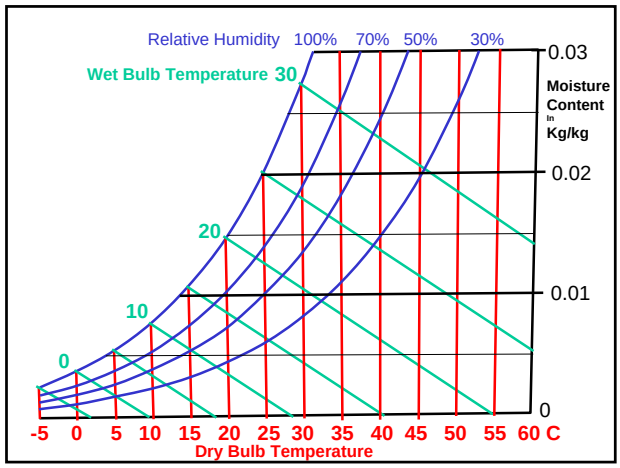
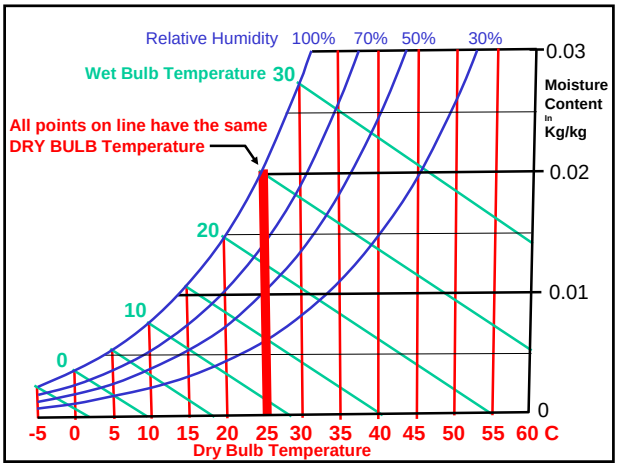
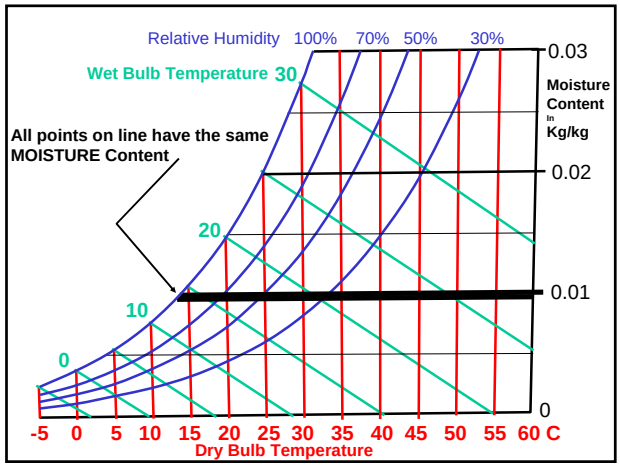
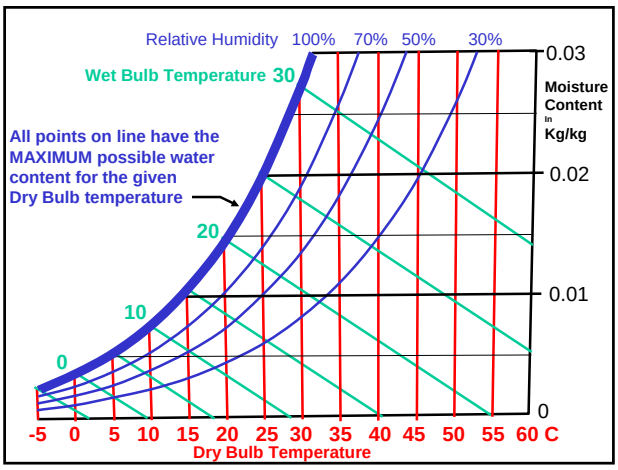
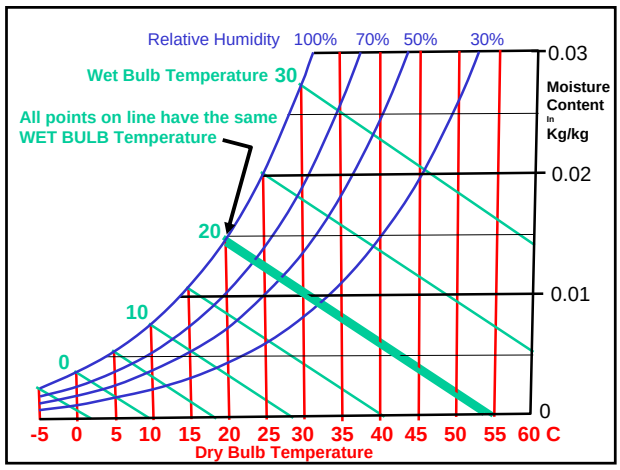
Mechanical Systems

