AeraDIGM, the new paradigm for using air as a refrigerant;

the proof of concept, and the path to commercialization.

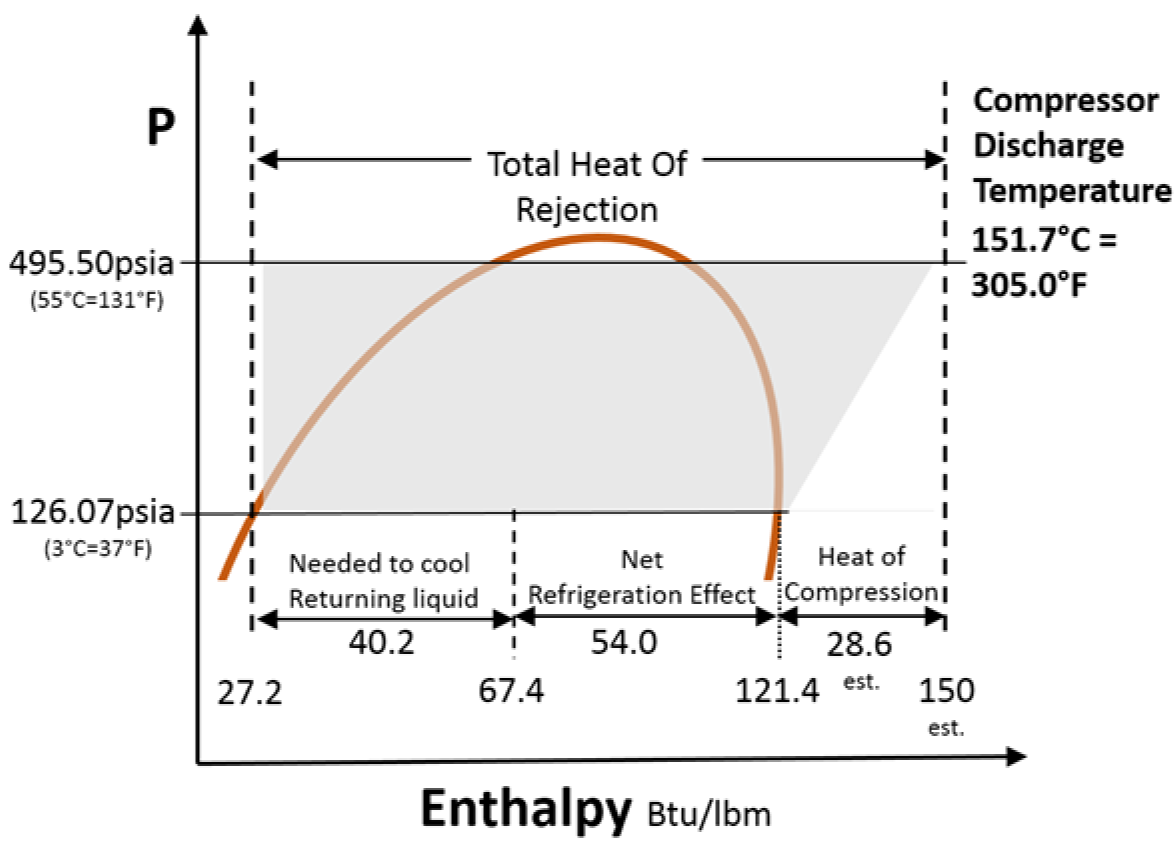
Myth-Reliance on Latent Heat, the dirty little secret of "Two-Phase Refrigerants":

VAPOR-COMPRESSION HAS NO ADVANTAGE OVER AIR ABOVE 95˚F

1. Coefficient of specific heat for air is 23% higher than R410A in the vapor phase.
    a. Air performs progressively better than R410A as temperatures increase above 95˚F.
    b. As the outside temperature falls below 95˚F, the advantage of air over R410A drops until they are about even at the room temperature defined by ASHRAE to be 80˚F.
    c. In summary, air performs better than R410A throughout the normal operating range from room temperature to extremes well above worst case desert actuals.

Latent heat contribution to refrigeration turns negative above 95˚F (R410A). The Net Refrigeration Effect of R401A is 54.0 Btu/lbm at the 95°F Rating Point. The latent heat delivered in the condenser is only 53.6 Btu/lbm, or 0.40 Btu/lbm less than the Net Refrigeration Effect in the evaporator.

Reductions in latent heat delivered to the condenser increasingly penalize performance as the temperature is raised to the critical point, 161.83˚F. (Enthalpy numbers are provided by DuPont, "Thermodynamic Properties of R410A": T-410A-ENG, with compressor entry temperature of 57.64°F from "Properties and Cycle Performance of Refrigerant Blends Operating Near and Above the Refrigerant Critical Point", NIST, Domanski and Payne, 2002 (b10328a). For reference, the latent heat of 54 Btu/lbm is 5% of the 970 Btu/lbm latent heat of water.)



