

EINSTEIN Curso avanzado

Module AT-02: Casos complejos Part c: procesos de secado

Entrega a los alumnos

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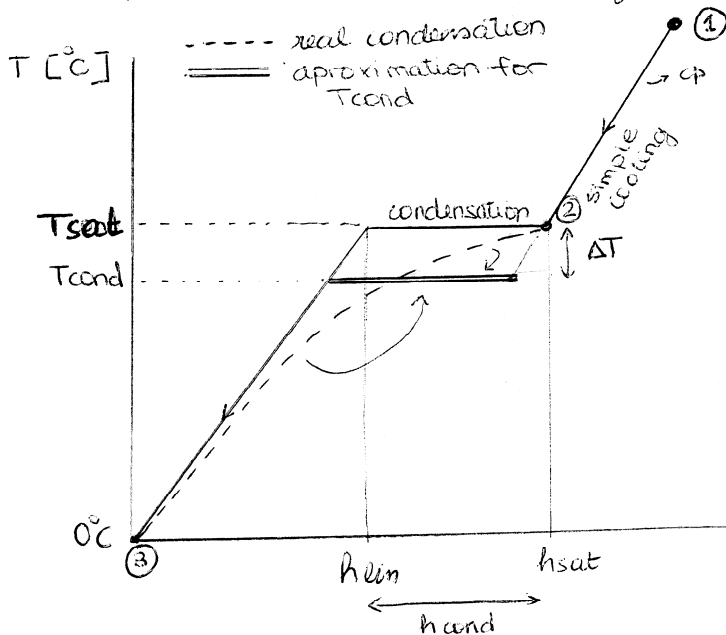
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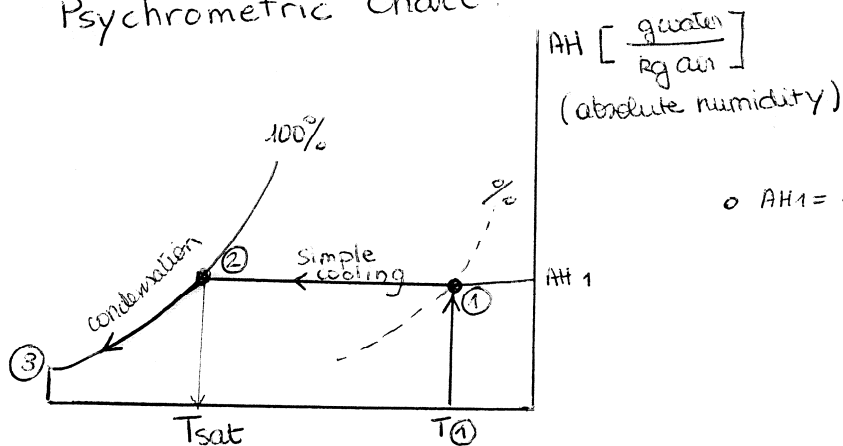
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1 Indicaciones para modelizar aire húmedo (e.g. calor residual de un proceso de secado)



Humid air is cooled down. At the temperature of dew point, vapour contained in the air starts to condensate. Condensation does not take place at constant temperature: temperature decreases. The real line of condensation is a curve. -----



• $AH_1 = AH_2$ (simple cooling)

In order to fix a $T_{condensation}$, it will be assumed that it is ΔT °C lower than $T_{saturation}$.

Exercise

① Humid Air

$T = 47^\circ\text{C}$ water
 $AH = 27,02 \text{ g}_{\text{air}}/\text{kg}_{\text{air}}$
 $RH = 37,1\%$
 $h = 115,245 \text{ kJ/kg}$
 $DP = 29,9^\circ\text{C} \rightarrow \text{Saturation}$
 $WB = 33,0^\circ\text{C}$

AH: absolute humidity
RH: relative humidity
h: enthalpy
DP: dew point
WB: wet bulb

② Dew Point (Start of condensation)

