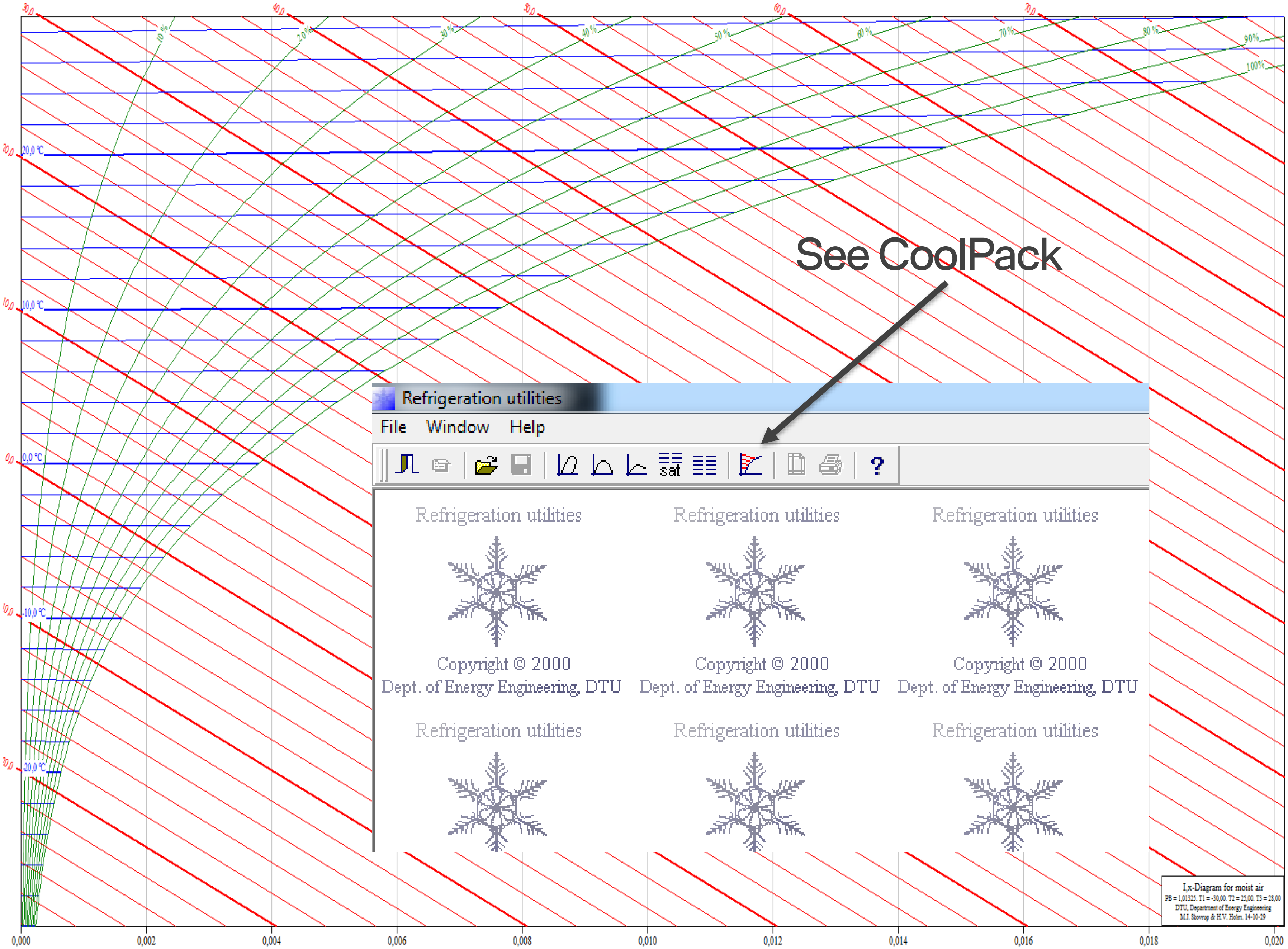
Bring ideas to life
VIA University College

