Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq

Sensible Heating

And

Sensible cooling

Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq

Object:

the purpose of this object is to understand how the sensible heating can be achieved at constant moisture content and represented it on psychrometric chart.

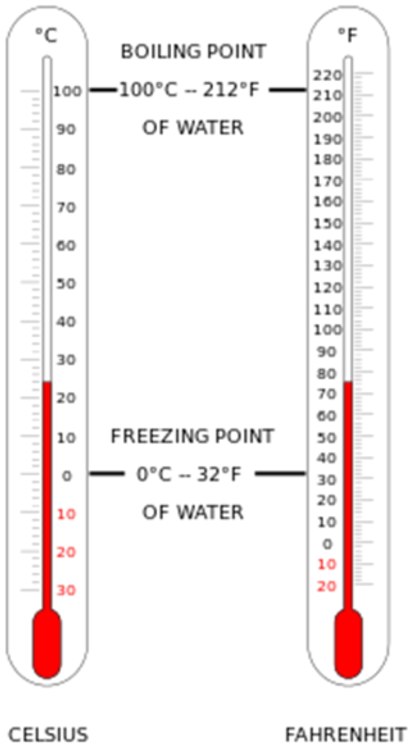
Sensible heating:

a psychrometric process that involves the increase or decrease in the temperature of air without changing its humidity ratio

Example: passing moist air over a room space heater and of kiln air over the heating coils.

The term is used in contrast to a latent heat, which is the amount of heat exchanged that is hidden, meaning it occurs without change of temperature. For example, during a phase change such as the melting of ice, the temperature of the system containing the ice and the liquid is constant until all ice has melted. The terms latent and sensible are correlative.

The sensible heat of a thermodynamic process may be calculated as the product of the body's mass (m) with its specific heat capacity (c) and the change in temperature (ΔT):



Joule described sensible heat as the energy measured by a thermometer

Sensible heat and latent heat are not special forms of energy. Rather, they describe exchanges of heat under conditions specified in terms of their effect on a material or a thermodynamic system.

In the writings of the early scientists who provided the foundations of thermodynamics, sensible heat had a clear meaning in calorimetry. James Prescott Joule characterized it in 1847 as an energy that was indicated by the thermometer .

Both sensible and latent heats are observed in many processes while transporting energy in nature. Latent heat is associated with changes of state, measured at constant temperature, especially the phase changes of atmospheric water vapor, mostly vaporization and condensation, whereas sensible heat directly affects the temperature of the atmosphere.

In meteorology, the term 'sensible heat flux' means the conductive heat flux from the Earth's surface to the atmosphere.
It is an important component of Earth's surface energy budget. Sensible heat flux is commonly measured with the eddy covariance method.

Procedure of representing Sensible Heating:

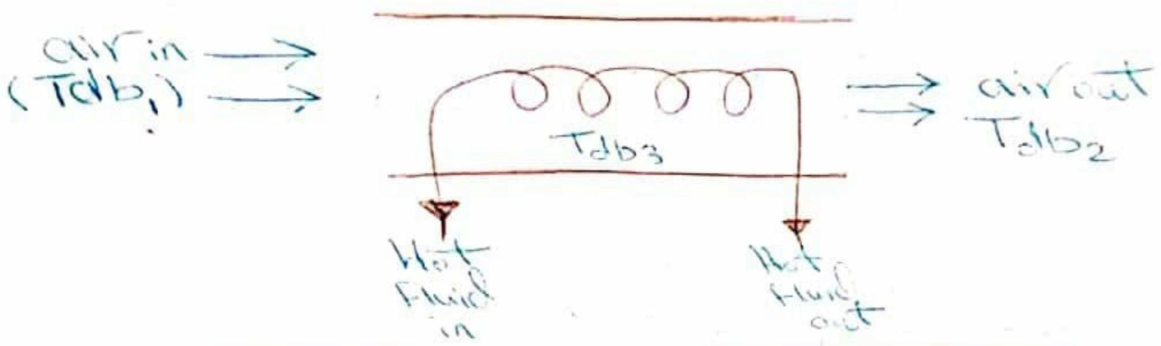
Sensible heating process is opposite to sensible cooling process. In sensible heating process the temperature of air is increased without changing its moisture content. During this process the sensible heat, DB and WB temperature of the air increases while latent of air, and the DP point temperature of the air remains constant. Sensible heating of the air is important when the air conditioner is used as the heat pump to heat the air. In the heat pump the air is heated by passing it over the condenser coil or the heating coil that carry the high temperature refrigerant. In some cases the heating of air is also done to suit different industrial and comfort air-conditioning applications where large air conditioning systems are used.