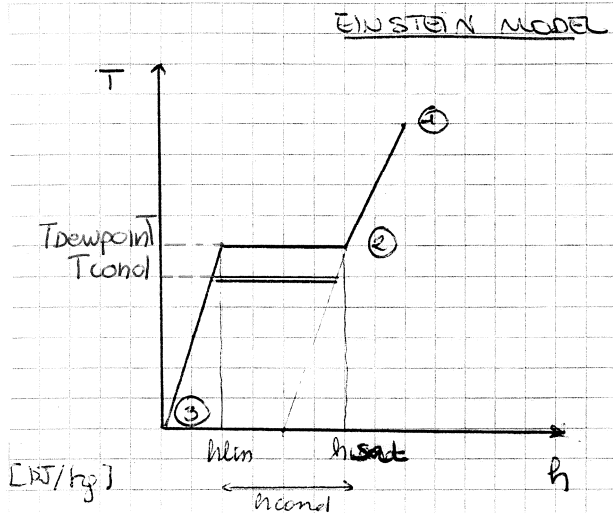
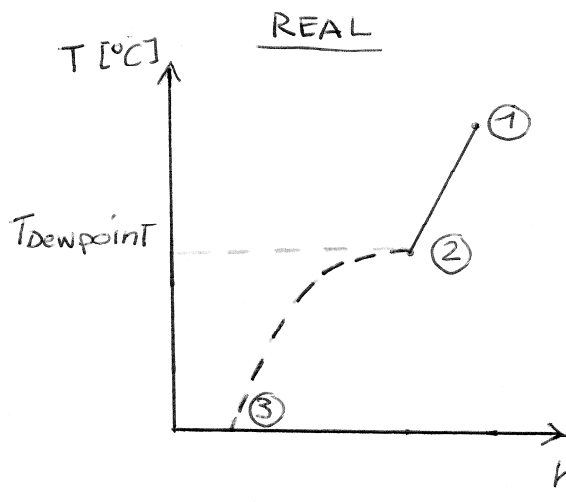
$T = 29,9^\circ\text{C}$
 $RH = 100\%$
 $AH = 27,02 \text{ g}_{\text{water}}/\text{kg}_{\text{air}}$
 $h = 98,120 \text{ kJ/kg}$
 $DP = 29,9^\circ\text{C}$
 $WB = 29,9^\circ\text{C}$

③ Final temperature

$T = 0^\circ\text{C}$
 $RH = 100\%$
 $AH = 3,76 \text{ g/kg}$
 $h = 9,493 \text{ kJ/kg}$
 $DP = 0^\circ\text{C}$
 $WB = 0^\circ\text{C}$

Assumptions

$$c_{pl} \approx c_{\text{air}} = 1 \text{ kJ/kg}$$



At $T = 0^\circ\text{C}$, the fluid has an enthalpy $h > 0 \text{ kJ/kg}$. However, in EINSTEIN it has to be modelled as if at $T = 0^\circ\text{C} \rightarrow$

$$h = 0 \text{ kJ/kg}$$

REAL

$$h_1 = 115,245 \text{ kJ/kg}$$

$$h_2 = h_{\text{sat}} = 98,120 \text{ kJ/kg}$$

$$h_3 = 9,493 \text{ kJ/kg}$$

EINSTEIN MODEL

$$h_1' = h_1 - h_3 = 115,245 - 9,493 = 105,75 \text{ kJ/kg}$$

$$h_2' = h_2 - h_3 = 98,120 - 9,493 = 88,63 \text{ kJ/kg}$$

$$h_3' = 0$$

$$h_{\text{lim}} = c_{\text{p,air}} T_{\text{sat}} = 1 \times 29,9 = 29,9 \text{ kJ/kg}$$

$$h_{\text{cond}} = h_{\text{sat}} - h_{\text{lim}} = 88,63 - 29,9 = 58,73 \text{ kJ/kg}$$

$$\Delta T = T_{\text{dewpoint}} - T_{\text{cond}}$$

$$\text{We choose } \Delta T = 5 \text{ K}$$

$$T_{\text{cond}} = 29,9 - 5 = 24,9 \text{ } ^\circ\text{C}$$