Aqua cool

healthy fresh air

Reliable, Energy Efficient and Sustainable Cooling using dew point cooling technology

(The break through of the century in cooling technology)

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Hi-Tech

Aqua cool

healthy fresh air

Aqua cool makes cooled ventilation & allow users to open window while saving 75% of the energy cost

The Future in cooled ventilation

Our Vision

"Energy we do not use
is the most ecological
and sustainable energy"

"We do not use chemicals and
refrigerant therefore environment
will not be damaged"

Application

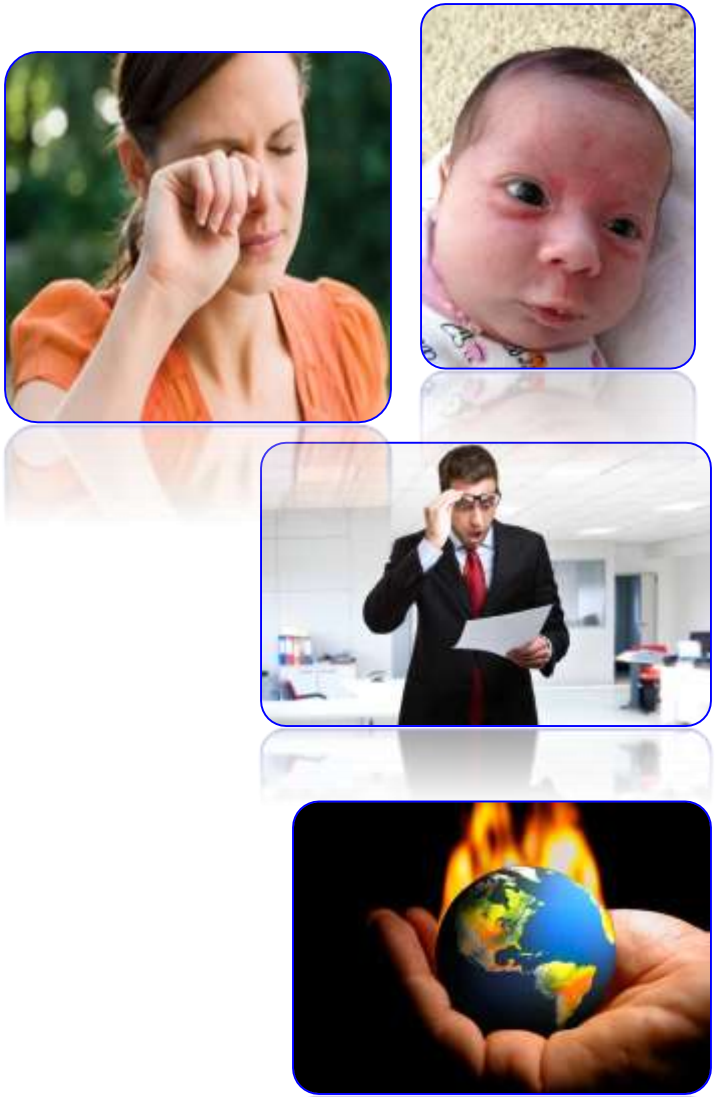
❖ Fresh air handling cooling.

❖ Comfort cooling for public places.

❖ maximum fresh air handling requirements such as:

- hospitals
- industrial kitchens
- smoking places
- public places
- toilets
- large industrial premises

Traditional systems, The problems

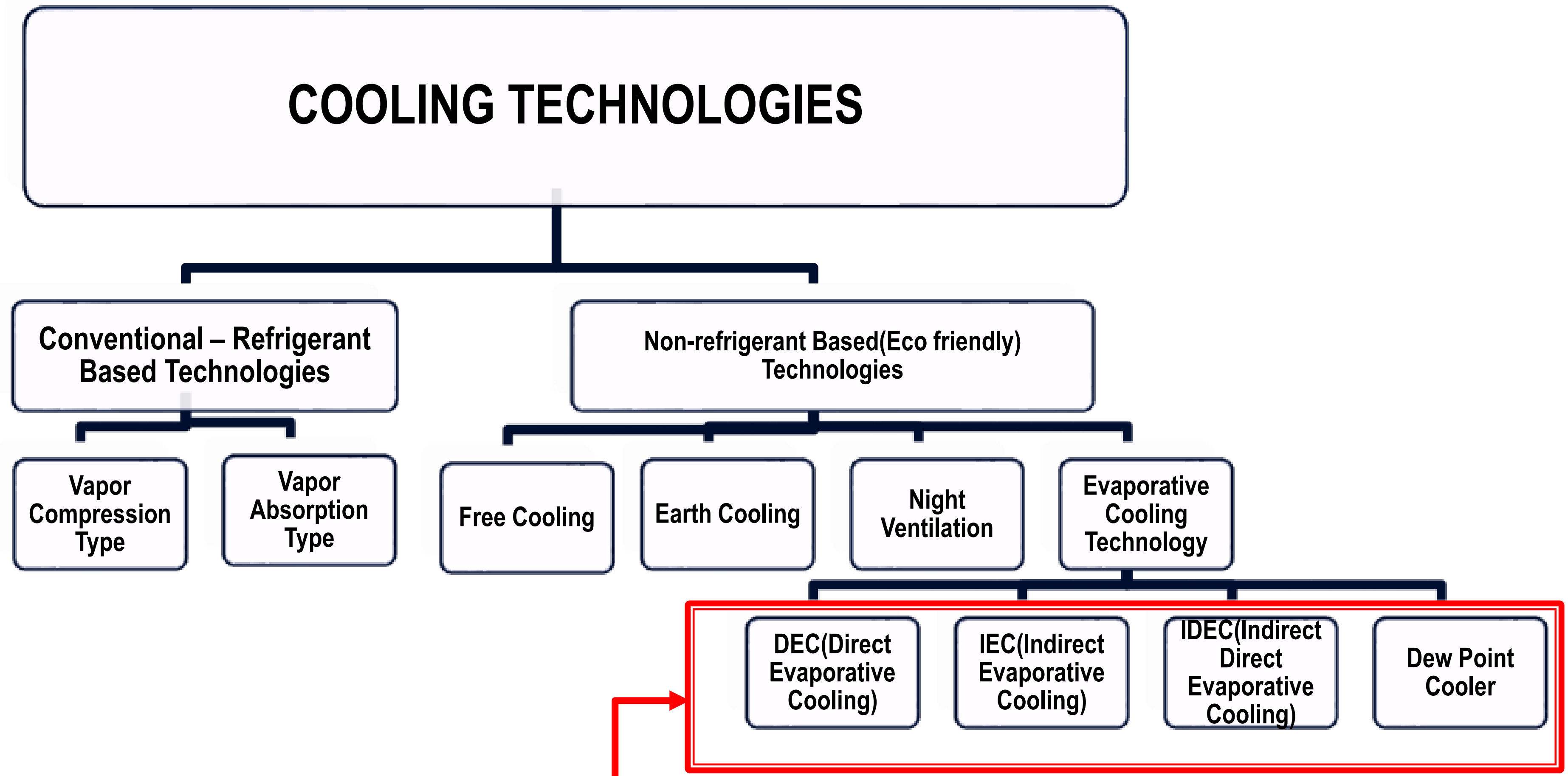


Many people suffer from irritations to the skin, throat, nose and eyes due to dry air and internal air recirculation

Air conditioning systems and other cooling systems consume a lot of energy (around 30% of national electricity consumption)

Air conditioning systems are partly responsible for the global warming through energy consumption and refrigeration leakage.

Cooling Solutions –
(For People comfort & Process requirements)



COOLING TECHNOLOGIES

Conventional – Refrigerant Based Technologies

Vapor Compression Type

Vapor Absorption Type

Non-refrigerant Based(Eco friendly) Technologies

Free Cooling

Earth Cooling

Night Ventilation

Evaporative Cooling Technology

DEC(Direct Evaporative Cooling)

IEC(Indirect Evaporative Cooling)

IDEC(Indirect Direct Evaporative Cooling)

Dew Point Cooler

Our technical focus

General Approach

- Utilization of psychometric energy available from latent heat of water evaporating into air.

- The smart combination of the basic thermodynamic processes of heat exchange and evaporation that results in production of a temperature approaching the dew point of ambient air

Comparison – Mechanical vs. IEC

- Mechanical Cooling Uses Electricity as the Principal Source of Energy

- IEC Uses Evaporation of Water as the Principal Source of Energy, it does not use any CFC or GHG (green house gases)

- EER of Mechanical is Approximately 12

- EER of IEC is Approximately 36 (energy saving 70%)

- IEC Evaporates More Water but Consumes Considerably Less Fuel

- Water is Completely Reusable – Fossil Fuels are NOT.

- Consumption of Fuels Generate Environmental Problems

A few international references..

- Internationally, systems working on similar principles are called IDEC systems or Two stage evaporative cooling systems.
  - These systems are identified as Zero ODP (ozone depletion potential) and Zero (Global warming potential) systems.

- Research references are available from:
  - DOE- Department of Energy, USA
  - CEC - California Energy commission
  - LBL - Lawrence Berkeley laboratory
  - NREL – National Renewable Energy Laboratory

Evaporative Cooling:

Why Is This Important To You (and your clients)?

If you could, would you provide your clients/customers with an HVAC system that:

- Supplies 100% fresh outdoor air instead of stale re-circulated air
- Uses significantly less energy to operate than current recirculation systems
- Can be installed on a first cost basis equal to or less than a standard mechanical system
- Can be retrofitted to their existing systems (in most cases)
- Is user user-friendly for maintenance personnel to operate and maintain

If you could, you should

so let's see how.

Evaporative Cooling:

What Does "Green" Mean To HVAC?

"Green" is not installing a high efficiency boiler or alternative refrigerant chiller

"Green" is avoiding the need for that boiler or chiller (or at least significantly downsizing them)

"Green" is designing a high efficiency hybrid system that used high efficiency components

Importance of Indirect Evaporative Cooling What Are the Adverse Affects Of Heat?

Industrial facilities are particularly susceptible to problems related to heat during extended periods of the year.

- Heat stress
- Increased down time
- Quality control problems
- Reduced productivity

Many companies have done internal studies on the true costs of such heat related problems…the results are discouraging and most often not made public!

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Evaporative cooling is the alternative for conventional cooling systems

Aqua cool
healthy fresh air

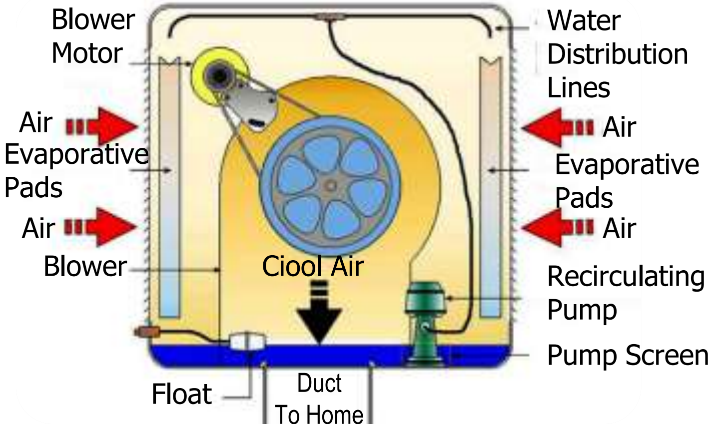
It is an energy efficient and environmentally friendly & uses only water as cooling agent and saves about 75% of energy on a warm summer day.

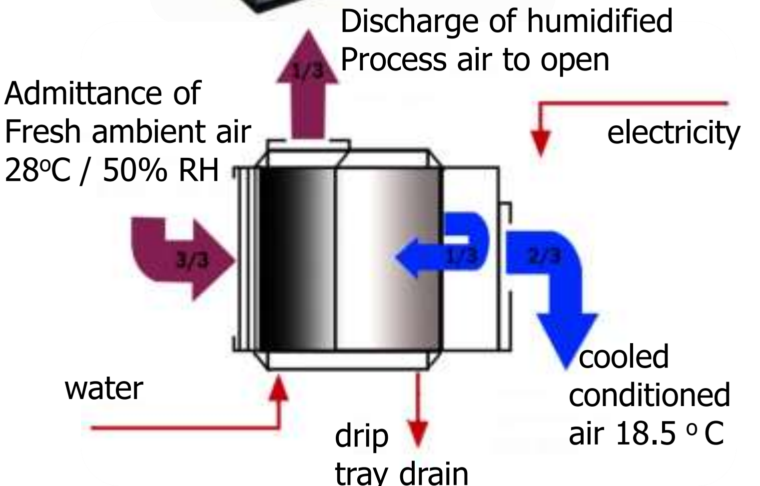
Three generations of evaporative cooling:

Direct Adiabatic Cooling

Indirect Adiabatic Cooling

Dew Point Cooling





What is "Comfort Conditioning"?

Comfort conditioning relates to human comfort.

The surrounding air needs to be treated so that the person occupying the place feels fresh & comfortable.

Factors that directly affect human comfort:

- Temperature
- Relative humidity
- Air motion
- % of fresh air
- Personal activity
- Clothing

What is 'Comfort Conditioning'?

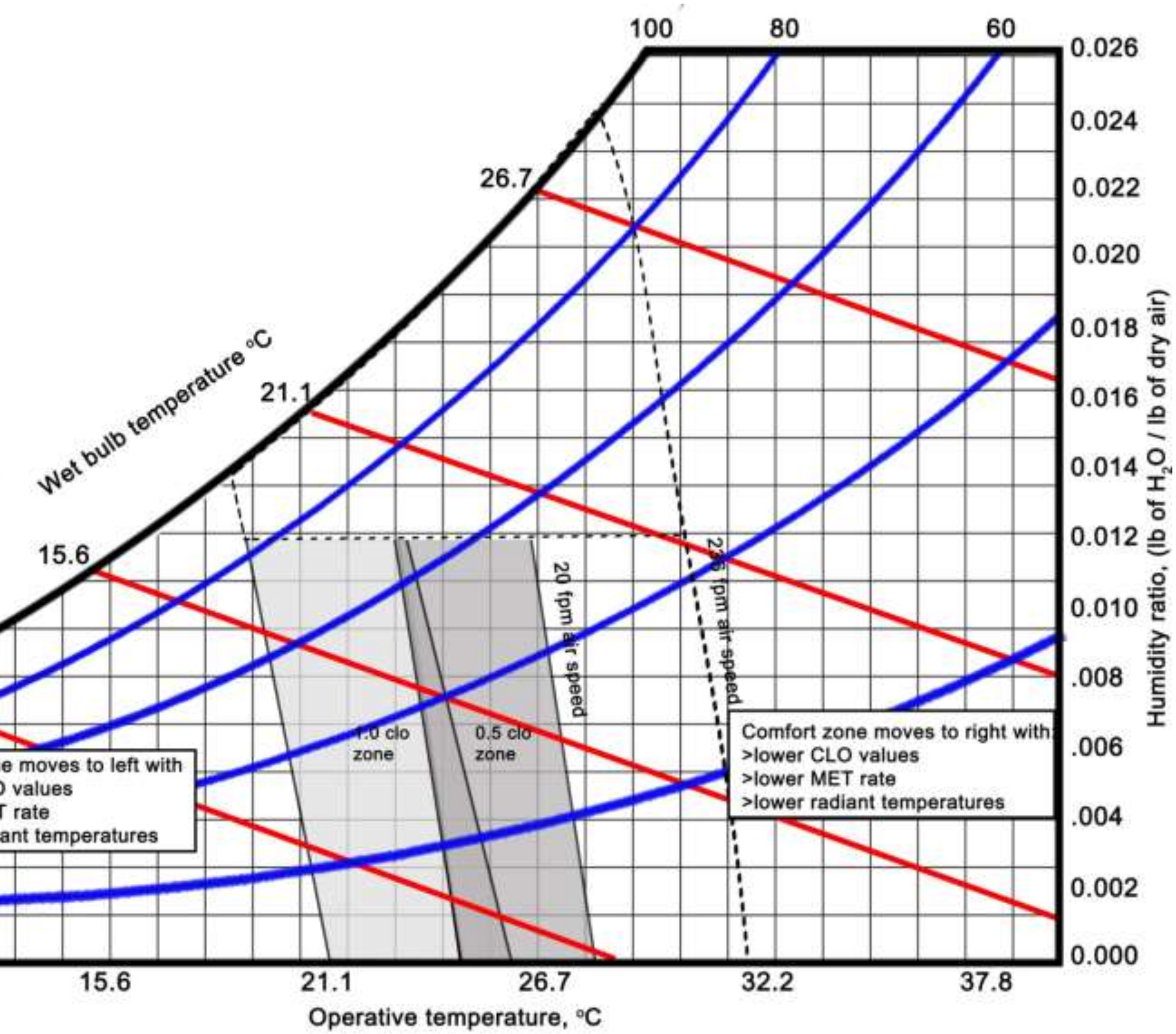
Often, one tends to look only at temperature & humidity as a measure for comfort. However, fresh air and air motion are equally important.

Humidity based on ASHRAE standard

ASHRAE STANDARD

Methods of Testing
PRE-MIX AND POST-MIX
SOFT DRINK VENDING
AND DISPENSING
EQUIPMENT

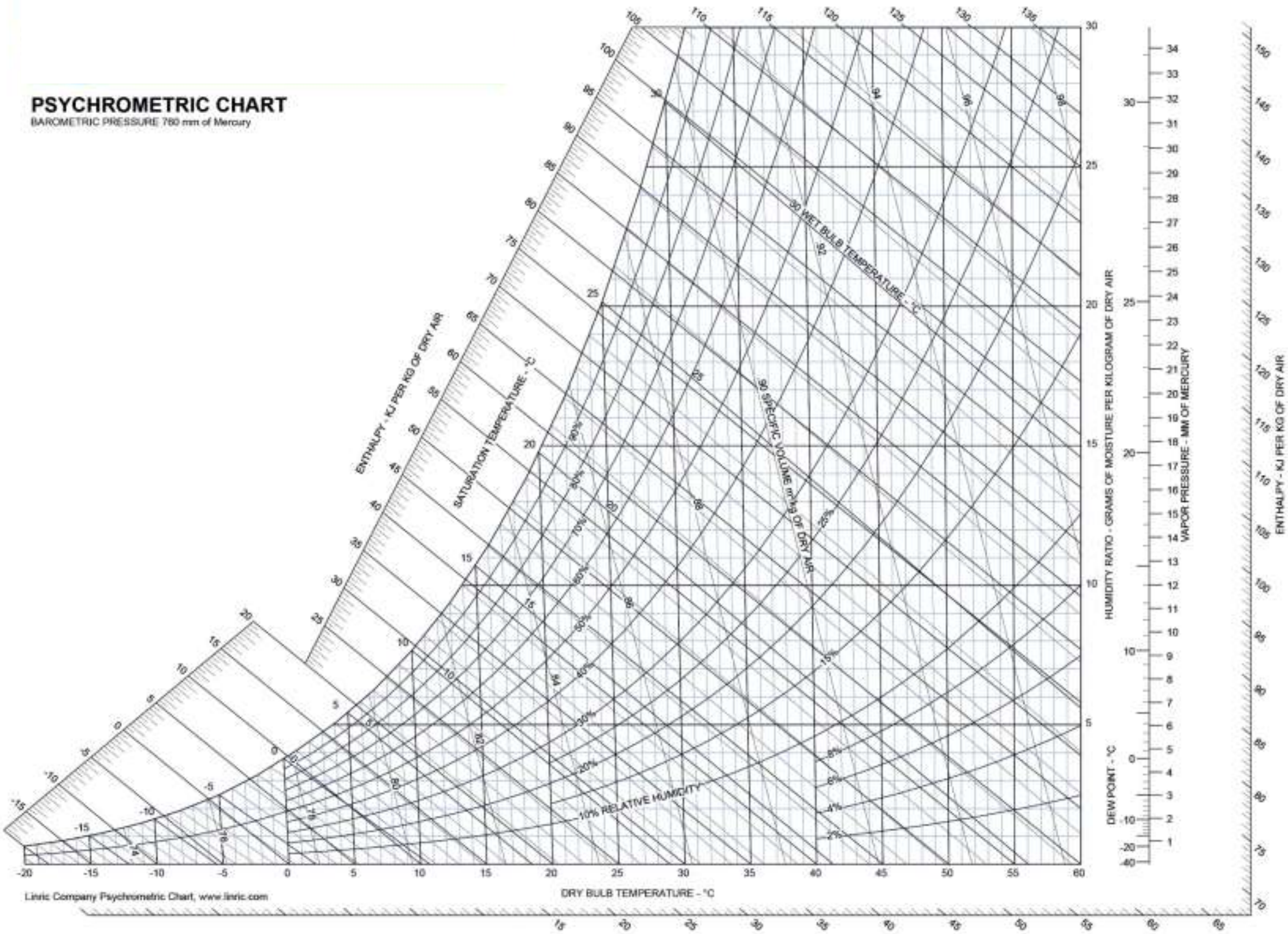
AMERICAN SOCIETY OF HEATING,
REFRIGERATING AND
AIR-CONDITIONING ENGINEERS, INC.



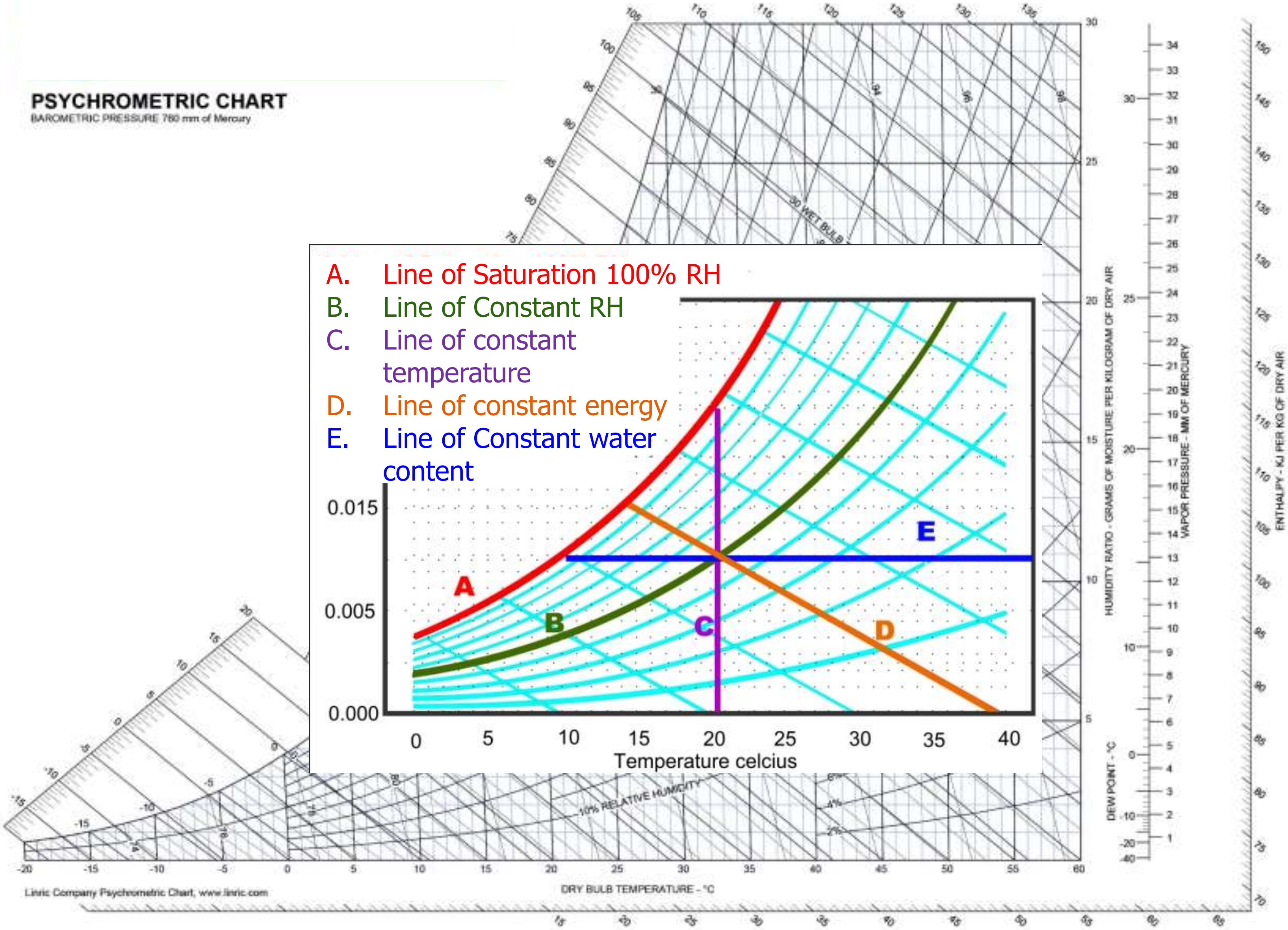
Comfort zone moves to left with
~higher CLO values
~higher MET rate
~higher radiant temperatures

Comfort zone moves to right with:
>lower CLO values
>lower MET rate
>lower radiant temperatures