DES
Humid air

Lecture 8

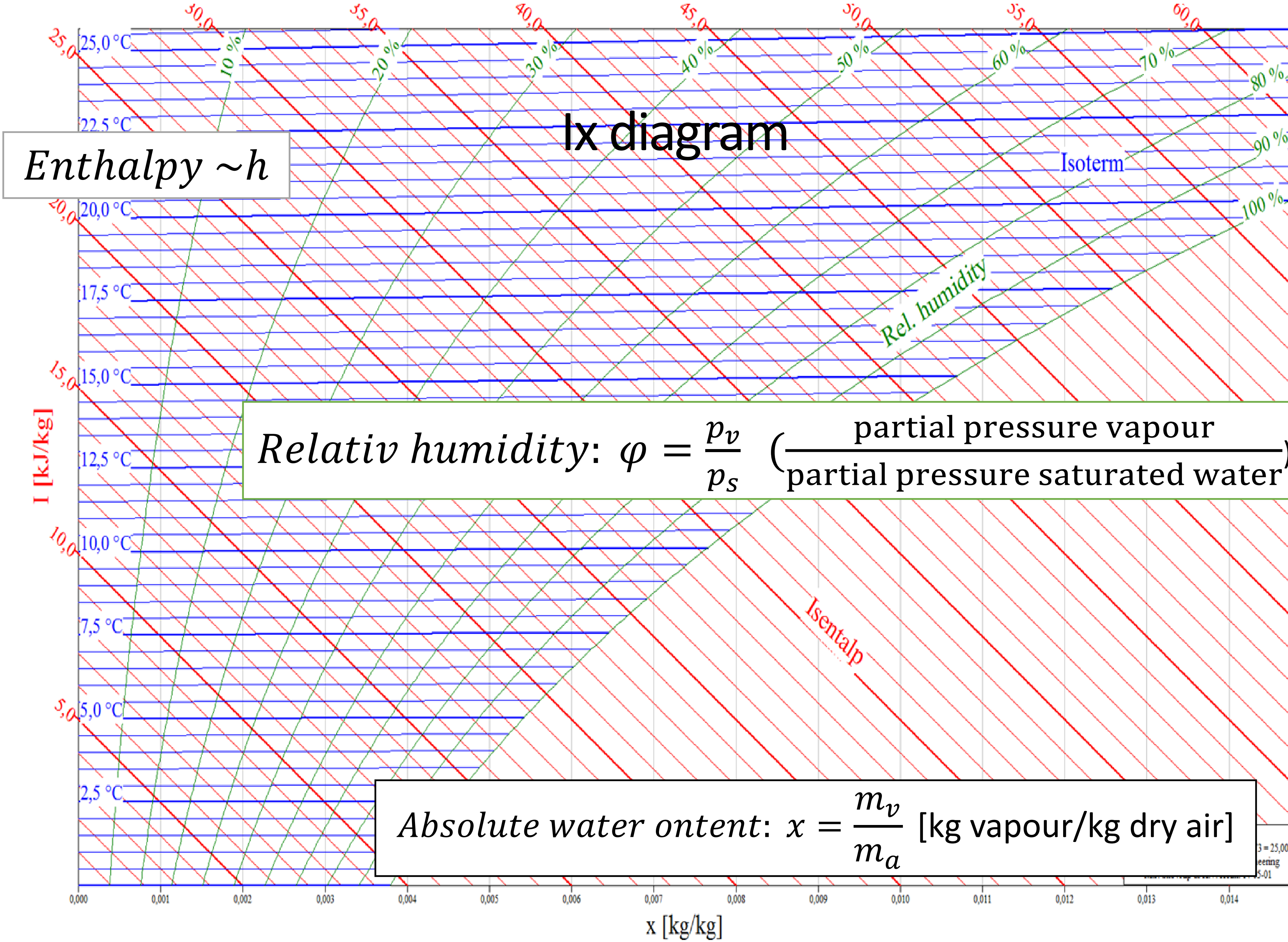
Use of IX diagram.