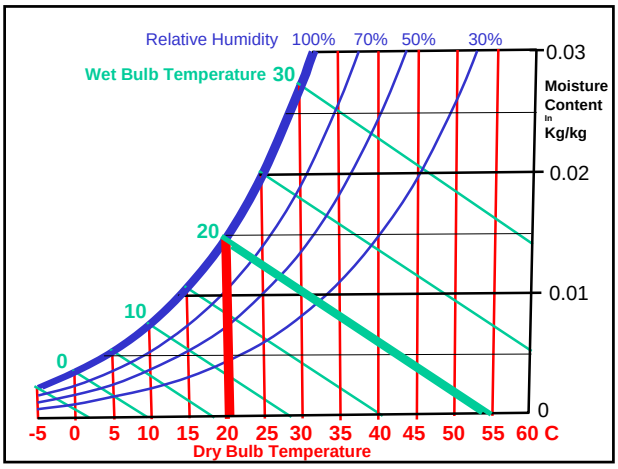


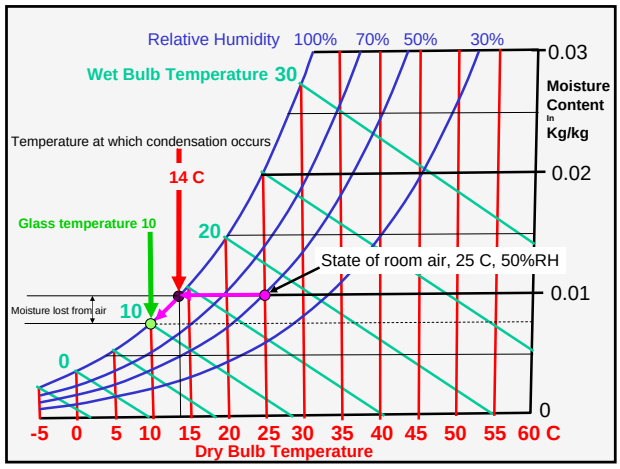


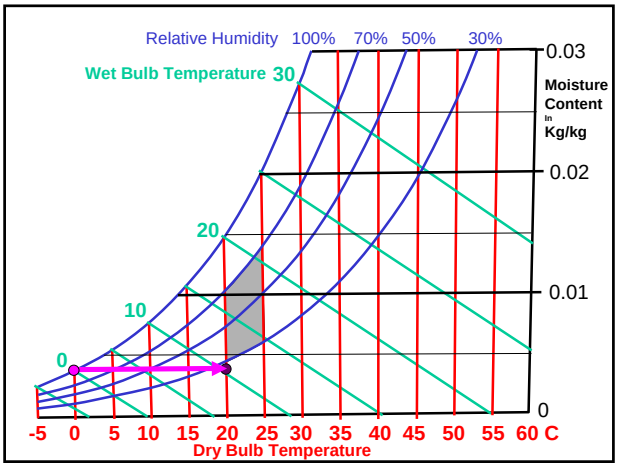




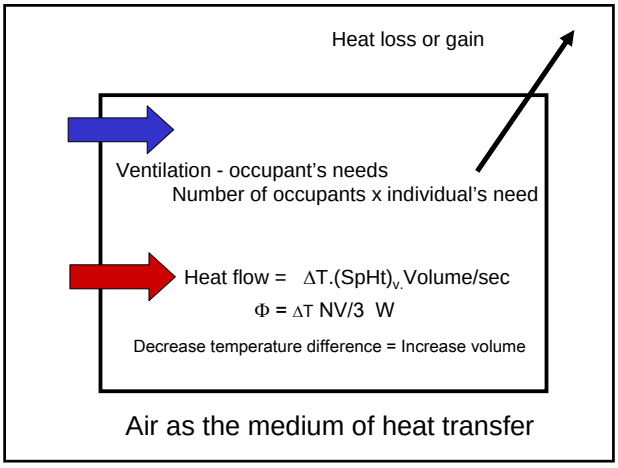






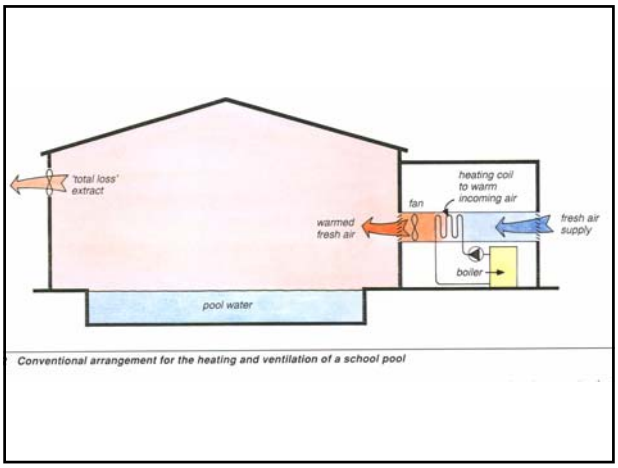


Fabric	Reduce heat loss lower U-Value, reduce areas of high U-Value
Ventilation	Reduce heat loss or heat gain control ventilation reduce need by increasing vol. use heat recovery
Solar Gain	Measured Entry, Reject excess changing requirements

