

Heat Exchanger Calculations

Hydrogen Fluoride (HF) gas is to be heated inside a heat exchanger from $t_1 = 20^\circ\text{C}$ to $t_2 = 80^\circ\text{C}$ at $p = 0.96$ bar. To calculate the heat duty for a throughput of 1000 kg/h one would most likely use the average ideal gas heat capacity of HF ($C_p=1.4564$ kJ/kg/K) as the temperature variation of the ideal gas heat capacity is less than 0.02% over the range of interest. This would result in a heat duty of 24.3 kW.

However, the HF gas forms hexamers (HF_6) and this greatly changes its heat capacity as shown in the figure below.

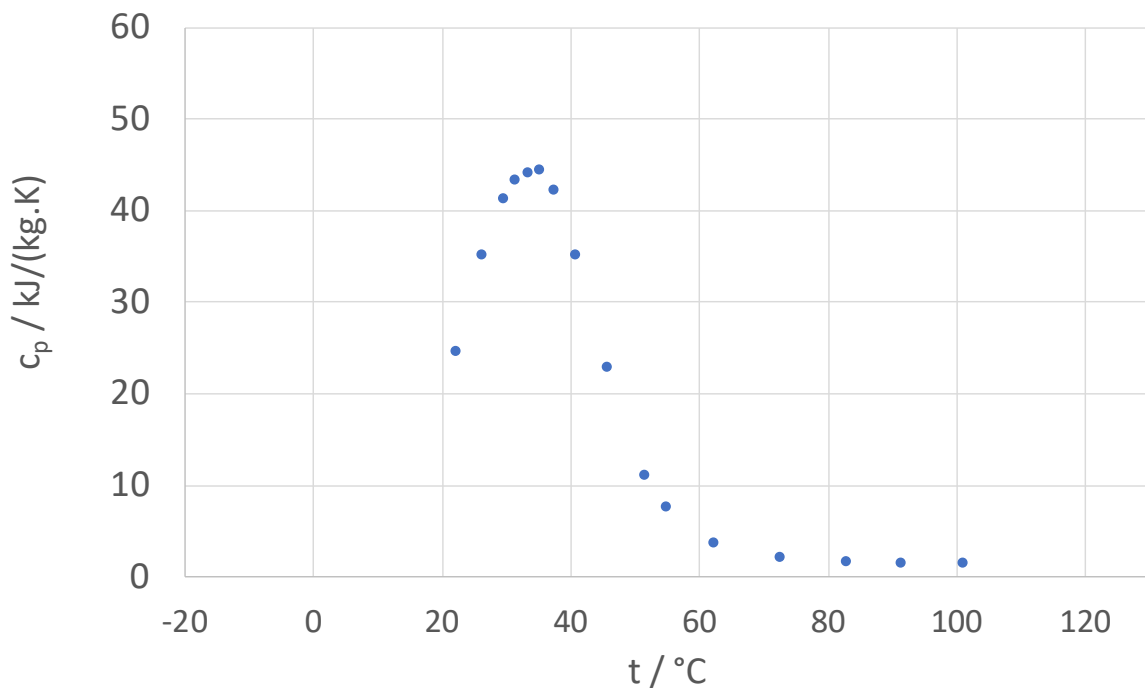


Figure 1 – Heat capacity of HF vapour at 0.96 bars; experimental data.

The maximum in the heat capacity curve is due to initial increase as the result of heat being consumed for cracking the hexamers; followed at higher temperature to a decrease in heat capacity as less and less hexamers are available for cracking. If one uses the correct C_p the heat duty required to heat HF gas increases by more than an order of magnitude to 348.3 kW. A number of mis-designs of HF heat exchangers happened, before HF heat capacity behavior, due to the presence of hexamer, was fully understood.