7. Helium

The heat required for vaporization comes from the heat energy of the liquid: $\lambda \,\mathrm{d}m = mc(T)\,\mathrm{d}T$. By separating the variables m and T and integrating, we get:

$$\lambda \int_{m_0}^{m} \frac{\mathrm{d}m'}{m'} = \int_{T_0}^{T} c\,\mathrm{d}T',$$

$$\lambda \ln \frac{m}{m_0} = \int_{T_0}^{T} c\,\mathrm{d}T',$$

$$\frac{m}{m_0} = \exp \frac{\int_{T_0}^{T} c\,\mathrm{d}T'}{\lambda}.$$

By numerically approximating the integral from the given graph, we get $\int_{T_0}^{T} c\,\mathrm{d}T' \approx -5.2\,\mathrm{kJ\,kg^{-1}}$. Thus the fraction of liquid that was vaporized is

$$\frac{m_0 - m}{m_0} = 1 - \frac{m}{m_0} \approx 1 - \exp \frac{-5.2\,\mathrm{kJ\,kg^{-1}}}{22\,\mathrm{kJ\,kg^{-1}}} \approx 0.21.$$