Let us study Psychrometric chart



Psychrometric chart



A. Line of Saturation 100% RH

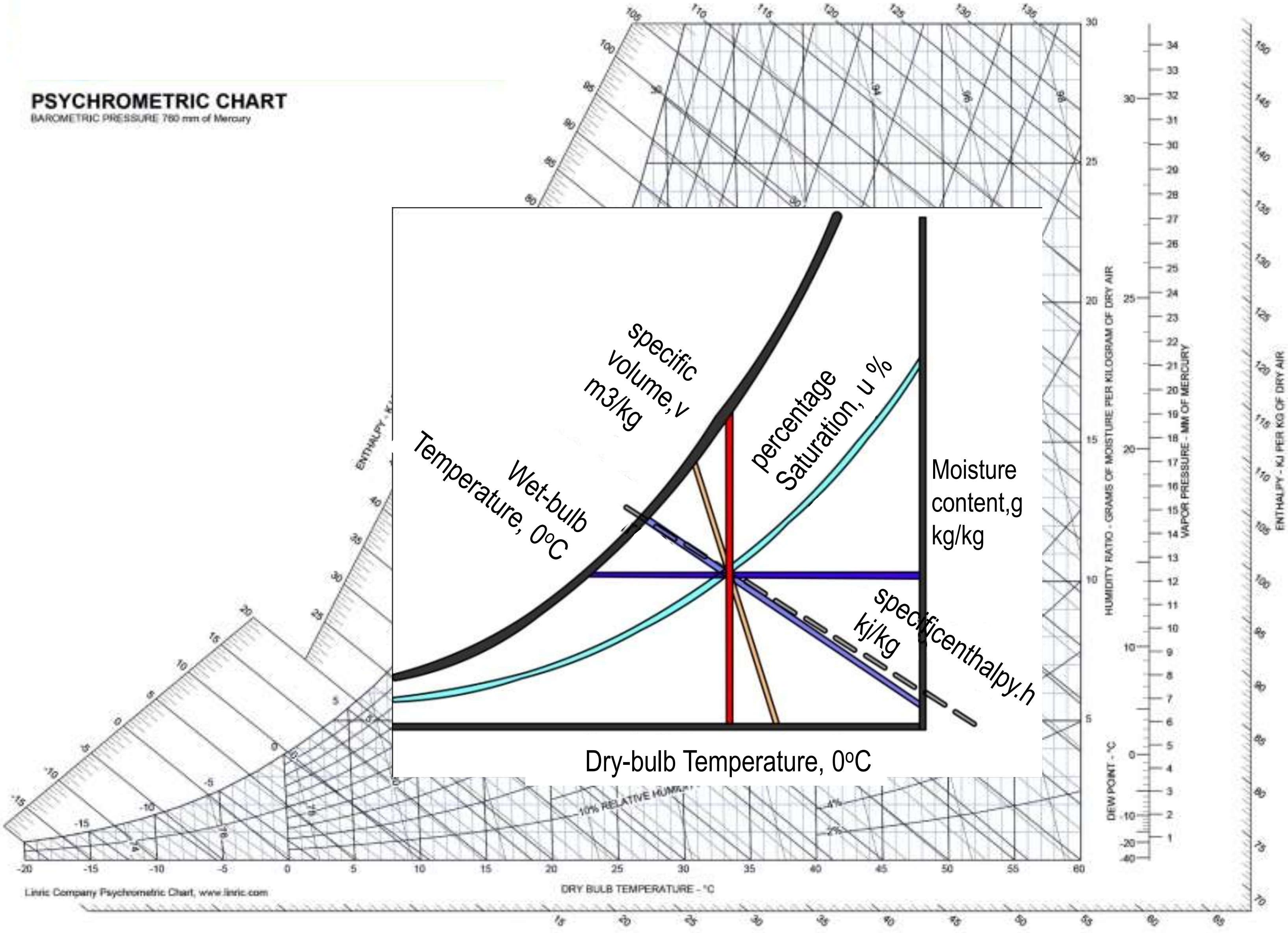
B. Line of Constant RH

C. Line of constant temperature

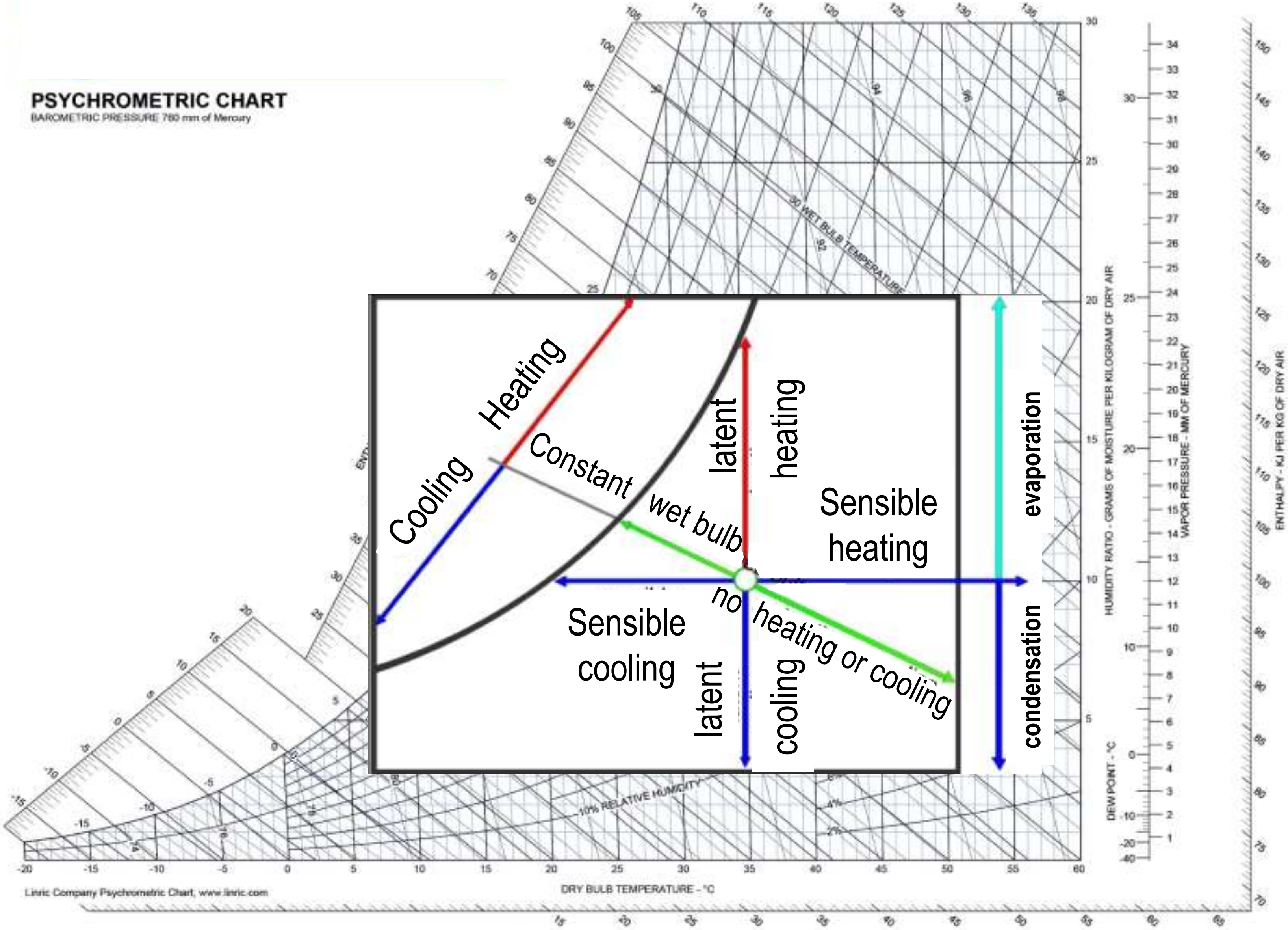
D. Line of constant energy

E. Line of Constant water content

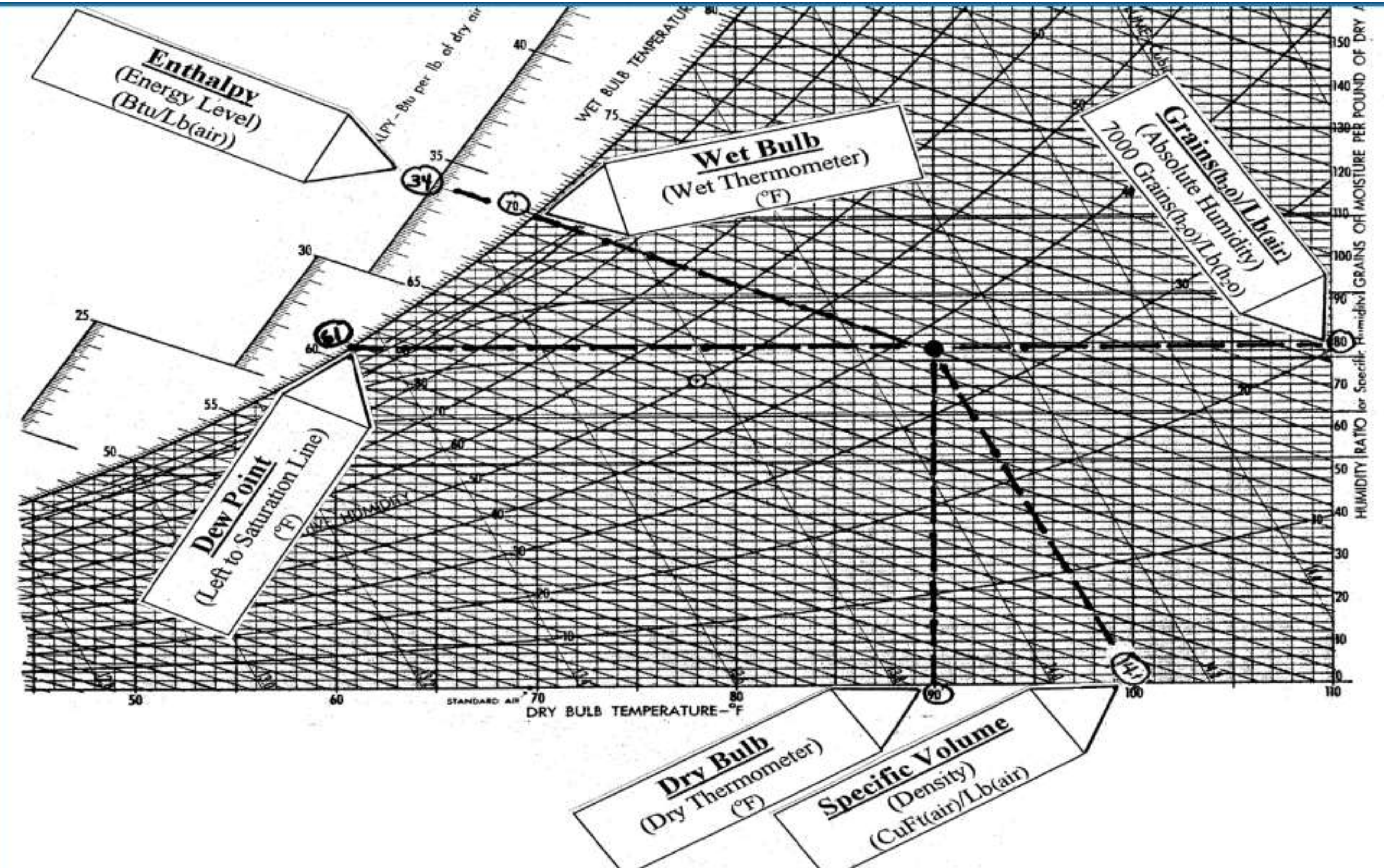
Psychrometric chart



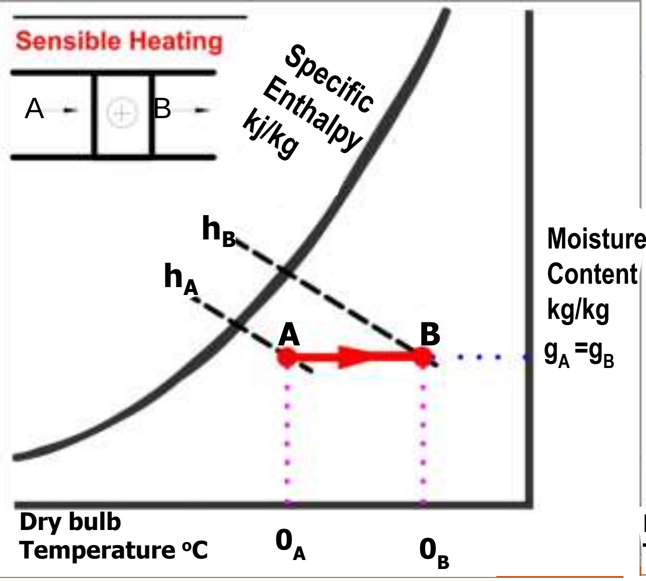
Psychrometric chart

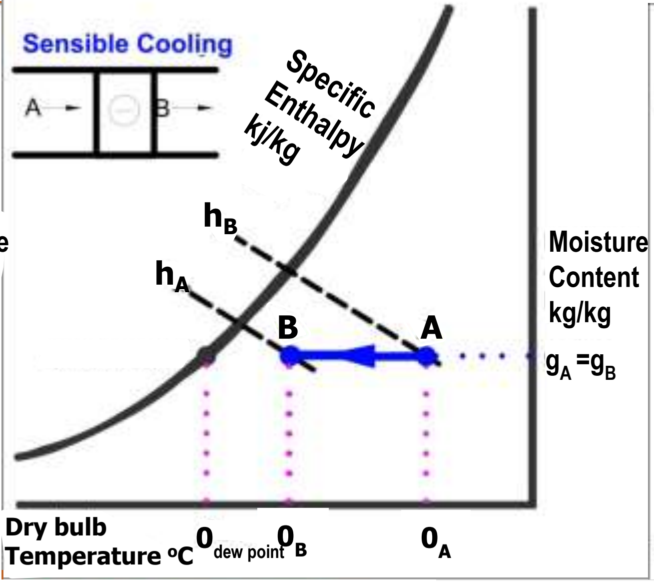


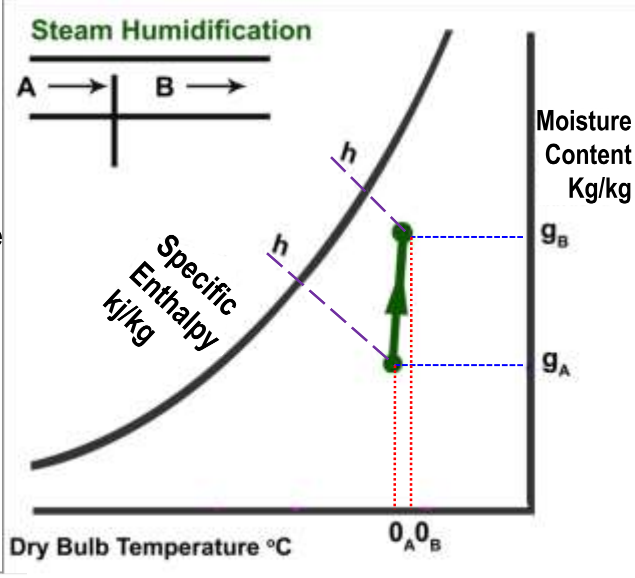
Understanding The Psychrometric Chart

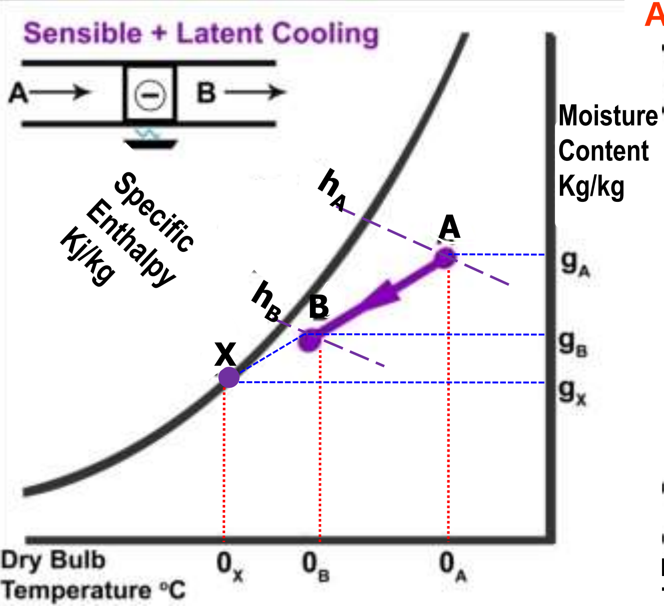


Various air treatment process on Psychometric chart

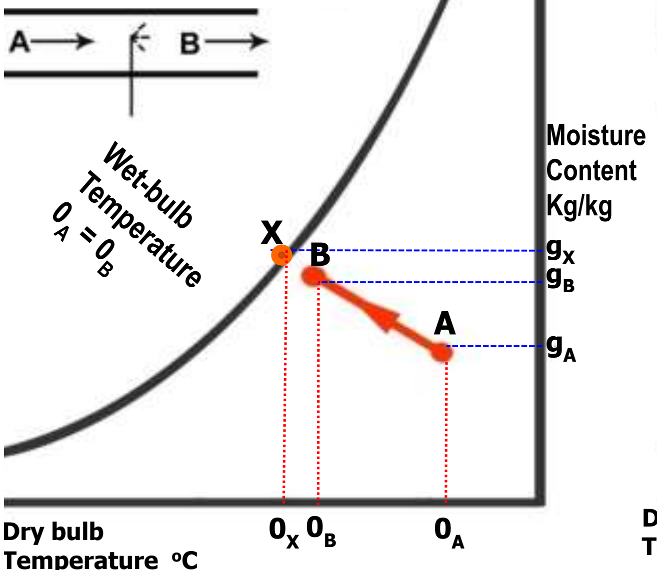

Sensible Heating

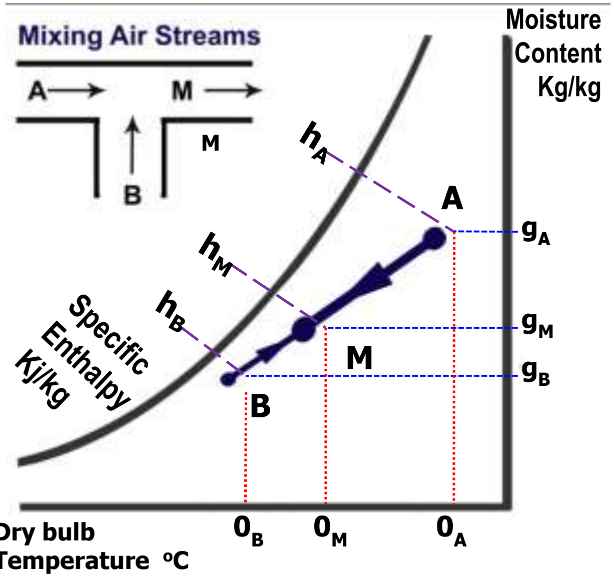

Sensible Cooling


Steam Humidification


Sensible + Latent Cooling

Adiabatic Humidification




Mixing Air Streams

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Comfort Zone: ASHRAE

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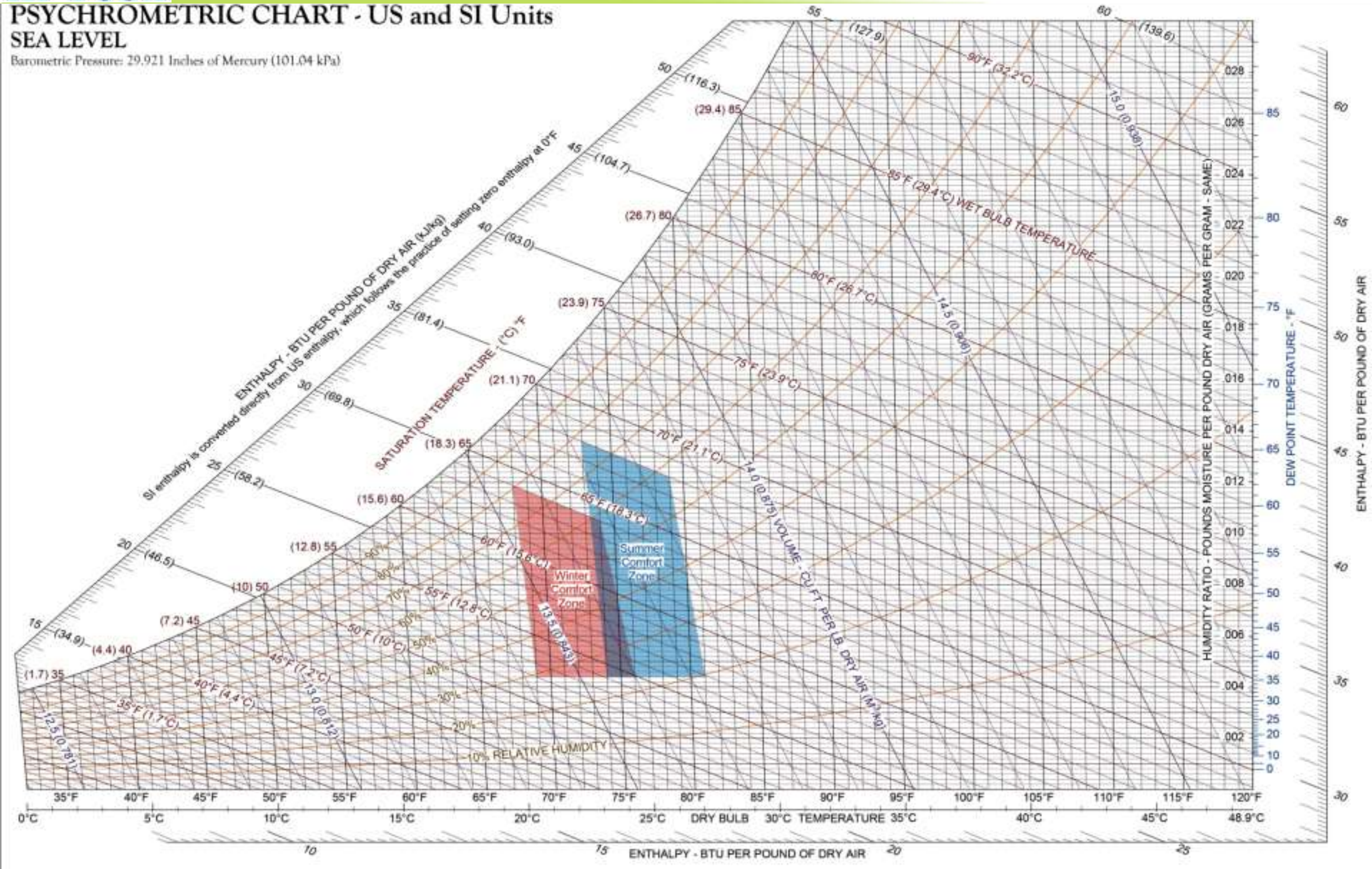
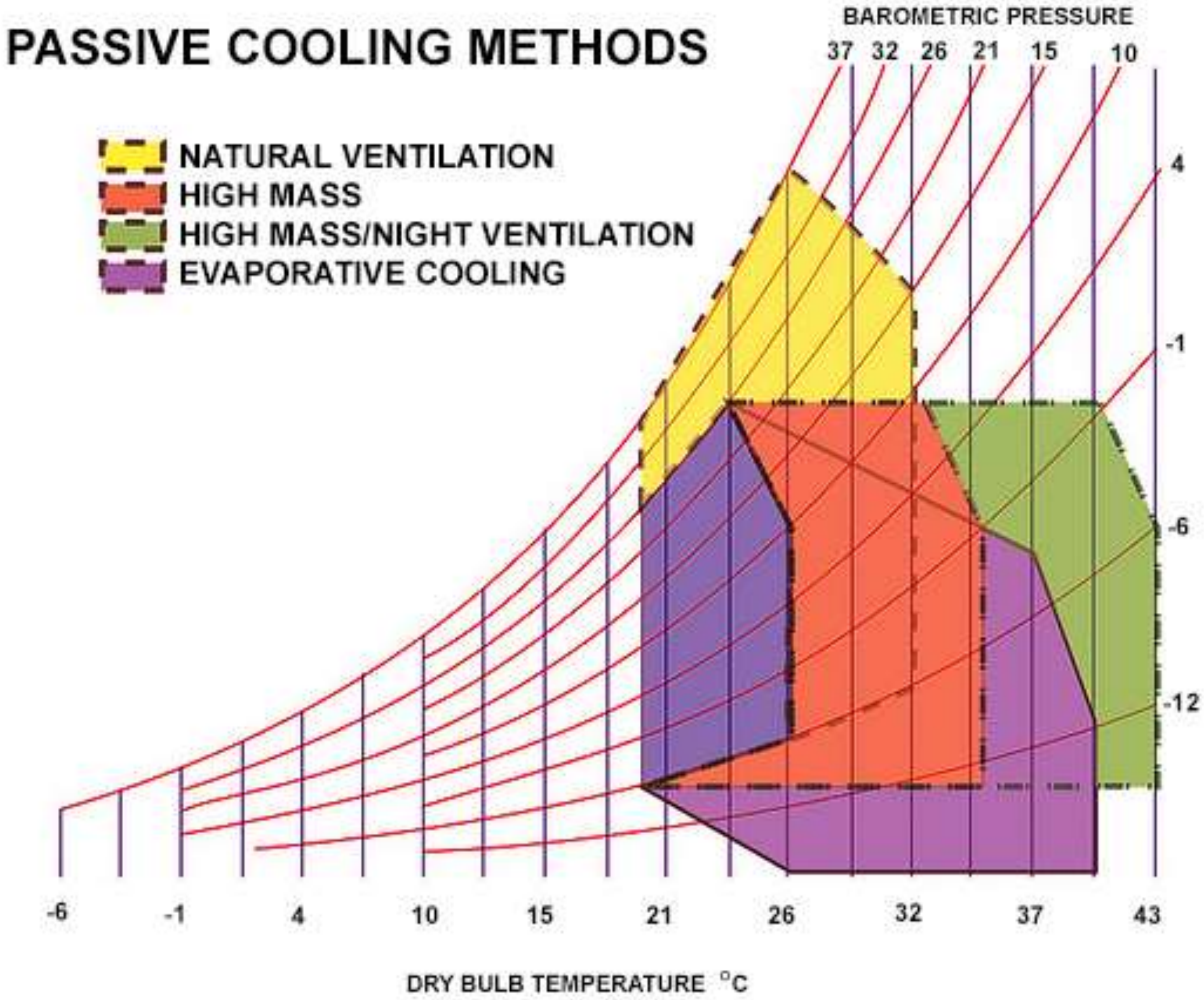


Various conditions where you can utilizes passive cooling methods



Psychrometric chart

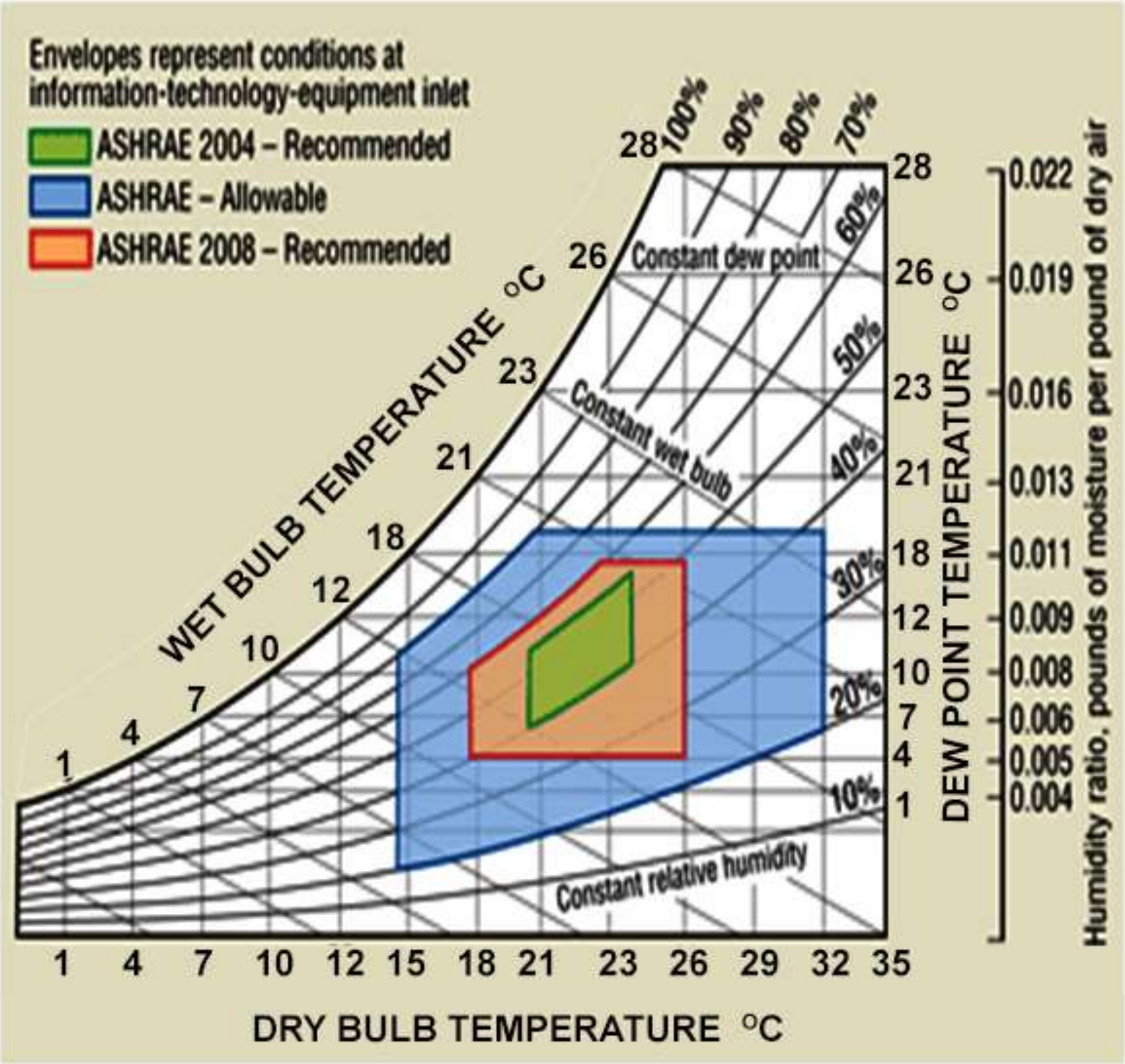


FIGURE 1. ASHRAE environmental specifications.

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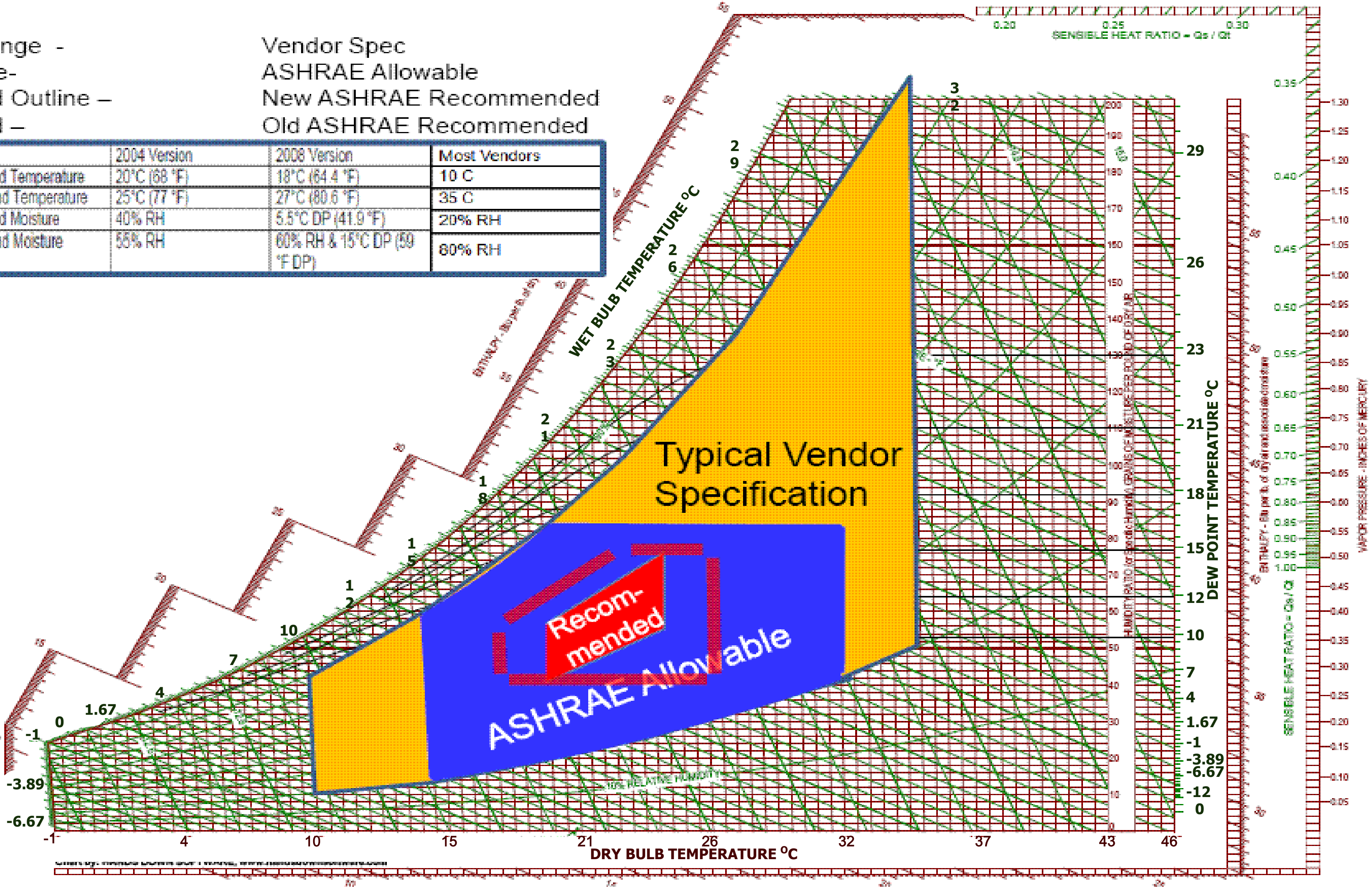
Psychrometric chart

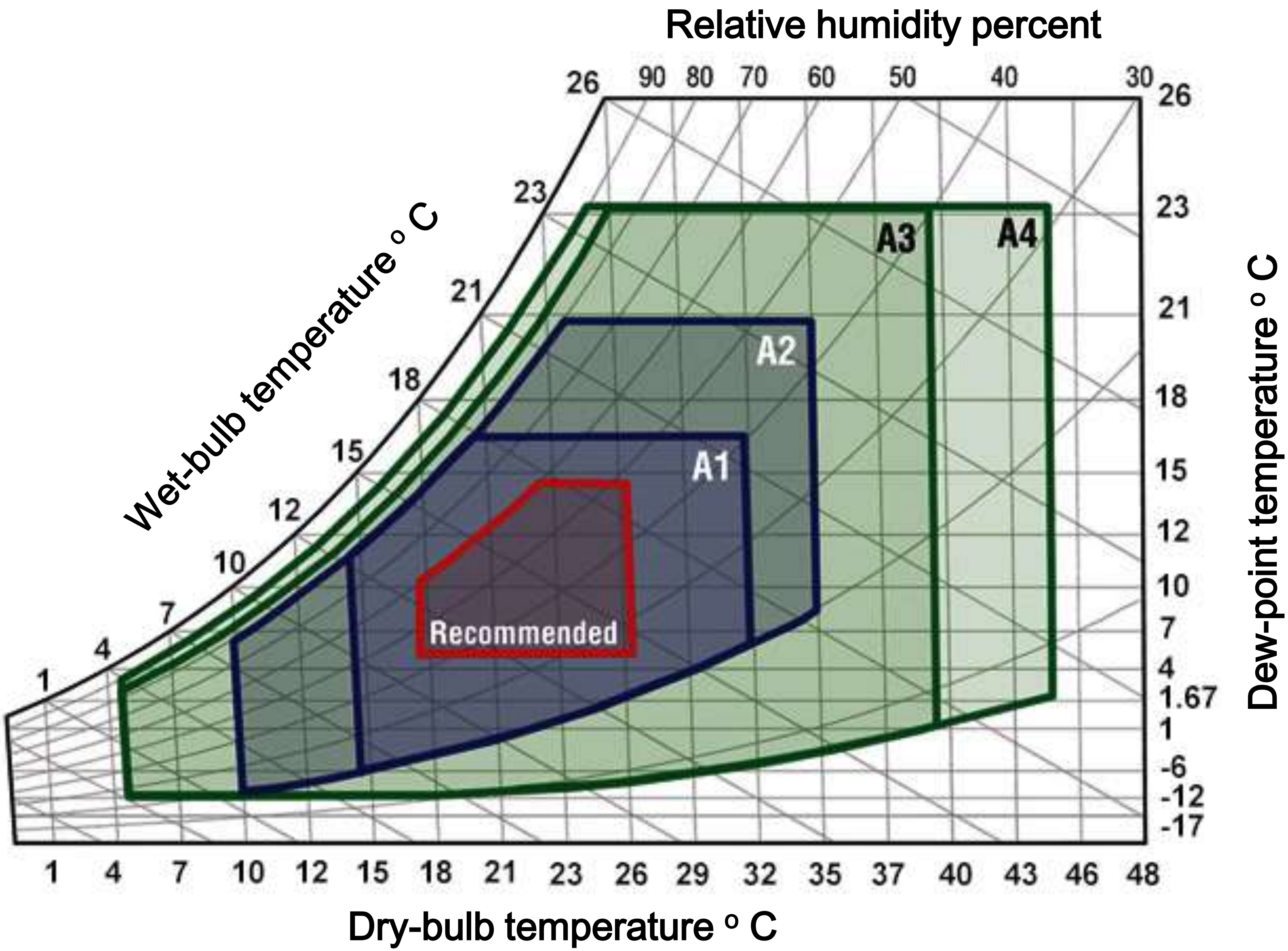
Aqua cool
healthy fresh air

Orange -	Vendor Spec
Blue-	ASHRAE Allowable
Red Outline –	New ASHRAE Recommended
Red –	Old ASHRAE Recommended

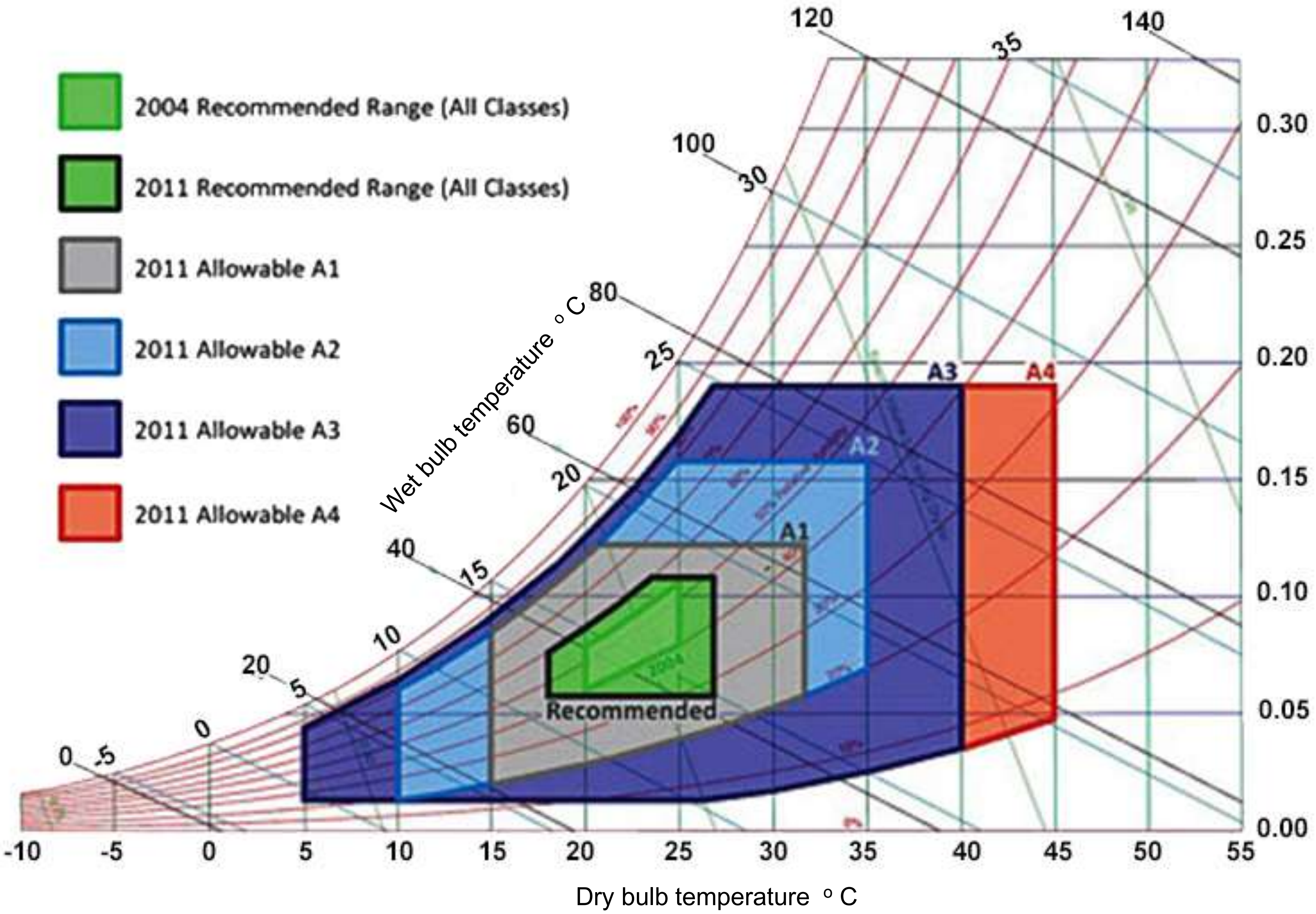
	2004 Version	2008 Version	Most Vendors
Low End Temperature	20°C (68 °F)	18°C (64.4 °F)	10 C
High End Temperature	25°C (77 °F)	27°C (80.6 °F)	35 C
Low End Moisture	40% RH	5.5°C DP (41.9 °F)	20% RH
High End Moisture	55% RH	60% RH & 15°C DP (59 °F DP)	80% RH



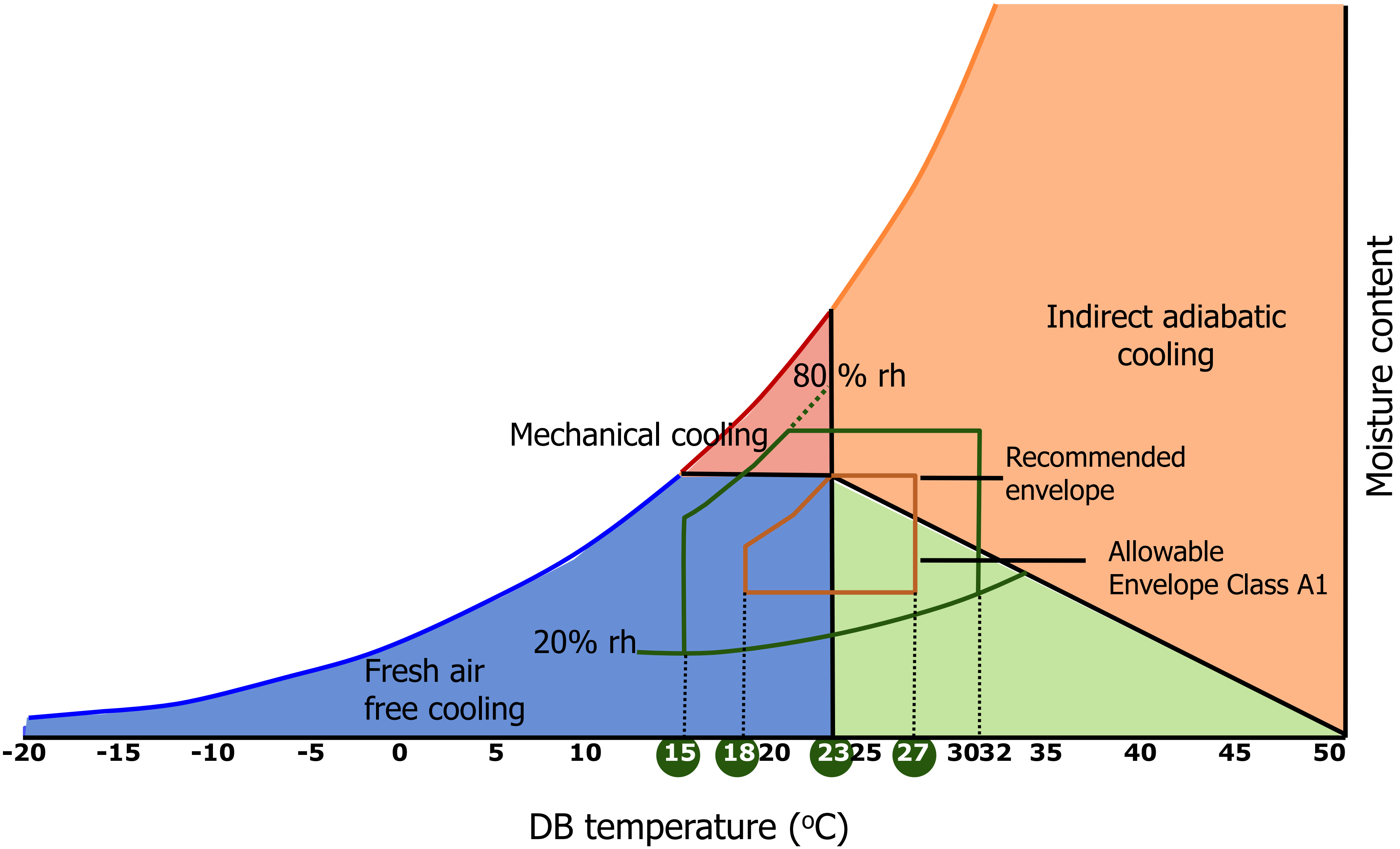
Psychrometric chart



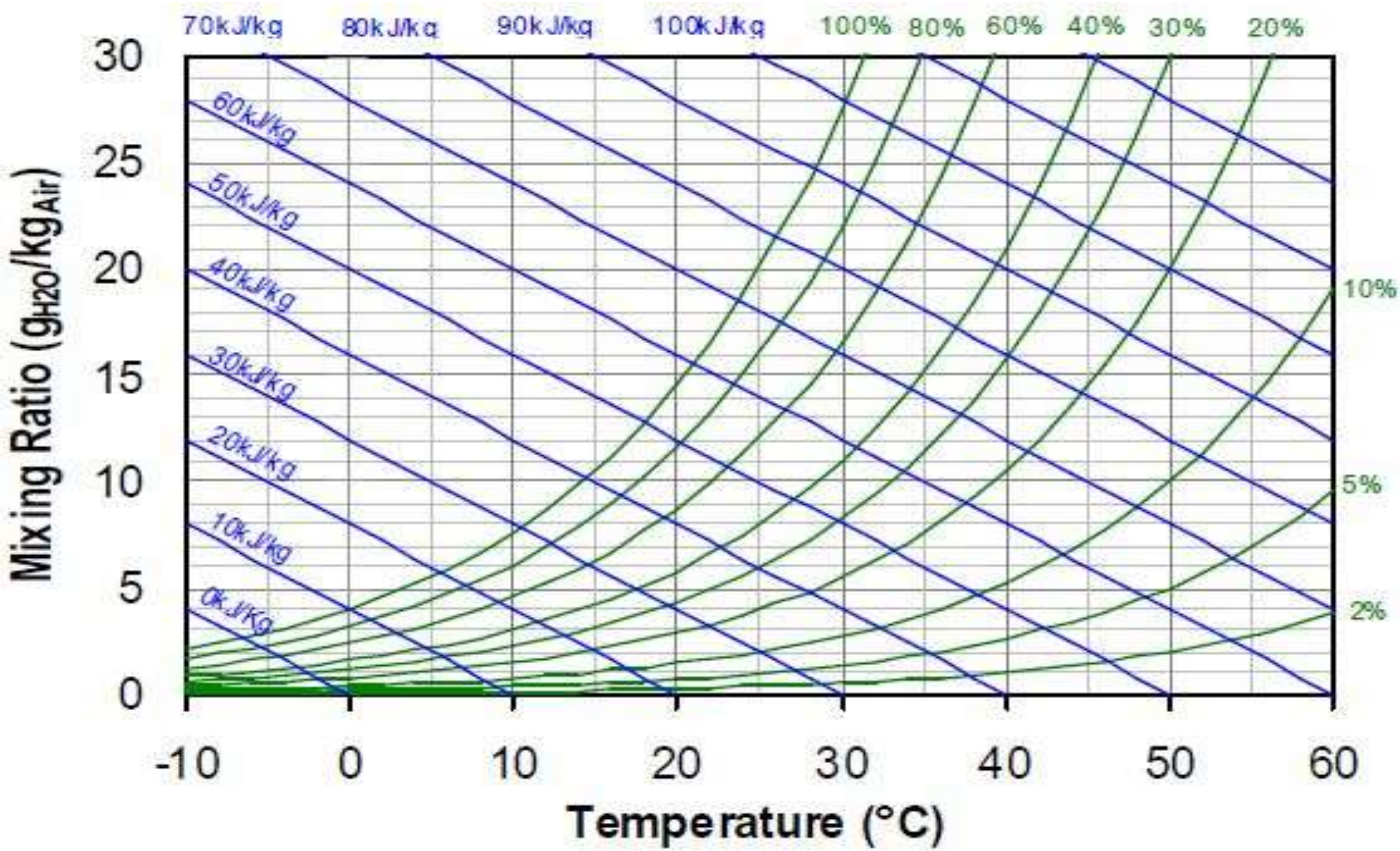
Psychrometric chart



Recommended methods for treatment of air



Details of enthalpy on Psychometric chart



Psychrometric chart

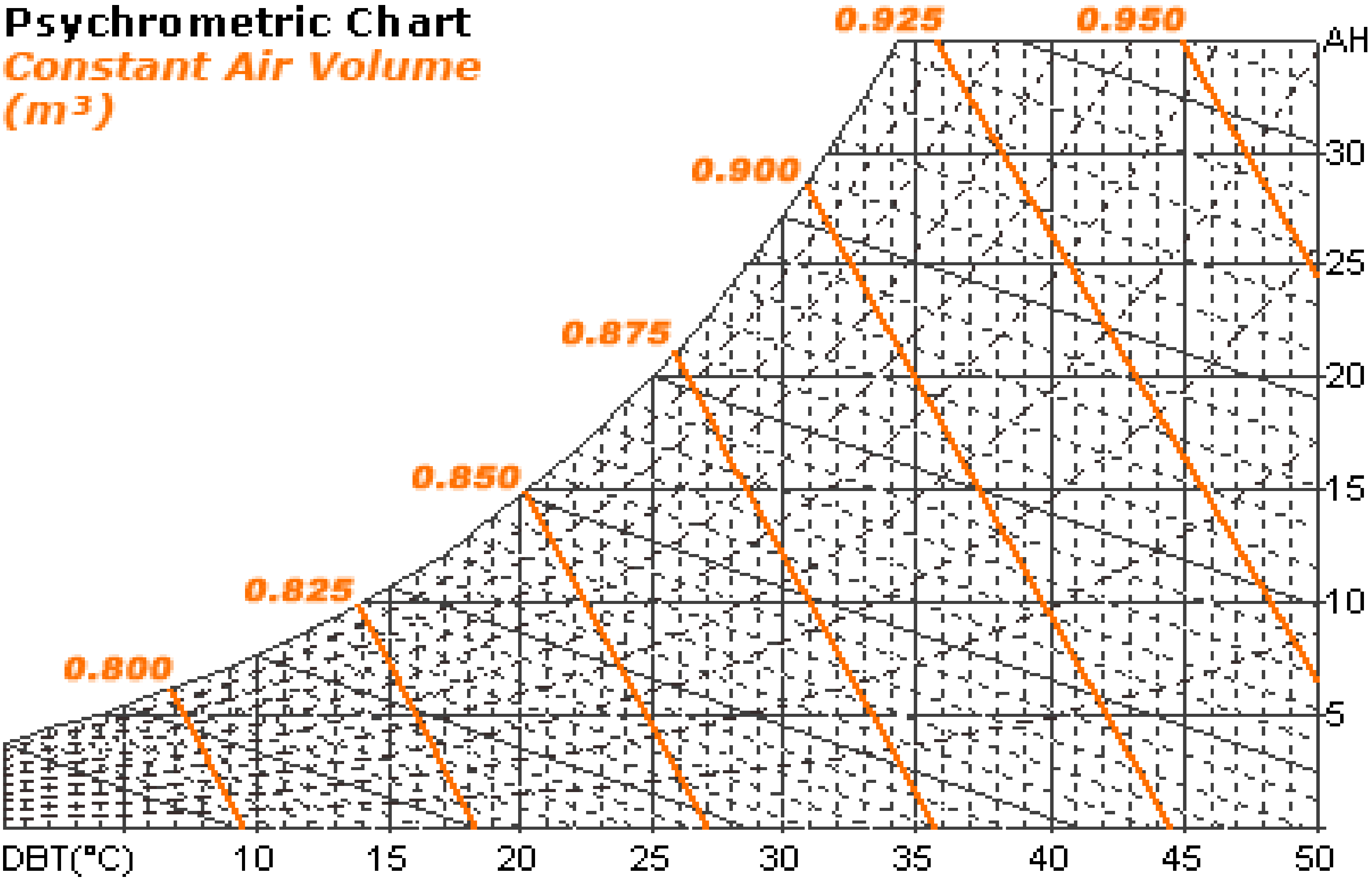


Chart to calculate quick Dewpoint temperature

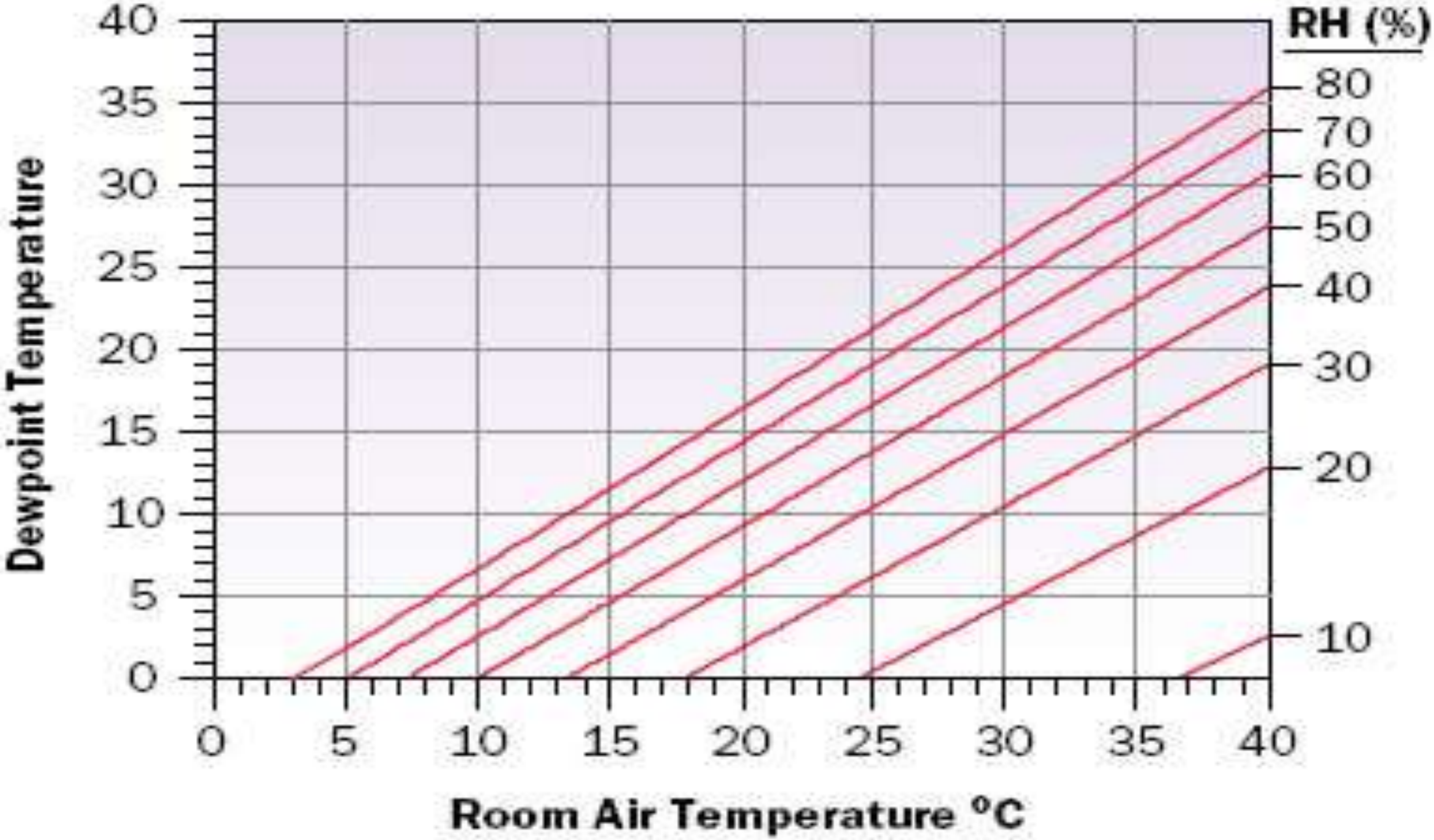
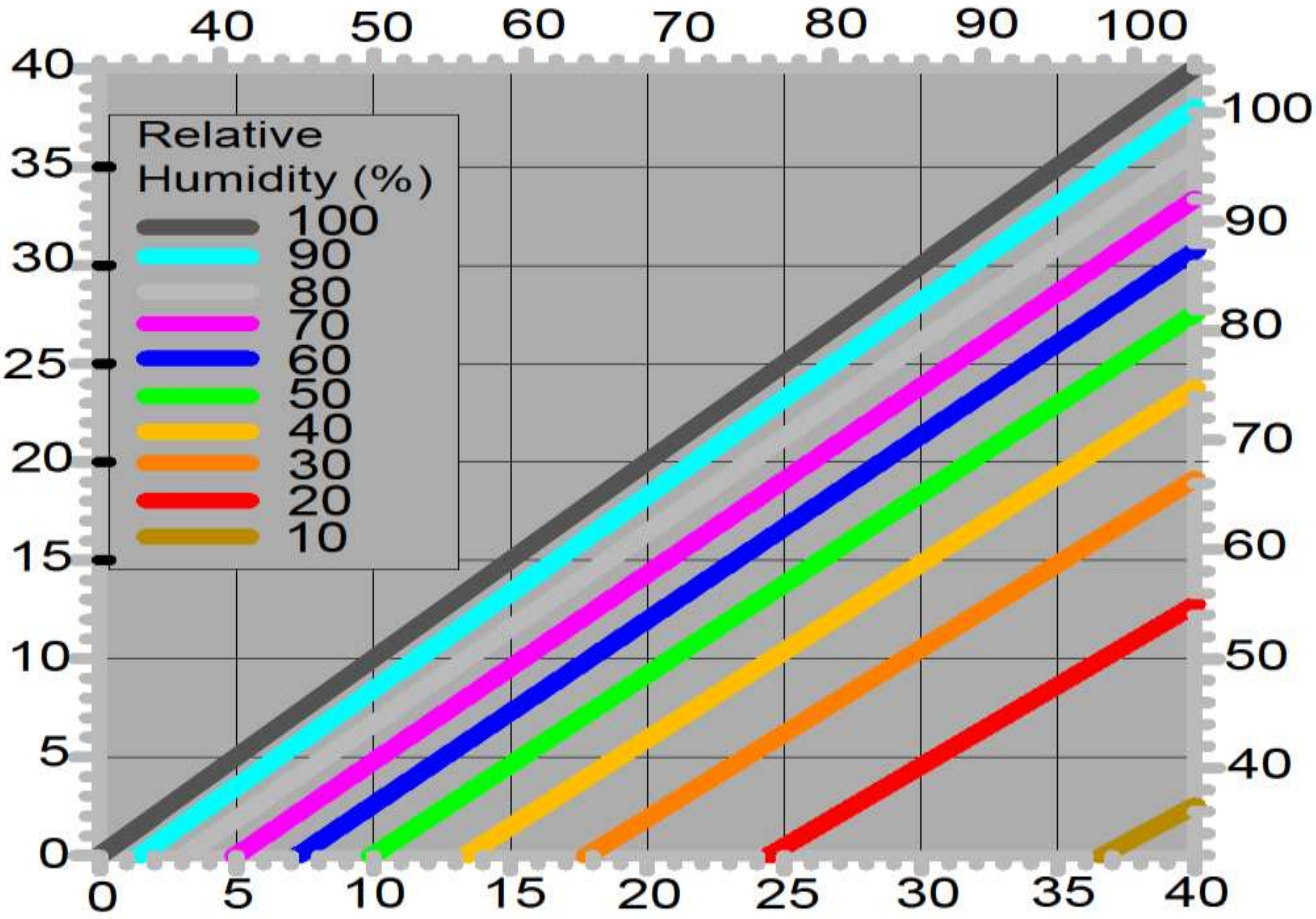
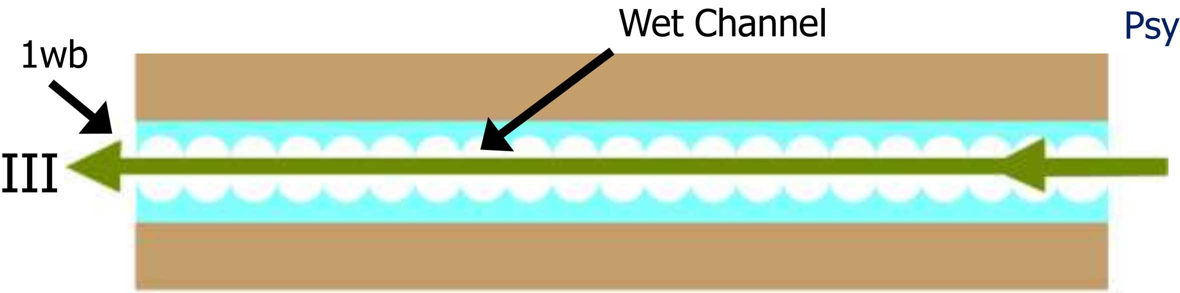


