Solid, Liquid and Vapour-- Change of state

Substances can exist in three different states (also called phases)-solid, liquid, or vapour (gas) depending on the temperature and pressure.

Let us consider Ice, Water and steam for a better understanding and we will discuss this under atmospheric pressure 14.7 psia(1 bar) at sea level.

Please see the image below

At (b) heat (Q) is being added to the water, and it is noted that its temperature continually rises as heat is added.

At some point in time (e). however, it is noted that the temperature stops rising (at 212 F /100 F).

Even though more heat is added after that (d), the temperature does not increase for a while but water will gradually change into its steam or vapour state.

This process is called boiling or vaporization.

As heat is added, no further temperature increase occurs as long as some liquid remains. At (e), all the water is evaporated.

If more heat is added, it will be noted that the temperature (of the steam) will begin to rise again, above 212 F /100 C, as seen in point j in the image.

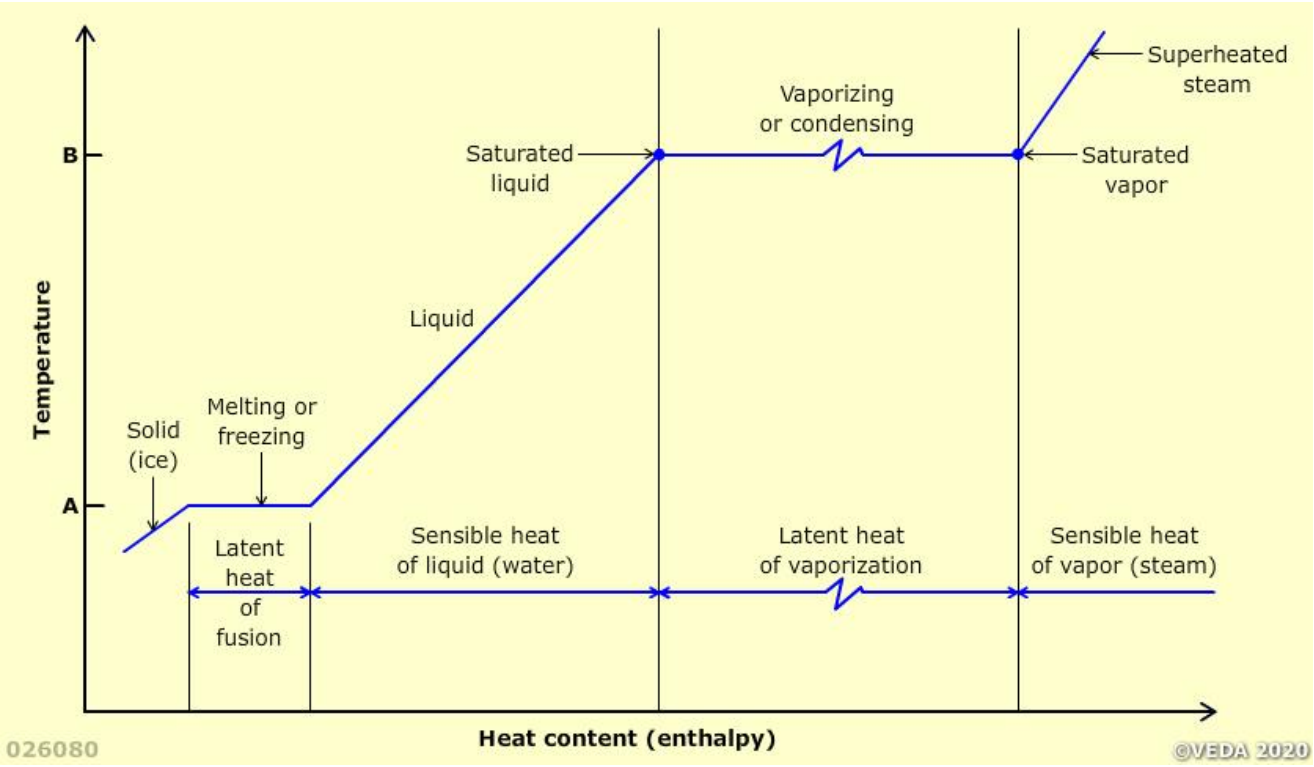
When heat is added to the water between 32 F/ 0 C and 212 F /100 C, both its enthalpy and temperature increase.

However, if more heat is added at 212 F /100 C, note that although its enthalpy continues increasing, the temperature remains constant.

What does happen is that the water gradually boils until it all vaporizes to steam, still at 212 F / 100 F, assuming enough heat is added.

Once all the liquid is evaporated, if more heat is added, then the temperature start to increase again. (The enthalpy continues to increase as before.)

The temperature and enthalpy increase of the steam will then continue if further heat is provided.



Please note the following:

a) Initial condition (subcooled liquid).
b) Heat added, temperature increases {subcooled liquid).
c) Heat added, liquid reaches boiling point (saturated liquid).
d) Heat added, liquid changing to vapour, no temperature increase.
e) Heat added, all liquid vaporized (saturated vapour).
f) Heat added, temperature of vapour increases (superheated vapour).

Subcooled liquid is liquid below its boiling point.

Saturated liquid and saturated vapour are the liquid and vapour at the boiling (condensing) point.

Superheated vapour is vapour above the boiling point.

The complete process can be reversed as given below

The whole series of processes just described could also be carried out in reverse. Removal of heat (cooling) from the steam lowers its temperature.

When the cooling continues to (e), the temperature no longer drops, but the gas begins to condense to a liquid (d).

After all of the steam is condensed (c), further removal of heat will result in a temperature drop of the liquid, (b) and (a).