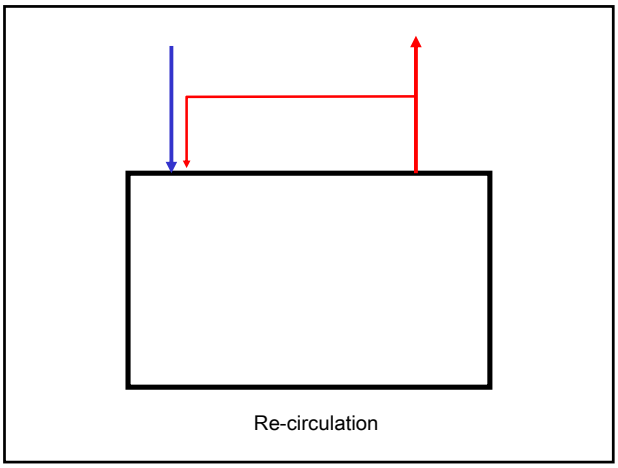


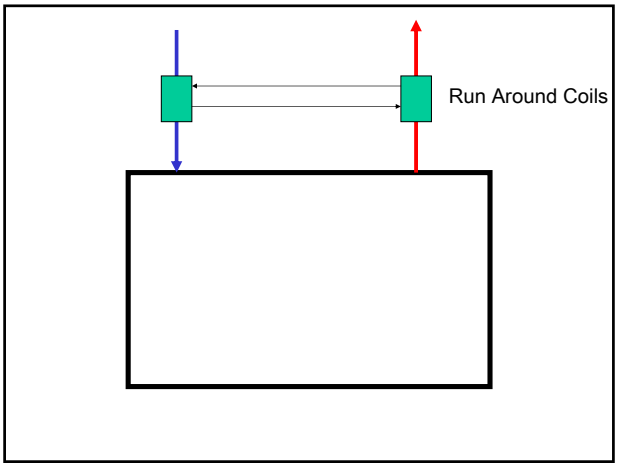
Ventilation mechanisms

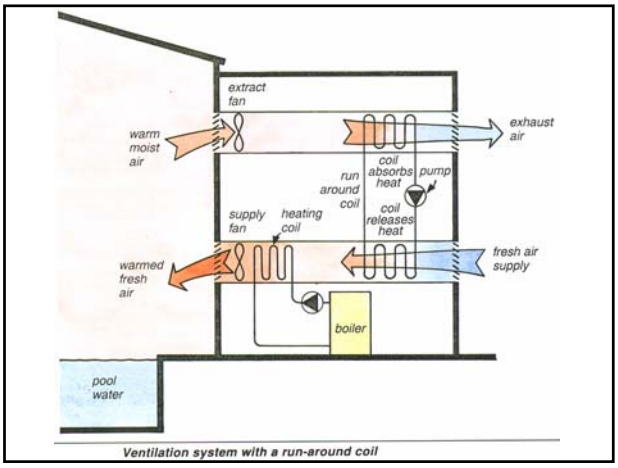
Natural Ventilation	-	Wind and Stack driven
Forced mechanical ventilation	-	Electrically driven fan
Mixed Mode ventilation	-	Choose appropriate method



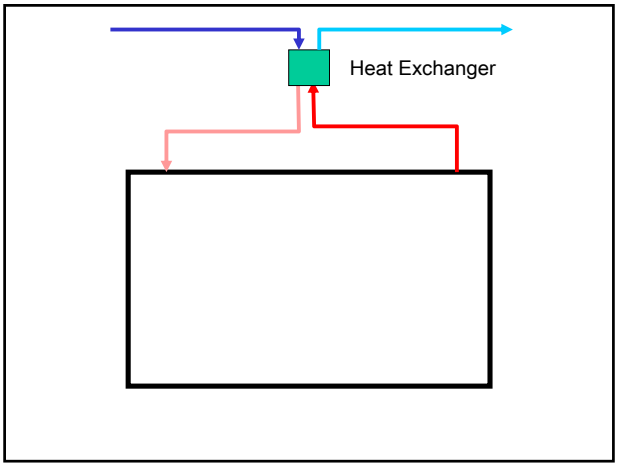
Conventional arrangement for the heating and ventilation of a school pool

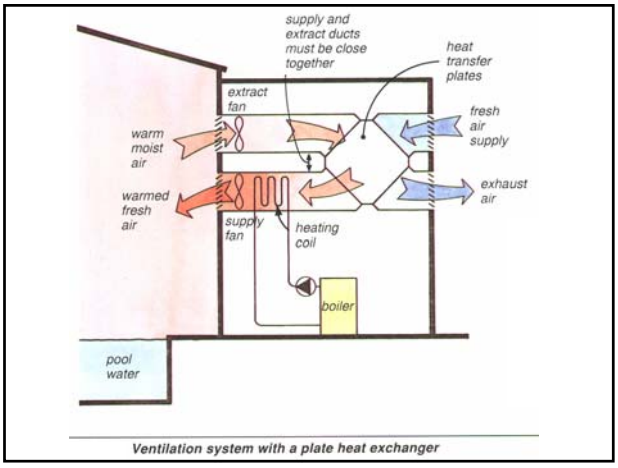

Re-circulation



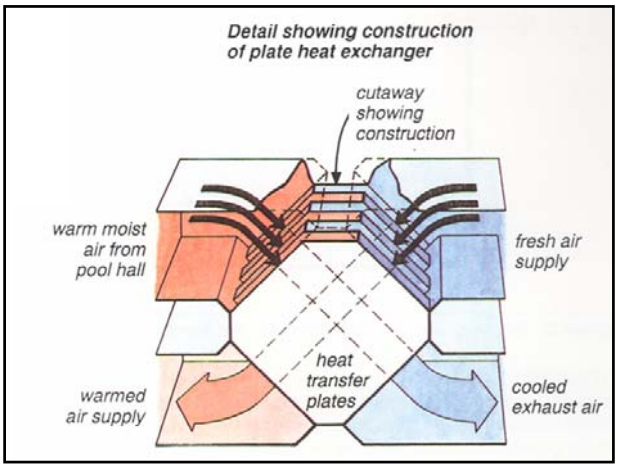


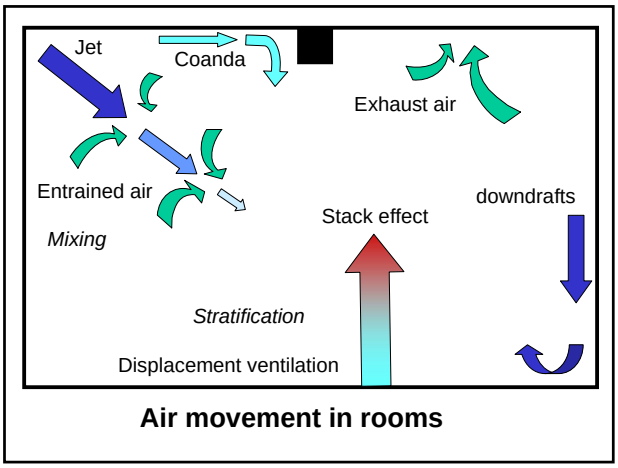
Ventilation system with a run-around coil