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i. Therefore, a sufficient mass flow of air can be delivered using the same "multi-piston" compressor (Pressure Ratio = 4) used with R410A and all the latest refrigerants today.

ii. The orifice (A) which now meters liquid refrigerant between the high pressure and low-pressure zones can be readily replaced with a similar orifice metering the flow of air.

The red (warm) flow is in the high-pressure zone from the compressor to the sonic nozzle.

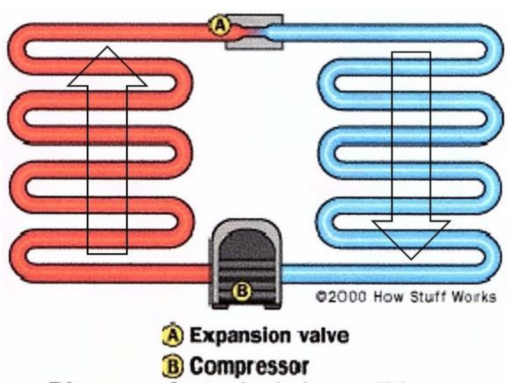

Diagram of a typical air conditioner

The blue (cool) flow is in the low-pressure zone, from the sonic nozzle to the compressor.

iii. CONCLUSION: Modern refrigerants can be advantageously displaced by air using essentially identical mechanical systems. Costly and harmful refrigerants can be eliminated while modestly reducing energy costs. (Note: US DOE, among others, has dismissed air cycle cooling based on the inefficiency of turbines while failing to acknowledge that multi-piston compressors already deliver adequate mass flows of vapor in leading commercial systems.)

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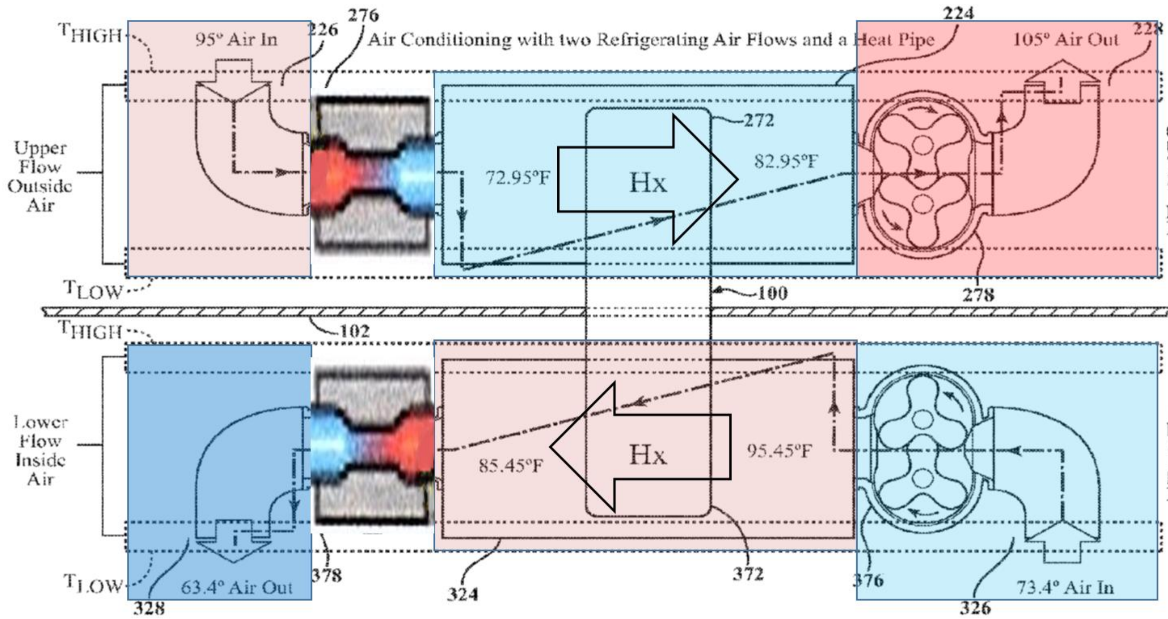
2. Reducing the pressure ratio to a range near 1.15 and using both ambient air streams as refrigerant, energy operating costs can be cut in half while moving the same heat. In other words, the COP is doubled. These energy reductions are achieved by adapting the sonic nozzle to the lower pressure ratio while moving exactly the same mass flow of ambient air which is already required on both sides of the present refrigeration systems. (All components well proven in commercial use since 1965. Patents pending.)



3. By replacing the sonic nozzle with a companion pump to manage the pressure across the heat exchanger, the work of compression will be directly recovered, increasing the overall energy reduction to 75% as previously outlined. (All components well proven in commercial use since 1965. Patents pending.)