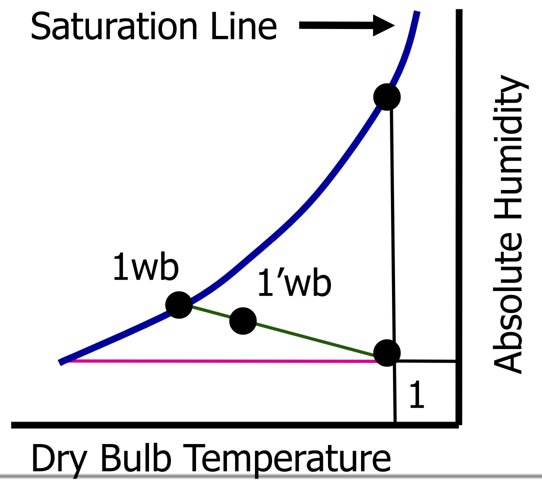
Chart to calculate quick Dewpoint temperature

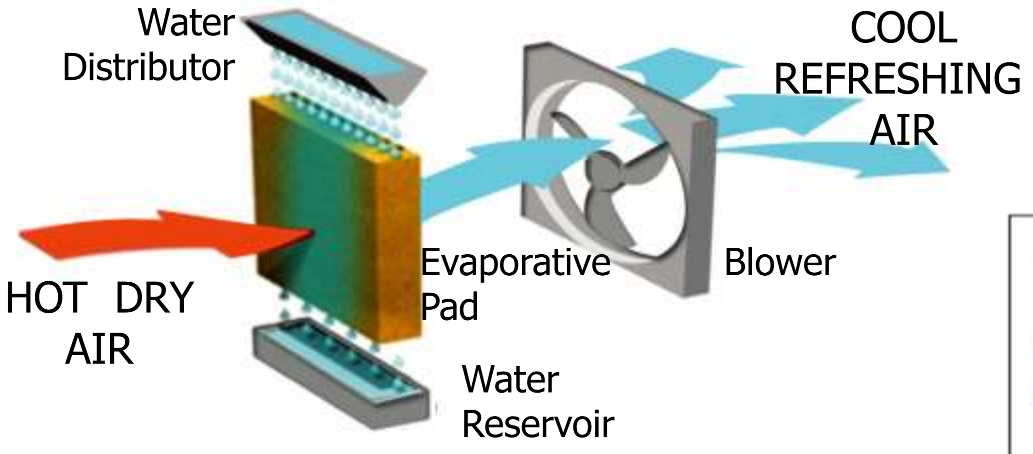


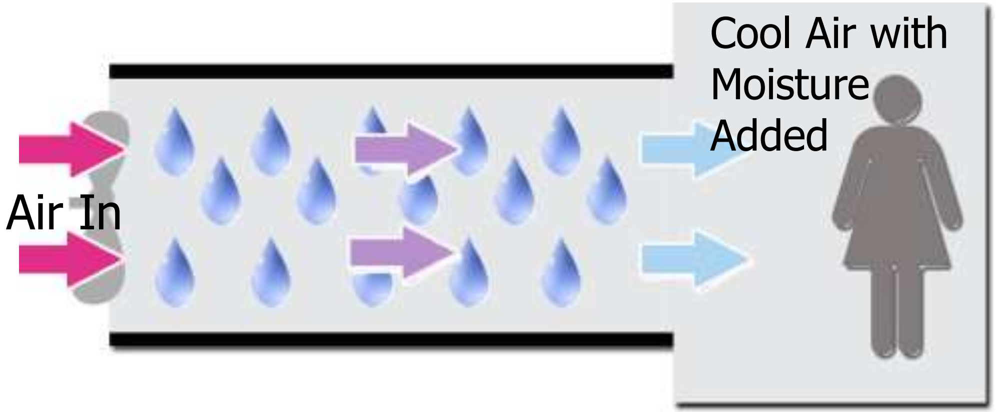
Direct evaporative cooling (DEC): Water evaporates directly into the air stream, thus reducing the air temperature while humidifying the air.

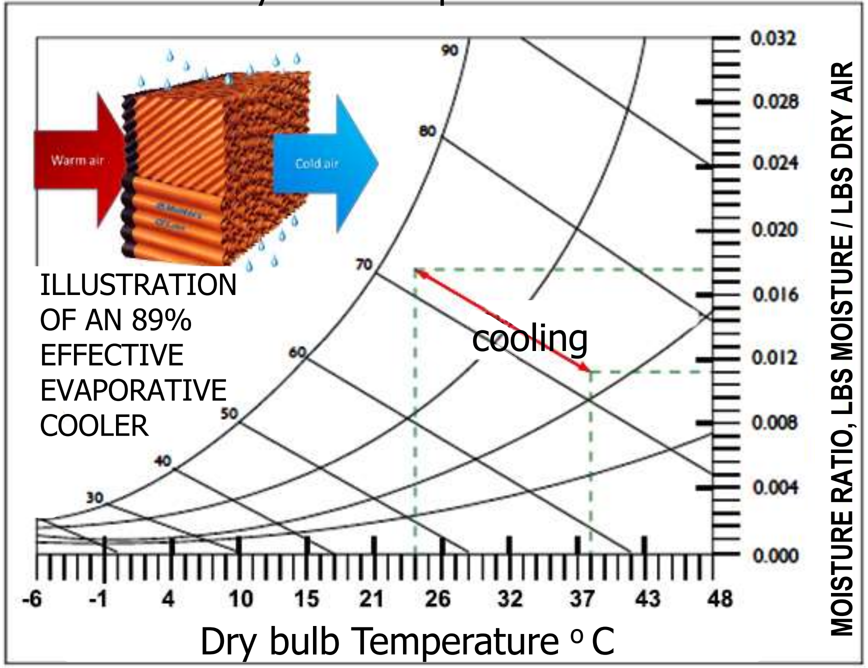


Psychometric chart of direct evaporative cooling









Direct evaporative cooling

"Effectiveness" is defined by the following equation:

$E = (TI_{db}-TD_{db}) \div (TI_{db}-TI_{wb})$

"Discharge Temperature" can be determined by the following equation:

$TD_{db} = TI_{db}-[E \times (TI_{db}-TI_{wb})]$

Factors affecting effectiveness are:

- Type of Media
- Depth of Media
- Face Velocity

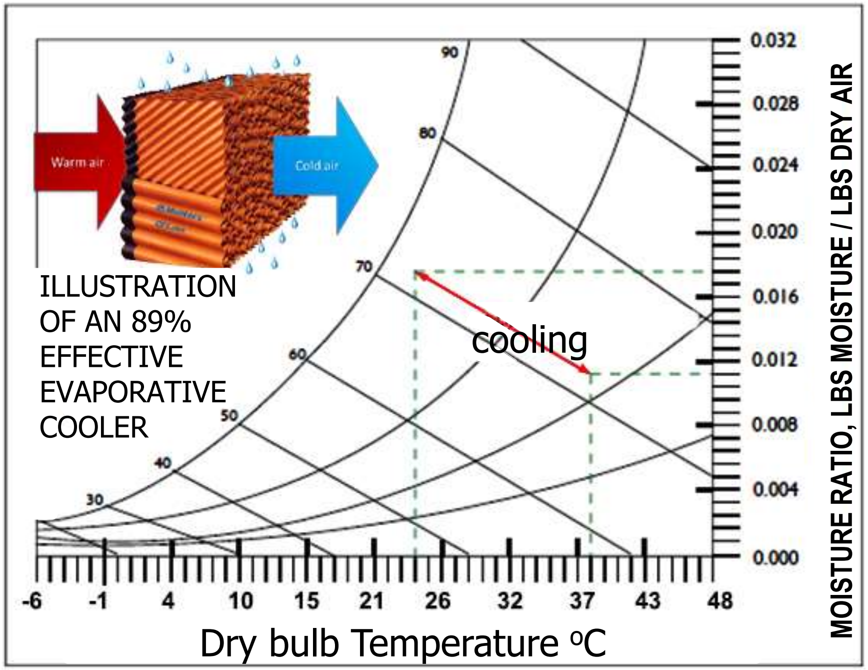
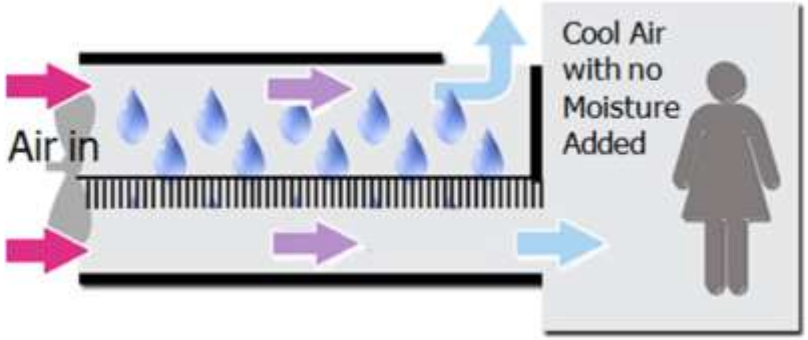


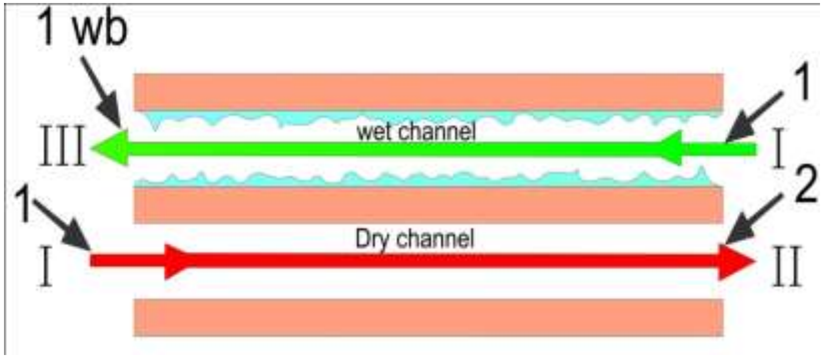
ILLUSTRATION OF AN 89% EFFECTIVE EVAPORATIVE COOLER

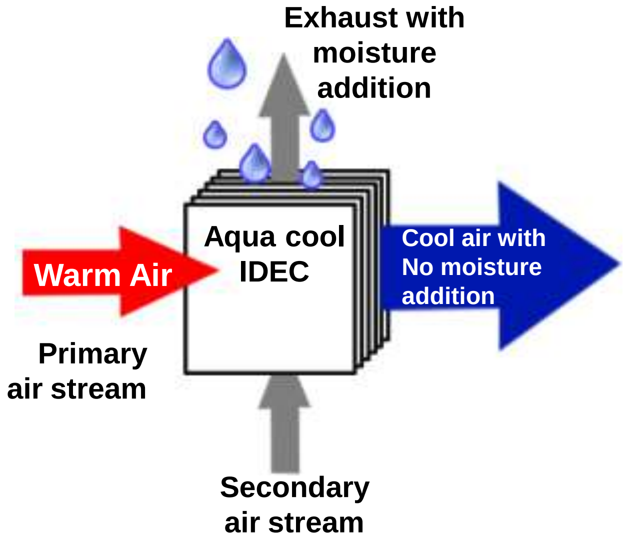
Indirect evaporative cooling (IEC):

Primary air is drawn across filters (5/10/20 microns depending upon requirement) and passed through sensible heat exchanger.

The primary air cooled sensibly with a heat exchanger, while the secondary air carries away the heat energy from the primary air as generated vapor







Exhaust with moisture addition

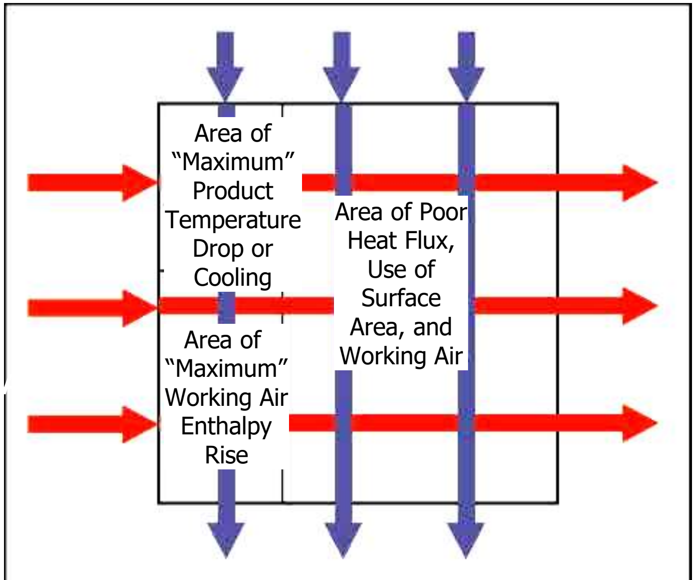
Aqua cool IDEC

Warm Air

Cool air with No moisture addition

Primary air stream

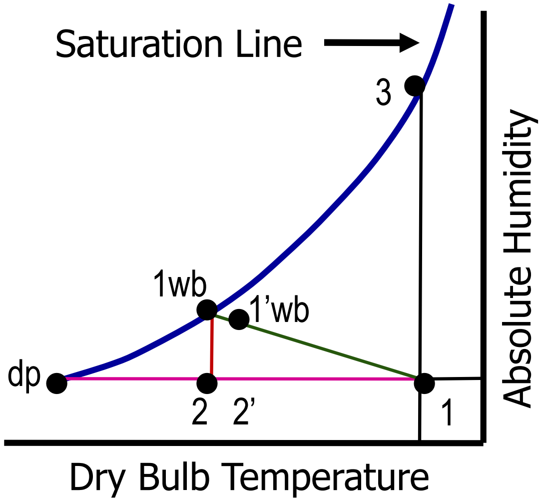
Secondary air stream



Area of "Maximum" Product Temperature Drop or Cooling

Area of Poor Heat Flux, Use of Surface Area, and Working Air

Area of "Maximum" Working Air Enthalpy Rise



Saturation Line

3

1wb

1'wb

dp

2 2'

1

Absolute Humidity

Dry Bulb Temperature

Indirect Evaporative Cooling

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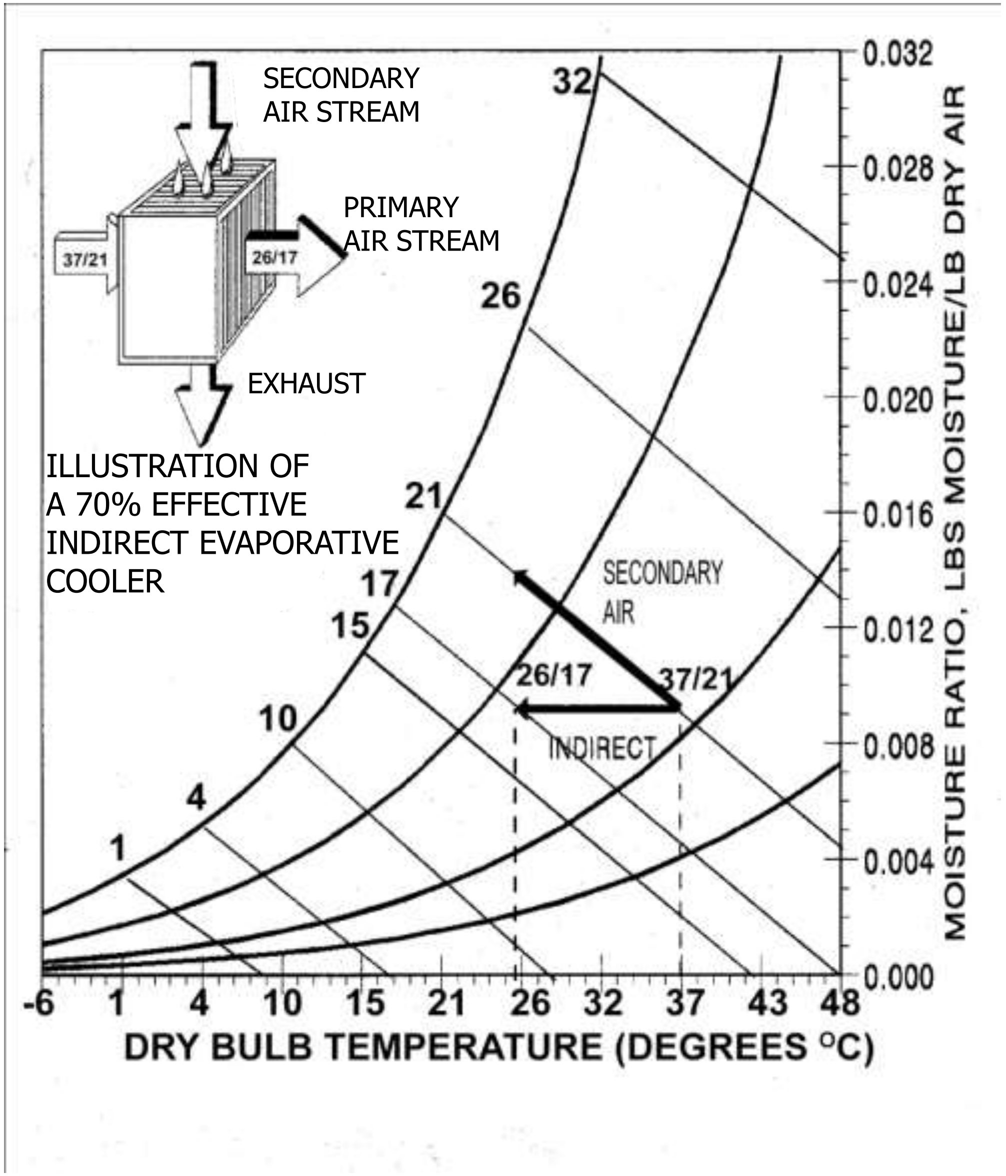
$$E = (TI_{db}-TD_{db}) \div (TI_{db}-TIS_{wb})$$

"Discharge Temperature" can be determined by the following equation:

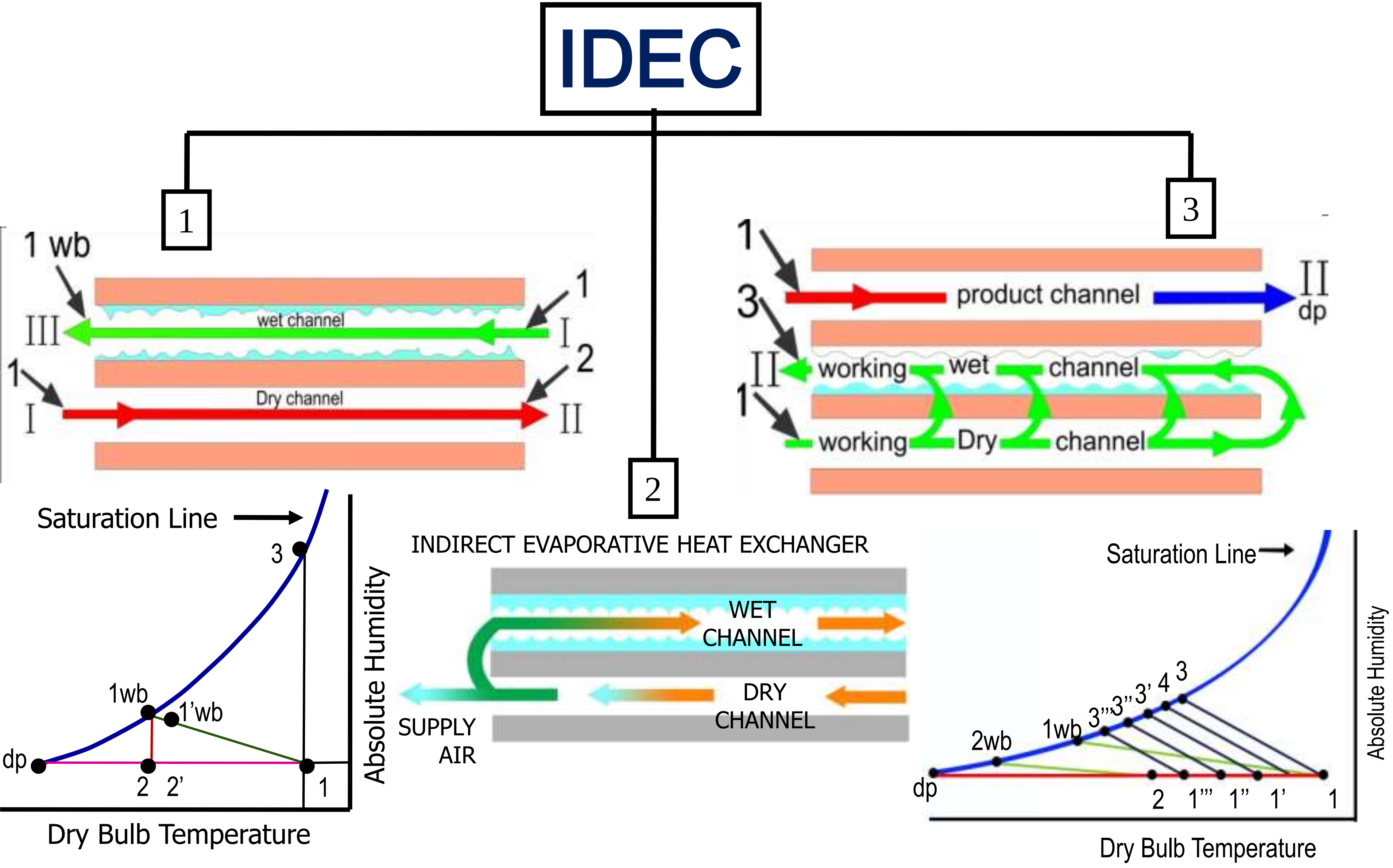
$$TD_{db}= TI_{db}-[E \times (TI_{db}-TIS_{wb})]$$

Factors affecting effectiveness are:

- Type of Heat Exchanger
- Supply Air Flow Through Exchanger
- Secondary Air Flow
- Use of Outside Air vs. Building Exhaust as the Secondary Air Source



Indirect evaporative cooling options



What Makes IEC an Attractive Alternative?

- Green is IN
- IEC is Energy Efficient
- IEC reduces green house gases
- IEC reduces demand charges – it works best on the hottest days
- The design mistakes of the past have, for the most part, been corrected
- New techniques to condition water have been developed

Indirect Evaporative Cooling

"Effectiveness" is defined by the following equation:

$$E = (TI_{db}-TD_{db}) \div (TI_{db}-TIS_{wb})$$

"Discharge Temperature" can be determined by the following equation:

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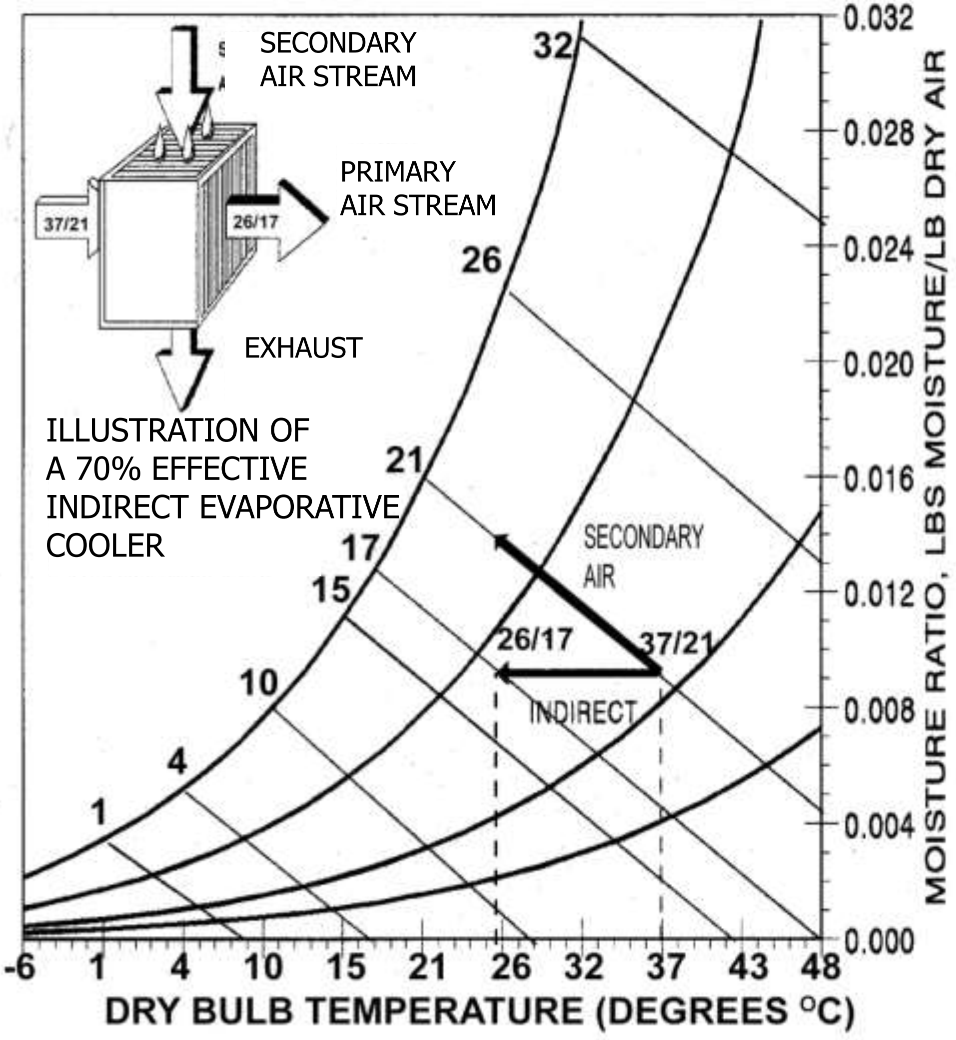
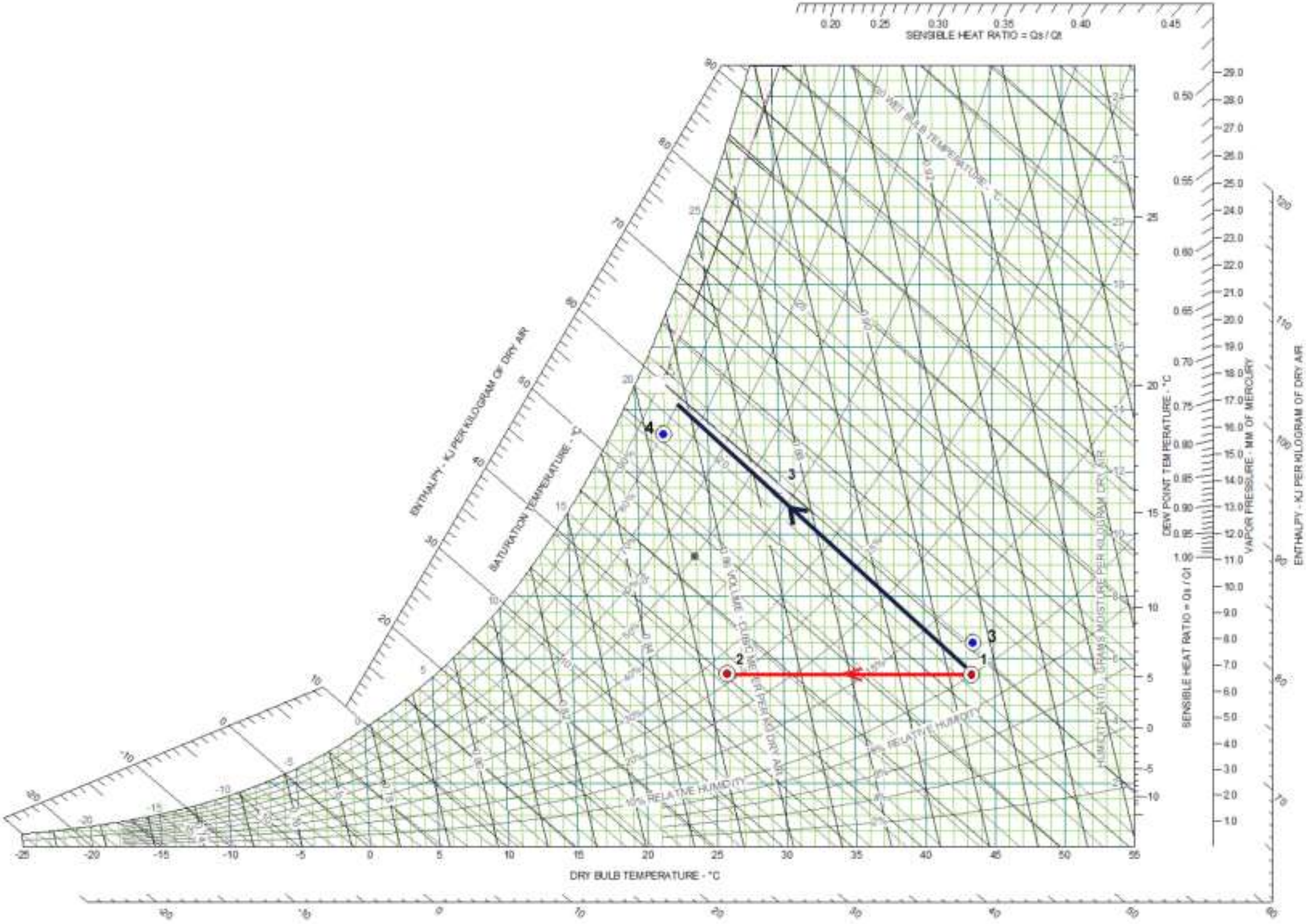


Psychometric chart showing cooling of fresh air by indirect evaporative cooling by using fresh air



Our offerings

Aqua cool - Ambiator family

- IEC
- IDEC
- IDEC+DX/CWC

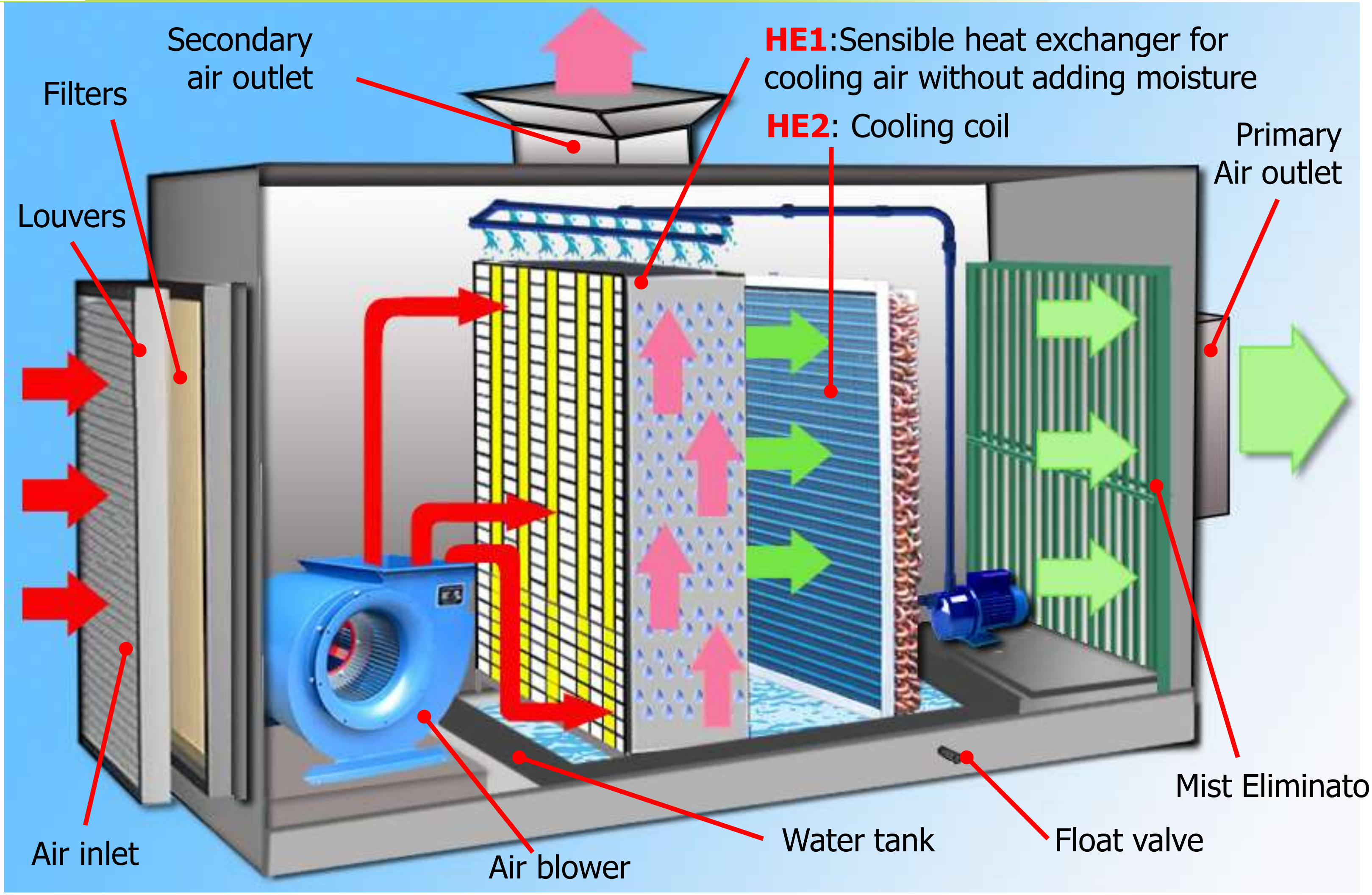
Aqua cool Pre-cooling unit family

- PCU-F
- PCU-R

Aqua cool heat & mass exchanger solution to cool fresh air pre cooling unit PCU–F (IEC + DX/CWC)

- The Aqua cool PCU – F is an excellent option to supply cooled fresh air to improve indoor air quality while simultaneously reducing the load on the compressor of the installed air conditioning system.
- Uses patented heat exchanger pre cool fresh air being supplied to air conditioned spaces or air handling units in the most economical manner.
- The total cooling capacity TR saved will vary from one location to another.
- Also an excellent option where the entire fresh air load is handled by the chiller or a DX system. Retrofitting of the existing fresh air handling unit is also possible with PCU-F.

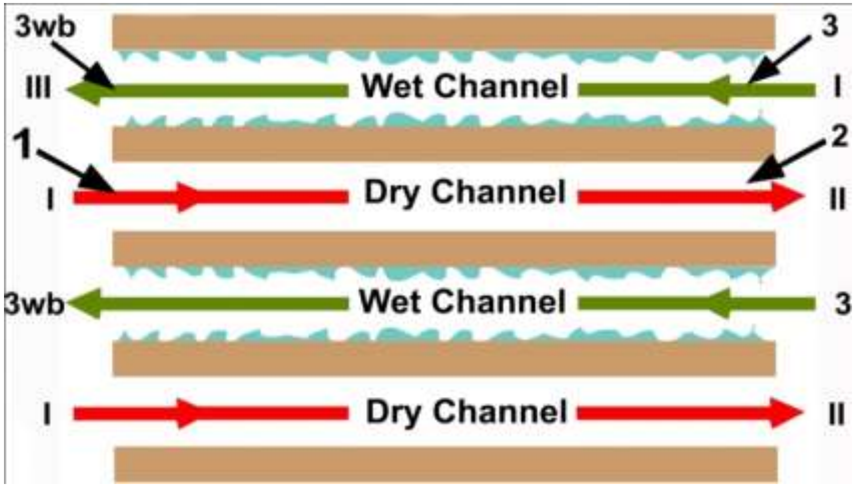
Aqua cool heat & mass exchanger solution to cool fresh air pre cooling unit PCU–F (IEC + DX/CWC)



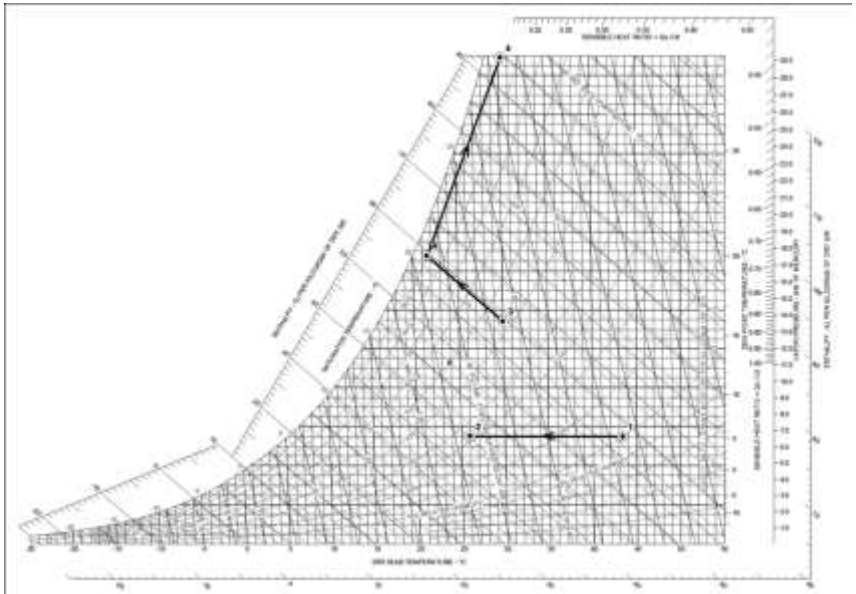
The primary air stream is cooled first with indirect evaporative cooling. This cools the primary air stream to the desired temperature. When more cooling is required, the supplemental DX/CWC module cools the air further to reach the desired temperature.