Ventilation system with a plate heat exchanger





Air movement in rooms

Primary Equipment

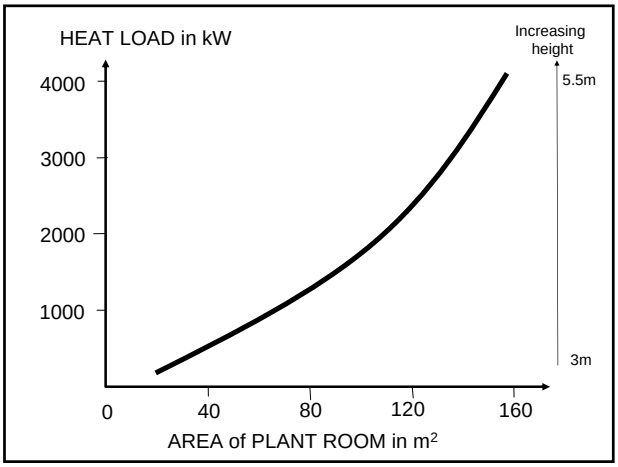
- Boilers
- Refrigeration machines

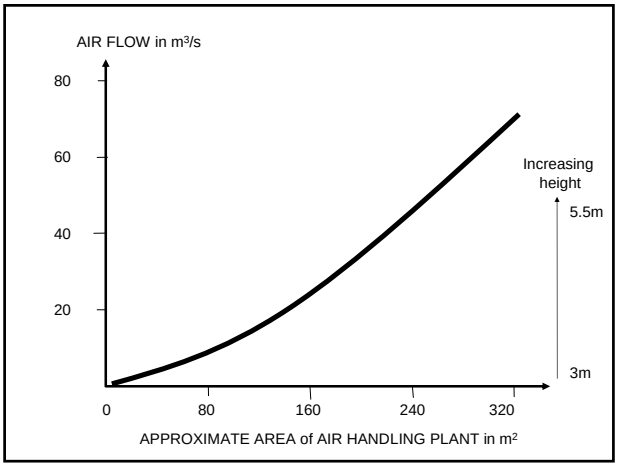
Secondary Equipment

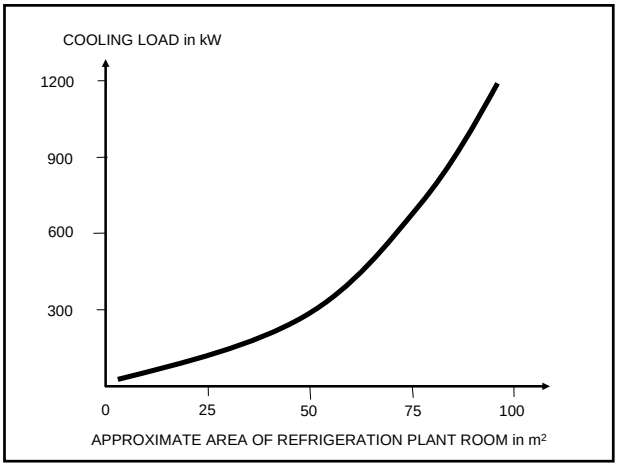
- Air Handling Plant
- Fans
- Pumps

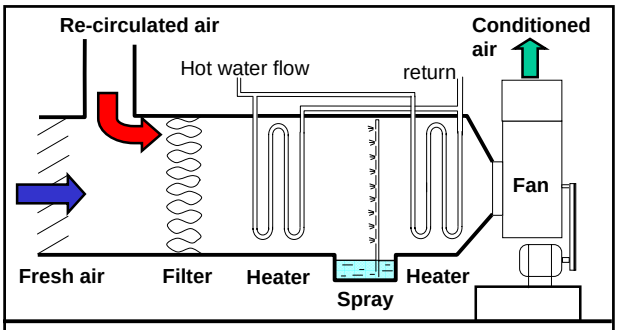
Tertiary appliances

- Radiators
- Ventilation grilles
- Air Diffusers
- Fan Coil units

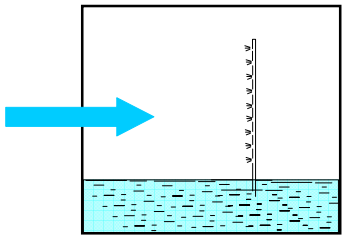




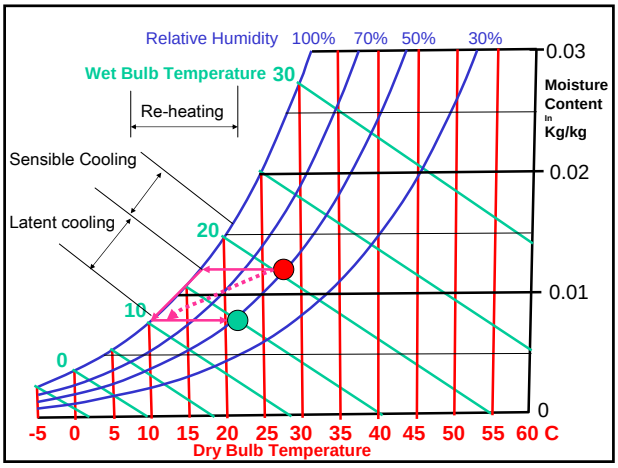


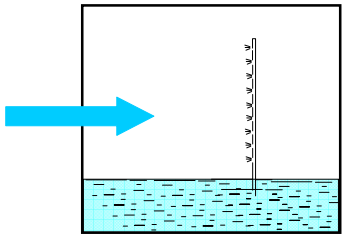


Air handling unit

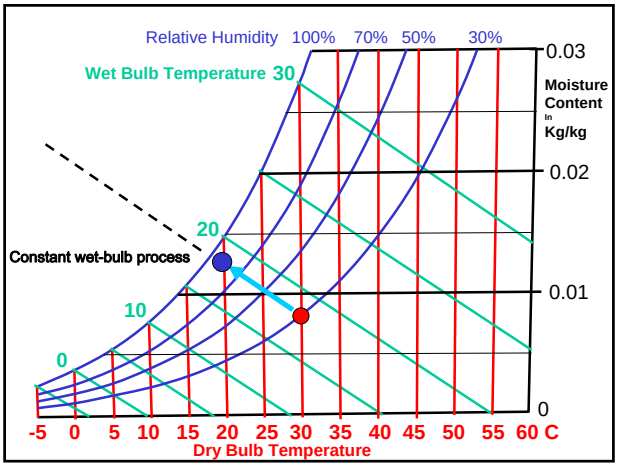


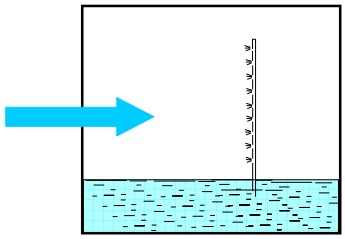