Mini project



See CoolPack
Refrigeration utilities
File
Window
Help
sat
Refrigeration utilities
Copyright © 2000
Dept. of Energy Engineering, DTU
20,0 °C
10,0 °C
0,0 °C
-10,0 °C
-20,0 °C
0,000
0,002
0,004
0,006
0,008
0,010
0,012
0,014
0,016
0,018
0,020
I,x-Diagram for moist air

Ix diagram



Enthalpy $\sim h$

Relativ humidity: $\varphi = \frac{p_v}{p_s}$ $\left(\frac{\text{partial pressure vapour}}{\text{partial pressure saturated water}}\right)$

Absolute water ontent: $x = \frac{m_v}{m_a}$ [kg vapour/kg dry air]

Dry and Wet bulp temperature

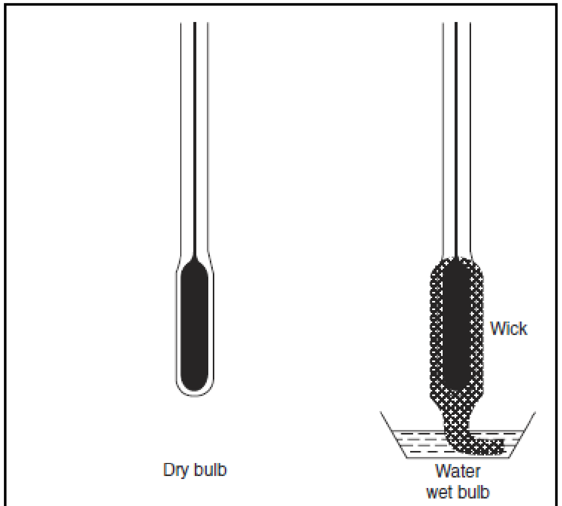


Figure 20.3 Thermometers, dry bulb and wet bulb

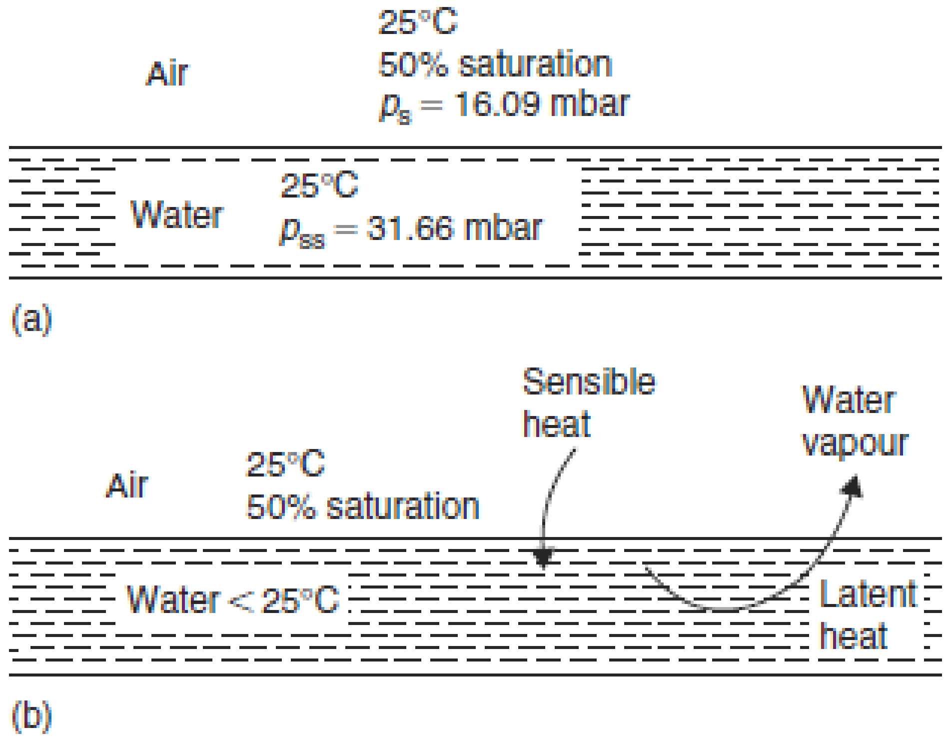
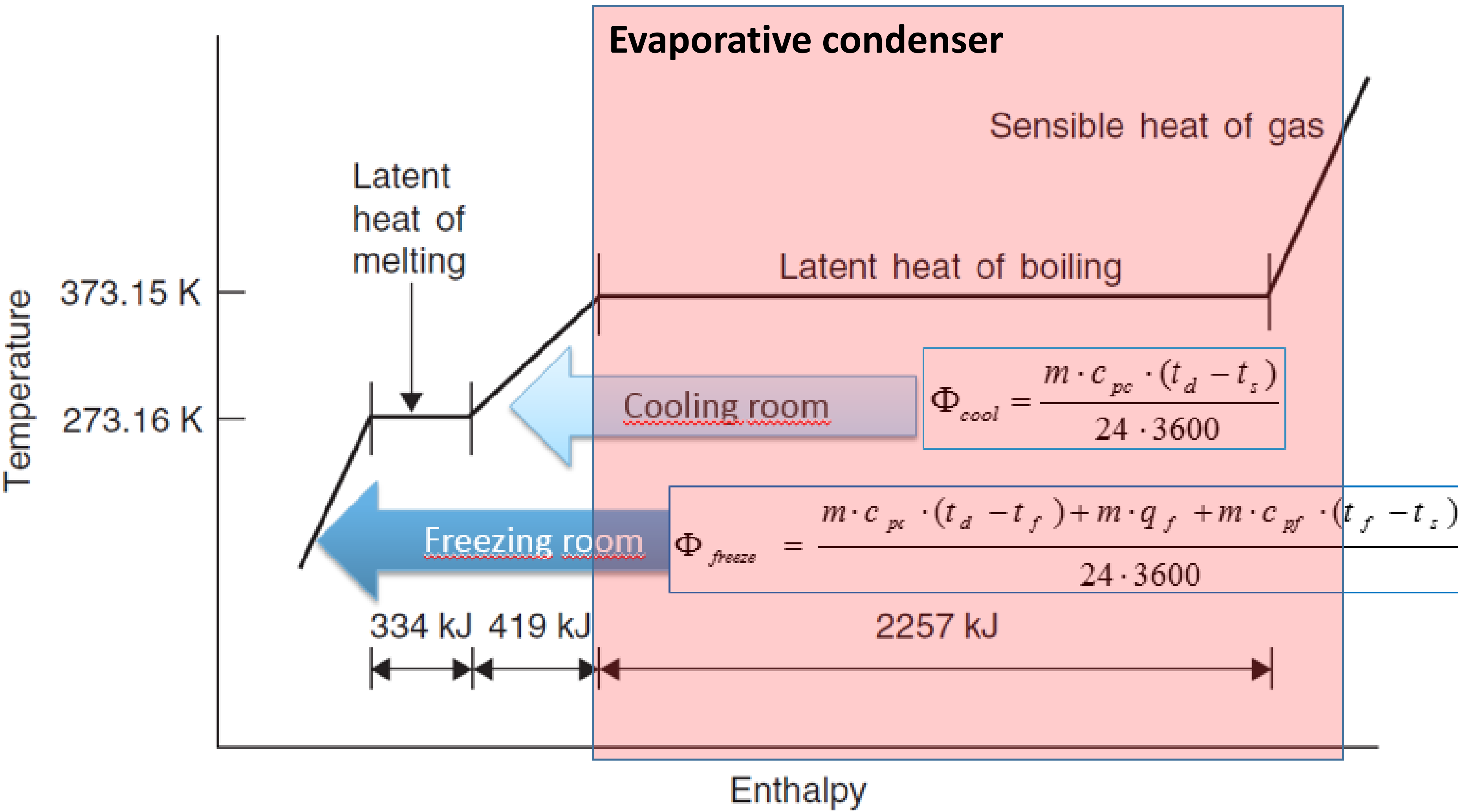