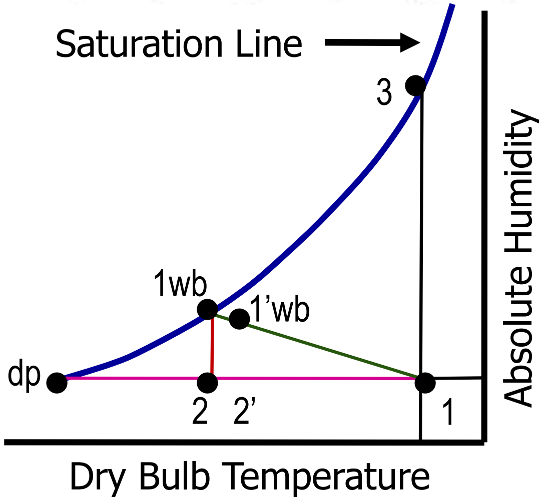
Cooling of fresh air by using outside fresh air or return air from the building

Return Air from building

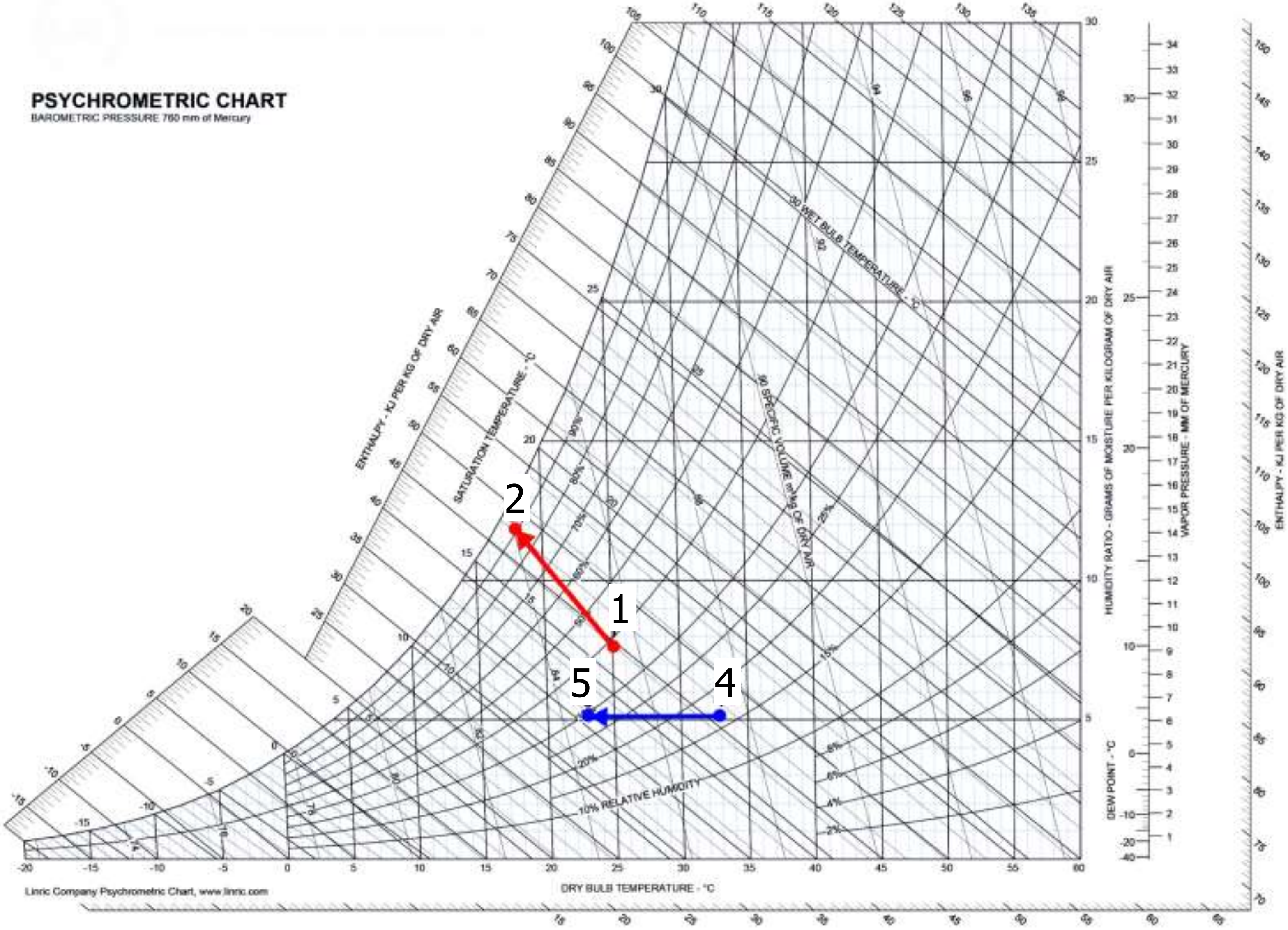


Fresh air





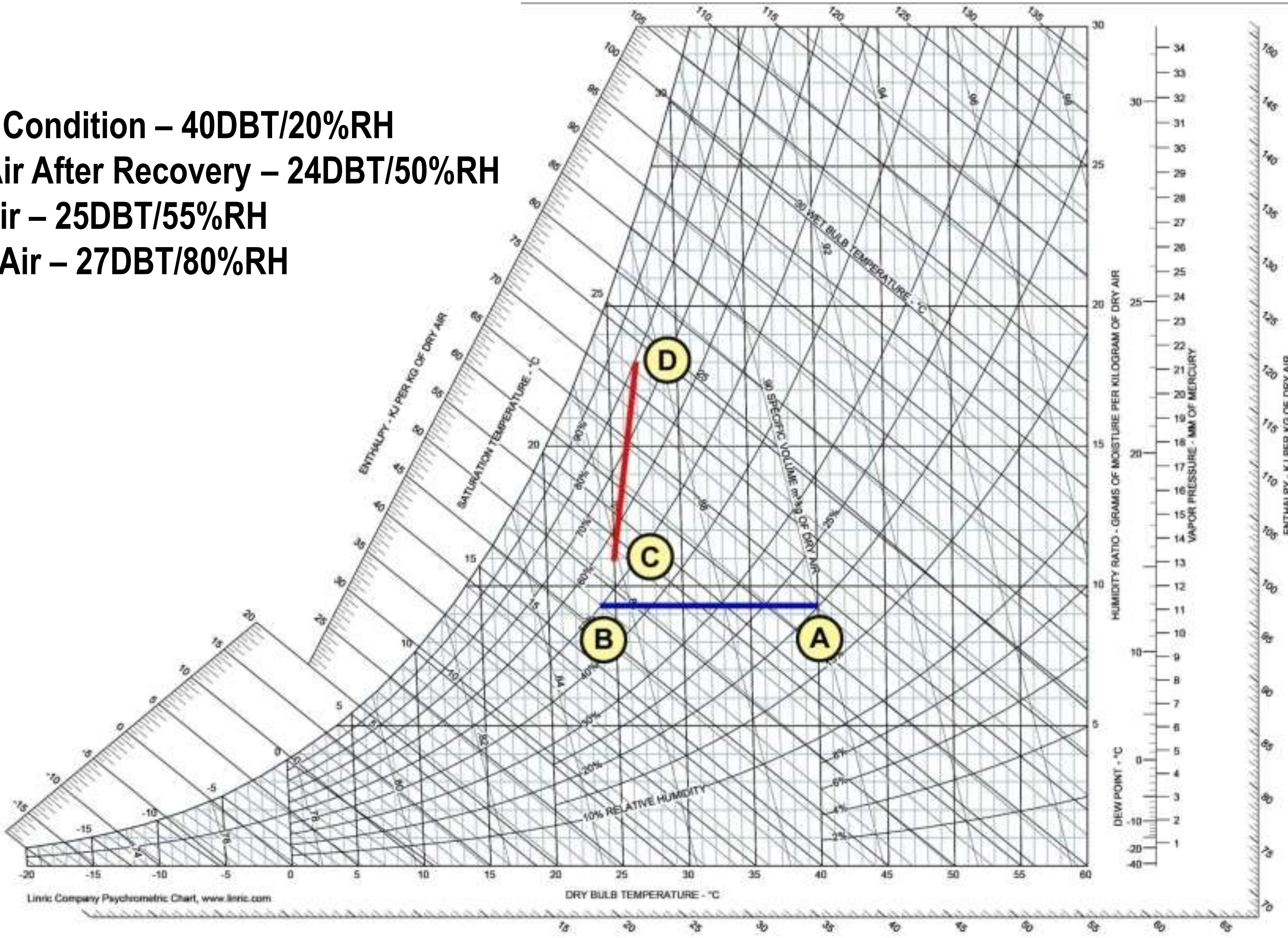
Schematic diagram of indirect evaporative cooling for fresh air cooled by exhaust air from the building



Cooling of fresh air by using return air of the building

Example:

A. Ambient Condition – 40DBT/20%RH
B. Supply Air After Recovery – 24DBT/50%RH
C. Return Air – 25DBT/55%RH
D. Exhaust Air – 27DBT/80%RH



Evaporative Cooling

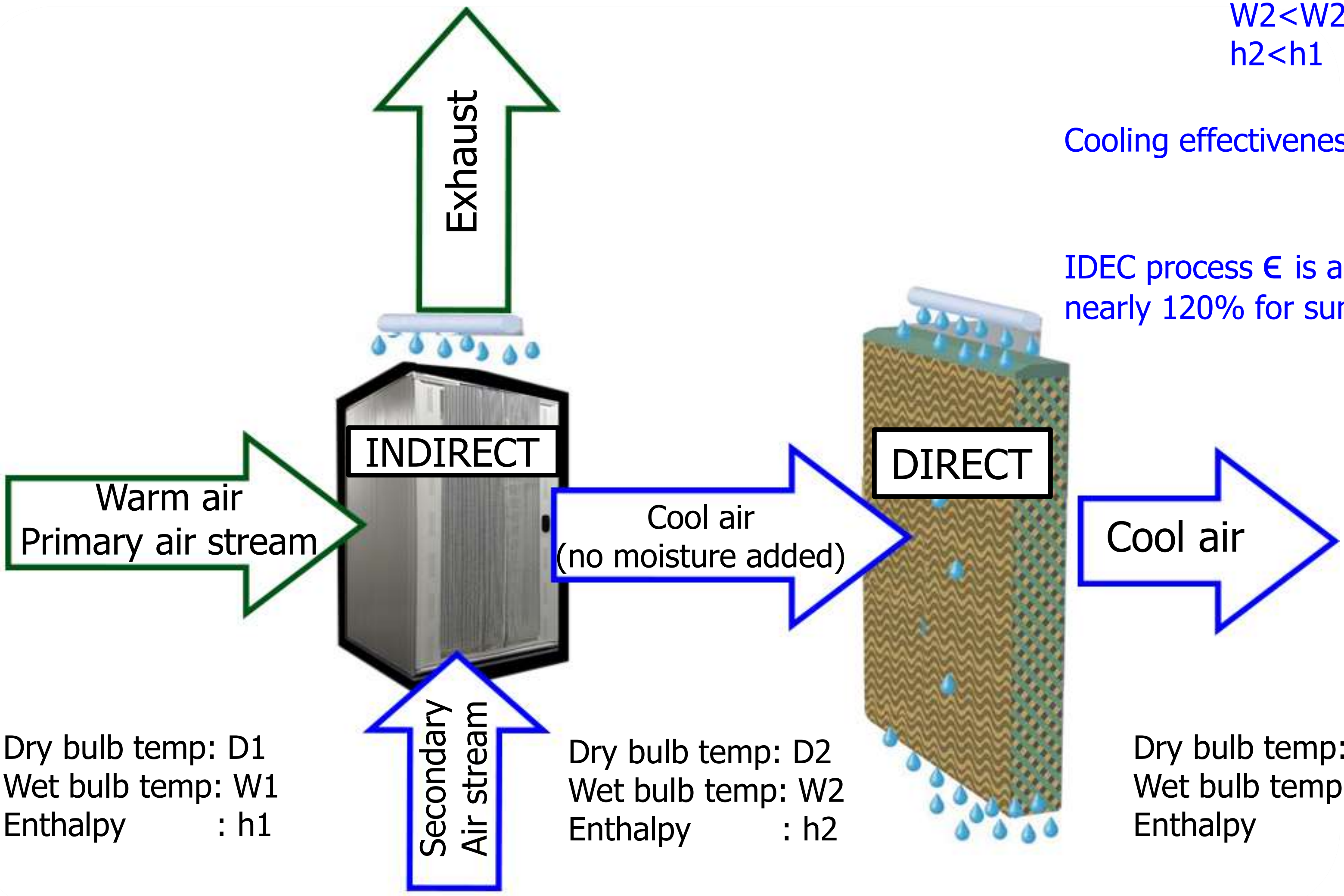
- ✓Principle of IDEC (indirect direct evaporative cooling)
- ✓Two-stage evaporative air cooling

In IDEC process:

D3<D2<D1
W2<W2
h2<h1

Cooling effectiveness (∈): $\frac{D1-D3}{D1-W1}$

IDEC process ∈ is always >100%; nearly 120% for summer



Exhaust

INDIRECT

Warm air
Primary air stream

Cool air
(no moisture added)

DIRECT

Cool air

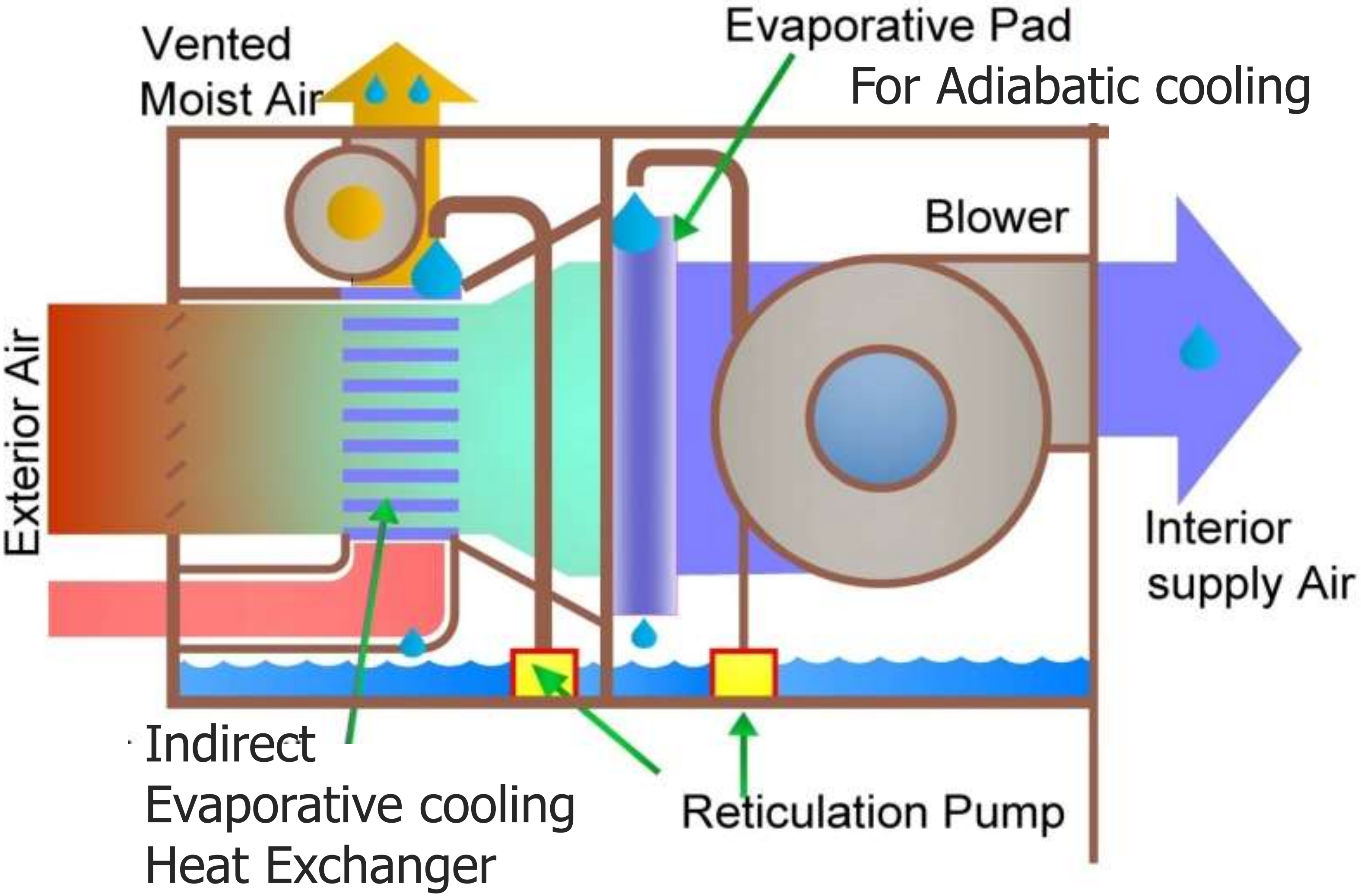
Secondary
Air stream

Dry bulb temp: D1
Wet bulb temp: W1
Enthalpy : h1

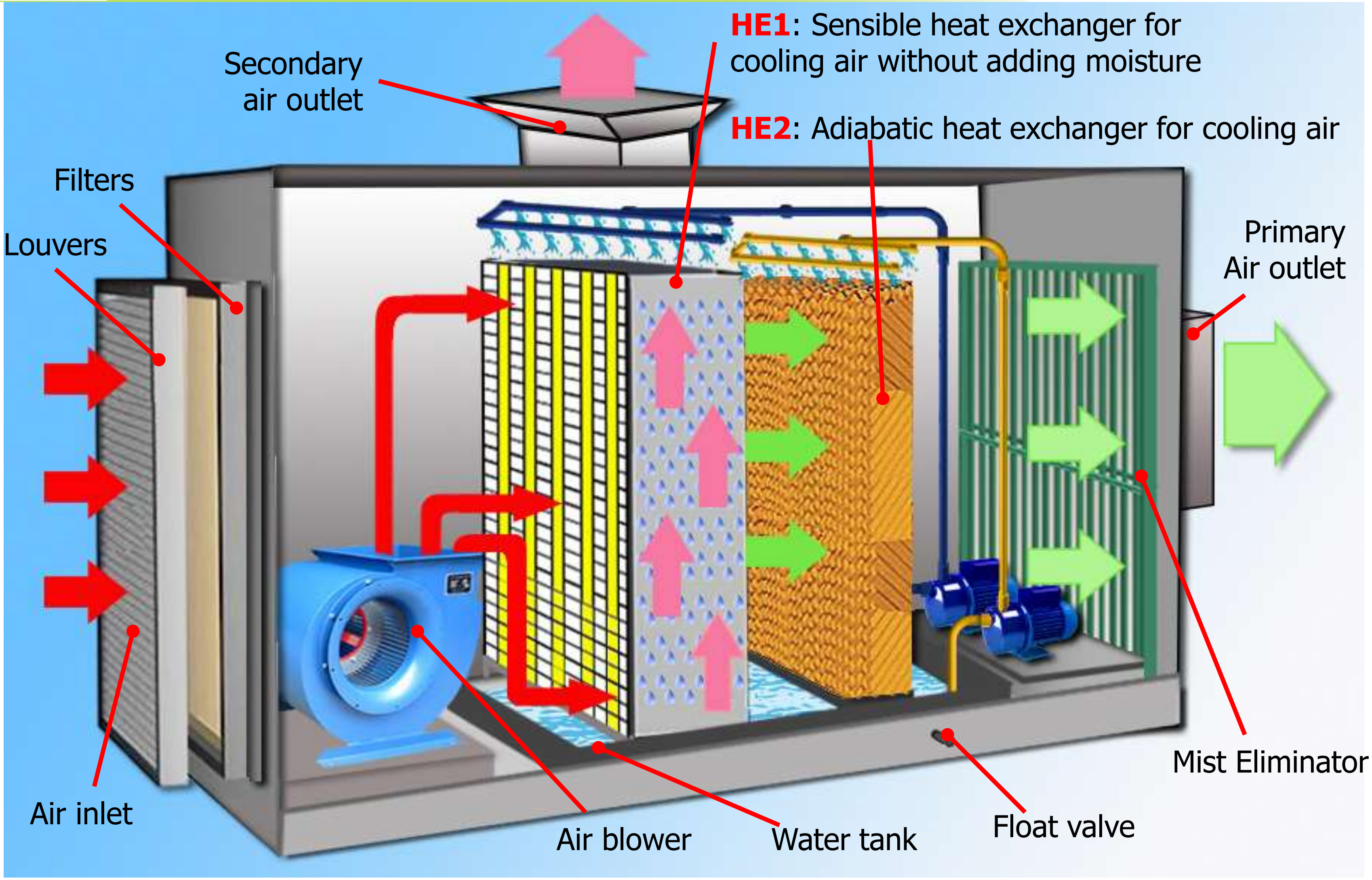
Dry bulb temp: D2
Wet bulb temp: W2
Enthalpy : h2

Dry bulb temp: D3
Wet bulb temp: W3
Enthalpy : h3

Indirect & Direct Evaporative cooling



Aqua cool Indirect & Direct Evaporative cooling (IDEC)

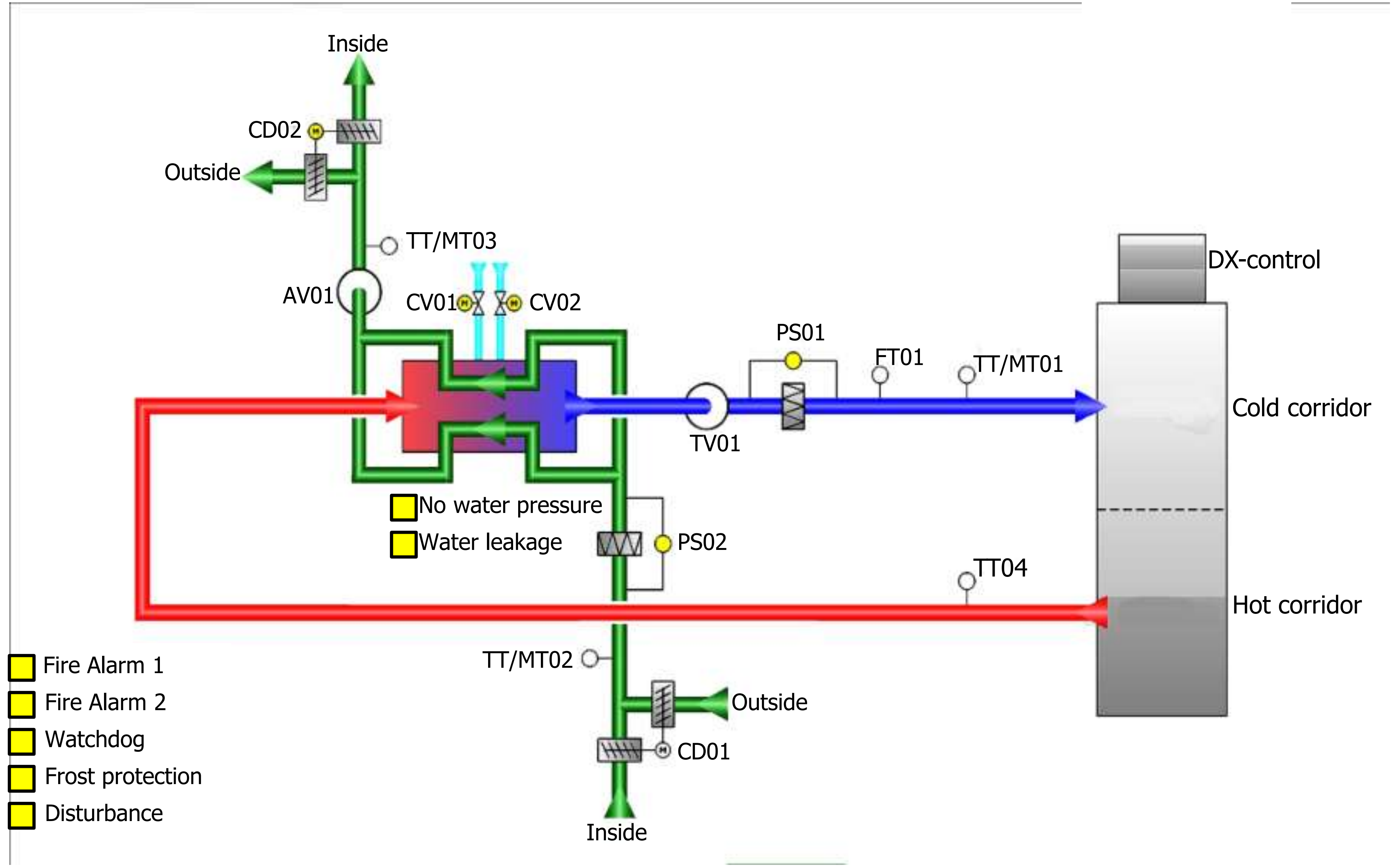

Secondary air outlet

HE1: Sensible heat exchanger for cooling air without adding moisture

HE2: Adiabatic heat exchanger for cooling air

With indirect/direct evaporative cooling, the primary air stream is cooled first with indirect evaporative cooling and then cooled further with direct evaporative cooling

Schematic overview of datacenter controller

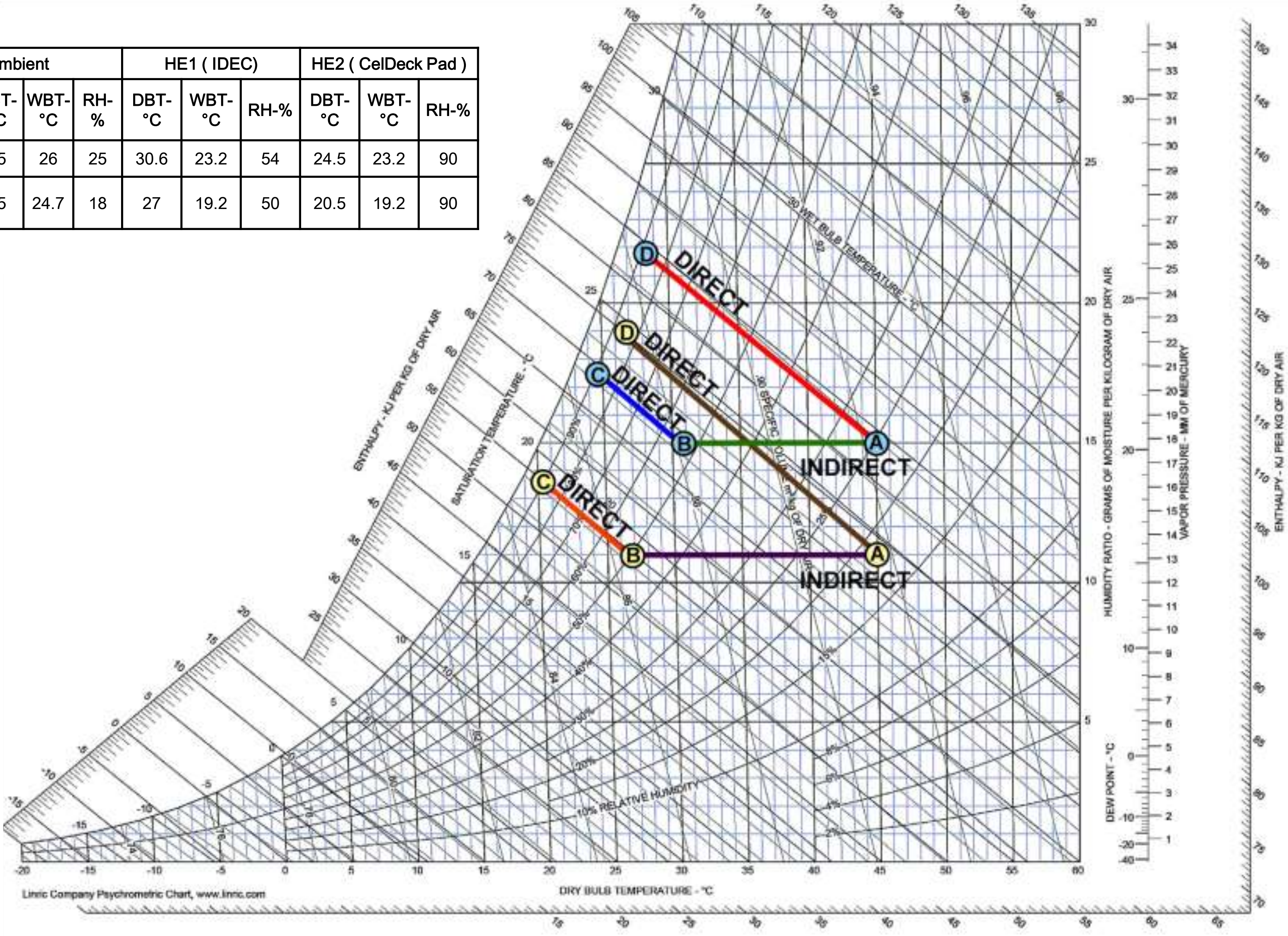


Title

Title

Comparison between direct & indirect direct Evaporative Cooling for city Dubai , Al Ain

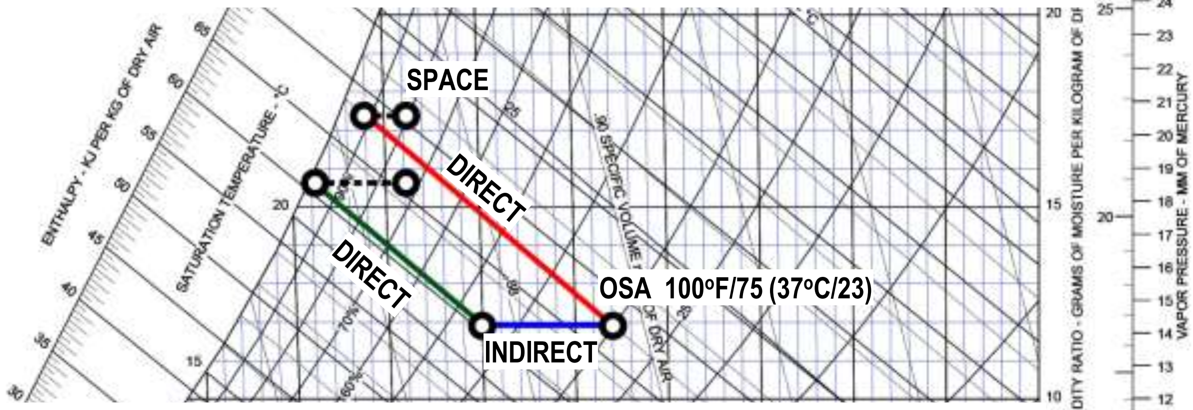
	Ambient				HE1 (IDEC)			HE2 (CelDeck Pad)		
	DPT C	DBT-°C	WBT-°C	RH-%	DBT-°C	WBT-°C	RH-%	DBT-°C	WBT-°C	RH-%
DUBAI	20.5	45	26	25	30.6	23.2	54	24.5	23.2	90
RIYADH or AL AIN	15.5	45	24.7	18	27	19.2	50	20.5	19.2	90



Linric Company Psychrometric Chart, www.linric.com

Comparison with direct evaporative cooling

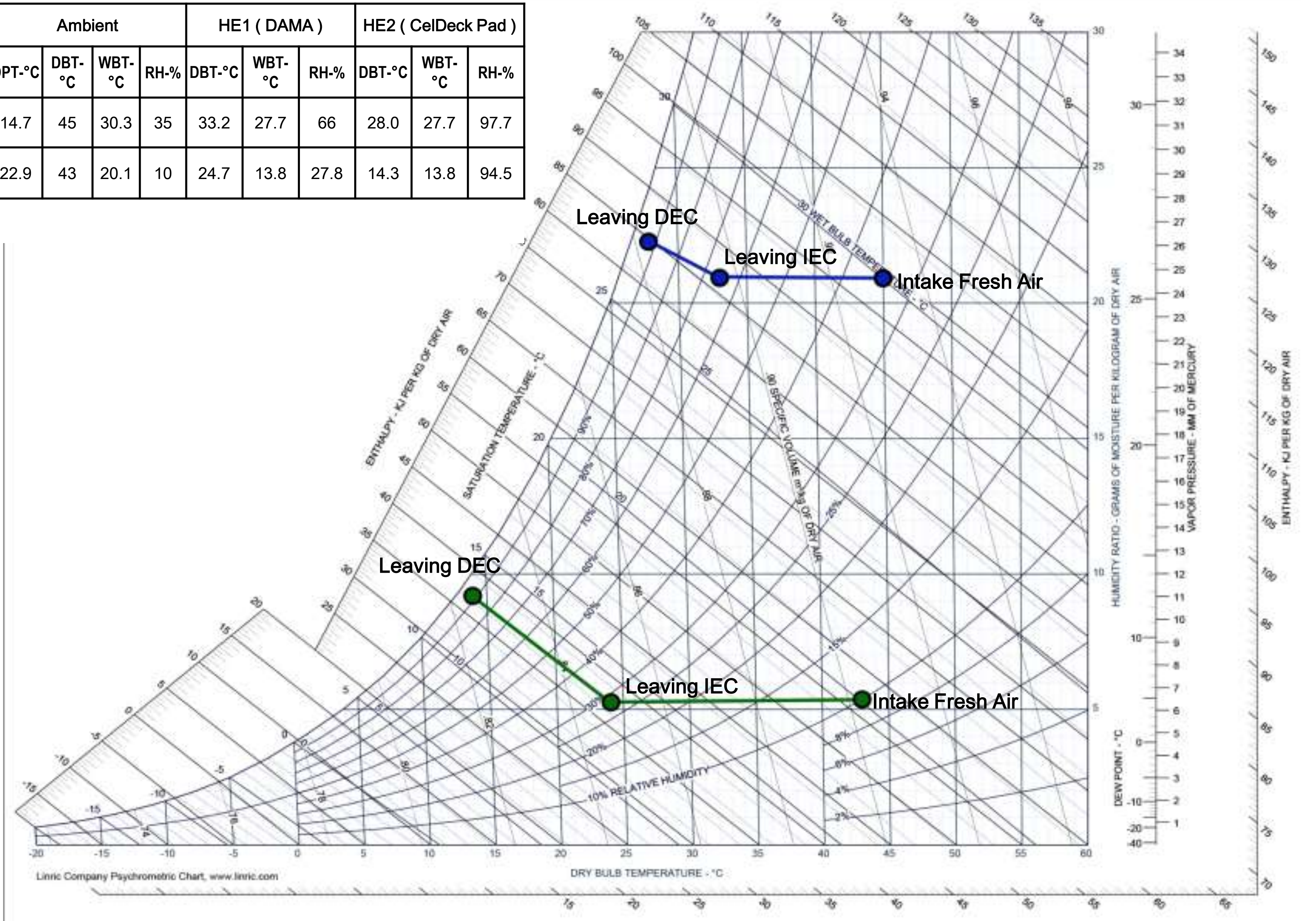
Due to the greater cooling effectiveness of an Indirect/Direct system compared to a Direct system, the Indirect/Direct system can maintain the same space condition with less air can have a significant affect on the economics of the ventilation system: (1) The air handler will be smaller since less air needs to be delivered into the space; (2) The ductwork will be smaller since less air is required; (3) Smaller motors will be required. This will result in a ***lower first cost*** as well as lowering operating costs for the Indirect/Direct system. This will result in a lower first cost as well as ***lower operating costs*** for the Indirect/Direct system.



- Hypothetical Building: 500’x 200’x 25’ (old building with moderate internal heat)
- Building Cooling Load: 20’ to 30’ Btu/SqFt (assume 30 for this example) 500’ x 200’ x 30 Btu/SqFt = 300,000 Btu/Hr
- Internal Heat Cooling Load: 0 to 20 Btu/SqFt (assume 10 for this example) 500’ x 200’ x 10 Btu/SqFt = 100,000 Btu/Hr
- Total Cooling Load: 300,000 + 100,000 = 400,000 Btu/Hr
- Btu/Hr = Cfm supply air x 1.08 x AT
- Direct evaporative system provides 8°F (-13°C) differential (discharge to space)
- Required Cfm (Direct system): 400,000/1.08/ 8°F(-13°C) = **46,296 Cfm**
- Indirect/Direct evaporative system provides 14°F (-10°C) differential (discharge to space)
- Required Cfm (Indirect/Direct system): 400,000/1.08/ 14°F (-10°C) = **26,455 Cfm**
- Use of **Stratification** and **Spot Cooling** strategies will reduce the actual cooling load approximately in half
- Required Cfm (Direct system): 46,295/2=**23,148 Cfm**
- Required Cfm (Inirect/Direct system): 26,455/2=**13,227 Cfm**

Performance of Aqua cool in the afternoon 12 A.M. with indirect and direct cooling process , Dubai , Riyadh and Al-Ain

	Ambient				HE1 (DAMA)			HE2 (CelDeck Pad)		
	DPT-°C	DBT-°C	WBT-°C	RH-%	DBT-°C	WBT-°C	RH-%	DBT-°C	WBT-°C	RH-%
DUBAI	14.7	45	30.3	35	33.2	27.7	66	28.0	27.7	97.7
RIYADH or AL AIN	22.9	43	20.1	10	24.7	13.8	27.8	14.3	13.8	94.5



Hi-Tech

Advantages over Air-washer

Aqua cool
healthy fresh air

Significant upgrade over air-washer

- Provide more cooling with same machine capacity as an air-washer
- Saves power for the same cooling effect as an air-washer

For same machine capacity

- More temperature drop (4 to 5 ºC) in Aqua cool vs Air-washer
- Aqua cool cools air without adding moisture in air during sensible cooling process in indirect evaporative cooling or little moisture to acceptable limit in case of indirect / direct evaporative cooling as compared to what Air-Washer does

Comparison

Aquacool: Comparison with direct evaporative systems

Aqua cool

e ϴ	30º	31º	32º		34º	35º	36º	37º	38º	39º	40º	41º	42º	43º	44º	45º
20%	16	16	17	17	18	18	19	19	20	20	21	21	23	22	23	24
25%	17	17	18	18	19	20	20	20	21	22	22	23	24	24	25	26
30%	18	18	19	20	20	21	22	22	23	23	24	25	25	26	27	27
40%	20	21	21	22	23	23	24	25	26	26	27	28	28	29	30	31
50%	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34
60%	24	25	25	26	26	27	29	30	30	31	32	33	34	35	36	37

e Relative Humidity

ϴ Dry bulb temperature

ϴh Wet bulb temperature

Conclusion:
Aqua cool outperforms traditional evaporative systems!

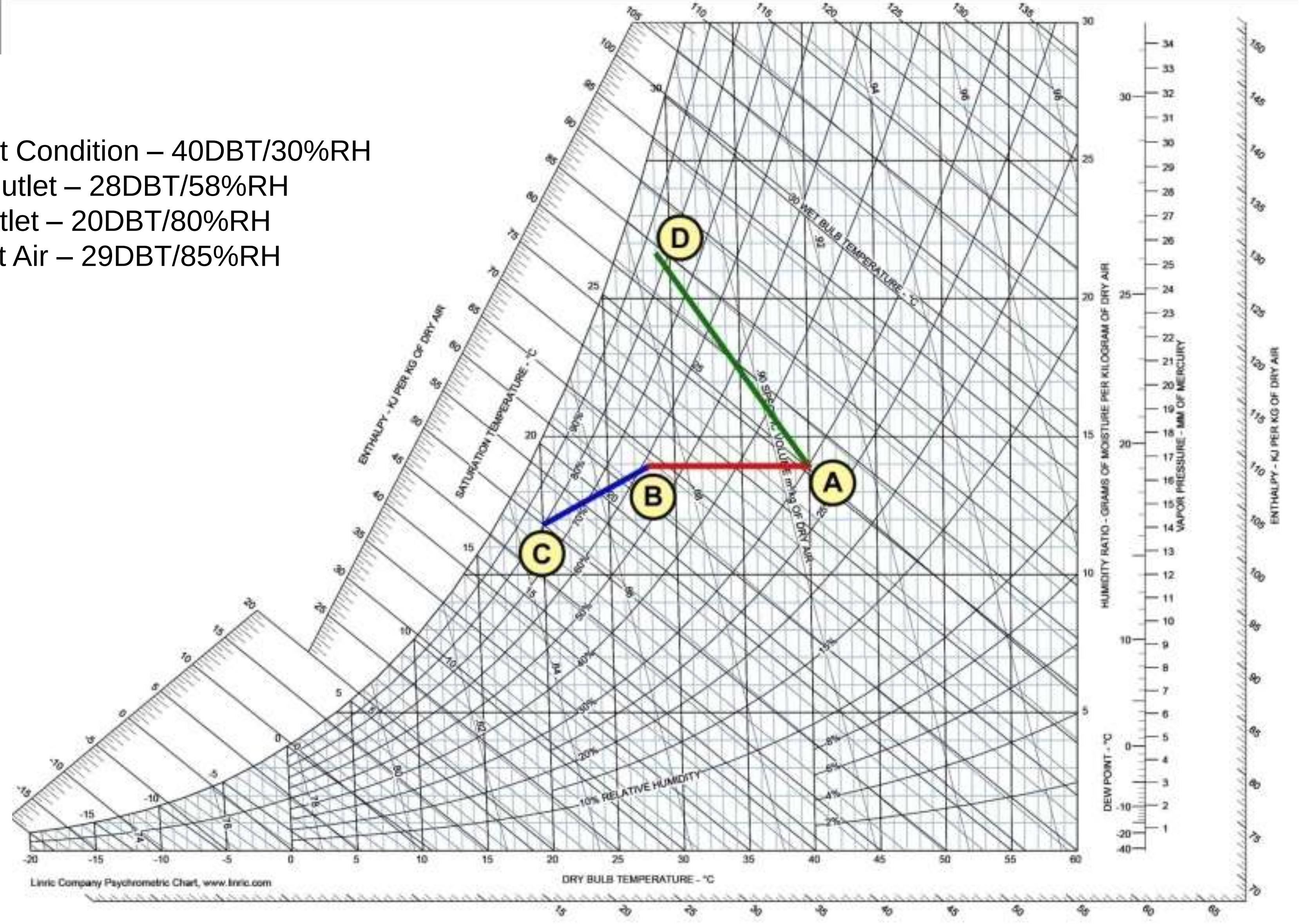
Evaporative system

e ϴ	30º	31º	32º	33º	34º	35º	36º	37º	38º	39º	40º	41º	42º	43º	44º	45º
20%	20	20	21	22	23	23	24	25	26	27	27	27	28	29	30	31
25%	21	21	22	23	24	24	25	26	27	28	29	29	30	31	32	33
30%	22	23	23	24	25	26	27	28	28	29	30	30	31	32	33	34
40%	23	24	25	26	27	27	28	29	29	30	31	32	33	34	35	36
50%	24	25	26	27	28	29	30	31	31	32	33	34	34	35	36	37
60%	25	27	28	29	30	31	32	33	33	34	35	36	36	37	38	39

Fresh air handling cooling by Indirect evaporative cooling and chilled water coil

Example:

A. Ambient Condition – 40DBT/30%RH
B. IDEC Outlet – 28DBT/58%RH
C. TFA Outlet – 20DBT/80%RH
D. Exhaust Air – 29DBT/85%RH



Working Principle of dew point cooler

•The Aqua cool has patented heat exchanger that forms the core of an air cooling system.

•The heat exchanger consists of proprietary plates made of polypropylene. Inside these plates there are air
•channels, through which primary air is blown, usually fresh ambient air.

•The outside of the heat exchanger plates are covered with a hygroscopic layer, which is externally moisturized by
•water. Due to forced evaporation of the water on the surface of the plates energy is extracted and this indirectly
•cools the air inside the channels.