Chilled Water



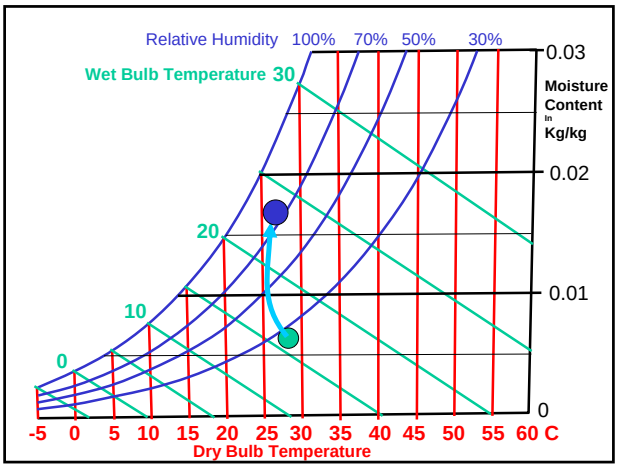


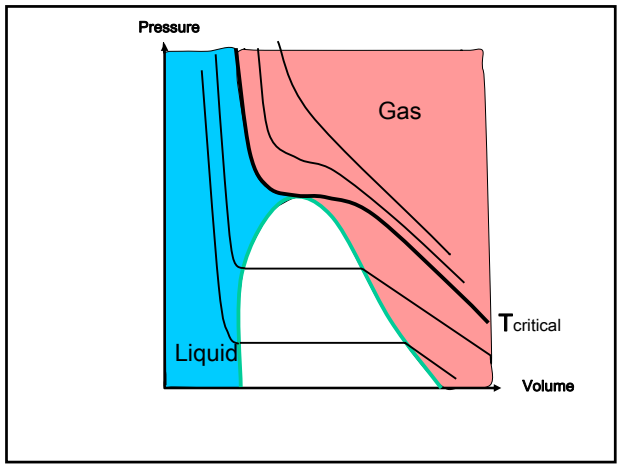
Adiabatic – no heat or coolth

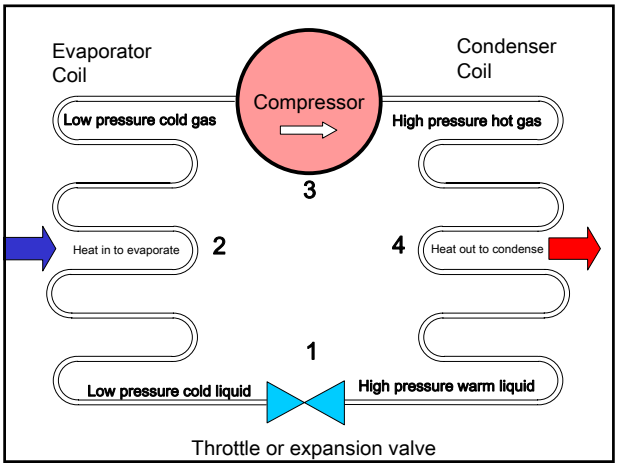


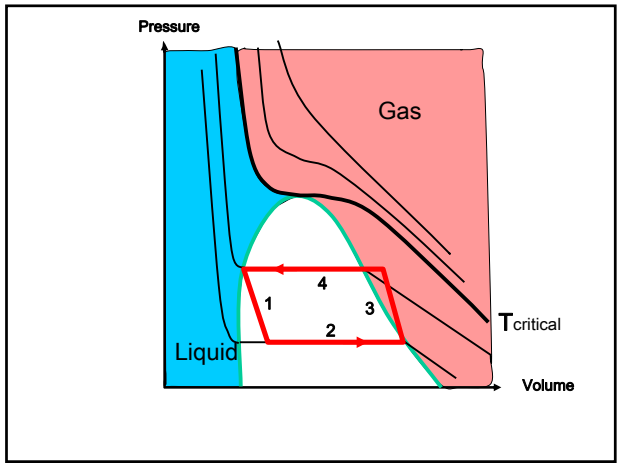


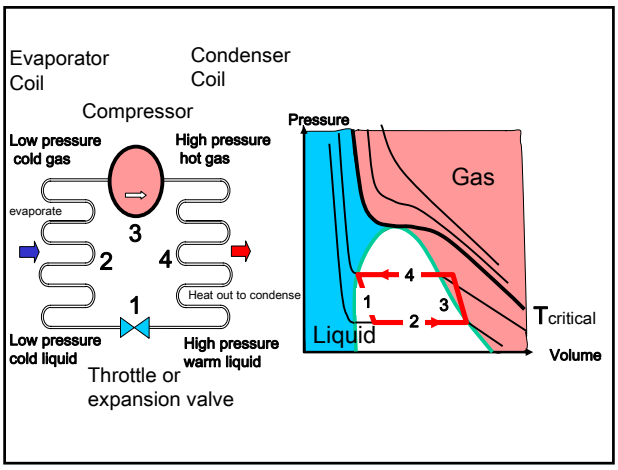
Heated Water

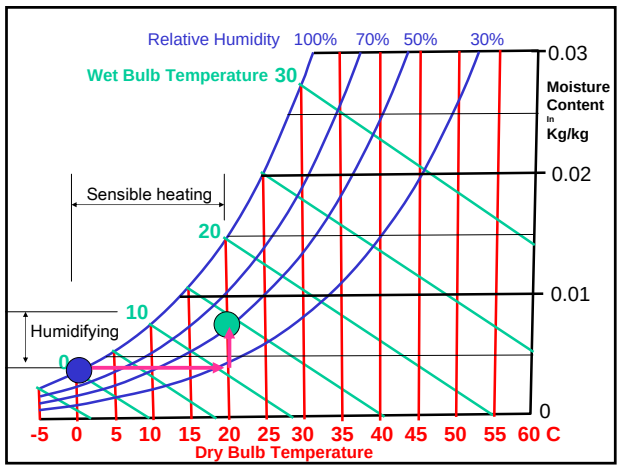

Relative Humidity 100% 70% 50% 30%
Wet Bulb Temperature 30
0.03
Moisture Content In Kg/kg
0.02
20
0.01
10
0
0
-5 0 5 10 15 20 25 30 35 40 45 50 55 60 C
Dry Bulb Temperature

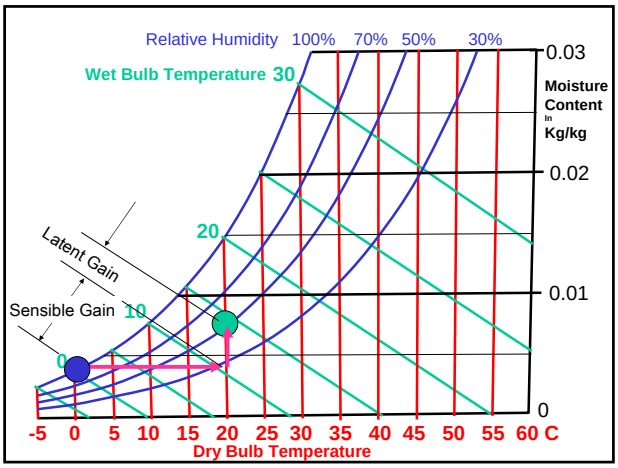

Pressure
Gas
Liquid
Tcritical
Volume


Evaporator Coil
Compressor
Condenser Coil
Low pressure cold gas
High pressure hot gas
3
