Checking He Enthalpy

K. Augusto

May 29, 2020

Using the HEPACK excel add-in, the change in enthalpy of Helium-4 in the saturated liquid phase, from 1.1K to 2.8K at saturated vapour pressure for a mass of 11.9848 kg.

From HEPACK, the pressure at 1.1K was found to be 38.00487078 Pa, and the enthalpy was 26.76366333 $\frac{J}{kg}$. At 2.8K, the pressure was 17551.75833 Pa and the enthalpy was 4661.791583$\frac{J}{kg}$. The difference in the enthalpies is 4635.02792$\frac{J}{kg}$.

The work needed to heat up the helium is found from:

$$W = \Delta H(m) \tag{1}$$

where W is work, ΔH is the change in enthalpy, and m is the mass of the helium. The time it would take for the Helium to heat up from 1.1 K to 2.8 K is found by:

$$t = \frac{W}{E} \tag{2}$$

where t is the time and E is the input energy. This is summarized in the tables below.

Starting Temperature	1.1 K
Starting Pressure	38.00487078 Pa
Starting Enthalpy	26.76366333 $\frac{J}{kg}$
Initial Volume	82.56469 L

Table 1: The inital conditions.

Final Temperature	2.8 K
Final Pressure	17551.75833 Pa
Final Enthalpy	4661.791583$\frac{J}{kg}$
Final Volume	3.971327429 L

Table 2: The final conditions

Difference in Enthalpy	4635.02792$\frac{J}{kg}$
Work	55549.88261 J

Table 3: The resulting difference in enthalpy and work.

Input energy	1.5 W
Time	37033.25507 s
	617.2209179 mins
	10.2870153 hrs

Table 4: The time it takes for the Helium to heat up for 1.5 Watts of input energy.

Input energy	5 W
Time	311109.97652 s
	185.1662754 mins
	3.086104589 hrs

Table 5: The time it takes for the Helium to heat up for 5 Watts of input energy.

References

[1] R. Picker. "Isopure volume, overflow, recovery". May 26, 2020. https://ucn.triumf.ca/meetings-and-workshops/weekly-canadian-group-meetings/new-ucn-source-meetings/2020/2020-05-26/IsopureVolume-Overflow-Pumpout.pdf.
Accessed June 3/2020.