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RS-45 (R434A)

DISCHARGE TEMPERATURE EFFECT IN HEAT PUMPS

It has been suggested that refrigerants with a high discharge temperature are more efficient when used in the heating cycle of a heat pump than refrigerants with a low discharge temperature. R22 has a high discharge temperature & most refrigerants, including RS-45, have lower discharge temperatures.

Such a statement in isolation is misleading since it fails to take into account a number of related factors when comparing different refrigerants in this particular application. The following points are key to understanding this:

1. Engineers commonly talk about discharge superheat in terms of temperature. It is perhaps not surprising that that, when they see a 30 ^{0}C difference between R22 and RS-45, their immediate response is that the output temperature of a heat pump operating on RS-45 is likely to be lower than with R22. But does this stand up to more detailed scrutiny?

2. Although the superheat of R22 expressed in terms of temperature is higher than that of RS-45, the superheat expressed in terms of enthalpy is the same. This means that the actual amount of heat delivered by R22 and RS-45 is the same.

3. The major proportion of the heat rejected from the condenser results from condensation. The minor portion is from desuperheating. A standard cycle calculation with evaporation at 7^{0}C and condensation at 45^{0}C shows that for both R22 and RS-45 latent heat accounts for 75% of heat output while the sensible heat from desuperheating accounts for only 25%.

4. Obviously the sensible heat from an RS-45 system is delivered at a lower temperature than that from and R22 system. But does this make a significant difference in the output temperature of a heat pump? The worst case scenario exists in a water system with a counter-current flow. Yet even in this case, the drop in the outlet temperature is marginal being only 1^{0}C to 4 ^{0}C depending upon flow rates. In cross-flow systems typical of air heat pumps, the difference will essentially disappear.

5. The much higher discharge temperature of R22 relative to RS-45 may even be disadvantage in that the superheated R22 will lose more heat to its surroundings in the pipe connecting the discharge port of the compressor to the condenser. For a heat pump this loss would potentially reduce the energy efficiency of R22 relative to RS-45.

6. Should any small lowering in the output temperature from a heat pump operating with RS-45 in place of R22 be experienced, it can be countered by appropriately adjusting the air or water flows entering the condenser so that the heat output will be similar to those produced by R22.

7. What about R410A? R410A has a significantly lower critical point than RS-45 resulting in approximately 68% of the heat output emanating from condensation while 32% arises from desuperheating, whereas the ratio for RS-45 is 25:75 which is essentially the same as that for R22. This means that R410A requires more heat exchanger area than RS-45 or R22 for de-superheating which clearly outs it at a disadvantage.

8. It should also be remembered that the significantly lower discharge temperature of RS-45 helps to minimize oil breakdown and to enhance compressor reliability.

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