Heat in to evaporate
2
4
Heat out to condense
1
Low pressure cold liquid
High pressure warm liquid
Throttle or expansion valve


Pressure
Gas
4
1
3
2
Liquid
Tcritical
Volume


Evaporator Coil
Condenser Coil
Compressor
Low pressure cold gas
High pressure hot gas
evaporate
3
2
4
Heat out to condense
1
Low pressure cold liquid
High pressure warm liquid
Throttle or expansion valve
Pressure
Gas
4
1
3
2
Liquid
Tcritical
Volume

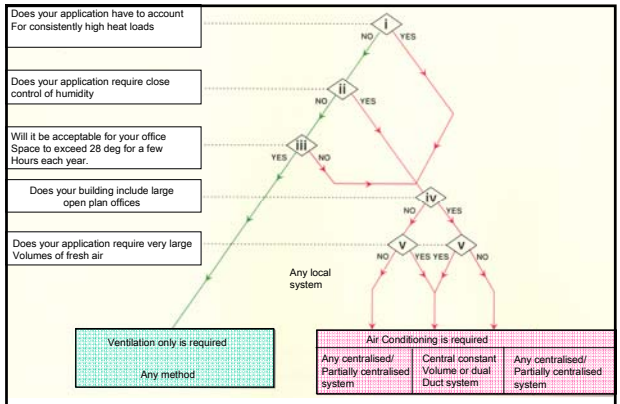

Relative Humidity 100% 70% 50% 30%
Wet Bulb Temperature 30
0.03
Moisture Content In Kg/kg
Sensible heating
0.02
20
0.01
10
Humidifying
0
0
-5 0 5 10 15 20 25 30 35 40 45 50 55 60 C
Dry Bulb Temperature