In general the sensible heating process is carried out by passing the air over the heating coil. This coil may be heated by passing the refrigerant, the hot water, the steam or by electric resistance heating coil. The hot water and steam are used for the industrial applications.

Like the sensible cooling, the sensible heating process is also represented by a straight horizontal line on the psychrometric chart. The line starts from the initial DB temperature of air and ends at the final temperature extending towards the right (see the figure). The sensible heating line is also the constant DP temperature line.

Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq

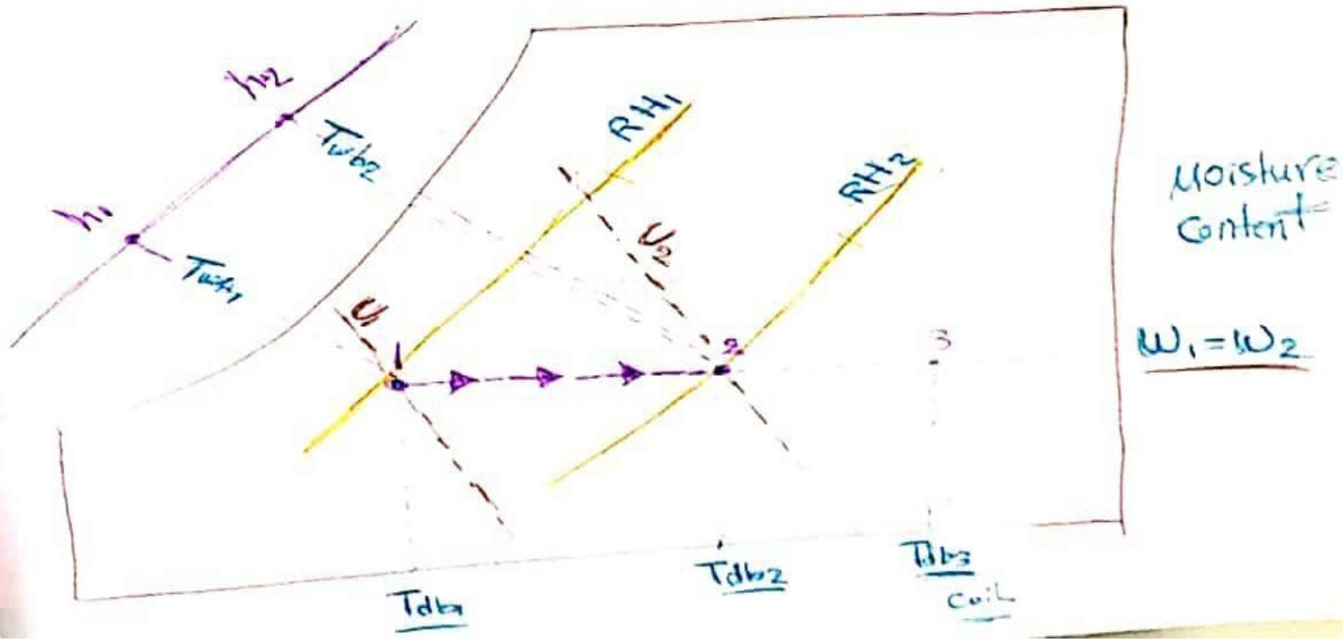
Sensible heating



$T_{db2} > T_{db1}$ and $T_{db3} > T_{db2}$

⇓

represented on psy-chart



Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq

amount of heat added through the processes of sensible heating

$$Q = \dot{m} \, C_{p_a} (\Delta T)$$

$$= \dot{m} \, (h_2 - h_1)$$

$h_2 - h_1$

Change of enthalpy through process 1-2 (sensible heating)

