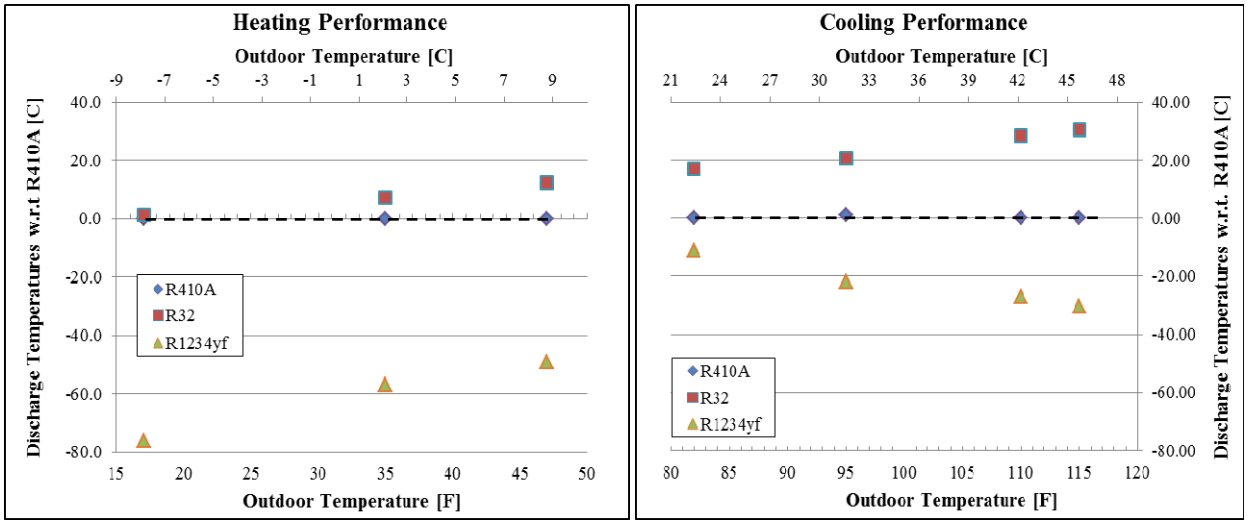


Figure 8: Compressor discharge temperatures for R410A (baseline), R32, and R1234yf

5. CONCLUSIONS

This paper presents data of drop-in energy performance and capacities of two low GWP refrigerants in a R410A heat pump split system for ducted HVAC residential applications. The experiments were conducted for cooling and heating mode of the unit and the outdoor temperature was varied from 17°F (-8°C) to 115°F (46°C). Cooling tests at AHRI standard rating conditions were performed and the refrigerant charge was optimized. Two additional off-design conditions were considered with outdoor temperatures of 110°F (43°C) and 115°F (46°C) to analyze the behavior of the refrigerant at extreme high temperature ambient. The findings from this work suggested than for