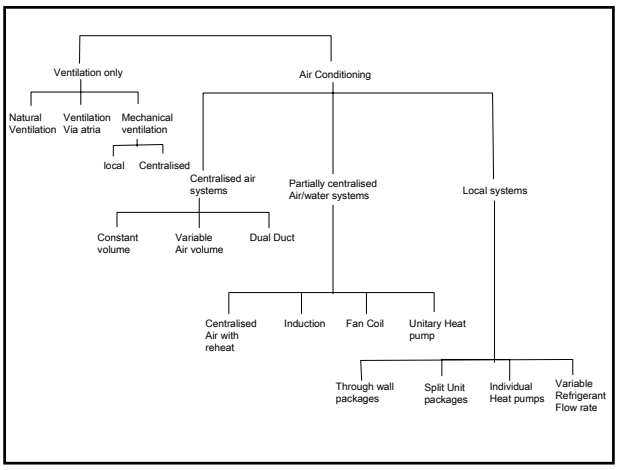


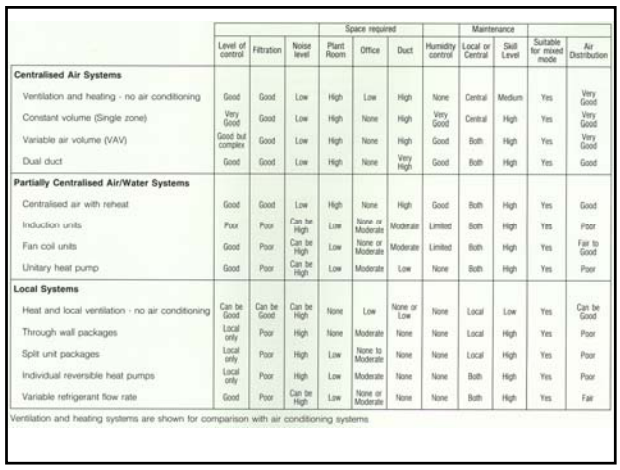
Dirty Ductwork

Cleaned Ductwork

Air Handling Unit





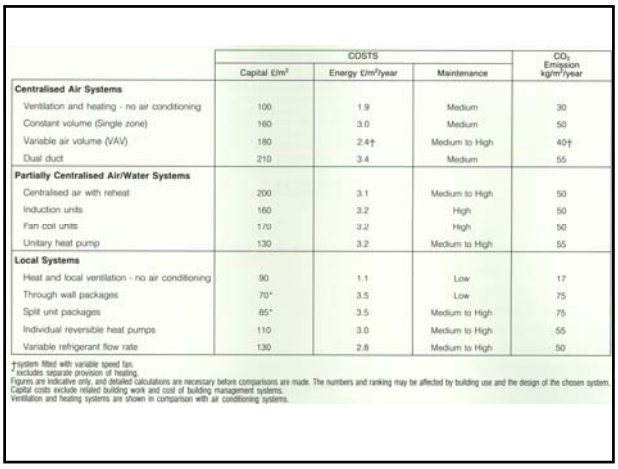


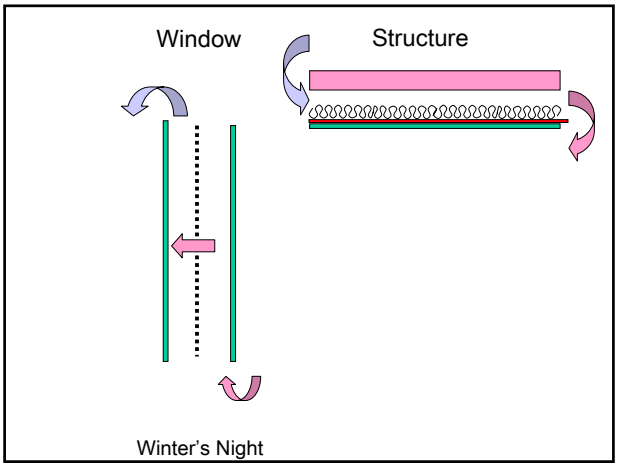
	Space required						Maintenance				
	Level of control	Filtration	Noise level	Plant Room	Office	Duct	Humidity control	Local or Central	Skill Level	Suitable for mixed mode	Air Distribution
Centralised Air Systems											
Ventilation and heating - no air conditioning	Good	Good	Low	High	Low	High	None	Central	Medium	Yes	Very Good
Constant volume (Single zone)	Very Good	Good	Low	High	None	High	Very Good	Central	High	Yes	Very Good
Variable air volume (VAV)	Good but complex	Good	Low	High	None	High	Good	Both	High	Yes	Very Good
Dual duct	Good	Good	Low	High	None	Very High	Good	Both	High	Yes	Good
Partially Centralised Air/Water Systems											
Centralised air with reheat	Good	Good	Low	High	None	High	Good	Both	High	Yes	Good
Induction units	Poor	Poor	Can be High	Low	None or Moderate	Moderate	Limited	Both	High	Yes	Poor
Fan coil units	Good	Poor	Can be High	Low	None or Moderate	Moderate	Limited	Both	High	Yes	Fair to Good
Unitary heat pump	Good	Poor	Can be High	Low	Moderate	Low	None	Both	High	Yes	Poor
Local Systems											
Heat and local ventilation - no air conditioning	Can be Good	Can be Good	Can be High	None	Low	None or Low	None	Local	Low	Yes	Can be Good
Through wall packages	Local only	Poor	High	None	Moderate	None	None	Local	High	Yes	Poor
Split unit packages	Local only	Poor	High	Low	None to Moderate	None	None	Local	High	Yes	Poor
Individual reversible heat pumps	Local only	Poor	High	Low	Moderate	None	None	Both	High	Yes	Poor
Variable refrigerant flow rate	Good	Poor	Can be High	Low	None or Moderate	None	None	Both	High	Yes	Fair