	Sensible heating	Sensible cooling
DBT	Increase	Decrease
ν	Increase	Decrease
h	Increase	Decrease
WBT	Increase	Decrease
μ	Decrease	Increase
g	Constant	constant
Tdew	Constant	Constant
Ps	Constant	Constant

Calculation of heating load

$Q = ma\ (h2 - h1)$

$m_a = \rho_a * V_a$ (Kg/s)

V_a Volume flow rate of air m / s va.A

V_a air velocity m/s (using pitot tube to measure)

$h1$ enthalpy of entering air kj/kg (from psychrometeric chart)

$h2$ enthalpy of exit air kj/kg (from psychrometeric chart)

To locate h1 and h2 dry bulb and wet bulb temperature should be measured for both entering and leaving air.

Procedure of Sensible Cooling

Sensible cooling process is opposite to sensible heating process. In sensible cooling process the temperature of air is decreased without changing its moisture content. During this process the sensible cooling, DB and WB temperature of the air decreases while latent of air, and the DP point temperature of the air remains constant. Sensible cooling of the air is important when the air conditioner by cooling coil. In the cooling coil the air is cooling by passing it over the evaporator coil or the cooling coil that carry the low temperature refrigerant. In some cases the cooling of air is also done to suit different industrial and comfort air-conditioning applications where large air conditioning systems are used.

In general the sensible cooling process is carried out by passing the air over the cooling coil. This coil may be cooled by passing the refrigerant in evaporator pipes. The refrigerant wide used in air conditioning and refrigeration system.

Like the sensible heating, the sensible cooling process is also represented by a straight horizontal line on the psychrometric chart. The line starts from the initial DB temperature of air and ends at the final temperature extending towards the left (see the figure). The sensible cooling line is also constant DP temperature line.

The heat transfer rate during this process is given by:

$$Q_T = \dot{m}_a(h_1 - h_2)$$

$$Q_T = \dot{m}_a C_{pa}(DBT_1 - DBT_2)$$

Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq

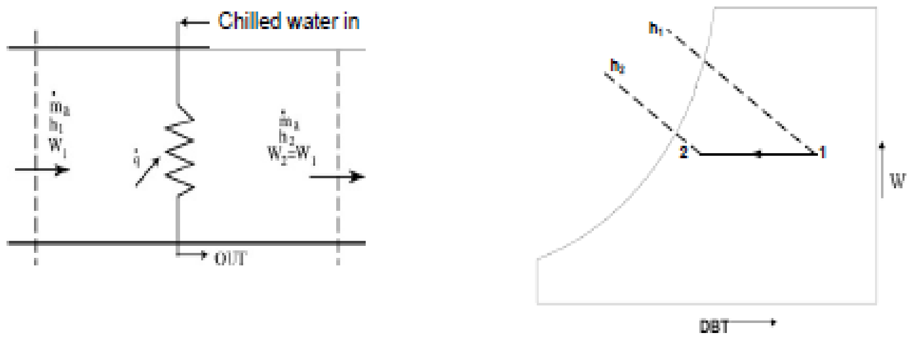


Figure 2 Sensible cooling

Calculate the cooling load when 1.5 m^3/s of moist-air, initially at a state of 21 ºC DBT, 15 ºC WBT and 101.325kPa barometric pressure, 1 is cooled sensibly by 5 ºC using cooler coil, what is the flow rate of chilled water necessary to effect this cooling if the flow return temperature of 10ºC and 15 ºC satisfactory.