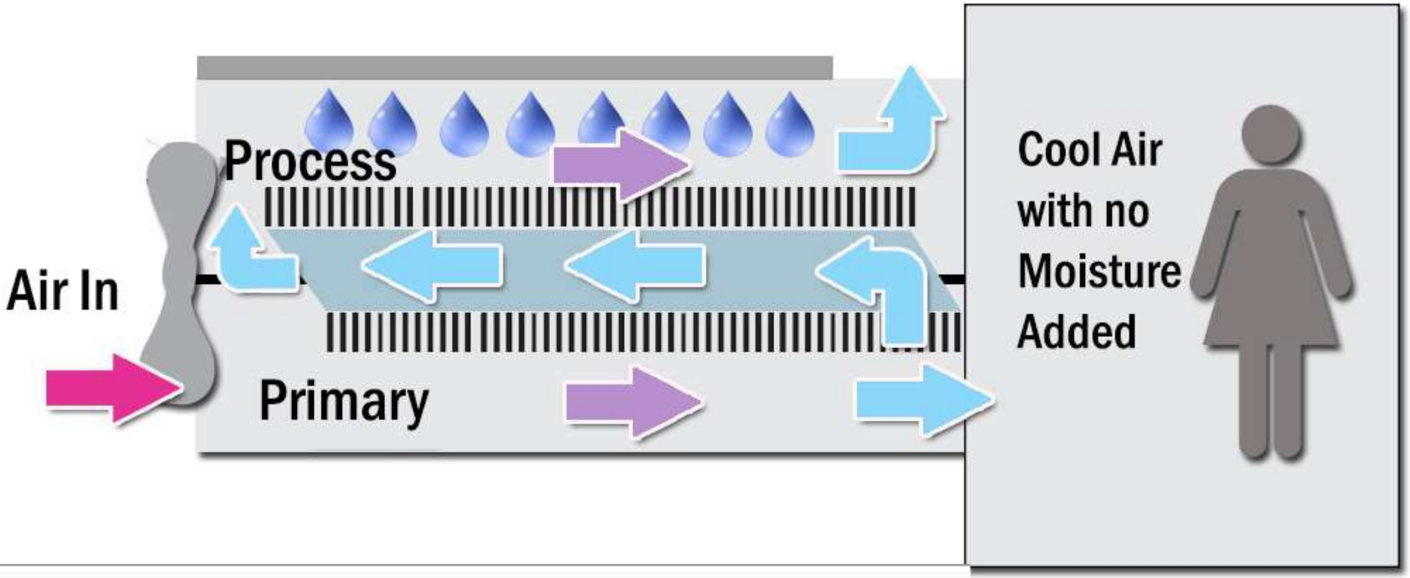
•100% primary air is cooled in the heat exchanger, 70% of the cooled air is supplied to the space which needs to be conditioned and a 30% of the cooled air is derived as scavenger air in a counter flow along the hygroscopic layer on the outside of air channels in the heat exchanger.

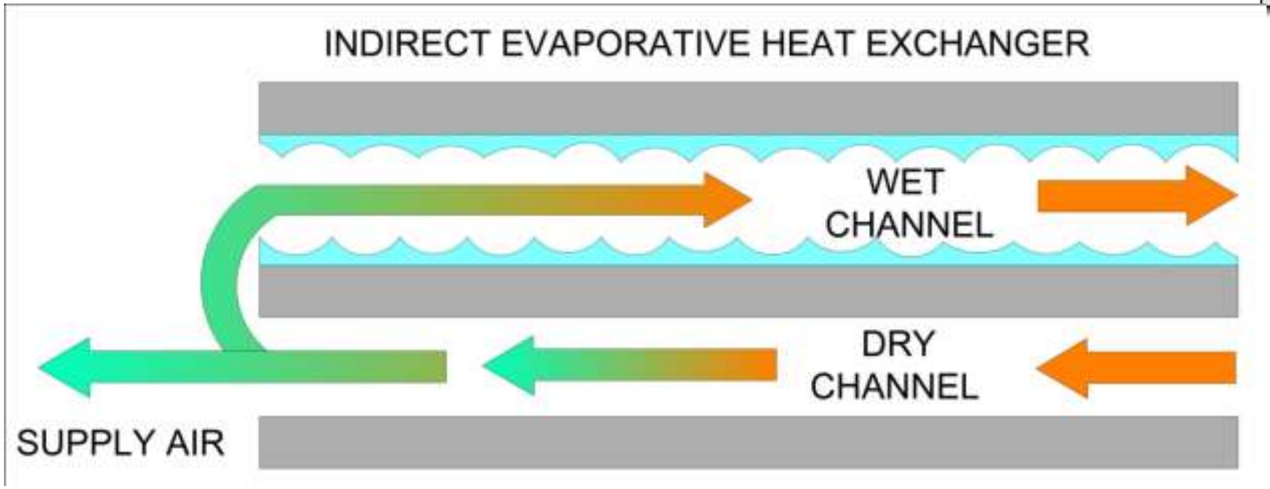
Principle of dew point indirect evaporative cooling

Hi-Tech

Aqua cool
healthy fresh air

Dew-point cooling

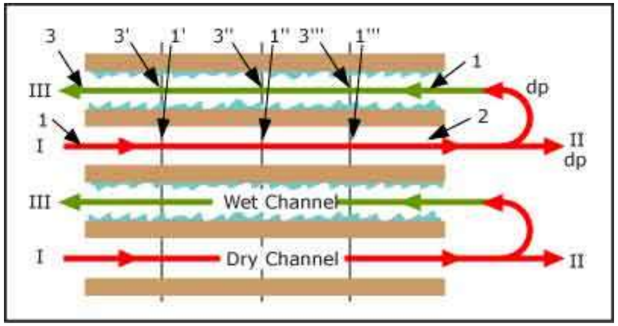


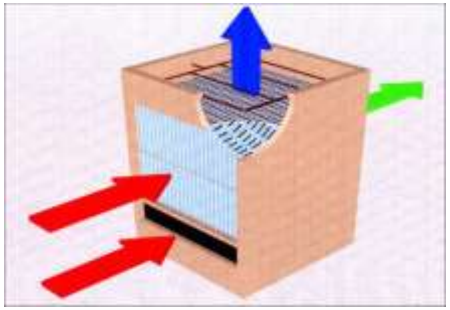


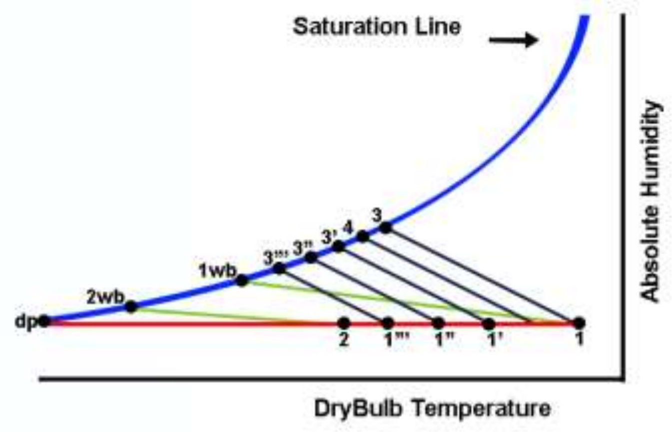
Working Principle of counter flow indirect evaporative cooling

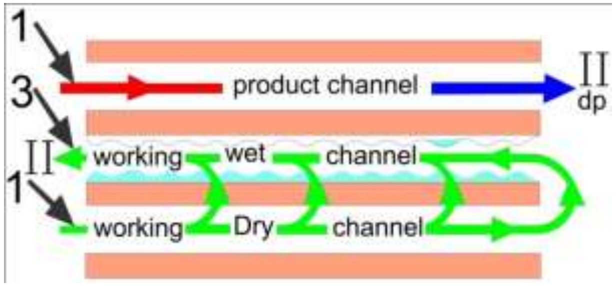
Counter flow Indirect evaporative cooling (IEC):

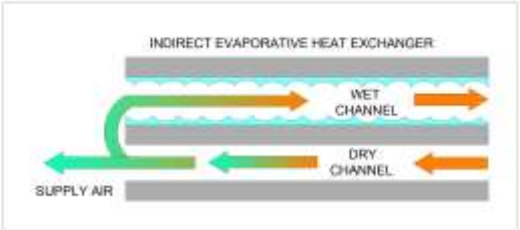
Primary air is cooled sensibly with a heat exchanger, and part of the cooled primary air is diverted in to wet channel and secondary air carries away more amount of heat energy from the primary air as generated vapor

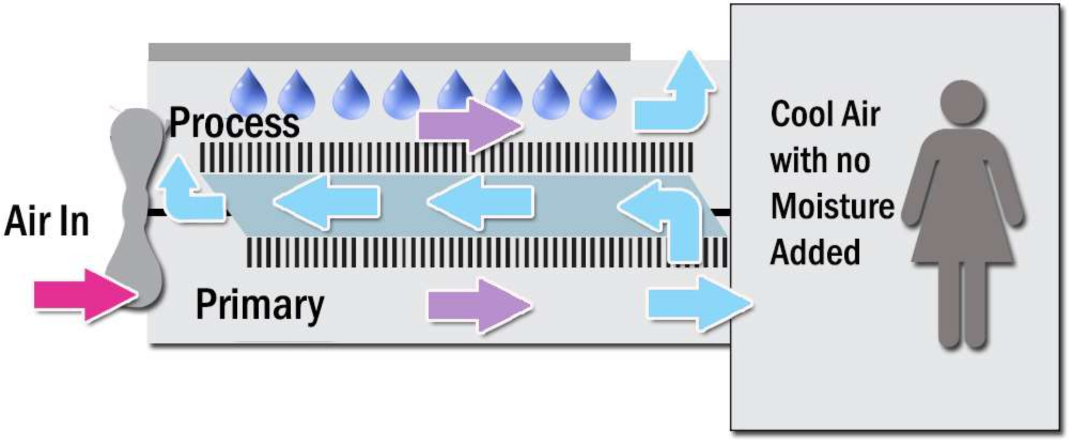






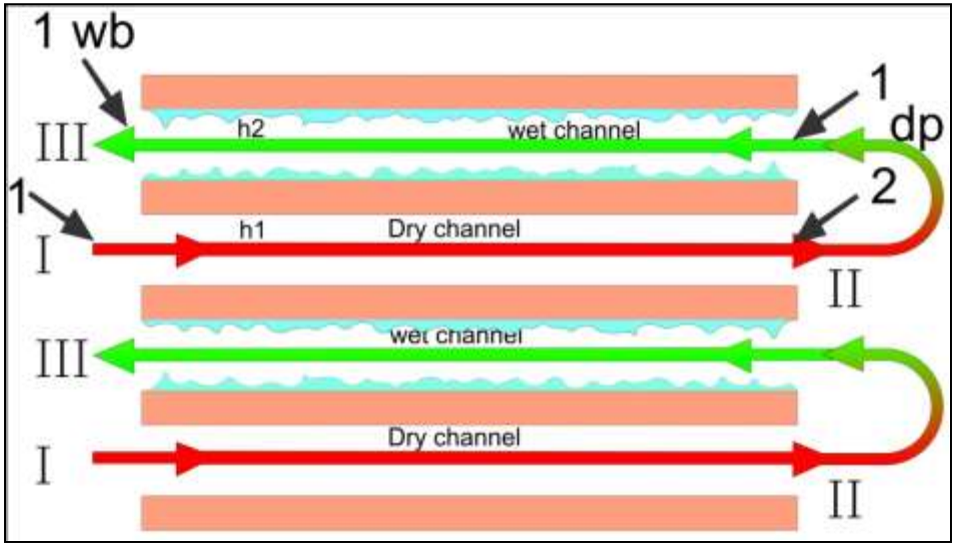


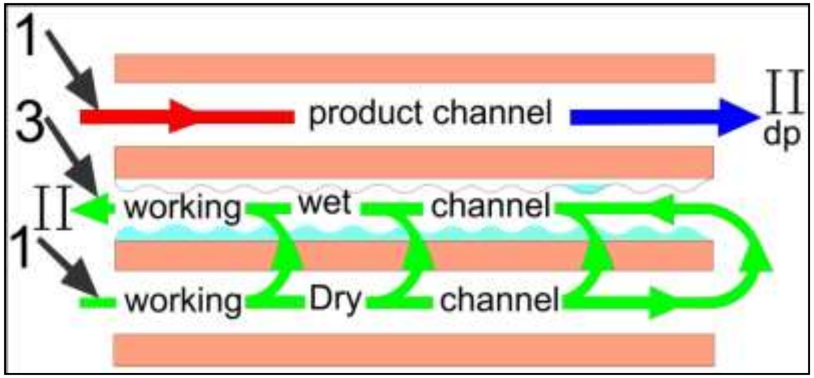


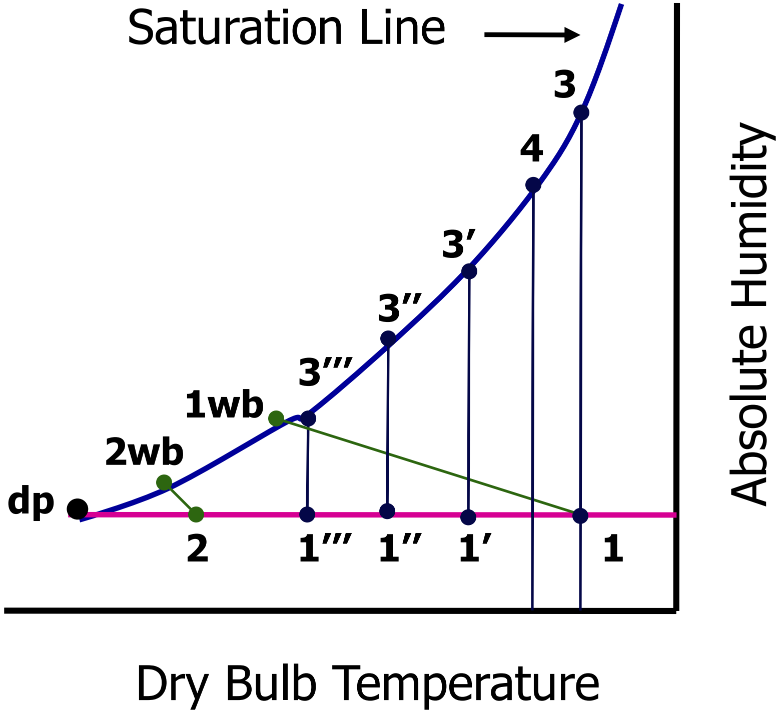


Working Principle of counter flow indirect evaporative cooling

Indirect evaporative cooling (IEC):
Primary air is cooled sensibly with a heat exchanger, while the secondary air carries away the heat energy from the primary air as generated vapor







Internals of Aqua cool dew point cooler process airstream and exhaust stream airflow

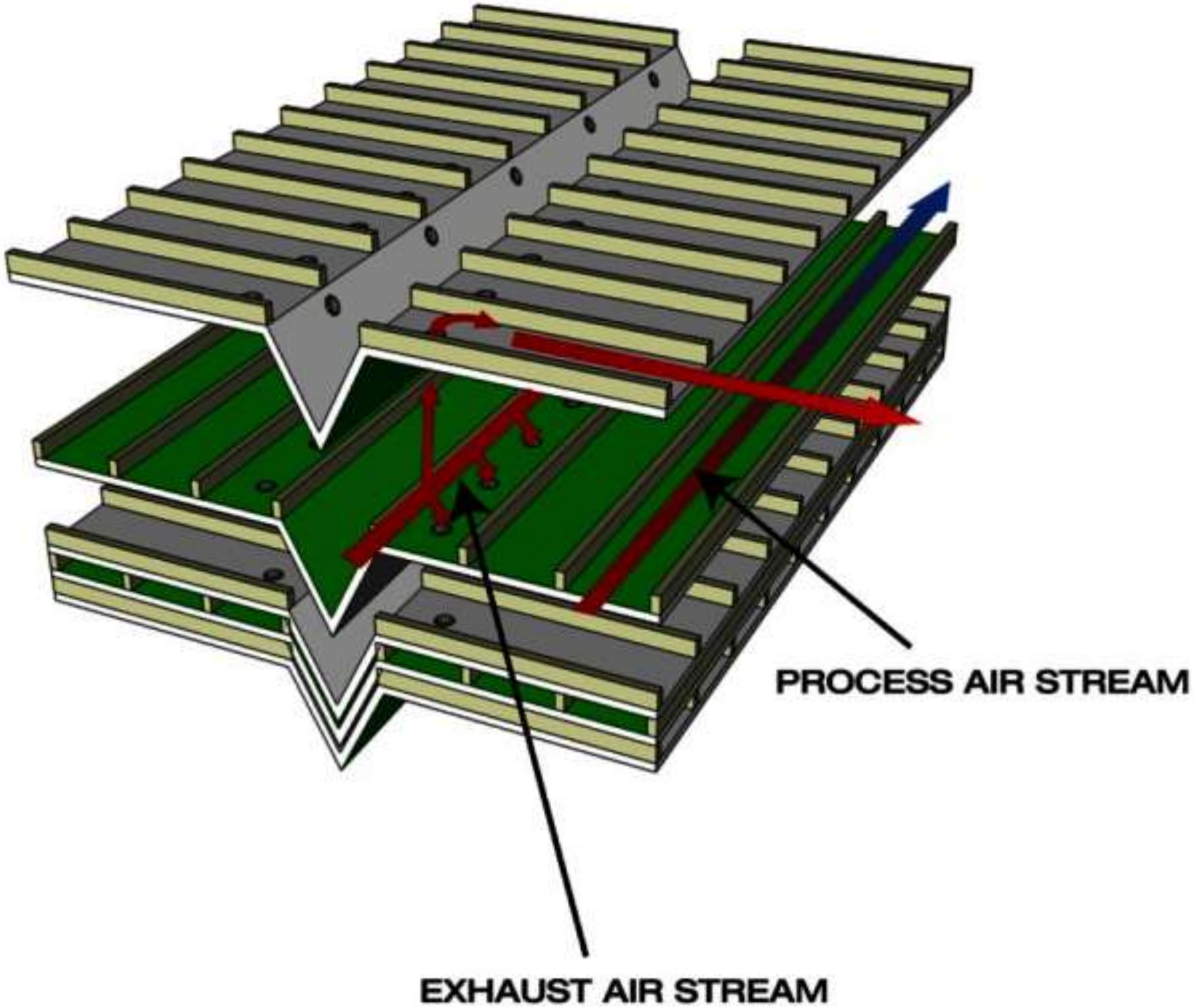
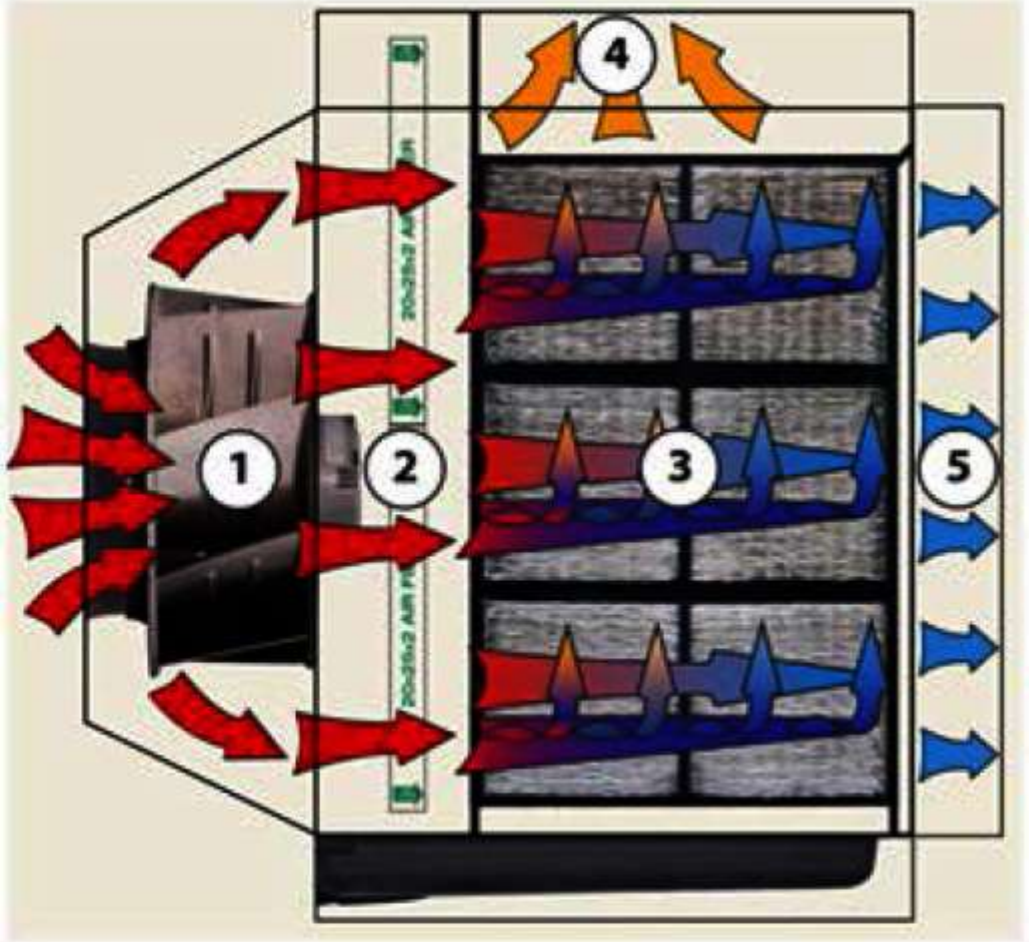


Figure 5.

Multistage indirect evaporative cooler airflow process



HOW IT WORKS

1. 100% Fresh air enters the system
2. The air is filtered of dust/allergens
3. Working air removes heat
4. Heat and moisture is exhausted from the system
5. Cool product air enters the building with no added humidity

Figure 6.

Conceptual psychrometric representation of the staged indirect cooling process

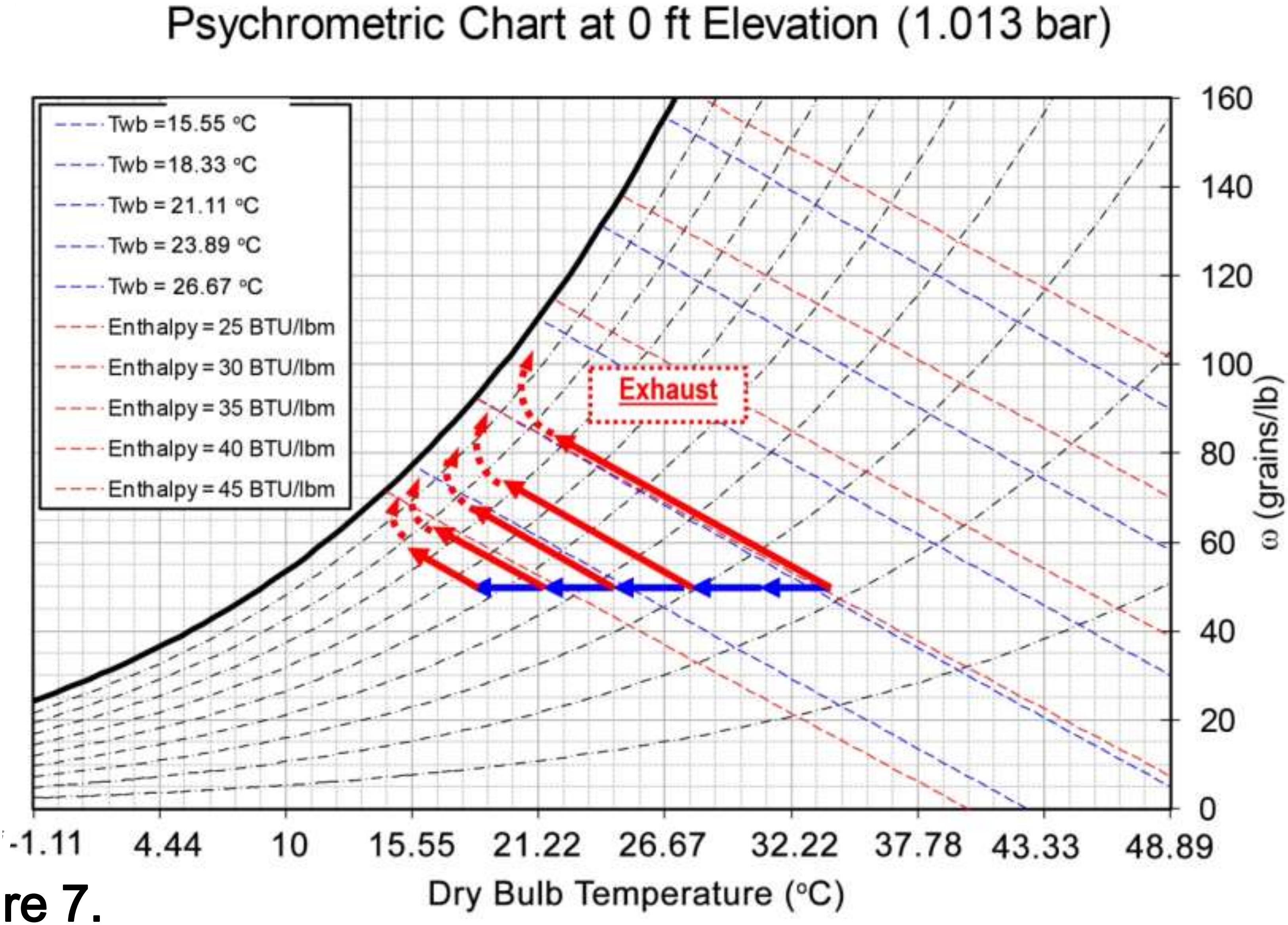
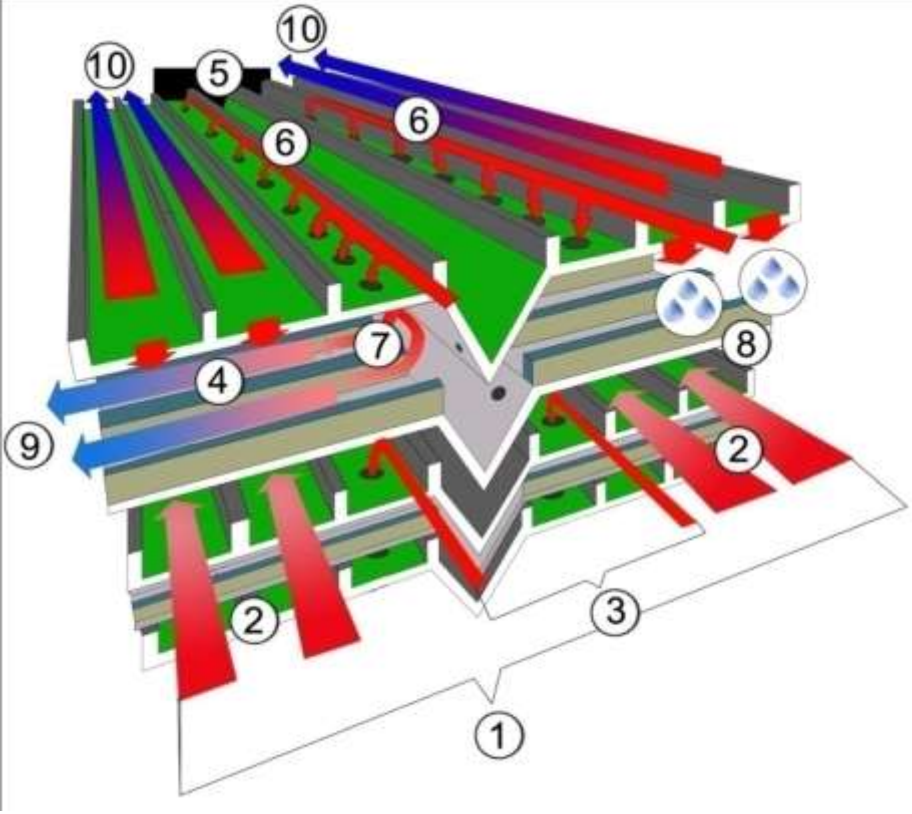


Figure 7.

Air flow in Dew point cooler



1. Outside air is pushed into Aqua cool heat exchanger with a single fan.

2. Product Air Channels.

3. Working Air Channels.

4. Heat from the Product Air is transferred through the thin plastic, and into the Wet Channels below.

5. Working Air is blocked from entering the building.

6. The Blocked Working Air is turned and passed through small holes into Wet Channels below the Product Air stream.

7. The Working Air in now moving through Wet Channels perpendicular or cross flow above and below the Dry Channels.

8. The heat that is passed from the Dry Channels is converted into the water vapor.

9. Heat from the Product Air has been converted into water vapor and is now rejected as exhaust to the outside air.

10. The Product Air which has now traveled the length of the heat exchanger, enters the desired space, cold and dry.

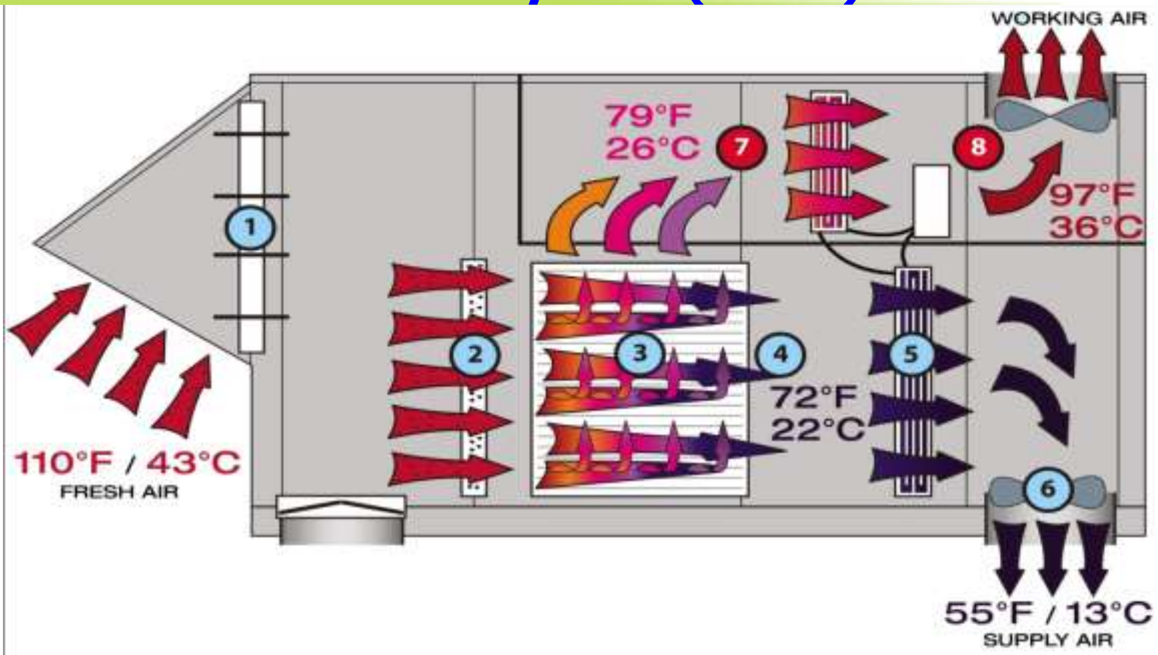
The green slide is the plastic coating that is used to create a Dry Channel.

The gray is the open paper side that is used to create a Wet Channel.

Hi-Tech

How it works:
Aqua cool - Fresh Air Example
Dedicated Outdoor Air System (DOAS)

Aqua cool
healthy fresh air



- 1. Fresh air is drawn into the air conditioner through an outside air damper. For example, outside summer air may be 110^{o}F (43^{o}C).

- 2. The air is then filtered before it enters Aqua cool's heat and mass exchange process.

- 3. The air that enters the heat and mass exchangers, is cooled without adding or removing humidity.

- 4. The example air will be cooled more than 35^{o}F (20^{o}C) with no change in humidity, and will leave the heat and mass exchanger at 72^{o}F(22^{o}C).

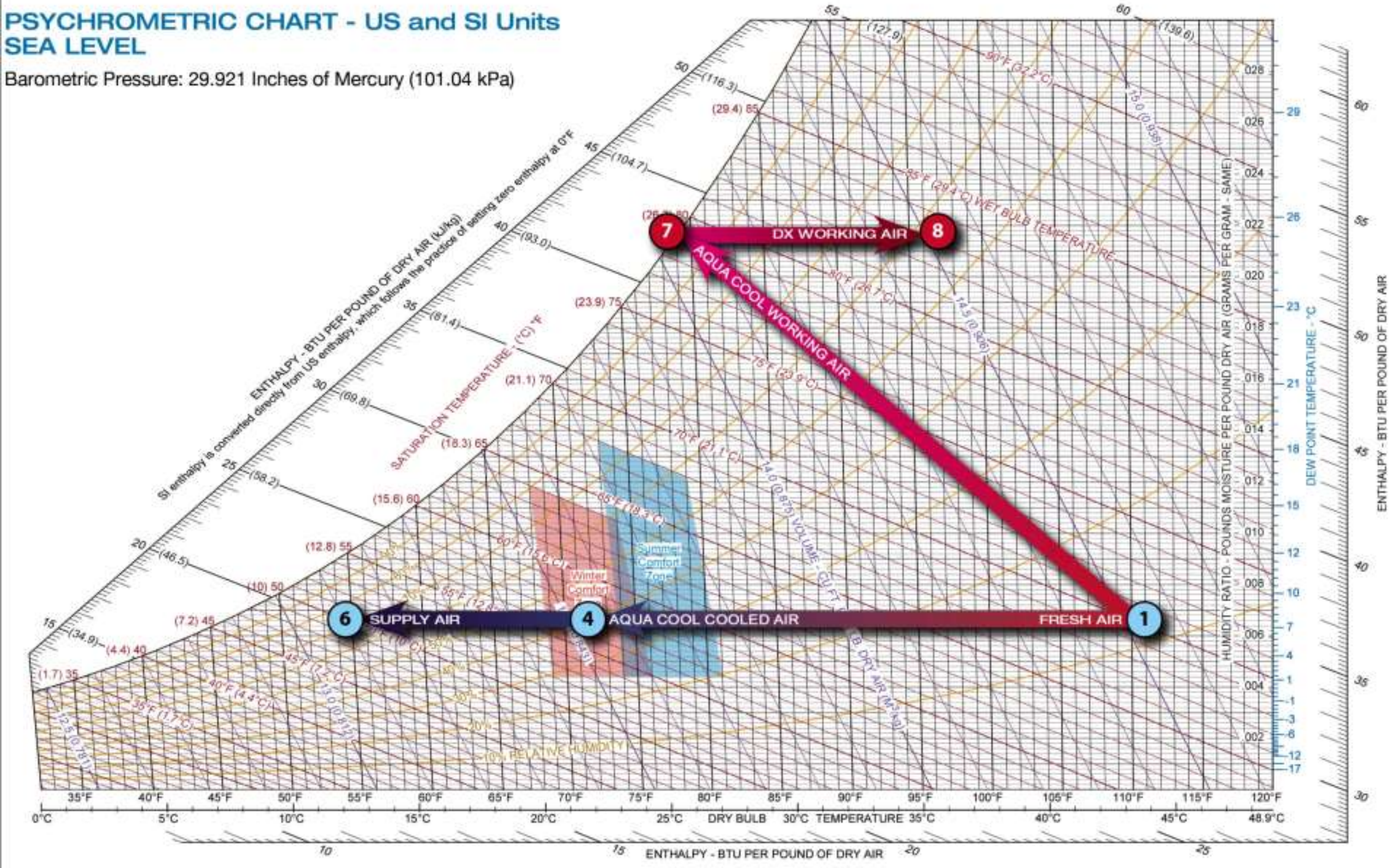
- 5. The air enters the cold refrigerants coils, where additional cooling and dehumidification can occur if needed.

- 6. The example air is cooled to 55^{o}F (13^{o}C).A high efficiency fan moves the conditioned air through the process and into the building where it is distributed via the building duct system.

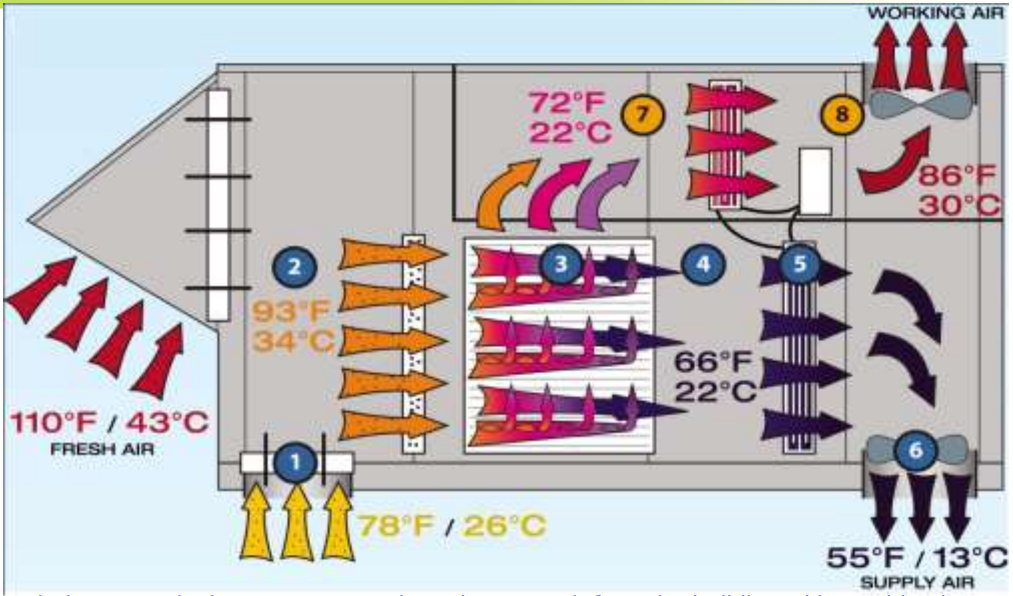
- 7. The vast majority of cooling system is performed by the heat and mass exchangers by using about half of the entering air as working air. Water is evaporate into the working air, which pulls heat away from heat exchangers that in turn pull heat away from the conditioned air. At 79^{o}F(26^{o}C) the working air example is over 30^{o}F(17^{o}C) cooler than the 110^{o}F(43^{o}C) ambient air. The saturated and cool working air is used to remove heat from the hot refrigerant condenser coils more efficiently.

- 8. The working air leaves the hot coils at 97^{o}F(36^{o}C) and then goes on to cool the 2-stage refrigerant compressor and working air fan, saving more power.

How it works:
Aqua cool - Fresh Air Example
Dedicated Outdoor Air System (DOAS)



How it works: Aqua cool - Mixed Air Example



- 1. If 100 percent fresh air is not needed, automatic dampers are used to mix return air from the building with outside air.

- 2. This mixed air will enter the filter at approximately 93^{o}F (34^{o}C). The air is then filtered before it enters Aqua cool's heat and mass exchange process.

- 3. The air that enters the heat and mass exchangers, is cooled without adding or removing humidity. The mixed air goes through the air conditioner at cooler temperatures.

- 4. The example air will be cooled with no change in humidity, and will leave the heat and mass exchangers at 66^{o}F (26^{o}C).

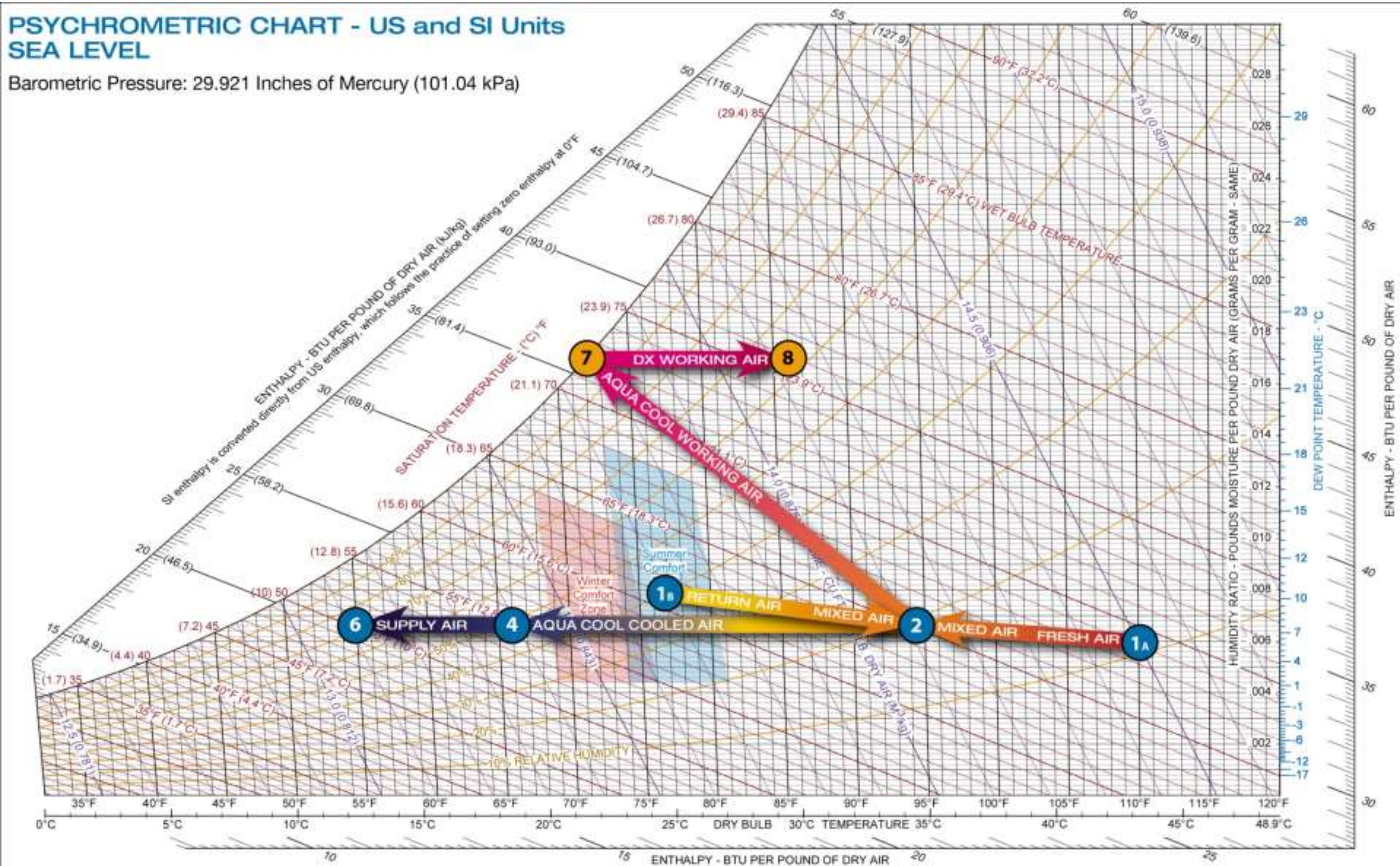
- 5. The air then enters the cold refrigerant coils, where additional cooling and dehumidification can occur if needed. In this example, only the first stage of the refrigerant system is needed; so the air conditioner requires less power and operates efficiently.

