SPC tech talk
The technical bulletin by SPC Heat Pipes
September 2018
Volume 1

Talking Point: What's the ideal refrigerant for Heat Pipe applications?

Our Verdict: R134a for greener, safer and longer life of heat pipes compared to R410a

The atmosphere is responding unmistakably to human-induced global warming, with disastrous damage to the economy and society as a result. The global commitment to a healthy and greener environment is changing the refrigerant choice for the HVAC industry. CFCs and HCFCs have already been designated for phase out by the Montreal Protocol. R410a and R134a represent the best two choices at present to use in HVAC industry for a limited period up to 2030. The focus of this study to compare and identify the potential refrigerant for heat pipe application from these two refrigerants by considering all facts like efficiency, GWP and safety to handle.

Findings

Properties	R134a	R410a
Chemical formula	H2FCF3 (Single component refrigerant)	HF2CF3+CH2F2 (Two component refrigerant)
Temperature Glide	0°C	0.5°C
Critical Temperature	101.08°C	72.13°C
Latent heat of vapourisation at 25oC	178 kJ/kg	187 kJ/kg
Latent heat of vapourisation at 48oC	154.3 kJ/kg	142.5 kJ/kg
Operating pressure	9.4 Bar	22.5 Bar
Global Warming Potential	1430	2880

- The most relevant thermal properties for heat pipe working fluid is latent heat of vapourisation. In thermodynamics, at critical point (or critical state) latent heat of vaporisation is zero. The critical temperature of R410a is relatively low as compared to R134a hence performance will start to deteriorate due to its reducing latent heat at higher temperature, say above 45°C. Latent heat of vapourisation of R134a at 48°C is 154.3 kJ/kg and that of R410a is 142.5 kJ/kg.

- The operating pressure of R410a is around 22.5 bar which is more than double of corresponding value of R134a. So R410a based heat pipes need a special care and require thicker tube material to guarantee integrity and reliability. However braze joint could still be a risk of burst through fatigue.

- Because of higher GWP (2880) and higher service pressure the chance of leakage and its impact on environment is high for R410a and leave higher carbon foot print.

- In order for a heat pipe to work efficiently the mixture of liquid and vapour inside the tube must be as close as possible to the same temperature along the axial length of the pipe; this is the isothermal quality of the heat pipe. If there are temperature differences inside the pipe then these will transfer outside the pipe and the rate at which heat is transferred from the air to and from the heat pipe is reduced. R134a is a single component refrigerant, have only one molecule in their structure, so they boil and condense at same temperature for given pressure.

Conclusion

The slight increase of efficiency of R410a compared to R134a at lower temperature region is due to higher thermal conductivity. But at higher temperature region the performance of R410a will reduce due to reducing latent heat. Overall, with widespread availability of R134a, at a reasonable cost, low working pressure and GWP, zero temperature glide, combined with its efficiency, it remains the best option for heat pipe applications in hot and humid climatic conditions in Middle East and Asia

References

1. WRAP AROUND HEATPIPE TESTING, Test work undertaken by Brunel University (London)
2. Thermodynamic properties of HFC-134a Refrigerant, https://www.chemours.com/Refrigerants/en_US/assets/downloads/h47752_hfc134a_thermo_prop_si.pdf
3. Thermodynamic properties of R410a, https://www.chemours.com/Refrigerants/en_US/assets/downloads/h64423_Suva410A_thermo_prop_si.pdf

Sreejith Subrahmanian
Technical Department