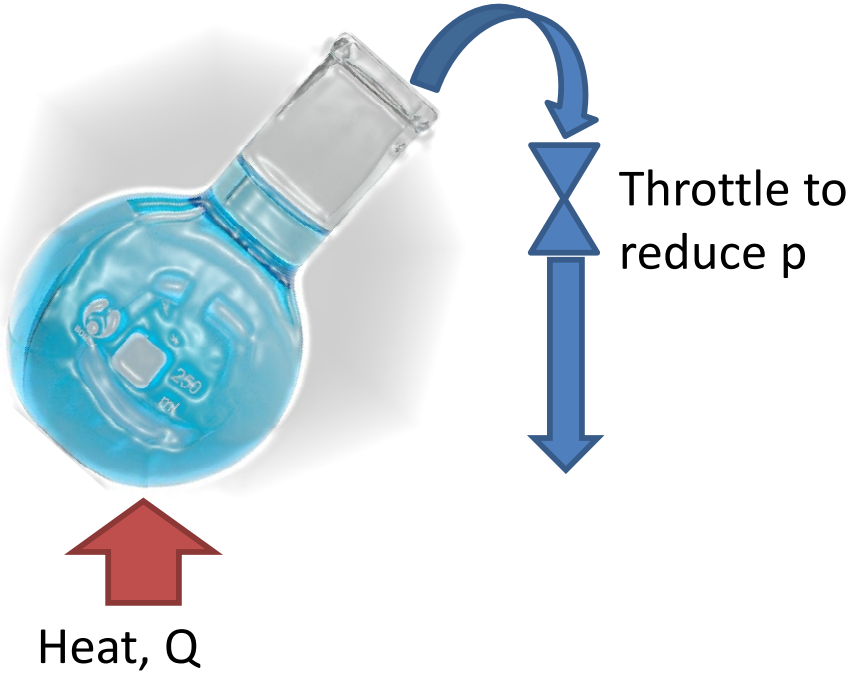
Superheated steam

Chapter 1.4

Superheated steam

- Water in a flask;
- Heat up;
- Put on throttle (pressure release valve);
- Boil off water;
- Keep heating!
- The steam in the flask then gains more energy;
- It is **superheated**.



To find the properties in superheated state

- Water is in a flask maintained at 10 bar (1MPa);
- What is the saturation condition for water at 10 bar?
- Tables p.3 show T_s at 10 bar is 179.9°C and h_g is 2778 kJ/kg.

Calculate superheat

- Further heat is added to 200°C;
- What is the degree of superheat and what is the enthalpy of the steam?
- Degree of superheat is temperature excess above saturation
- i.e. 200-179.9 = 20.1°C
- Enthalpy of steam is on superheated steam data on p.7, h = 2829 kJ/kg.

Critical?

- Critical point – the last point at which liquid and vapour can exit together
- A higher T & p result in what is called supercritical fluid – for which there is neither liquid nor vapour, but a state like a liquid and a vapour at the same time

Interpolating superheat tables

- Interpolating is very useful for sparse datasets;
- In superheat tables, the pressure intervals are typically 10 bar, and temperature intervals are typically 50°C;
- Therefore there is a need to interpolate.

Superheat interpolation example

- What is the **enthalpy** of steam at 4MPa (40 bar) and at 525°C?
- Look at p.7 of tables;
- Enthalpy at 40 bar and temperatures are 500°C and 600°C;
- Therefore interpolate: $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$
- $\frac{h-3445}{3674-3445} = \frac{525-500}{600-500}$, so h=3502.2 kJ/kg

Superheat interpolation entropy

- What is the **entropy** of steam at 4MPa (40 bar) and at 525°C?
- Look at p.7 of tables again;
- Entropy, s, at 40 bar and temperatures are 500°C and 600°C;
- Therefore interpolate: $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$
- $\frac{s-7.089}{7.368-7.089} = \frac{525-500}{600-500}$, so s=7.159 kJ/kgK

Superheat interpolation - pressure

- A process is done on the steam, to keep the entropy constant but reduce pressure to 4 bar;
- What is the temperature at the lower pressure?
- Need to find at 4 bar what the temperature is for the same entropy as before.
- Looking for s = 7.159 kJ/kgK, it's between 150 and 200°C.
- Interpolate: $\frac{7.159-6.929}{7.172-6.929} = \frac{T-150}{200-150}$; T = 197.3°C.