Figure 20.2 Exchange of sensible and latent heat at water–air surface

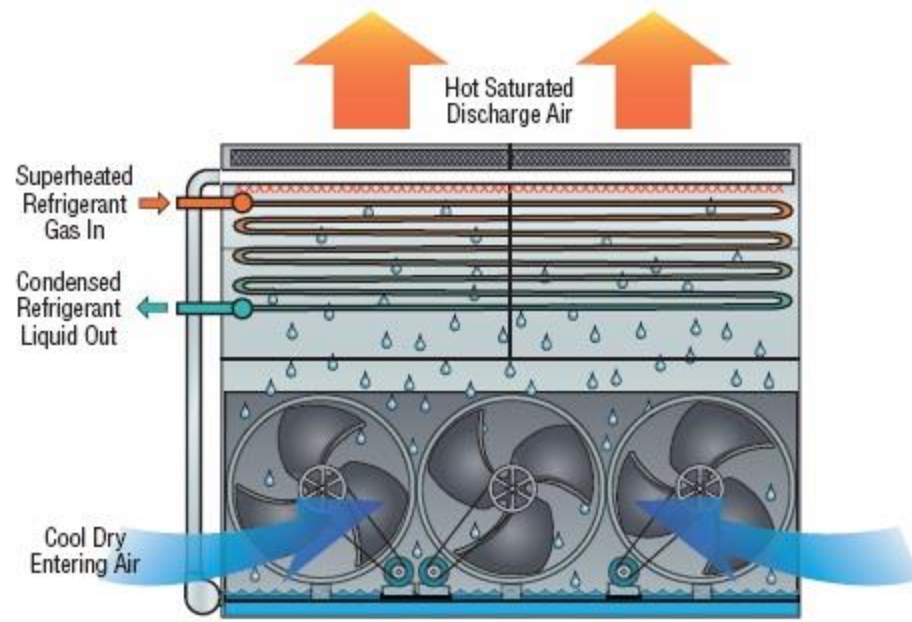
Source: Hundy, Refrigeration and air condition