- 6. The example air is cooled to 55oF (13^{o}C). A high efficiency fan moves the conditioned air through the process and into the building where it is distributed via the building duct system.

- 7. The vast majority of cooling is performed by the heat and mass exchangers by using about half of the entering air as working air. Water is evaporated into the working air, which pulls heat away from the heat exchangers that in turn pull heat away from the conditioned air. At 72^{o}F (22^{o}C) the working air example is over (20^{o}C) cooler than the 110^{o}F (43^{o}C) ambient air. The saturated and cool working air is used to remove head from the hot refrigerant condenser coils more efficiently.

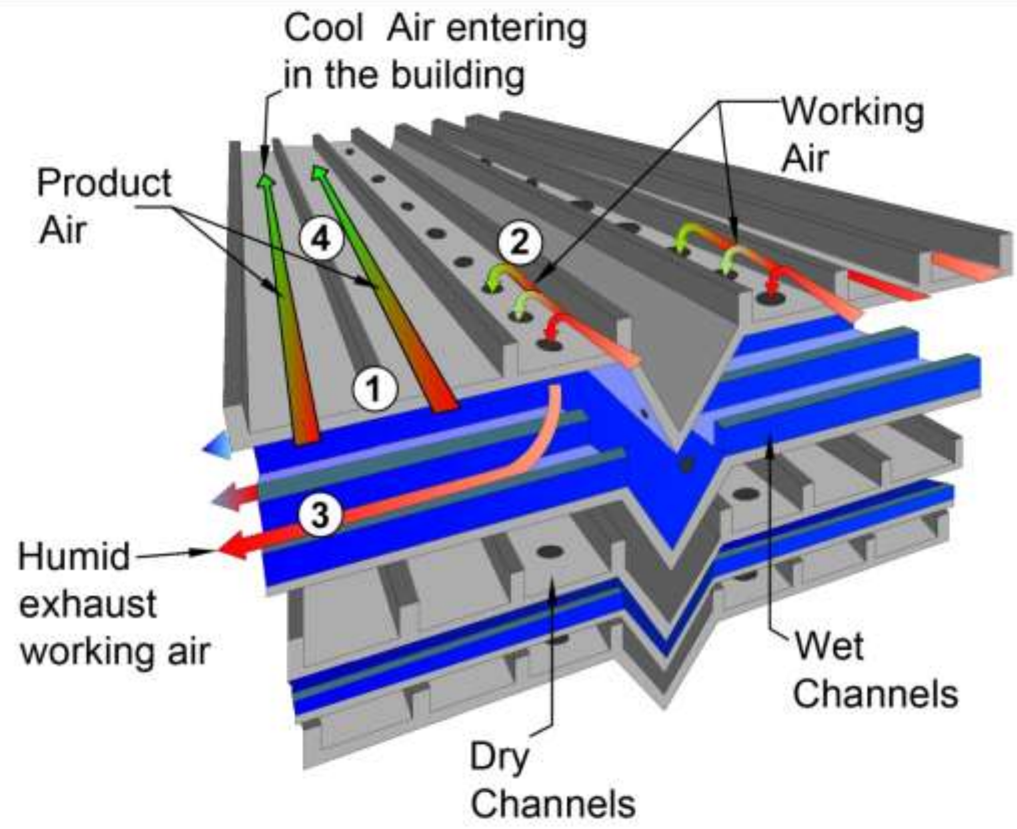
- 8. The working air leaves the hot coils at 86^{o}F (30^{o}C) and then goes on to cool the 2-stage refrigerant compressor and working air fan, saving more power.

How it works:
Aqua cool - Mixed Air Example



Air flow in Dew point cooler

Primary air is cooled sensibly with a heat exchanger, and part of the cooled primary air is diverted in to wet channel and secondary air carries away more amount of heat energy from the primary air as generated vapor



① Product air and Working Air enter the dry side of the Heat exchanger

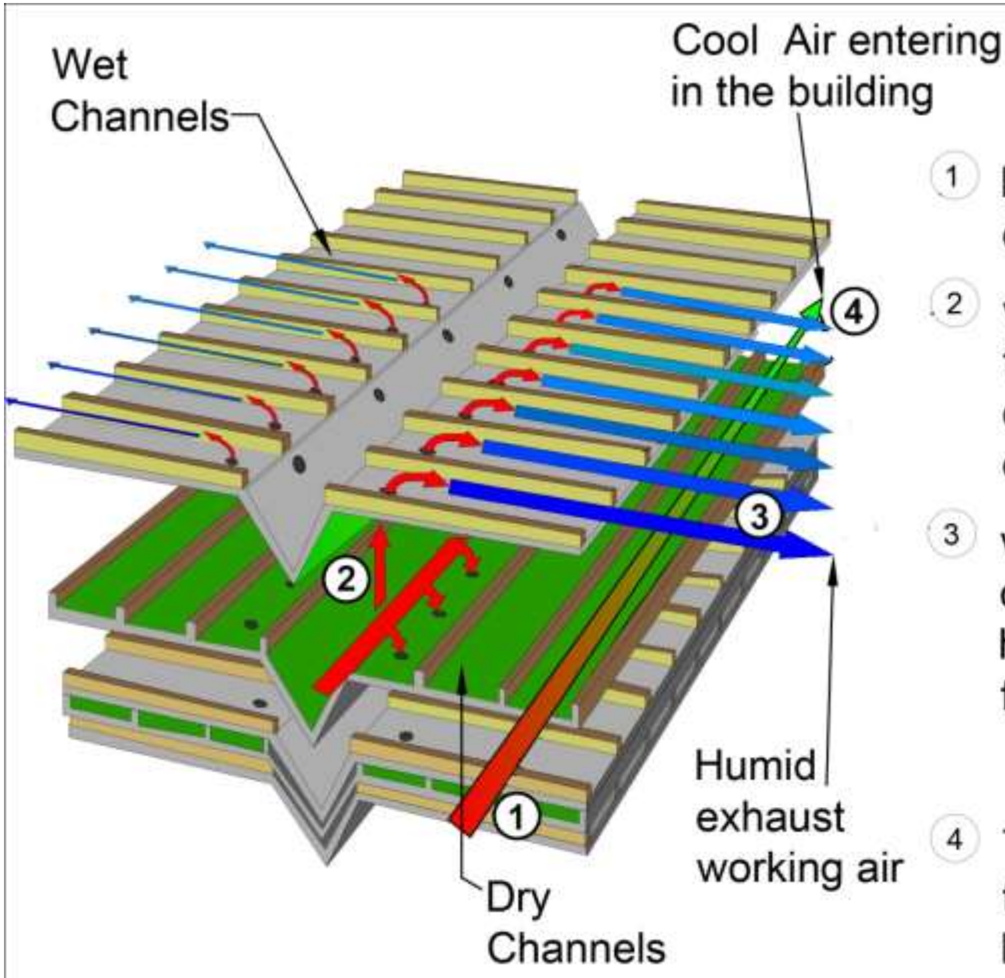
② Cooled Working Air is fractioned off into wet channel throughout the exchanger

③ Heat from the product air is transferred into the working air though evaporation and is rejected as exhaust

④ The Product air travels the length of the dry channels while transferring its heat to the working air in the wet channels above and below . as a result the product air cools drown and remains dry as it enters the building .

Air flow in Dew point cooler

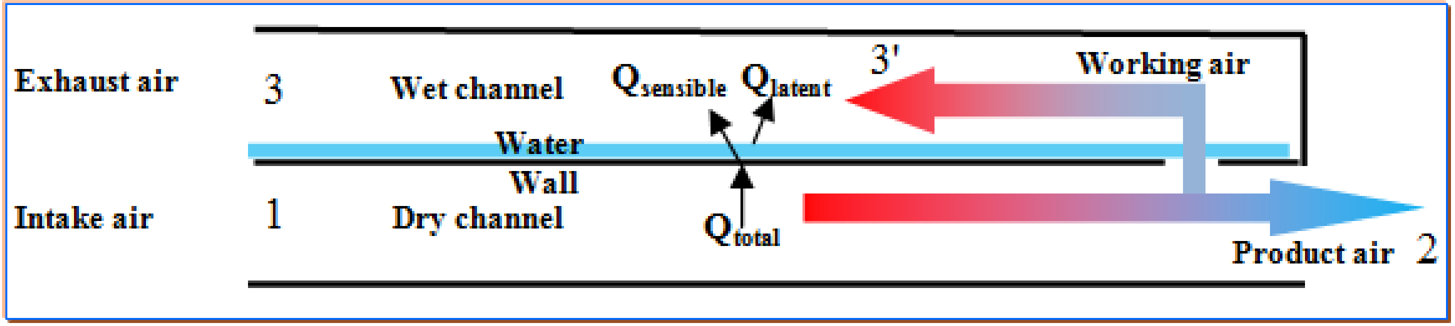
Primary air is cooled sensibly with a heat exchanger, and part of the cooled primary air is diverted in to wet channel and secondary air carries away more amount of heat energy from the primary air as generated vapor



1. Product fluid enters the heat and mass exchanger here
2. working fluid that has been cooled is fractioned off into the wet (gray) channels repeatedly across the exchanger
3. working fluid air fractioned off into wet channels.heat from the product fluid has been transferred int the working fluid and is rejected as exhaust.
4. The Product fluid traveled the length of the dry (green) channels,transferring its heat to the working fluid is now dry and close to the dew point temperature of the entering fluid.

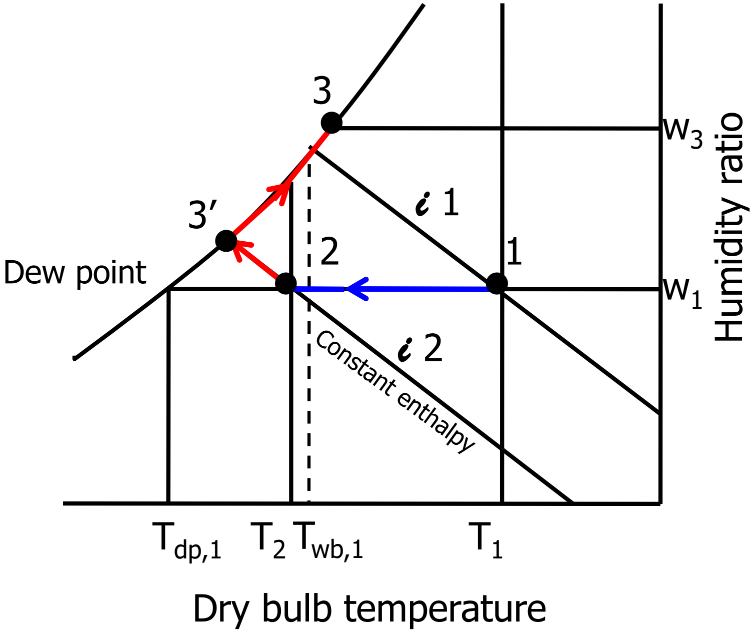
Working Principle of counter flow indirect evaporative cooling

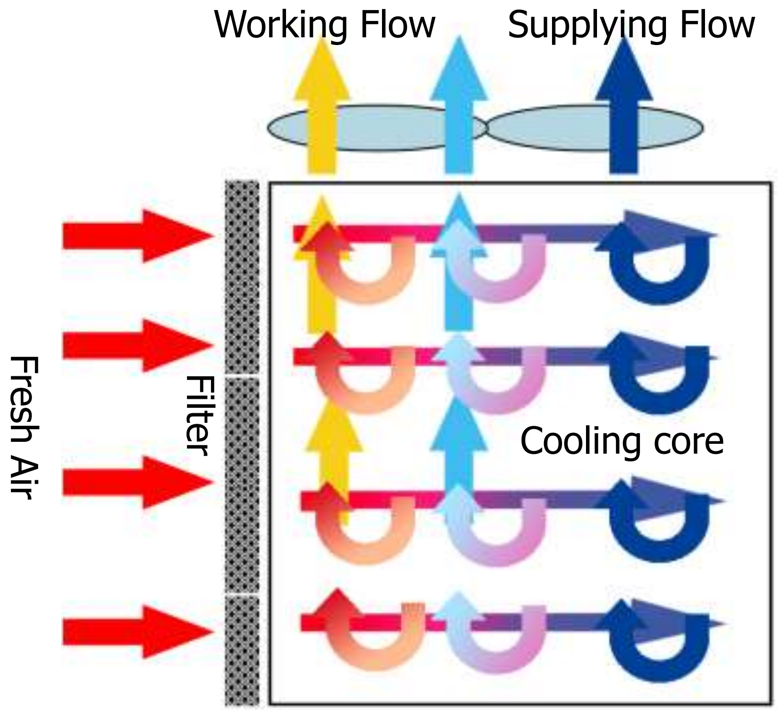
Counter flow Indirect evaporative cooling (IEC):
Primary air is cooled sensibly with a heat exchanger, and part of the cooled primary air is diverted in to wet channel and secondary air carries away more amount of heat energy from the primary air as generated vapor



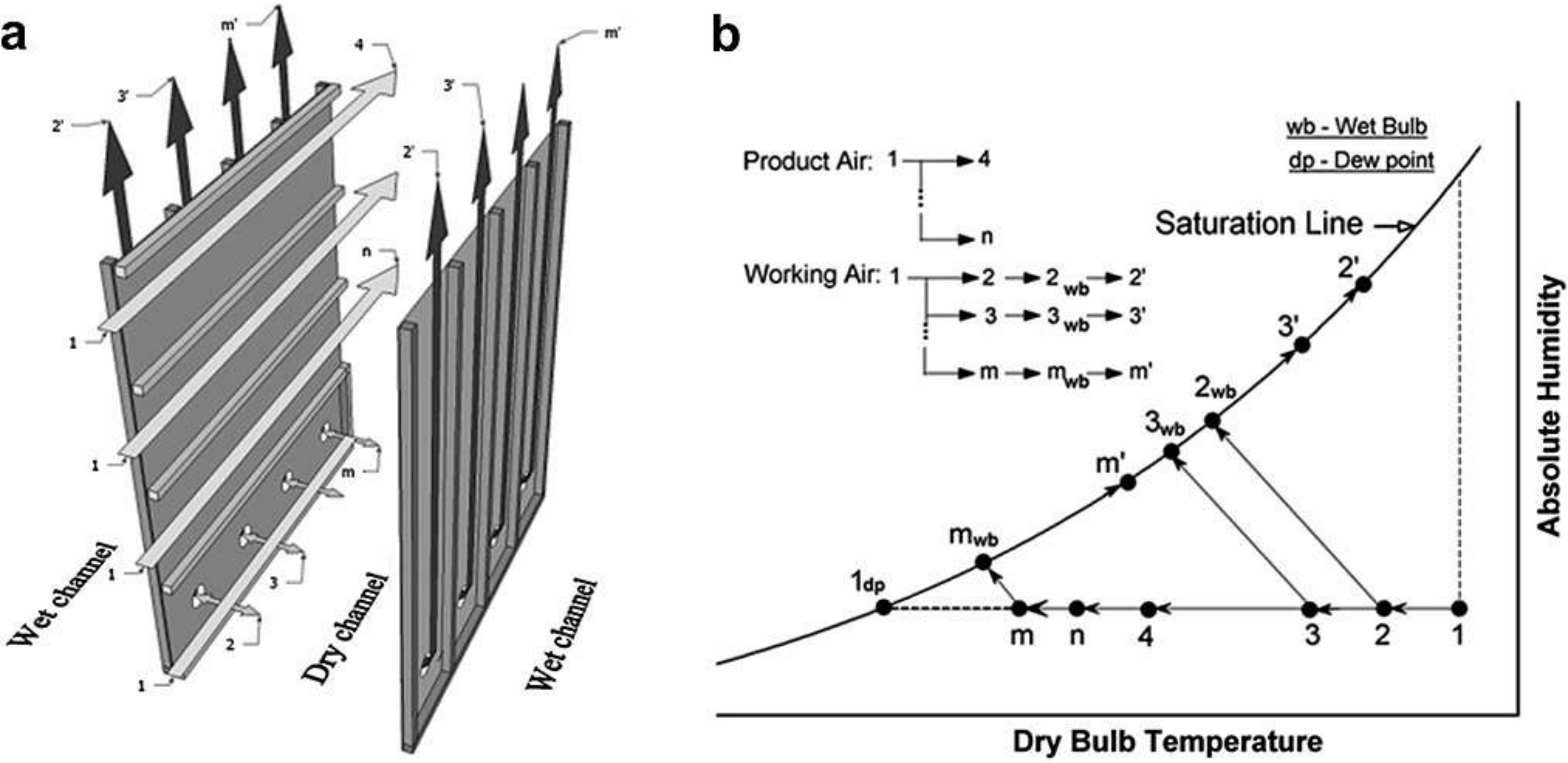
1-2: Product air

2-3′-3: Working air





Air flow direction in heat exchanger & on Psychometric chart



Aquacool's, Independent ***Counter Flow Enthalpy Exchanger*** (CFEX), how does it work?

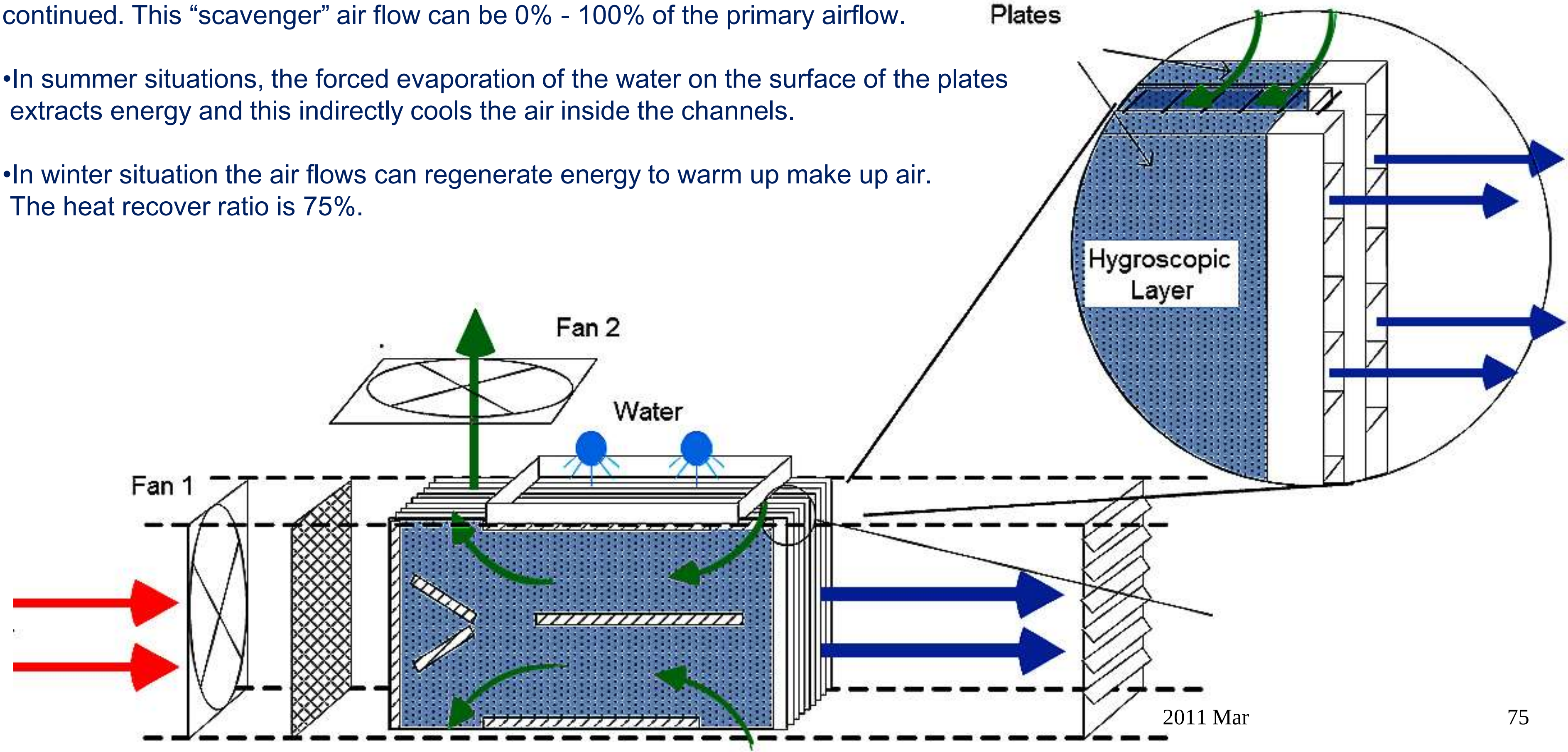
- The Aqua cool is a heat exchanger that forms the core of an air cooling and recovery system.

- The heat exchanger consists of proprietary plates made of polypropylene. Inside these plates there are air channels, through which the primary air is blown. The primary airflow can be ambient air, recycled air or a combination of the two.

- The outside of the heat exchanger plates are covered with a hygroscopic layer, which is externally moisturized by water. Along the hygroscopic layer a second airflow is led by a second fan. This airflow can be ambient air or air from the building to be continued. This "scavenger" air flow can be 0% - 100% of the primary airflow.

- In summer situations, the forced evaporation of the water on the surface of the plates extracts energy and this indirectly cools the air inside the channels.

- In winter situation the air flows can regenerate energy to warm up make up air. The heat recover ratio is 75%.



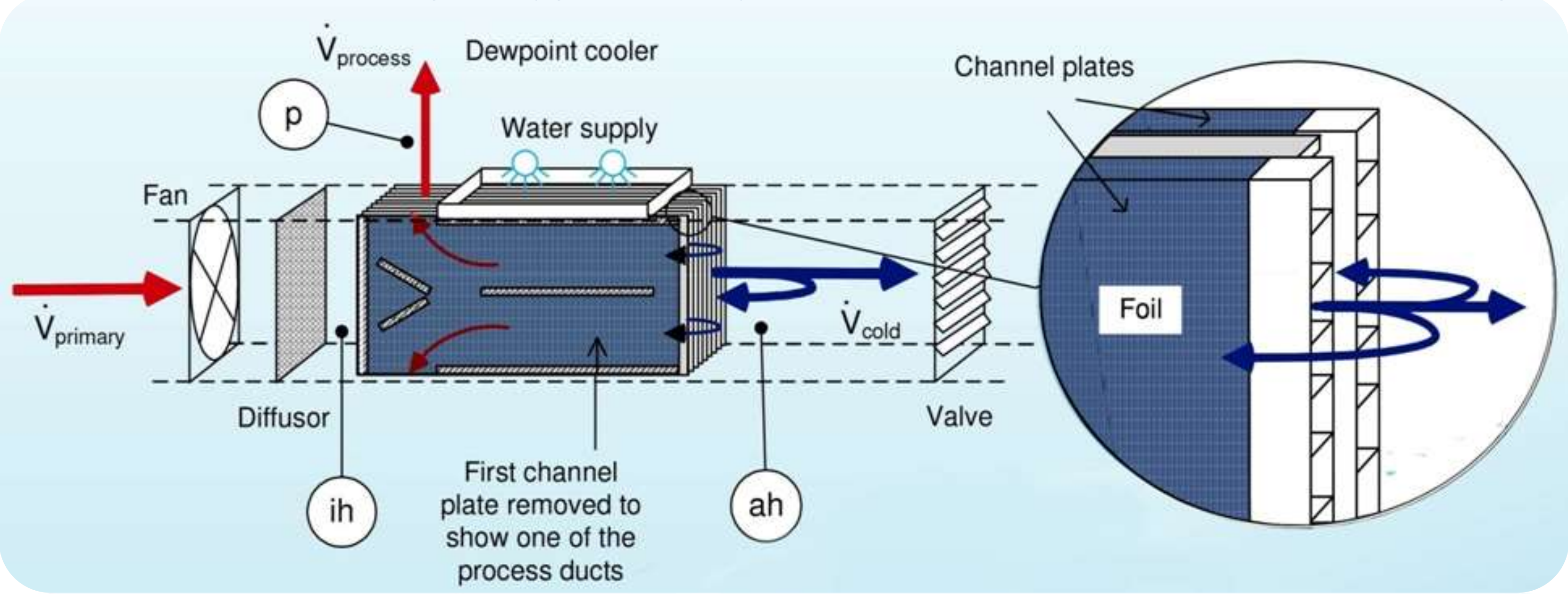
How does it work

Aqua cool is a heat exchanger that forms the core of an air cooling system

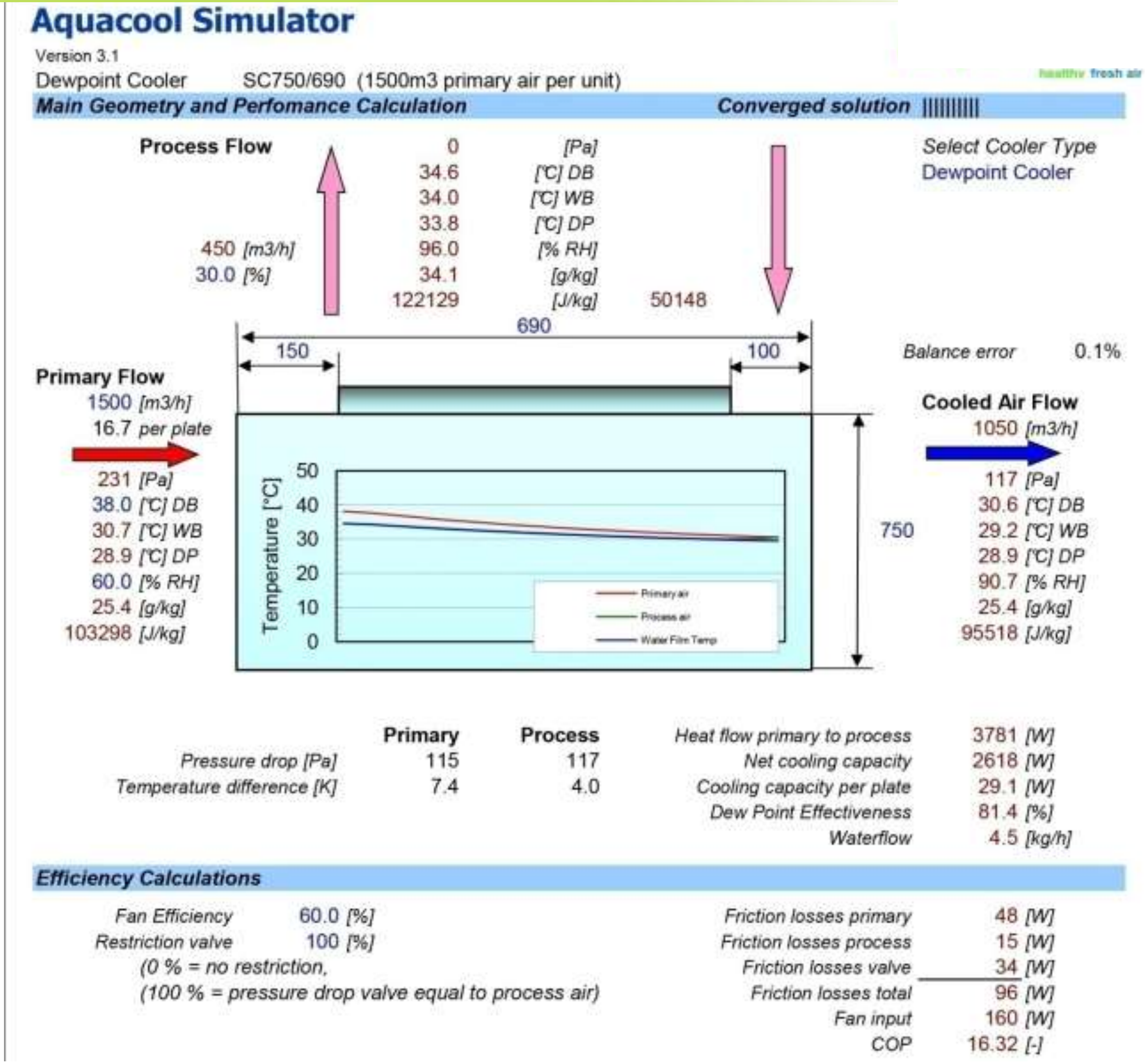
•The heat exchanger consists of proprietary plates made of polypropylene. Inside these plates there are air channels, through which fresh ambient air is blown.

•The outside of the heat exchanger plates are covered with a hygroscopic and moisture absorbing layer, which is externally moisturized by water. Due to forced evaporation of the water the surface of the plates are cooled and this indirectly cools the air inside the channels.

•70% of the cooled air is supplied to the space which needs to be cooled and 30% of the cooled air is re-routed as process air in a counter flow along the hygroscopic layer on outside of air channels in the heat exchanger.



Simulator results 38 ºC 60% humidity



Aquacool Simulator

Version 3.1

Dewpoint Cooler SC750/690 (1500m3 primary air per unit)

healthy fresh air

Main Geometry and Perfomance Calculation ***Converged solution*** ||||||||||

Process Flow

0	[Pa]
34.6	[°C] DB
34.0	[°C] WB
33.8	[°C] DP
96.0	[% RH]
34.1	[g/kg]
122129	[J/kg]

50148

450 [m3/h]

30.0 [%]

Select Cooler Type

Dewpoint Cooler

690

150

100

Balance error 0.1%

Primary Flow

1500	[m3/h]
16.7	per plate
231	[Pa]
38.0	[°C] DB
30.7	[°C] WB
28.9	[°C] DP
60.0	[% RH]
25.4	[g/kg]
103298	[J/kg]

750

Cooled Air Flow

1050	[m3/h]
117	[Pa]
30.6	[°C] DB
29.2	[°C] WB
28.9	[°C] DP
90.7	[% RH]
25.4	[g/kg]
95518	[J/kg]

	Primary	Process
Pressure drop [Pa]	115	117
Temperature difference [K]	7.4	4.0

Heat flow primary to process	3781	[W]
Net cooling capacity	2618	[W]
Cooling capacity per plate	29.1	[W]
Dew Point Effectiveness	81.4	[%]
Waterflow	4.5	[kg/h]

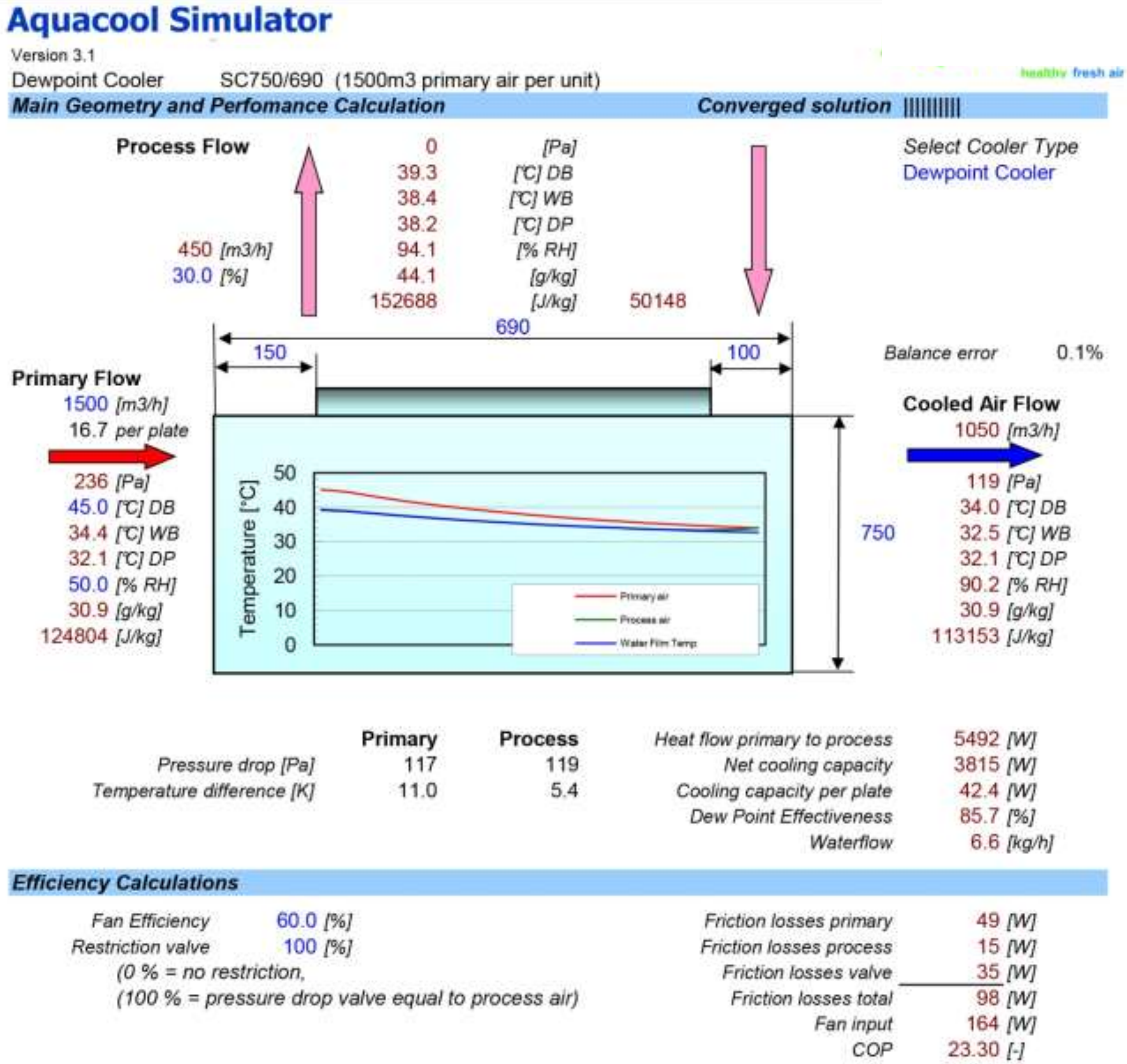
Efficiency Calculations

Fan Efficiency	60.0	[%]
Restriction valve	100	[%]

(0 % = no restriction,
(100 % = pressure drop valve equal to process air)

Friction losses primary	48	[W]
Friction losses process	15	[W]
Friction losses valve	34	[W]
Friction losses total	96	[W]
Fan input	160	[W]
COP	16.32	[-]

Simulator results 45 ºC 50% humidity



Aquacool Simulator

Version 3.1

Dewpoint Cooler SC750/690 (1500m3 primary air per unit)

Main Geometry and Perfomance Calculation — **Converged solution** ||||||||||

Select Cooler Type
Dewpoint Cooler

Process Flow

450 *[m3/h]*
30.0 *[%]*

0 *[Pa]*
39.3 *[°C] DB*
38.4 *[°C] WB*
38.2 *[°C] DP*
94.1 *[% RH]*
44.1 *[g/kg]*
152688 *[J/kg]* 50148

Balance error 0.1%

Primary Flow
1500 *[m3/h]*
16.7 *per plate*
236 *[Pa]*
45.0 *[°C] DB*
34.4 *[°C] WB*
32.1 *[°C] DP*
50.0 *[% RH]*
30.9 *[g/kg]*
124804 *[J/kg]*

Cooled Air Flow
1050 *[m3/h]*
119 *[Pa]*
34.0 *[°C] DB*
32.5 *[°C] WB*
32.1 *[°C] DP*
90.2 *[% RH]*
30.9 *[g/kg]*
113153 *[J/kg]*

	Primary	Process
Pressure drop [Pa]	117	119
Temperature difference [K]	11.0	5.4

Heat flow primary to process	5492 *[W]*
Net cooling capacity	3815 *[W]*
Cooling capacity per plate	42.4 *[W]*
Dew Point Effectiveness	85.7 *[%]*
Waterflow	6.6 *[kg/h]*

Efficiency Calculations

Fan Efficiency	60.0 *[%]*
Restriction valve	100 *[%]*

(0 % = no restriction,
(100 % = pressure drop valve equal to process air)

Friction losses primary	49 *[W]*
Friction losses process	15 *[W]*
Friction losses valve	35 *[W]*
Friction losses total	98 *[W]*
Fan input	164 *[W]*
COP	23.30 *[-]*

Indirect With Chiller & Heat Recovery

An Indirect evaporative pre pre-cooler can be used to reduce the size of a new chilled water system, or can be used to reduce the outside air load on an existing system.

When used for energy (heat) recovery in winter operations, that same indirect unit can pre pre-heat the outside air.