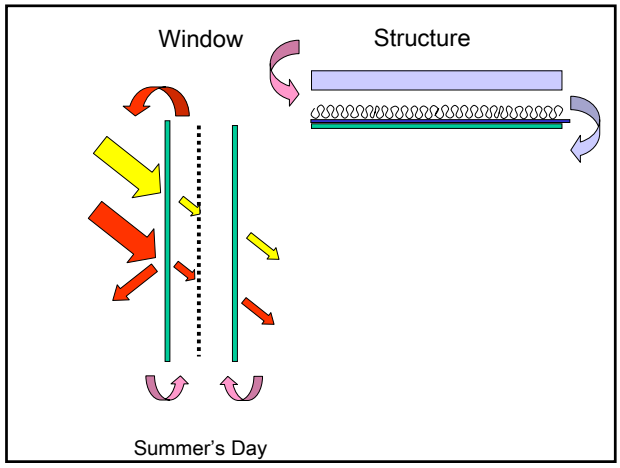
Ventilation and heating systems are shown for comparison with air conditioning systems

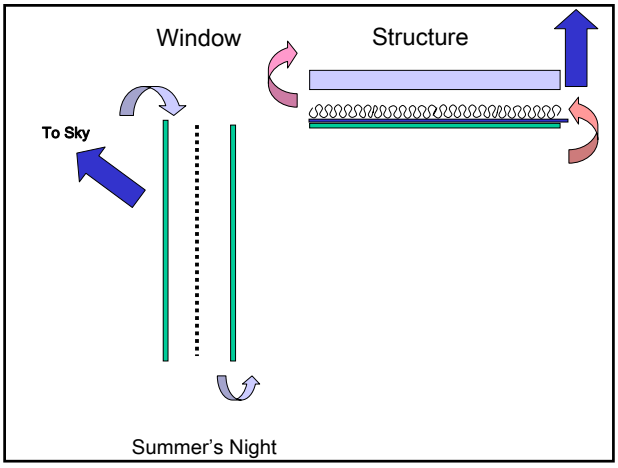
	COSTS			CO_2 Emission
	Capital £/m²	Energy £/m²/year	Maintenance	kg/m²/year
Centralised Air Systems				
Ventilation and heating - no air conditioning	100	1.9	Medium	30
Constant volume (Single zone)	160	3.0	Medium	50
Variable air volume (VAV)	180	2.4†	Medium to High	40†
Dual duct	210	3.4	Medium	55
Partially Centralised Air/Water Systems				
Centralised air with reheat	200	3.1	Medium to High	50
Induction units	160	3.2	High	50
Fan coil units	170	3.2	High	50
Unitary heat pump	130	3.2	Medium to High	55
Local Systems				
Heat and local ventilation - no air conditioning	90	1.1	Low	17
Through wall packages	70*	3.5	Low	75
Split unit packages	85*	3.5	Medium to High	75
Individual reversible heat pumps	110	3.0	Medium to High	55
Variable refrigerant flow rate	130	2.8	Medium to High	50

†system fitted with variable speed fan.
* includes separate provision of heating.
Figures are indicative only, and detailed calculations are necessary before comparisons are made. The numbers and ranking may be affected by building use and the design of the chosen system
Capital costs exclude related building work and cost of building management systems.
Ventilation and heating systems are shown in comparison with air conditioning systems.

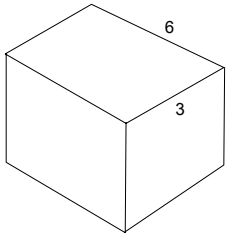








Energy that you want to be stored Power x time



Volume = 54 m^3

Ventilation need is 10 l/s per person

10 x 3600 / (1000) = 36 m^3/hr
this is equivalent to 2/3 Air change per hour

$\Phi v = NV \Delta t / 3$ W

= 2/3 x 54 x 20 /3 = 240 W

$\Phi f = U \times A \times \Delta t$

= 0.35 x (9 + 18 + 18) x 20

= 315 W

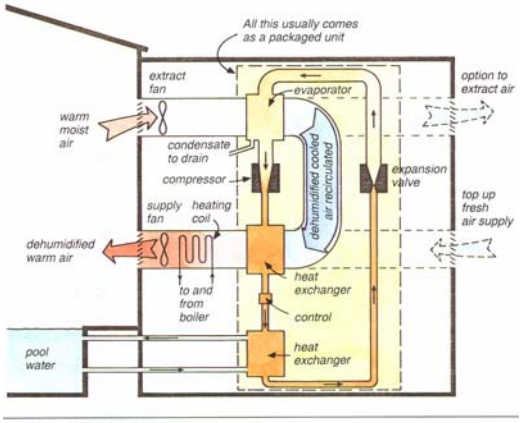
Over an 8 hour day = 675 x 8 x 3600
1.9 MJ

Power that can be put into store

$\Phi s = C \times A \times \Delta t$

$\Phi s = A \times \Delta t / r_s$

R_s = surface resistance to heat transfer = 0.06 or 0.12 m^2K/W



A heat pump/dehumidification unit