Evaporating condensers



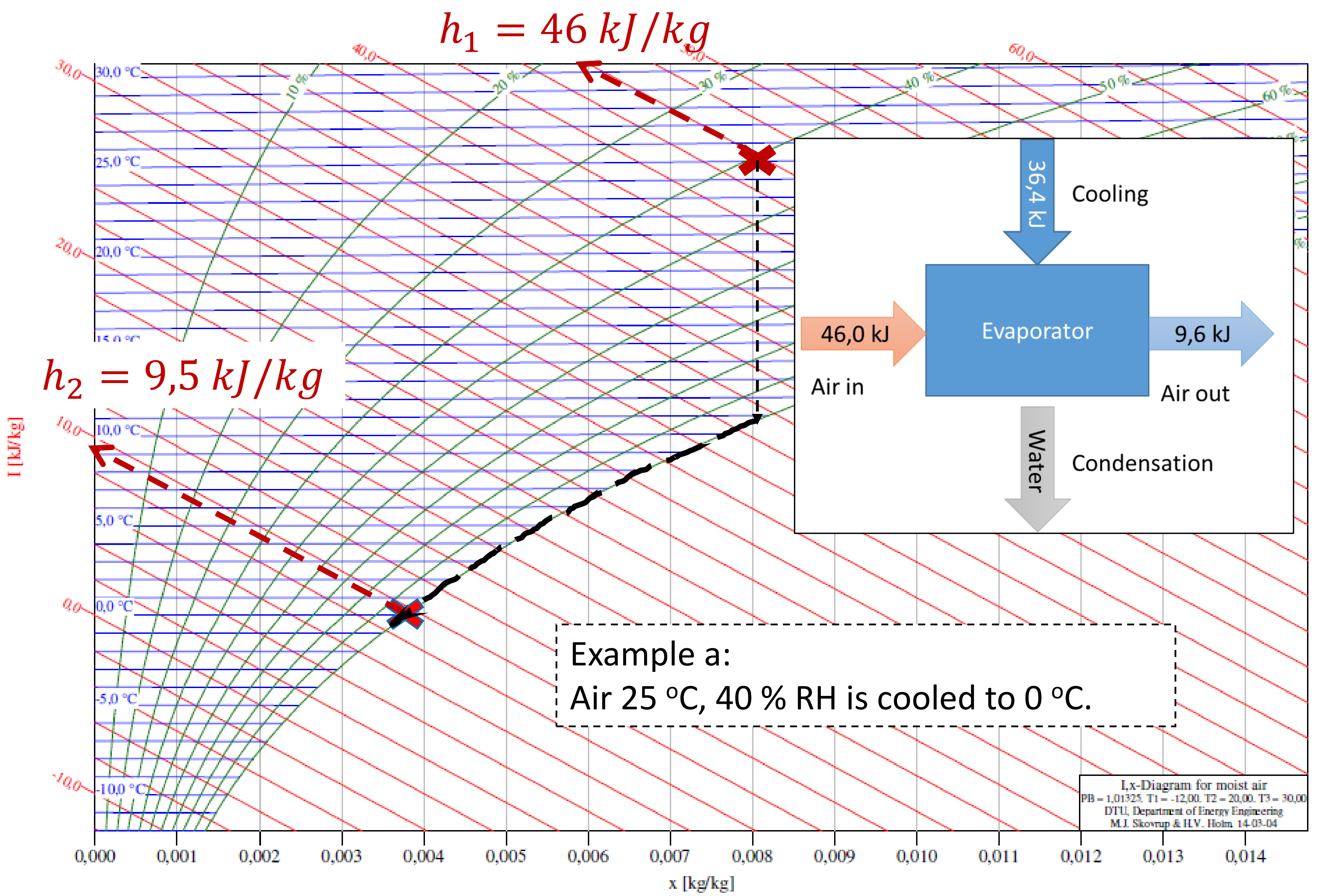
Evaporating condenser

Dry condenser

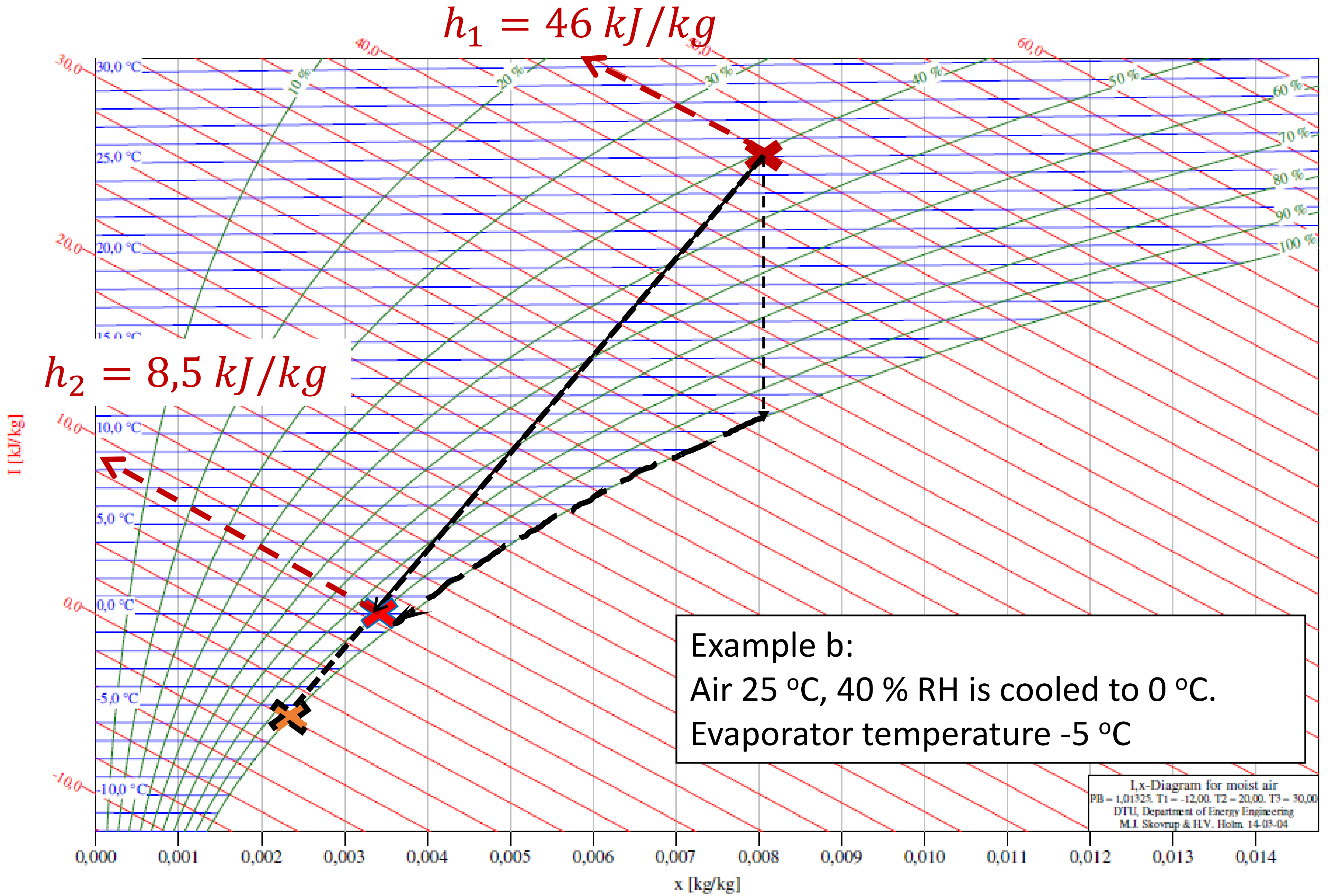


Principle of Operation

Cooling load
Evaporator



$h_1 = 46\ kJ/kg$
$h_2 = 9,5\ kJ/kg$
36,4 kJ
Cooling
46,0 kJ
Air in
Evaporator
9,6 kJ
Air out
Water
Condensation
Example a:
Air 25 °C, 40 % RH is cooled to 0 °C.
30,0 °C
25,0 °C
20,0 °C
10,0 °C
5,0 °C
0,0 °C
-5,0 °C
-10,0 °C
10 %
20 %
30 %
40 %
50 %
60 %
I [kJ/kg]
x [kg/kg]
0,000
0,001
0,002
0,003
0,004
0,005
0,006
0,007
0,008
0,009
0,010
0,011
0,012
0,013
0,014
I,x-Diagram for moist air
PB = 1,01325, T1 = -12,00, T2 = 20,00, T3 = 30,00
DTU, Department of Energy Engineering
M.J. Skovrup & H.V. Holm 14-03-04



$h_1 = 46\ kJ/kg$
$h_2 = 8{,}5\ kJ/kg$
Example b:
Air 25 °C, 40 % RH is cooled to 0 °C.
Evaporator temperature -5 °C
I,x-Diagram for moist air
DTU, Department of Energy Engineering
x [kg/kg]
I [kJ/kg]

Exercise

a) Find enthalpy difference and amount of water condensed for air 28 ^{o}C, 50 % RH cooled to 0 ^{o}C.

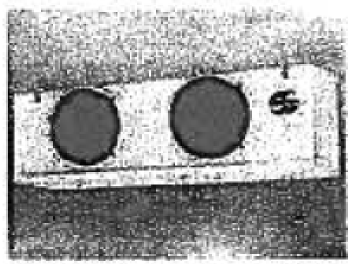
b) Data as a) but the air is cooled in an evaporator with refrigerant temperature at -10 ^{o}C

Exercise 1.2

Exercise 1.12

A cooling coil is mounted in a cold storage room. The storage room temperature $t_1 = -1°C$ and the relative humidity $\varphi_1 = 80\%$.
The cooling coil sucks in 1200 m^3/h air with the state variable mentioned above. The air is cooled to $t_2 = -5°C$ in the cooling coil and the relative humidity $\varphi_2 = 90\%$.

Cooling coil



a) Plot the process into a h-x diagram (use low temperature h,x diagram).

b) Calculate the mass flow of dry air.

c) Calculate how much humidity which is removed (kg/h).