- In certain parts of the country, the energy savings from heat recovery may be even greater than those from evaporative cooling

Hi-Tech

Key features of all Aqua cool cooling system

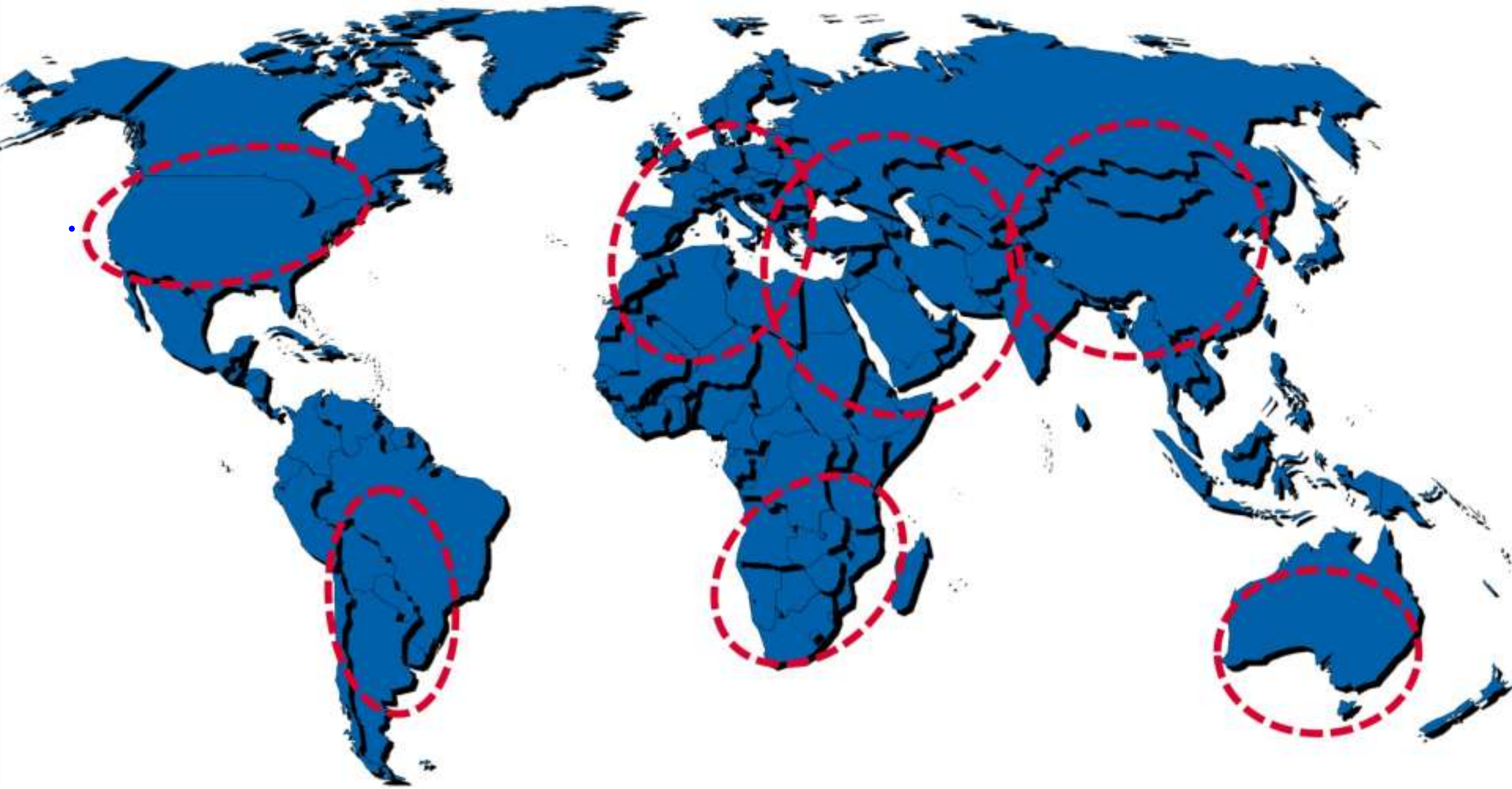
Aqua cool
healthy fresh air

Energy Efficient (EER of over 25)
Eco friendly (No CFC is used)

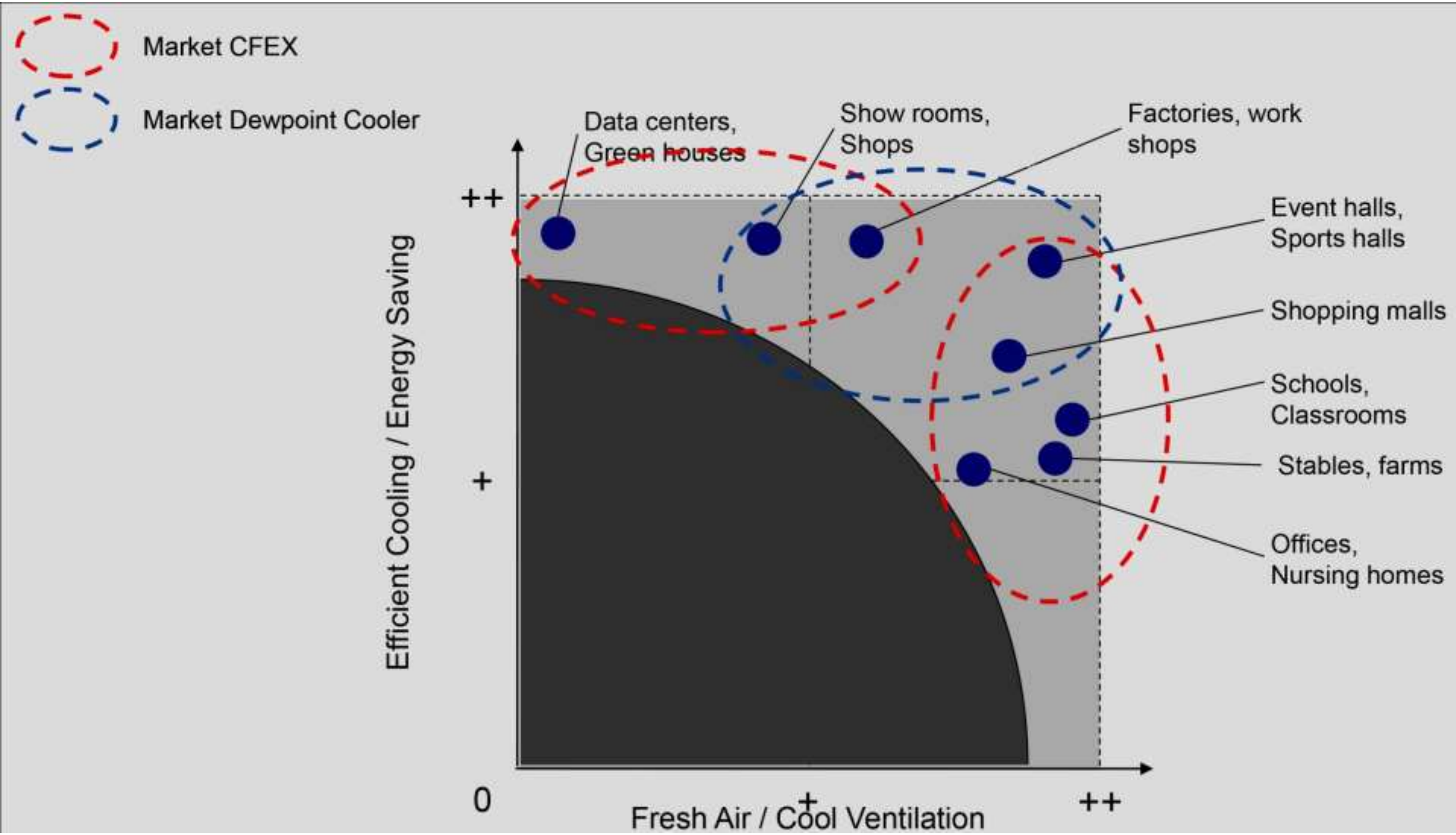
Aqua cool comes with an integrated control panel with options such as:

- Variable speed drives
- PLC/Micro controller based control systems
- Remote management
- Integration with existing control systems / BMS / Energy Management

Suitable locations worldwide; the warmer and dryer the climate the better the Aqua cool performance

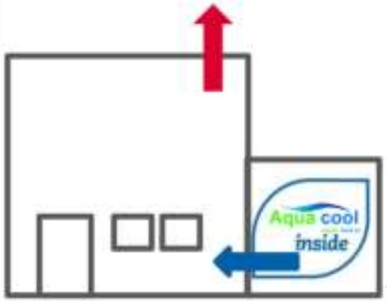


Typical usage for the Dewpoint Cooler is in open spaces and for the CFEX is in balanced ventilation or air recirculation systems

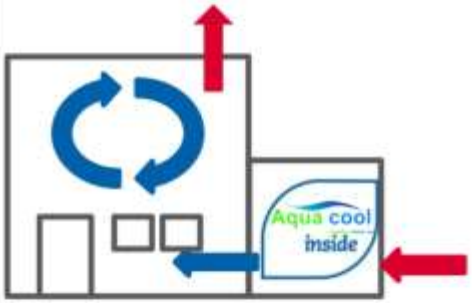


The Aqua cool can be used in several configurations

Dewpoint cooling

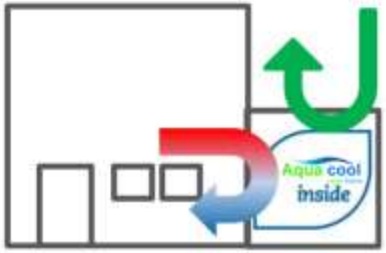


Displacement ventilation

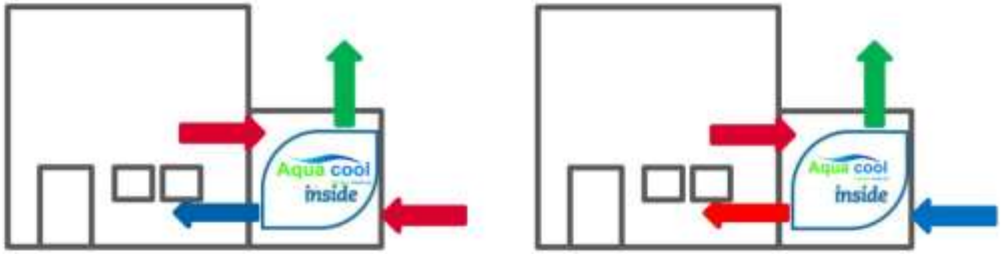


Pre-cooling of make up (ventilation) air

CFEX



100% Air recirculation with independent scavenger air flow



Summer **Winter**

0-100% balanced ventilation with adiabatic cooling in summer and heat recovery in winter

Case study , Cooling of fresh air by exhaust air of the building by indirect evaporative cooling, Al Ain or Riyadh

A	area, m2
cp	specific heat capacity at constant pressure, kJ/kg.K
h	enthalpy, kJ/kg
m	mass flow rate, kg/s
Q	volume flow rate, m3/s
q	heat transfer rate, kW
t	temperature, ºC
U	heat transfer coefficient, kW/m2K
u	velocity, m/s
vol	volume, m3

Greek Letters

εs	effectiveness, %
ρ	density,kg/m3

Suffixes

a	air
e	exhaust air, element
he	heat exchange
i	inlet
o	outlet
s	supply air, sensible
tot	total
w	wet bulb

Various parameters of air

Supply air inlet
t1 = supply air inlet dry bulb temperature
ϕ1 = supply air inlet humidity
tw1= supply air inlet wet bulb temperature
w1 = supply air inlet moisture in the air
h1 = supply air inlet enthalpy

Supply air outlet
t2 = supply air outlet dry bulb temperature
ϕ2 = supply air outlet humidity
tw2= supply air outlet wet bulb temperature
w2 = supply air outlet moisture in the air
h2 = supply air outlet enthalpy

Exhaust air inlet
t3 = supply air inlet dry bulb temperature
ϕ3 = supply air inlet humidity
tw3= supply air inlet wet bulb temperature
w3 = supply air inlet moisture in the air
h3 = supply air inlet enthalpy

Exhaust air outlet
t4 = supply air outlet dry bulb temperature
ϕ4 = supply air outlet humidity
tw4= supply air outlet wet bulb temperature
t4 = supply air outlet moisture in the air
h4 = supply air outlet enthalpy

Simulation inputs

Simulation inputs:

Volume flow rate on supply air side,

Qa = 25485 m3/h = 7079 L/s = 15000 cfm

•

Ambient outdoor, supply air temperature at inlet of PHE,

t1 = 41.5°C, h1 = 76.5 kJ/kg =32.89 Btu/lb

Exhaust air temperature at inlet of humidifier,

t3 = 30°C, h3 = 59.2 kJ/kg = 25.45 Btu/lb

Effectiveness of heat exchanger,

εs = 80%

Calculations

Enthalpy of exhaust air after dehumidification,

hA = h.3 = 59.2 kJ/kg = 25.45 Btu/lb

Minimum enthalpy to which supply air can go,

hmin = 63.11 kJ/kg = 27.13 Btu/lb

Enthalpy of supply air at outlet,

h.2 = h.1 - εs (h1 – hmin) = 71.7 kJ/kg = 30.83 Btu/lb

- Mass flow rate, ma = ρa
  Qa = 7.89 kg/s = 1044 lb/min

Heat loss by supply air,

qs = ma . dt12 . cp.a = 270.7 kW = 9.237e5 Btu/h

From velocity of air, ua, we can get cross section area,

A.cs.p = Qa/ua

Calculating the total outer area required for heat exchange,

A.he.o.re = qs/(Uo . lmtd)

For these values of A.cs.p and A.he.o.re,

We get the size of heat exchanger.

From this, we can calculate initial cost of the system for the calculated size.

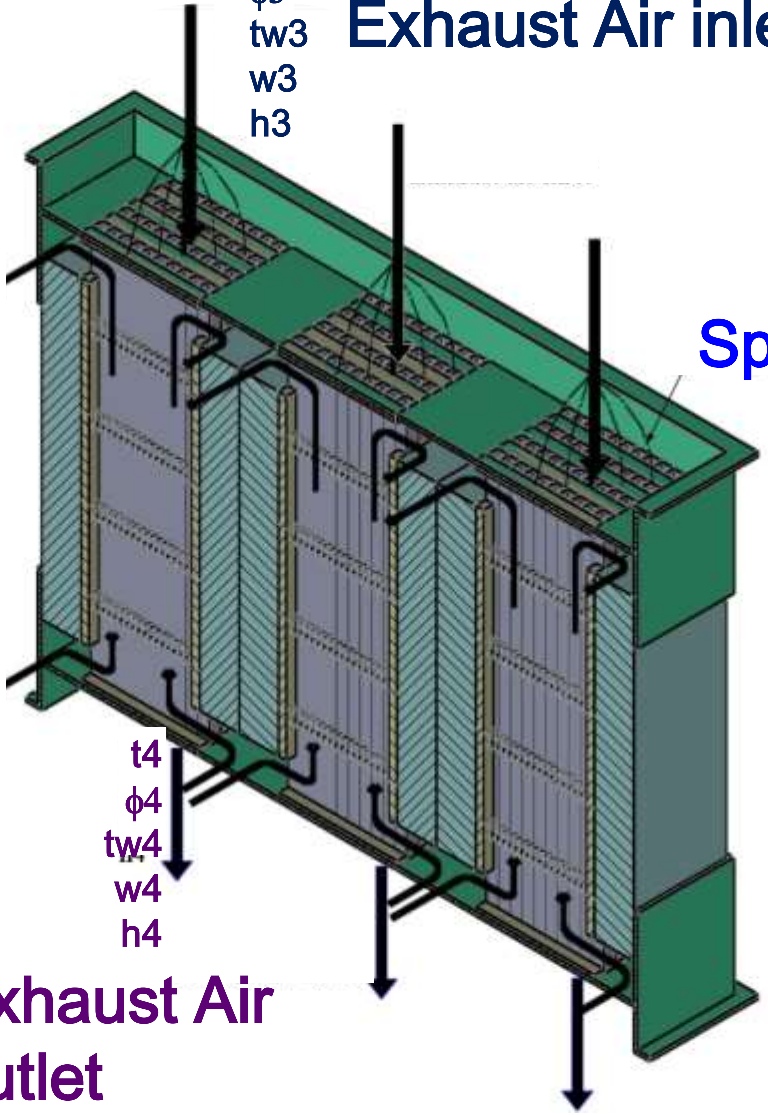
Energy saved,

qsav = qs/3.3

Where, 3.3 is the assumed COP of the chiller unit. The cost of energy saved per unit time can be calculated from qsav.

Payback = (Initial total cost)/(Cost of energy saved per unit time)

Process



t3
φ3
tw3
w3
h3

Exhaust Air inlet

Supply Air Outlet

t2
φ2
tw2
w2
h2

Sprinkling water

t1
φ1
tw1
w1
h1

Supply Air Inlet

t4
φ4
tw4
w4
h4

Exhaust Air outlet

Assumptions for simulation

Assumptions for simulation

a.Exhaust air is adiabatically humidified to 90% saturation during process 3-A

b.Adiabatically humidified air is then used to cool fresh ambient air in a counter current air toair heat exchanger with water continuing in contact with adiabatically saturated exhaust air

c.Mass flow rate of exhaust air is 7500 cfm (3539 L/s) and mass flow rate of supply air is 15000cfm (7079 L/s)

d.Effectiveness of heat exchanger is 80%

e.Exhaust air conditions are 30°C DBT and 16°C DPT

Process

Hi-Tech

Aqua cool
healthy fresh air

Table 1: Case Studies and comparison with experimental results

City	Qa	Qa	m_a	t_3	tw_3	$\varnothing_3$	w_3	h_3	ε_s	t_1	tw_1	$\varnothing_1$
	cfm	m^3/h	kg/s	ºC	ºC	%	g/kg	kJ/kg	%	ºC	ºC	%
Sample	15000	25485	7.89	45	20.6	42.8	11.4	59.2	80	45	25.3	20.2
Mumbai	15000	25485	7.89	33.3	20.6	42.8	11.4	59.2	80	33.3	28.1	70
Dubai	15000	25485	7.89	41.3	20.6	42.8	11.4	59.2	80	41.3	32.9	57
Riyadh	15000	25485	7.89	43.4	20.6	42.8	11.4	59.2	80	43.4	20.1	10
Abu Dhabi	15000	25485	7.89	40.4	20.6	42.8	11.4	59.2	80	40.4	33.4	63
Doha	15000	25485	7.89	41.5	20.6	42.8	11.4	59.2	80	41.5	31.2	49
Baghdad	15000	25485	7.89	44	20.6	42.8	11.4	59.2	80	44	25.1	22

Table 2: Case Studies and comparison with experimental results

City	w_1	h_1	t_A	tw_A	$\varnothing_A$	w_A	h_A	t_4	tw_4	$\varnothing_4$	w_4	h_4
	g/kg	kJ/kg	ºC	ºC	%	g/kg	kJ/kg	ºC	ºC	%	g/kg	kJ/kg
Sample	12.2	76.65	21.6	20.5	90	14.8	59.2	31	29.5	90	25.8	97.2
Mumbai	22.4	90.5	21.6	20.5	90	14.8	59.2	32.1	30.6	90	25.6	103.0
Dubai	29	116	21.6	20.5	90	14.8	59.2	36.8	35.1	90	36.2	130.0
Riyadh	5.47	57.7	21.6	20.5	90	14.8	59.2	30.3	28.9	90	24.8	94.6
Abu Dhabi	30.6	119	21.6	20.5	90	14.8	59.2	36.8	35.1	90	36.2	130.0
Doha	25	106	21.6	20.5	90	14.8	59.2	36.3	34.7	90	35.3	127.8

Process

Table 3: Case Studies and comparison with experimental results

City	t_2	tw_2	$\varnothing_2$	w_2	h_2	q_{12}	Re	dP	Cost	Payback	CO_2e
	°C	°C	%	g/kg	kJ/kg	kW	-	Pa	10^6	Day	t/year
									INR		
Sample	26.3	20.1	56.7	12.2	57.5	150	1122	165	3.03	278	0.106
Mumbai	23.0	23.0	100	17.8	68.6	173	1122	189	3.47	278	0.122
Dubai	24.3	24.3	100	19.3	73.7	334	1122	368	6.74	278	0.236
Riyadh	26.0	14.4	26.2	5.47	40.0	140	1122	154	2.82	278	0.099
Abu Dhabi	24.5	24.5	100	19.6	74.3	353	1122	399	7.13	278	0.249
Doha	23.8	23.8	100	18.7	71.7	271	1122	298	5.45	278	0.191
Baghdad	26.1	20.2	58.8	12.5	58.0	264	1122	292	5.34	278	0.186

Aqua cool system for cooling of fresh air with return air of building

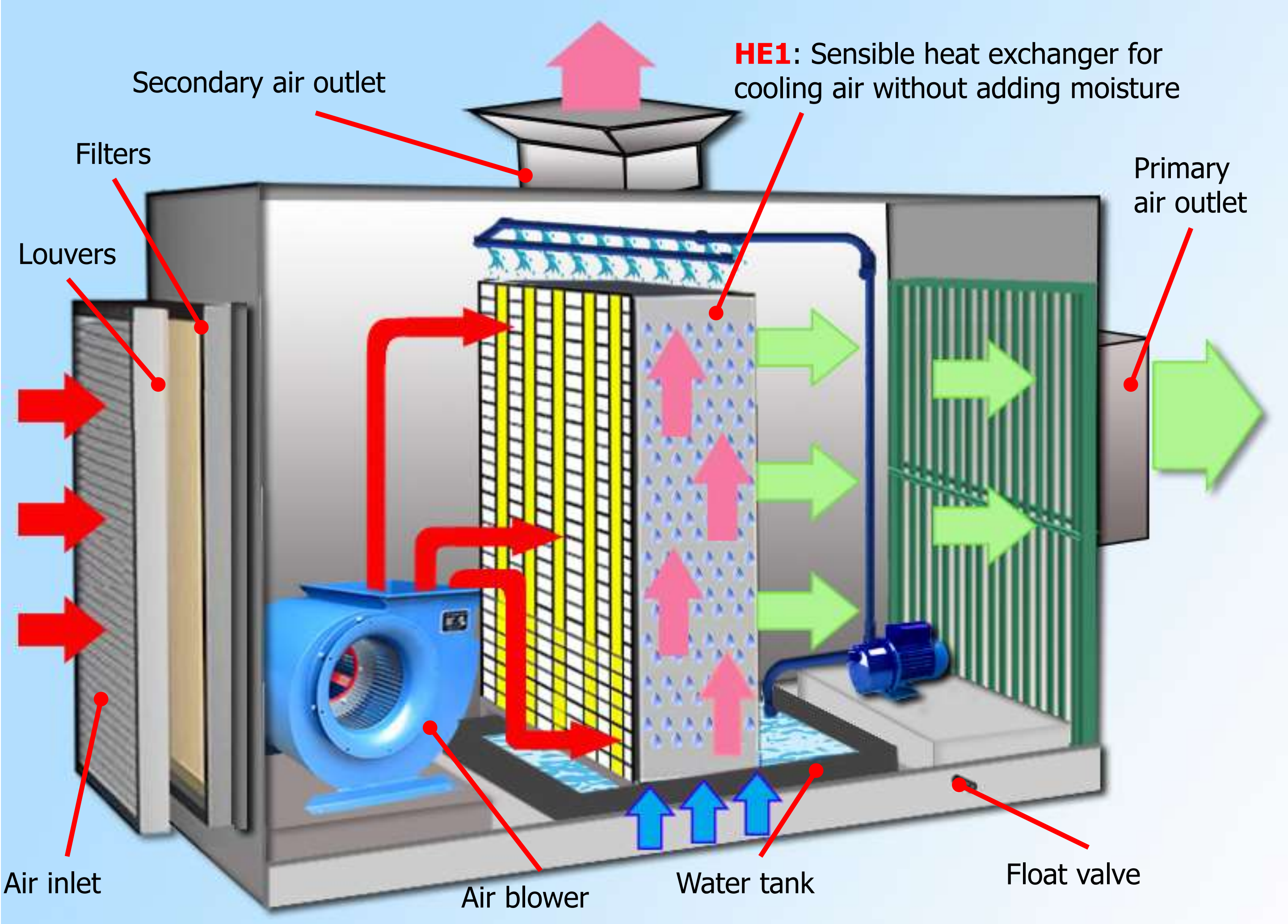
- The qua cool -HMX – PCU – R is a perfect solution where the application requires pre cooled fresh air and return air is available.

- The objective of PCU-R is to replace inefficient and maintenance intensive energy recovery wheels, heat pipes, air-to-air heat exchangers, etc.

- The air flow is made such that the cold return air, by design available at room temperature of 24°C and 55±5 % RH, is used as secondary air for the HMX heat exchanger .

Energy Efficiency Ratio (EER) is more than 25

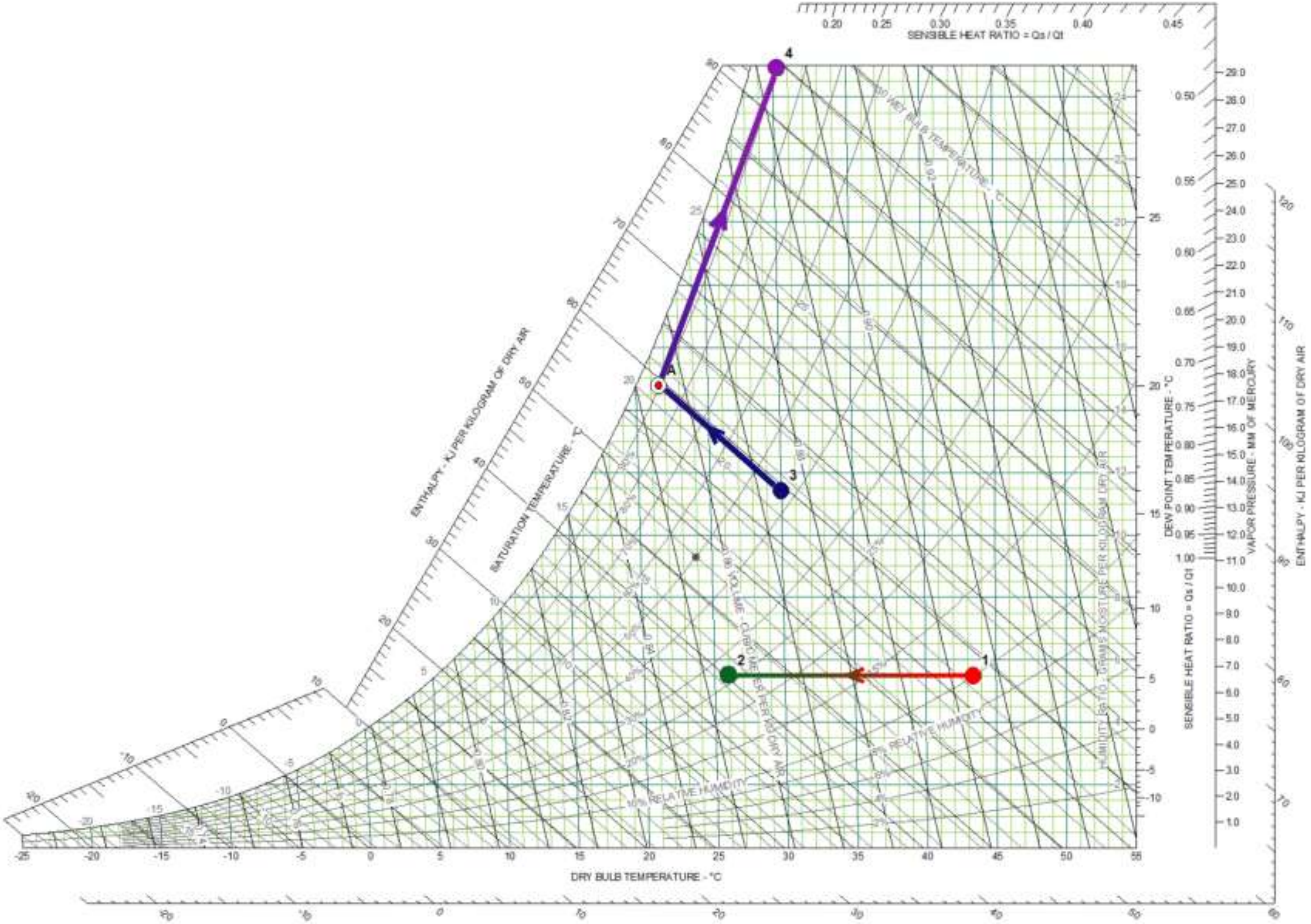
Aqua cool system for cooling of fresh air with return air of building



The primary air stream is cooled with indirect evaporative cooling with the help of the return air coming out of the air-conditioned space. This cools the primary air to the desired temperature.

Energy Efficiency Ratio (EER) is more than 25

Fresh air cooling indirect evaporative cooling by using building exhaust air for maximum energy saving for dry location such as Al-Ain, Riyadh in GCC.

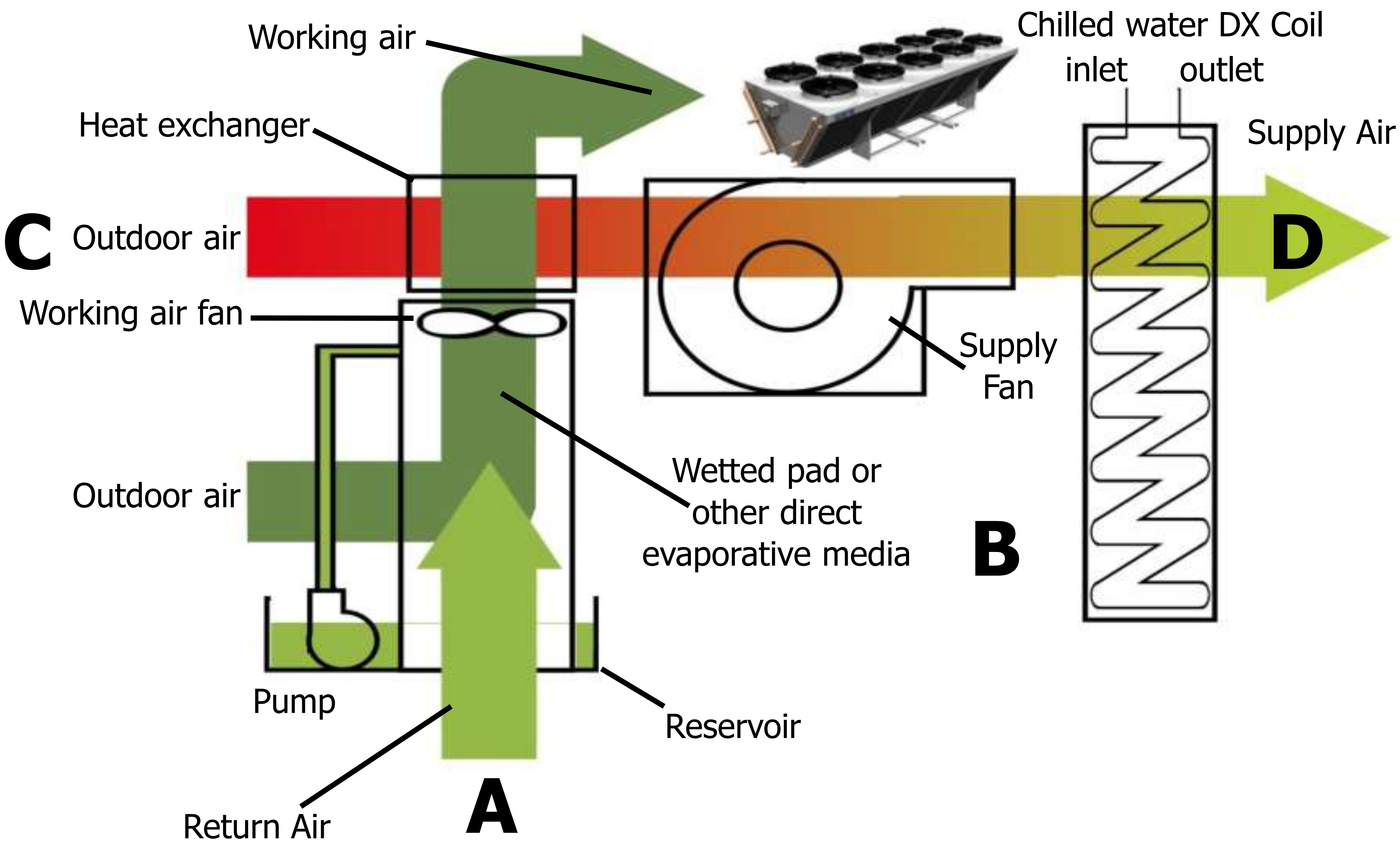


Aqua cool system for Fresh Air cooling by using return air for maximum efficiency

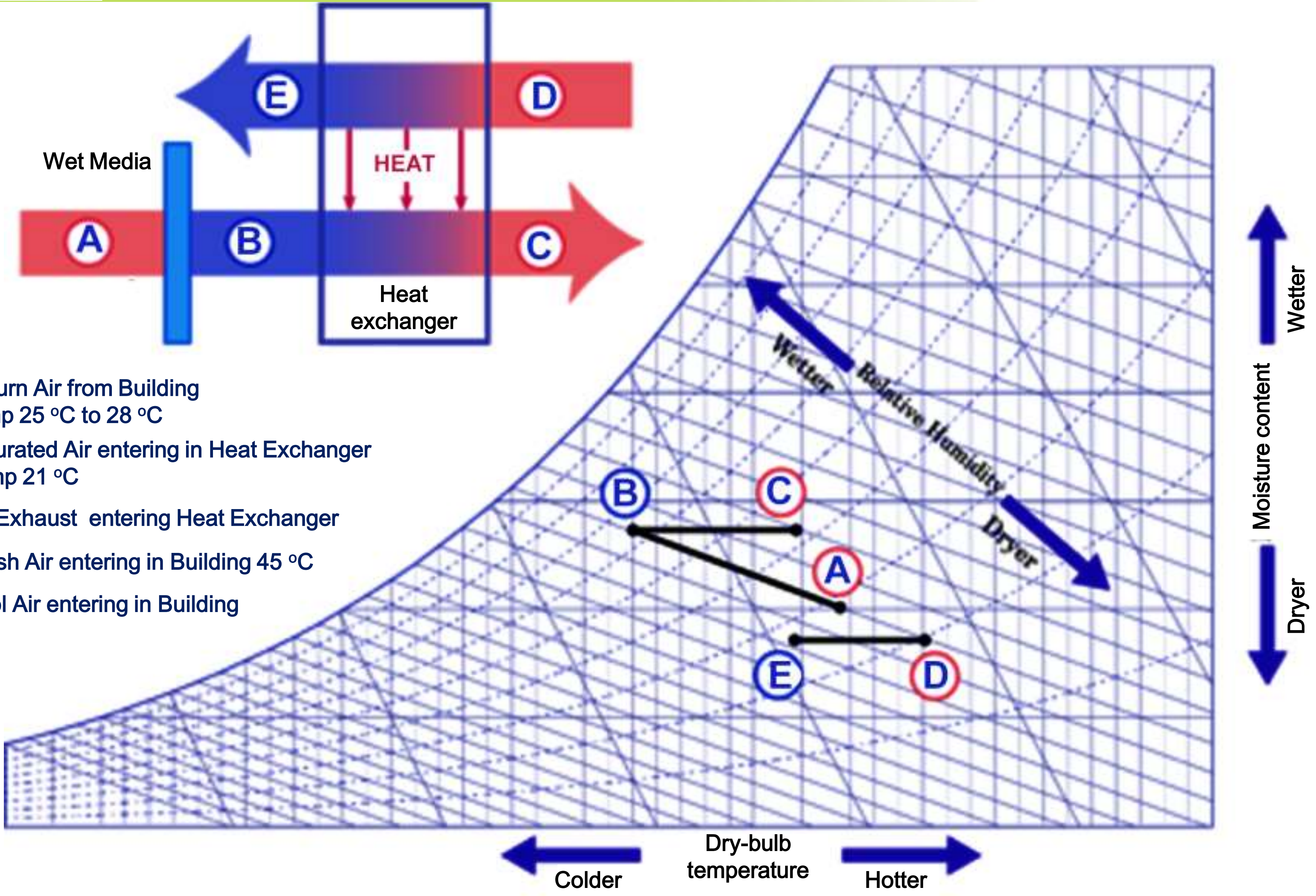
Hi-Tech

Aqua cool healthy fresh air

(This can be use to cool the condenser for the DX coil)



Hybrid air conditioning process to cool fresh air



A. Return Air from Building
temp 25 °C to 28 °C

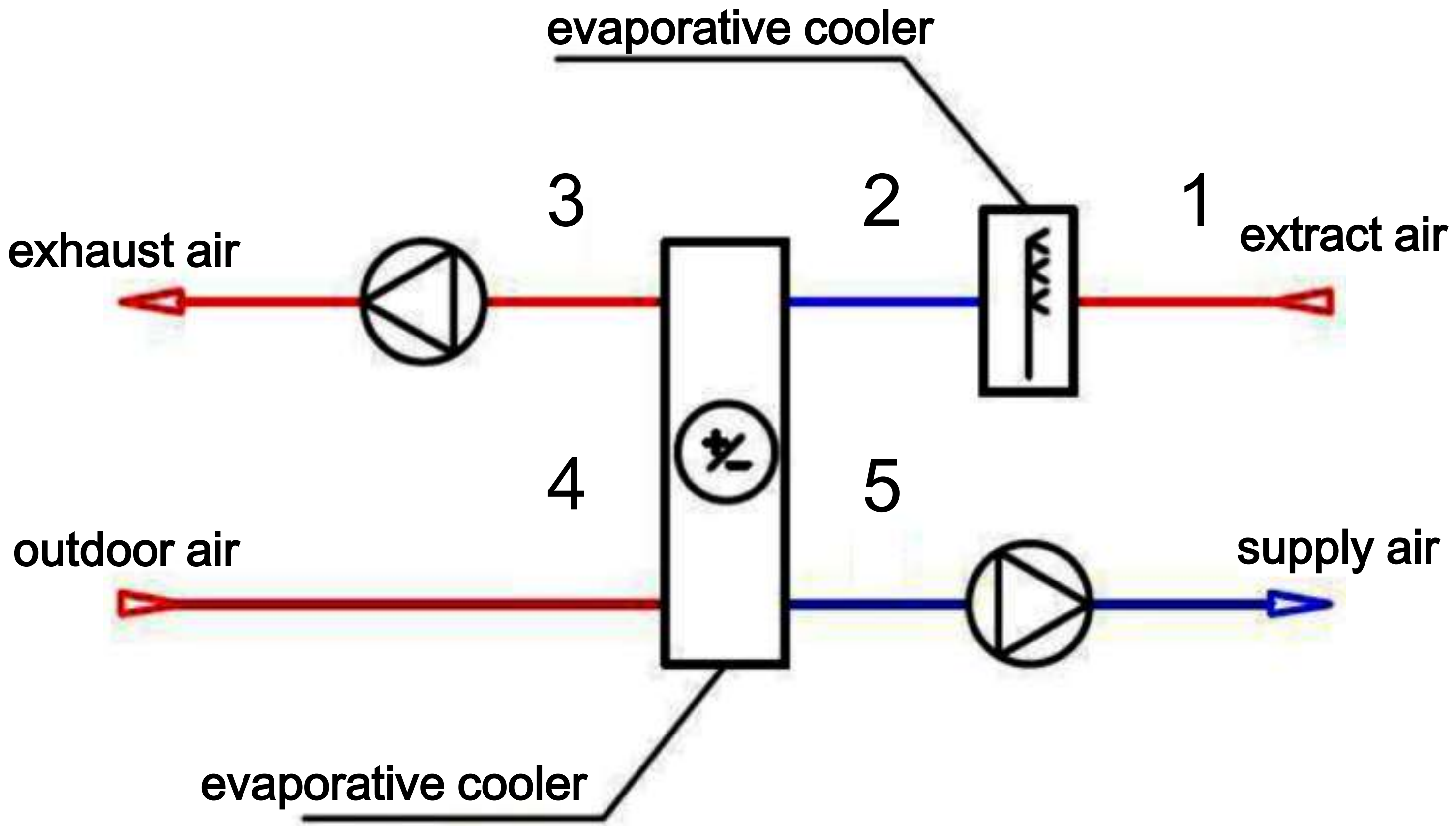
B. Saturated Air entering in Heat Exchanger
temp 21 °C

C. Air Exhaust entering Heat Exchanger

D. Fresh Air entering in Building 45 °C

E. Cool Air entering in Building

Schematic diagram of the indirect evaporative cooling



Warm extract air from rooms (1) comes to the evaporative cooler. There because of the evaporation the air cools down and becomes more humid (2). After that the air comes to the heat exchanger, where it takes heat from the incoming outdoor air (3). On the other hand, the outdoor air comes to the heat exchanger (4), where it is cooled by the exhaust air flow without increasing of the moisture content (5).

Aqua cool vs Air-washer

For same cooling effect (space temp to be maintained is same)

Sr	Particulars	Air-Washer	Aqua cool
1	Area to be cooled	30,000 sft	30,000 sft
2	Space temp to be maintained	30 degC	30 degC
3	CFM reguired	20,000 CFM	1,20,000 CFM
4	Humidity in space	High	Much lesser than in Air-Washer's case
5	Net water addition in supply air	Summer: 2900L/hr, Monsoon: 1100L/hr	Summer: 750L/hr, Monsoon: 340L/hr
6	Power consumption per hour	90 Kwh (0.45 Kwh per 1000CFM)	72 Kwh (0.60 Kwh per 1000CFM)
7	Power consumption per year	90*12*300 = 3,24,000 Kwh	72*12*300 = 2,59,000 Kwh
8	Power cost per year (@Rs5 per Kwh)	16,20,000/-	12,96,000/-
9	Appr. Ducting cost	60,00,000/-d	36,00,000/-

CONCLUSIONS

1. Savings in power cost <u>for every year</u>
2. Saving in ducting cost
3. Saving in capex => can be calculated on case to case basis

Note -:Above calculations can be worked-out on case to case basis

Aqua cool vs Air-washer continued….