$Q_{1\text{-}3} = m_a (h_1 - h_3)$

h_3= 36.77 kJ/kg

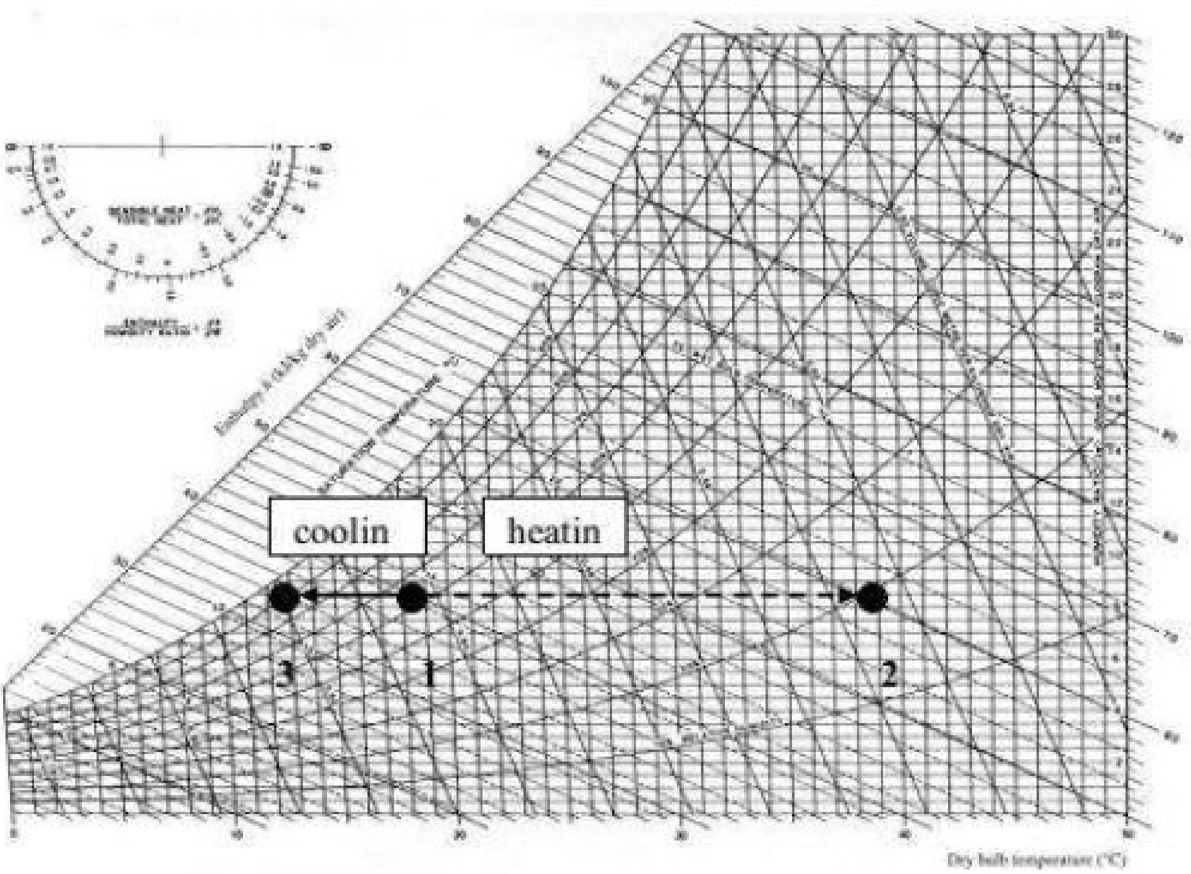
$Q_{1\text{-}3}$ = 1.777 (41.88 - 36.77) = 9.1kW

Heat lost from air = heat gain by water

9.1 = m_w x 4.186 x (15-10)

m_w = 0.434 kg_w/s

Class: 4th Stage
Asst.Lecturer: Asmaa khudhair yakoop
E-mail: asmaa.khudhair@mustaqbal-college.edu.iq



points	DBT °C	WBT °C	m^3/Pkg	h kg/kjL	Head mm
1					
2					
1					

Discussion:

Discuss the results.