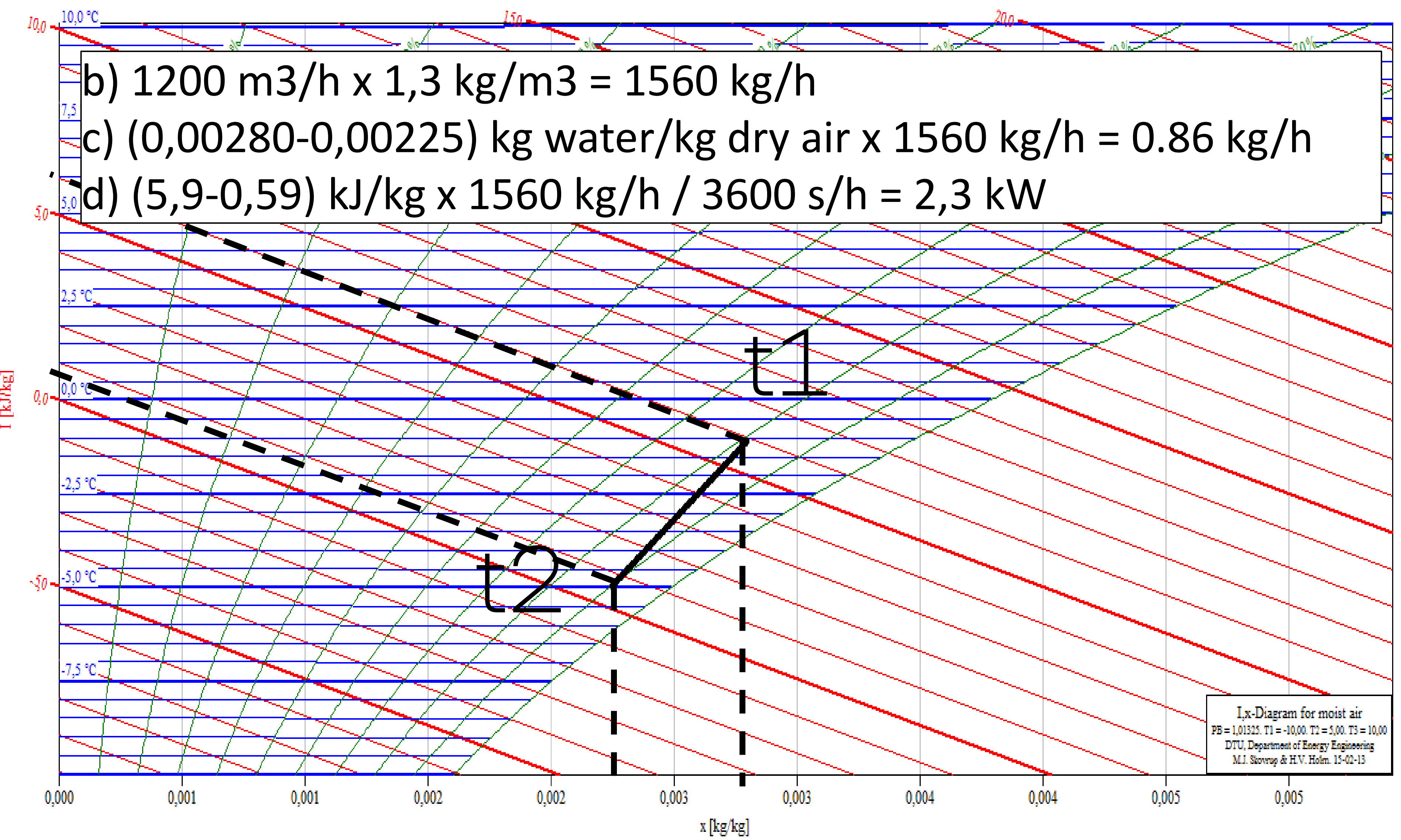
d) Calculate the capacity (heat flow rate) of the cooling coil.

Exercise 1.2, solution

b) 1200 m3/h x 1,3 kg/m3 = 1560 kg/h

c) (0,00280-0,00225) kg water/kg dry air x 1560 kg/h = 0.86 kg/h

d) (5,9-0,59) kJ/kg x 1560 kg/h / 3600 s/h = 2,3 kW



Cooling load
Ventilation losses

Ix diagram

$$\Phi_{AC} = \frac{n \cdot V_{room} \cdot \rho_{air} \cdot (h_1 - h_2)}{24 \cdot 3600}$$

Air change rate:

$$n \sim 70/\sqrt{V_{room}}$$