Significant upgrade over air-washer

1. 'Provides more cooling with same machine capacity as an air-washer'

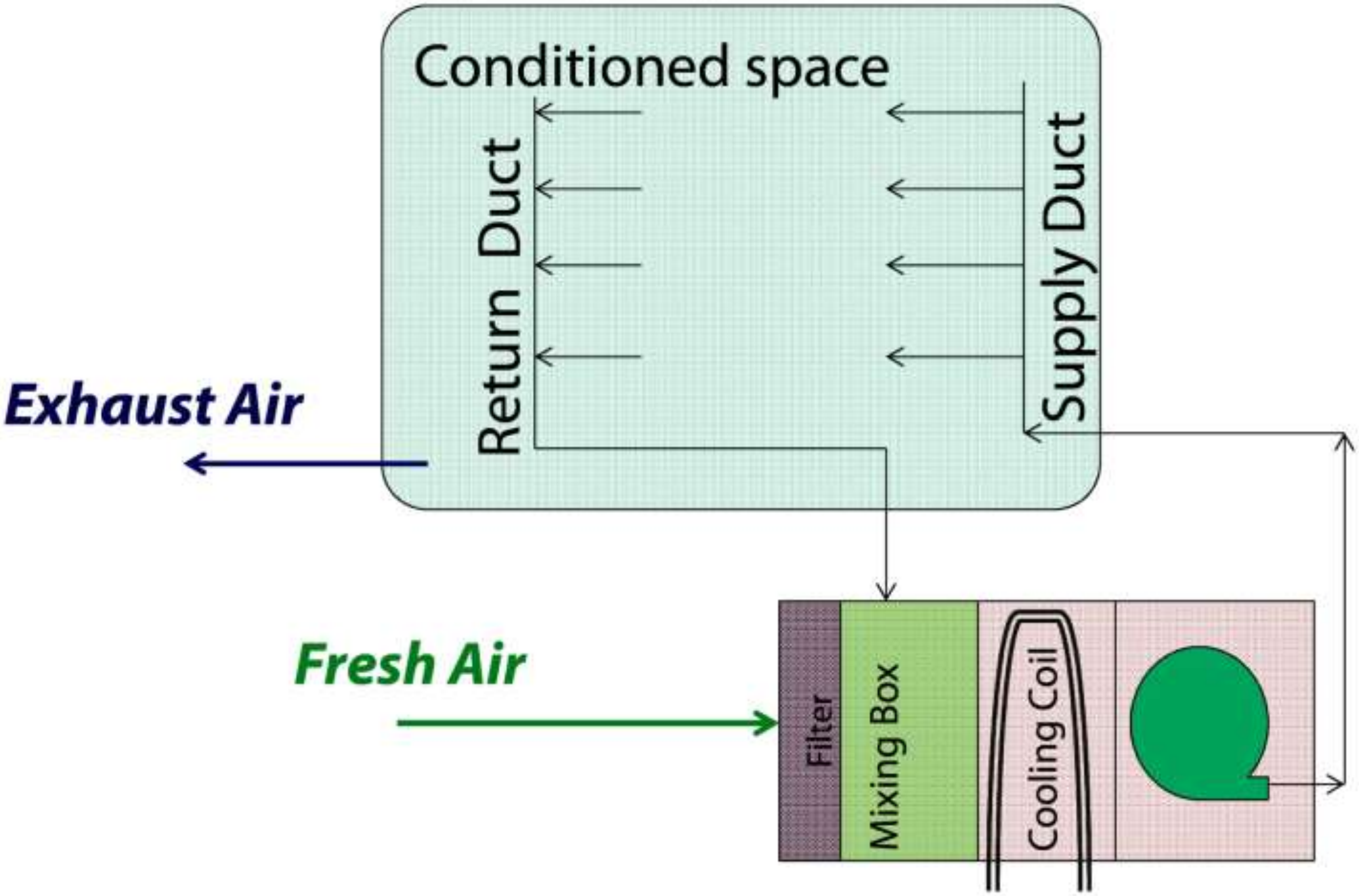
   or

2. 'Saves power for the same cooling effect as an air-washer';

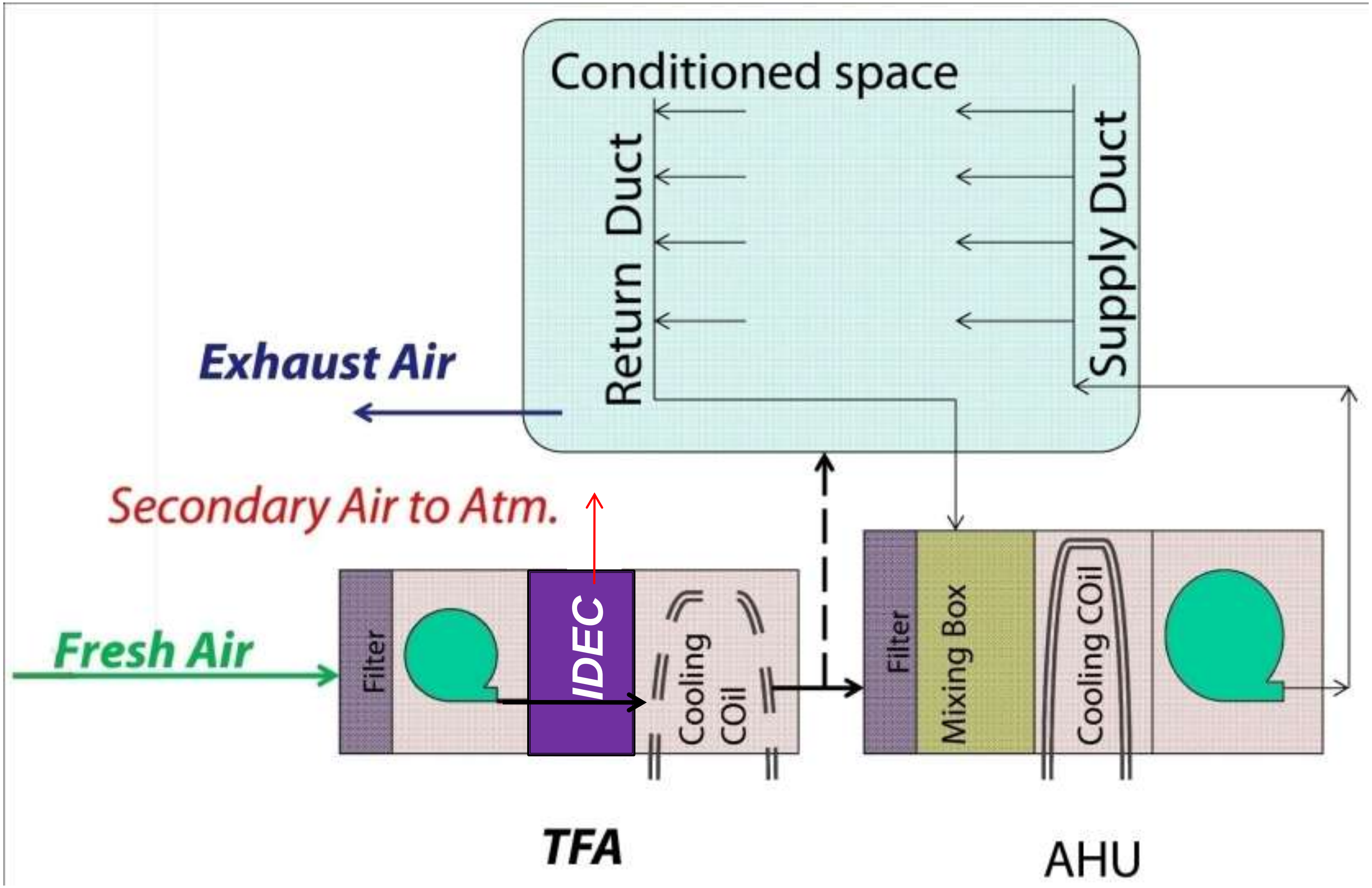
1. For same machine capacity

- ✓ More temperature drop (4 to 5 deg C) in **Aqua cool** vs. Air-washer
- ✓ **Aqua cool** adds only half of the moisture in air during cooling process, as compared to what Air-Washer does

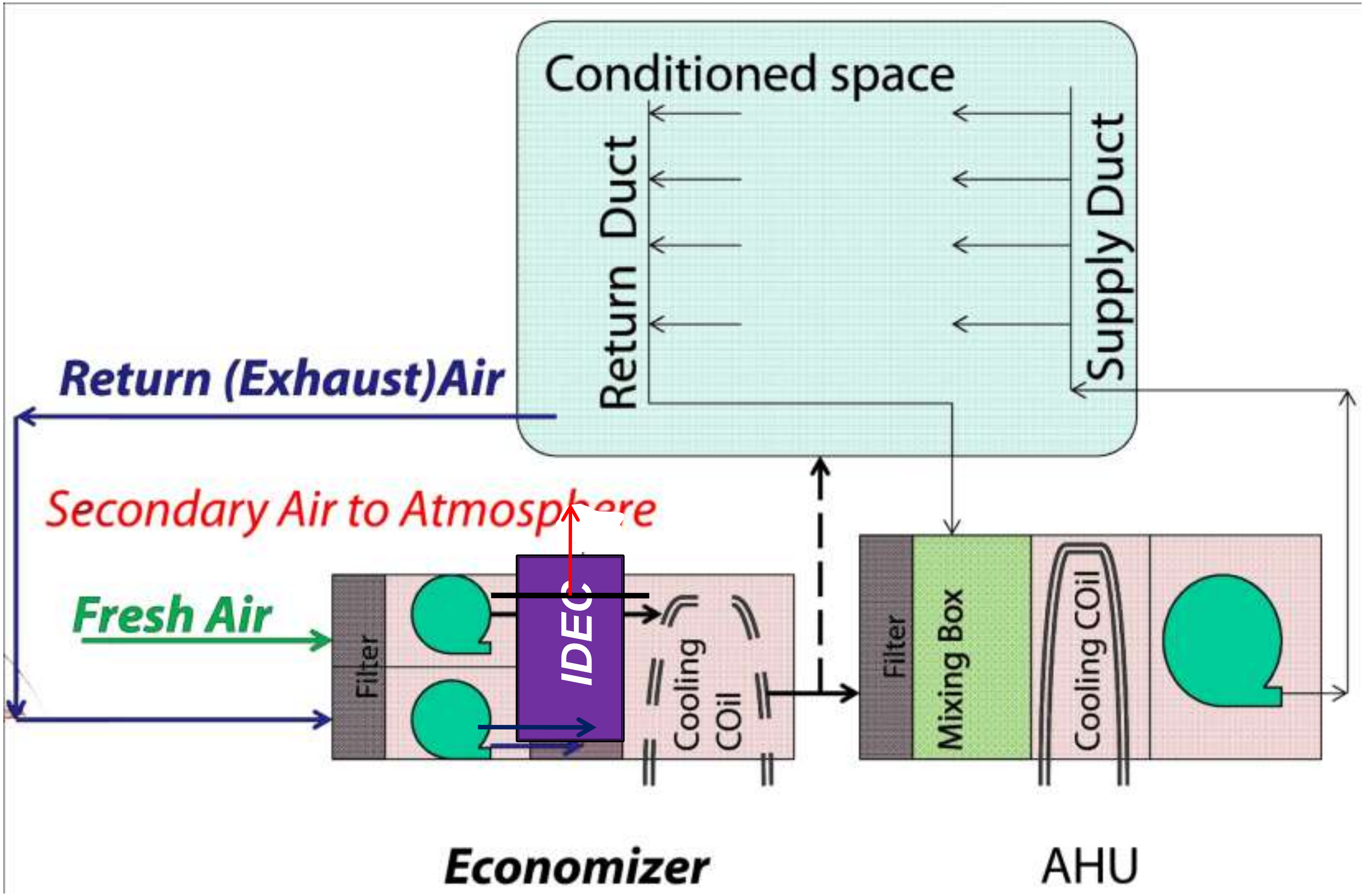
Solution for fresh air handling



Solution for cooling fresh air



Solution for cooling fresh air



Multistage IEC evaluation

The multistaged IEC has a unique design that maximizes the effectiveness of the direct and indirect stages of its cooling process. The schematic in Figure 5 illustrates fluid movement through the Aqua cool's heat and mass exchanger. The Aqua cool heat and mass exchanger is made of plastic in a geometric design that cools both the product and working airstreams in an isolated heat exchange process.

Fan energy is the only form of electrical energy input into the system. The fan is driven by an ECM that is greater than 90% efficient and is variable down to a near 0% flow rate. The inlet air passes through a filter before it enters the unit. The top portion of the inlet air is supplied to the space as the primary/product air stream. The air that flows through the bottom part of the Aqua cool's heat and mass exchanger is the secondary/working air. The system of cascading incremental airflows creates a thermodynamic process called the Maisotsenko Cycle (or M-Cycle) (Figure 5 and Figure 6). The process works by cooling both the primary/product air and the secondary/working air in a 20-stage process. The cumulative result is a lower primary/product air temperature than is possible with conventional evaporative cooling technologies. The key difference between this and other direct/indirect processes is that the secondary/working air that is accumulating moisture is exhausted at each stage, enabling the primary/product air to be delivered at a lower dry bulb temperature. This staging of air flows creates supply air that is driven by the colder dewpoint temperature rather than the wetbulb temperature.

In the psychrometric chart shown in Figure 7, the red arrows indicate the direct evaporative cooling taking place in the secondary/working airstream, which is exhausted at each of the 20 stages. The blue arrows represent indirect cooling of the primary/product airstream through the plastic heat exchange material; no moisture is added to this air stream during this process. This portion of the secondary/working air mixes with the secondary/working airstream during the purge process, so it will mix with air at higher humidities but only in the secondary/working airstream.

The advantage of the M-Cycle is that the working air is purged repeatedly so the initial conditions are essentially reset, as lower dry bulb and wet bulb temperatures are established with each purge cycle. This allows the eventual supply air temperature to be below what the original initial conditions would indicate possible—below the thermodynamic wet bulb temperature. This key staged-cooling process is essentially what sets the multistaged IEC apart from other IEC and DEC systems and enables greater cooling performance. During this process, no moisture is added to the primary/product air.
Figure 5 and Figure 7 illustrate the continuous purge process. Because of this purging, the multistaged IEC requires greater total airflow than other types of cooling systems. However, because the supply air temperature is lower than that possible with DEC and typical IEC systems, less supply air is required to meet space conditioning needs.9 Furthermore, the cooling effect on the building is greater during the most humid day and will therefore displace more mechanical cooling when used to supplement mechanical cooling equipment.

Product Range: Unbalanced ventilation, adiabatic cooling and heat recovering variant

Unbalanced Heat Recovery & Indirect Adiabatic Cooling (UHR&IAC)						Cooling capacity		
						28°C/50% outside	35°C/25% outside	
760/1380/79/4/3				US		23°C/60% return	25°C/45% return	
nominal volume	Supply air	**2400**	m3	**1.414**	cfm	6,2	10,8	kW
nominal volume	Exhaust air	**1100**	m3	**648**	cfm			
760/1380/158/4/3				US				
nominal volume	Supply air	**4800**	m3	**2.827**	cfm	12,4	21,6	kW
nominal volume	Exhaust air	**2200**	m3	**1.296**	cfm			
1010/1380/79/4/3				US				
nominal volume	Supply air	**3200**	m3	**1.885**	cfm	8,3	14,4	kW
nominal volume	Exhaust air	**1500**	m3	**884**	cfm			
1010/1380/158/4/3				US				
nominal volume	Supply air	**6400**	m3	**3.770**	cfm	16,6	28,8	kW
nominal volume	Exhaust air	**3000**	m3	**1.767**	cfm			
1500/1380/79/4/3				US				
nominal volume	Supply air	**4800**	m3	**2.827**	cfm	12,4	21,6	kW
nominal volume	Exhaust air	**2250**	m3	**1.325**	cfm			
1500/1380/158/4/3				US				
nominal volume	Supply air	**9600**	m3	**5.654**	cfm	24,8	43,2	kW
nominal volume	Exhaust air	**4500**	m3	**2.651**	cfm			

Hi-Tech

Output Calculator
Dubai, U.A.E.

Aqua cool
healthy fresh air

Weather conditions analysis

Month	Average sunlight (hours)	Temperature				Discomfort from heat and humidity	Relative Humidity		Average Precipation (mm)	Wet days (+25)
		Average		Record						
		Min	Max	Min	Max		am	pm		
Jan	8	12	23	3	29	Moderate	81	61	23	2
Feb	9	14	24	8	33	Moderate	81	63	23	2
Mar	8	16	27	8	40	Medium	74	61	10	1
Apr	10	18	30	12	39	High	66	63	5	0.3
May	11	22	34	16	43	Extreme	61	63	0	0
Jun	11	25	36	19	44	Extreme	64	65	0	0
Jul	11	28	38	23	47	Extreme	64	64	0	0
Aug	10	28	39	23	48	Extreme	66	64	0	0
Sep	10	25	37	21	45	Extreme	73	64	0	0
Oct	10	22	33	18	40	High	77	62	0	0
Nov	10	18	31	12	36	High	78	59	10	0.2
Dec	8	14	26	8	31	Medium	82	62	36	2

Outside Temperature

Total annual hours (365*24)	8,760 hours
Number of cooling hours per year (>15 ^{o}C)	8,030 hours
Cooling hours as % of total year	92%

Relative Humidity

Average relative humidity year	72%
Average relative humidity when >15% ^{o}C (%)	70%

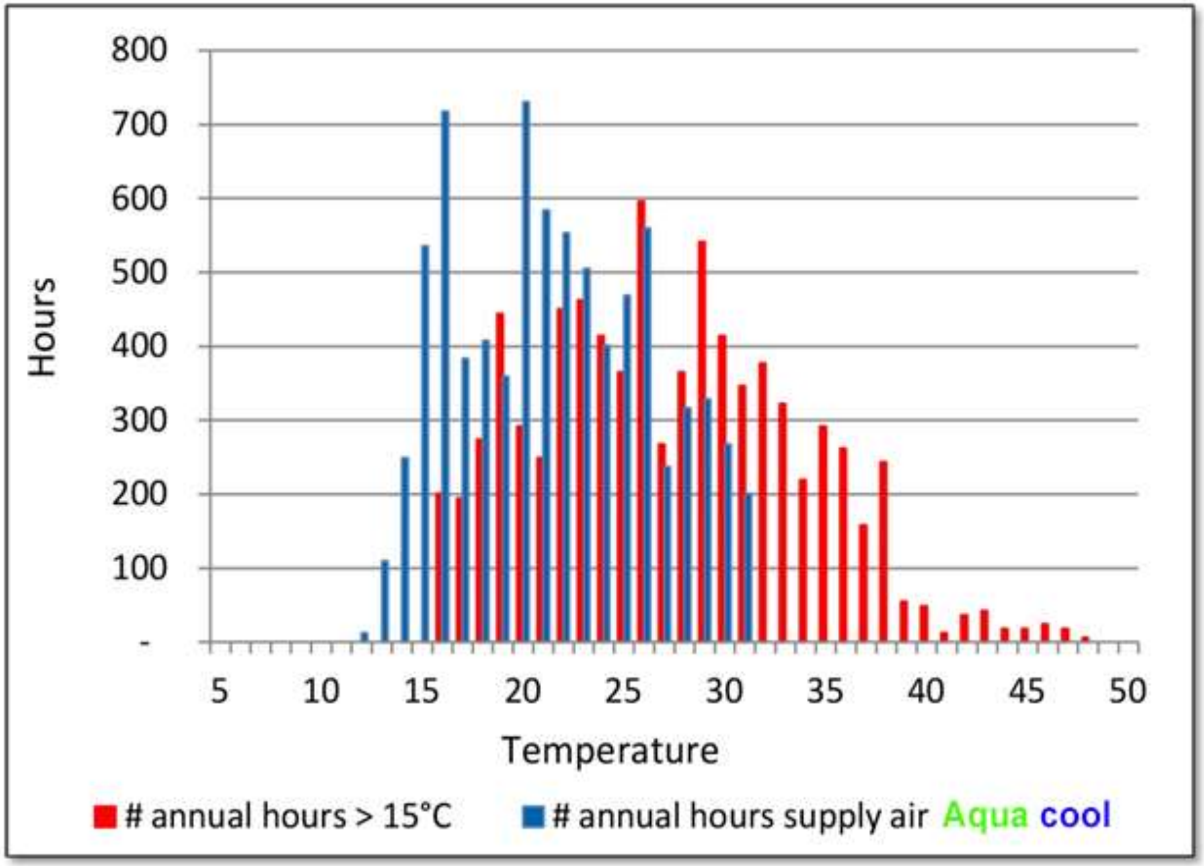
Output Calculator
Dubai, U.A.E.

Hi-Tech

Aqua cool
healthy fresh air

Supply air temperature analysis

Hours exceeding	Hours / year (cumulative)
25 °C	1,910
26 °C	1,351
27 °C	1,113
28 °C	797
29 °C	468
30 °C	201



Displacement Ventilation

Is an air distribution technique where conditioned outdoor air is supplied at floor level and extracted above the occupied zone, usually at ceiling height

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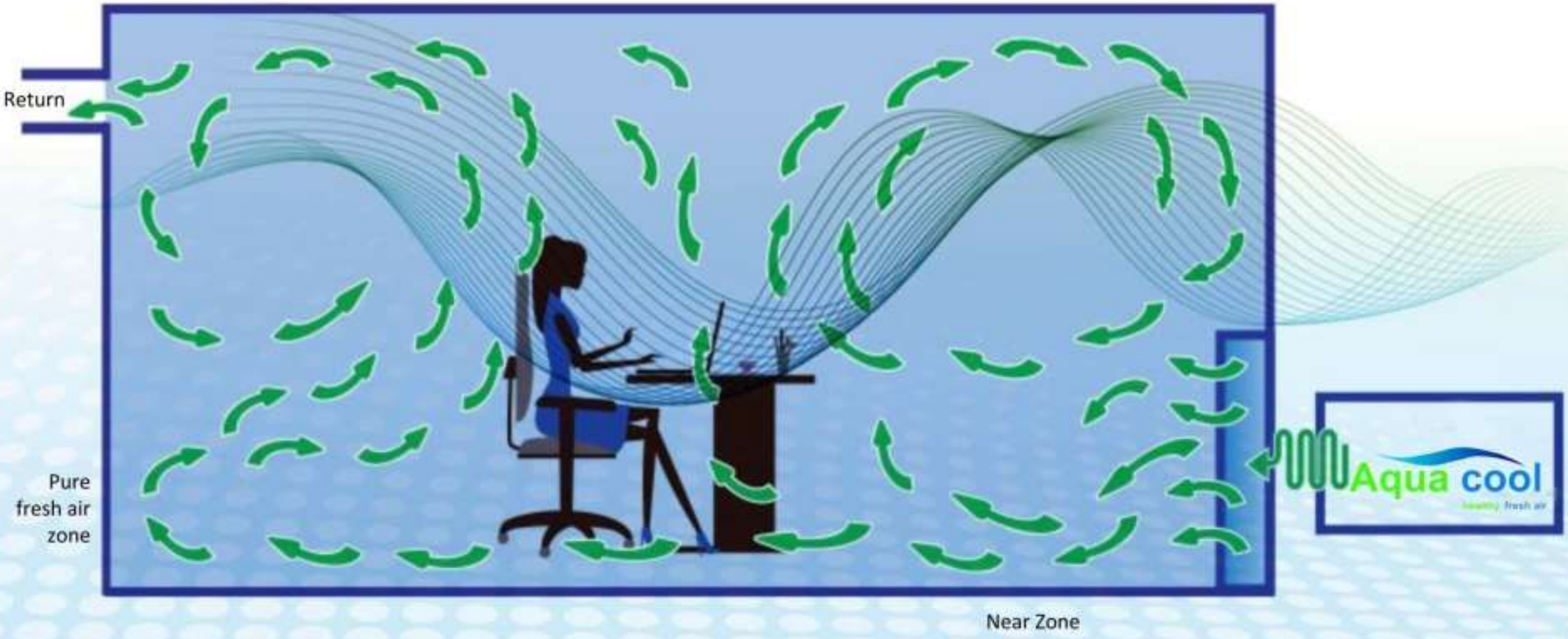
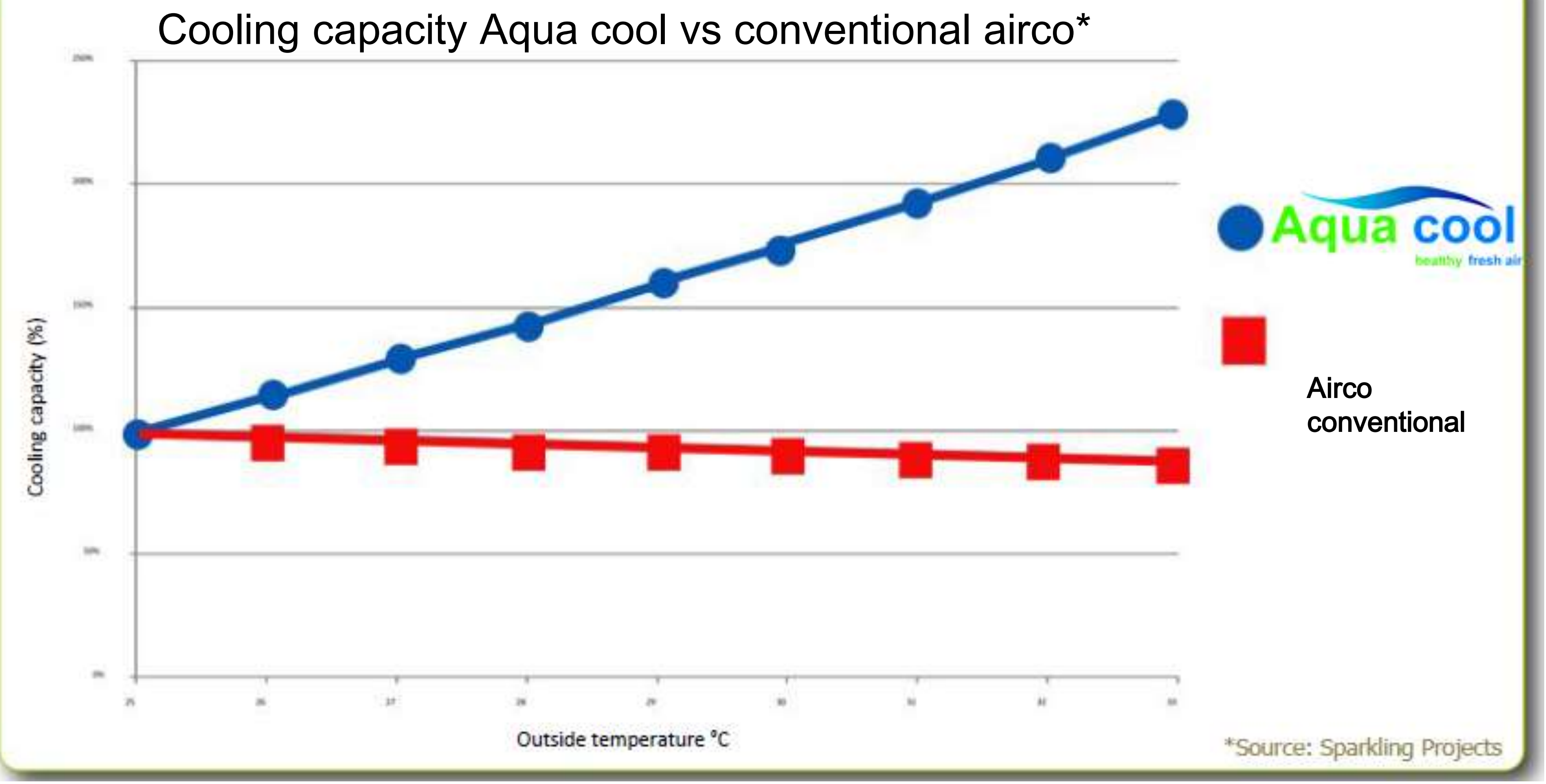


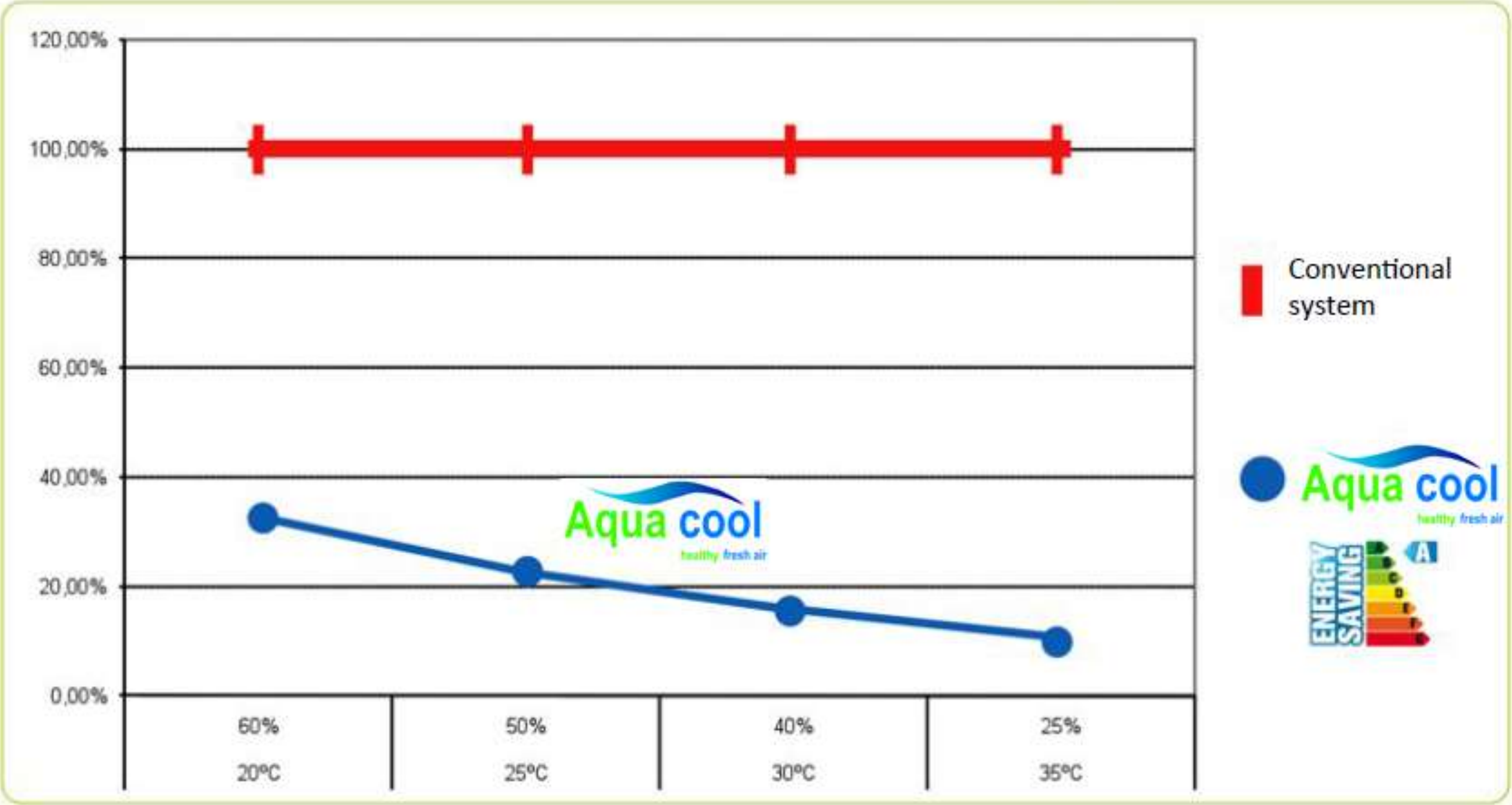
Capacity

The Aquacool AHU offers more cooling capacity when it is needed



*Source: Sparkling Projects

The energy consumption of the Aqu acool system Compared to a conventional air-conditioning system with same cooling capacity



Apply in various configurations

As a stand alone cooling and ventilation system in new buildings or as a replacement of redundant conventional air conditioning systems. Cooling the building by bringing cool air and forcing warm air out.

As a pre-cooler for the ventilation air in combination with a conventional air conditioning system that circulates air in the building.

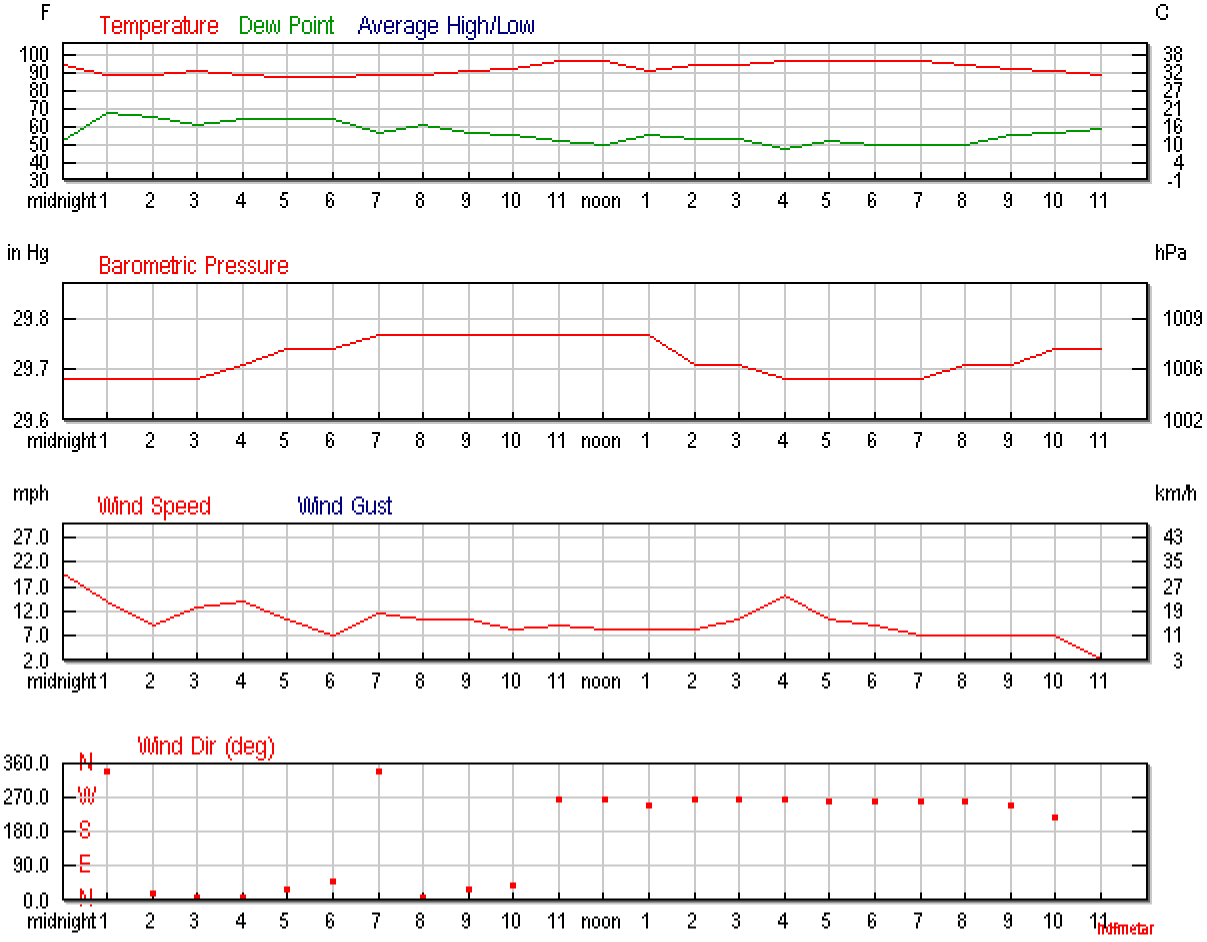
In combination with heat recovery systems for use in winter.

Temperature readings in Dubai on hottest day in the month of May (May 10, 2015)

Temperature			
Mean Temperature	**34** °C	-	
Max Temperature	**36** °C	**37** °C	**42** °C (2008)
Min Temperature	**31** °C	**25** °C	**20** °C (1997)
Cooling Degree Days	26		
Growing Degree Days	42 (Base 50)		
Moisture			
Dew Point	**14** °C		
Average Humidity	30		
Maximum Humidity	49		
Minimum Humidity	13		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**1006.48** hPa		
Wind			
Wind Speed	**17** km/h ()		
Max Wind Speed	**32** km/h		
Max Gust Speed	-		
Visibility	**10.0** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of May (May 10, 2015)

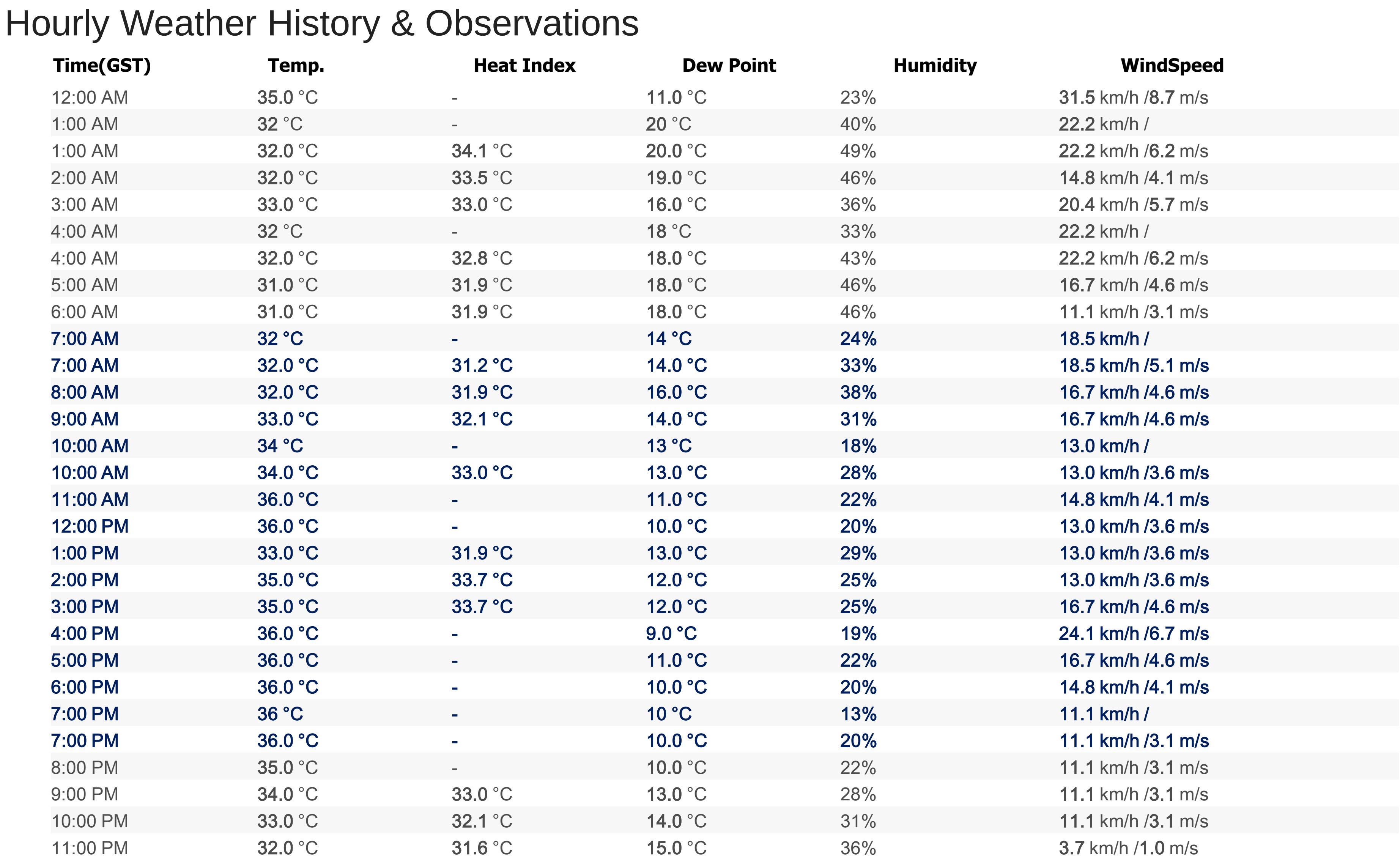
Daily Weather History Graph



Temperature readings in Dubai on hottest day in the month of May (May 10, 2015)

Hi-Tech

Aqua cool
healthy fresh air



Hourly Weather History & Observations

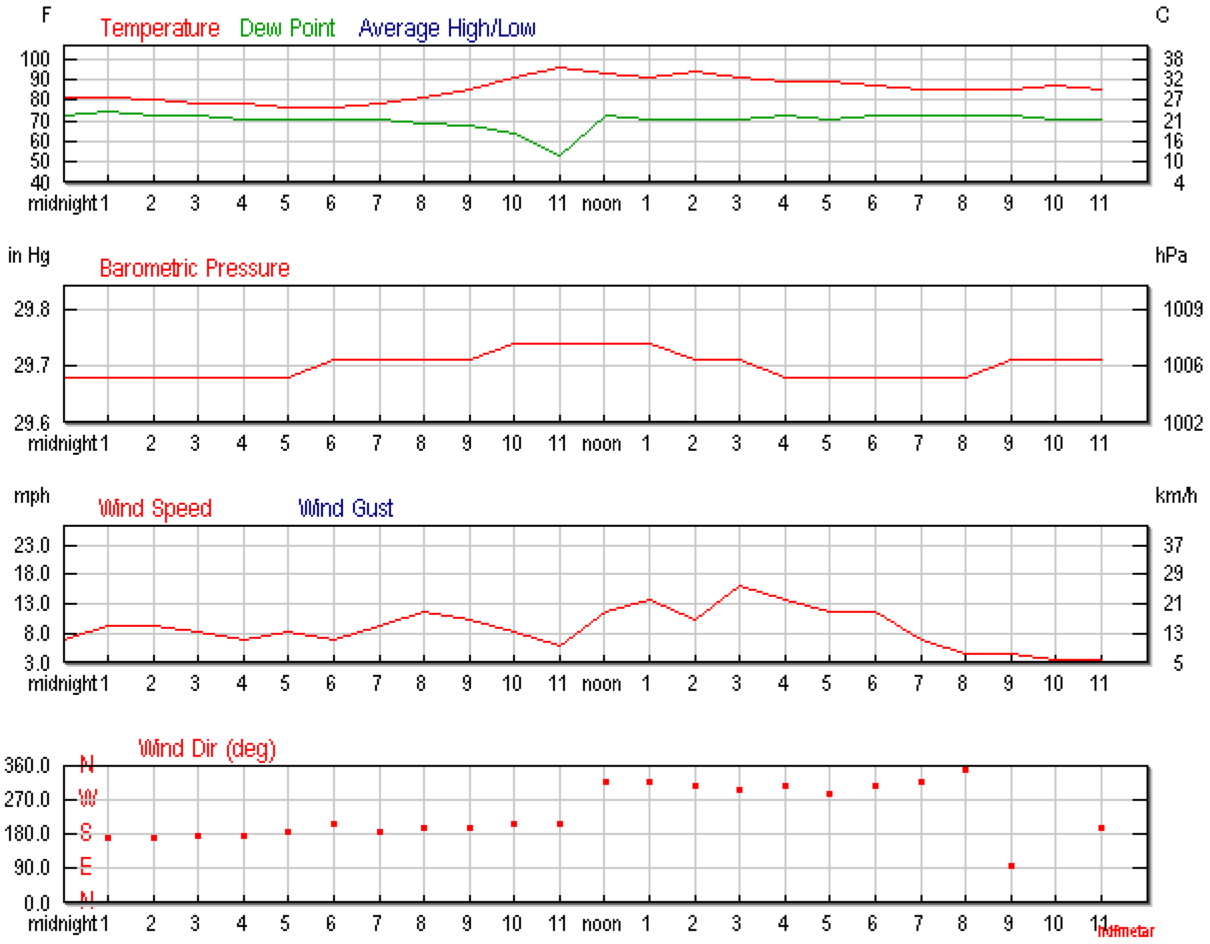
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	35.0 °C	-	11.0 °C	23%	31.5 km/h /8.7 m/s
1:00 AM	32 °C	-	20 °C	40%	22.2 km/h /
1:00 AM	32.0 °C	34.1 °C	20.0 °C	49%	22.2 km/h /6.2 m/s
2:00 AM	32.0 °C	33.5 °C	19.0 °C	46%	14.8 km/h /4.1 m/s
3:00 AM	33.0 °C	33.0 °C	16.0 °C	36%	20.4 km/h /5.7 m/s
4:00 AM	32 °C	-	18 °C	33%	22.2 km/h /
4:00 AM	32.0 °C	32.8 °C	18.0 °C	43%	22.2 km/h /6.2 m/s
5:00 AM	31.0 °C	31.9 °C	18.0 °C	46%	16.7 km/h /4.6 m/s
6:00 AM	31.0 °C	31.9 °C	18.0 °C	46%	11.1 km/h /3.1 m/s
7:00 AM	**32 °C**	**-**	**14 °C**	**24%**	**18.5 km/h /**
7:00 AM	**32.0 °C**	**31.2 °C**	**14.0 °C**	**33%**	**18.5 km/h /5.1 m/s**
8:00 AM	**32.0 °C**	**31.9 °C**	**16.0 °C**	**38%**	**16.7 km/h /4.6 m/s**
9:00 AM	**33.0 °C**	**32.1 °C**	**14.0 °C**	**31%**	**16.7 km/h /4.6 m/s**
10:00 AM	**34 °C**	**-**	**13 °C**	**18%**	**13.0 km/h /**
10:00 AM	**34.0 °C**	**33.0 °C**	**13.0 °C**	**28%**	**13.0 km/h /3.6 m/s**
11:00 AM	**36.0 °C**	**-**	**11.0 °C**	**22%**	**14.8 km/h /4.1 m/s**
12:00 PM	**36.0 °C**	**-**	**10.0 °C**	**20%**	**13.0 km/h /3.6 m/s**
1:00 PM	**33.0 °C**	**31.9 °C**	**13.0 °C**	**29%**	**13.0 km/h /3.6 m/s**
2:00 PM	**35.0 °C**	**33.7 °C**	**12.0 °C**	**25%**	**13.0 km/h /3.6 m/s**
3:00 PM	**35.0 °C**	**33.7 °C**	**12.0 °C**	**25%**	**16.7 km/h /4.6 m/s**
4:00 PM	**36.0 °C**	**-**	**9.0 °C**	**19%**	**24.1 km/h /6.7 m/s**
5:00 PM	**36.0 °C**	**-**	**11.0 °C**	**22%**	**16.7 km/h /4.6 m/s**
6:00 PM	**36.0 °C**	**-**	**10.0 °C**	**20%**	**14.8 km/h /4.1 m/s**
7:00 PM	**36 °C**	**-**	**10 °C**	**13%**	**11.1 km/h /**
7:00 PM	**36.0 °C**	**-**	**10.0 °C**	**20%**	**11.1 km/h /3.1 m/s**
8:00 PM	35.0 °C	-	10.0 °C	22%	11.1 km/h /3.1 m/s
9:00 PM	34.0 °C	33.0 °C	13.0 °C	28%	11.1 km/h /3.1 m/s
10:00 PM	33.0 °C	32.1 °C	14.0 °C	31%	11.1 km/h /3.1 m/s
11:00 PM	32.0 °C	31.6 °C	15.0 °C	36%	3.7 km/h /1.0 m/s

Temperature readings in Dubai on hottest day in the month of May (May 20, 2015)

	Actual	Average	Record
Temperature			
Mean Temperature	**30** °C	-	
Max Temperature	**36** °C	**37** °C	**41** °C (2006)
Min Temperature	**25** °C	**26** °C	**23** °C (2013)
Cooling Degree Days	22		
Growing Degree Days	36 (Base 50)		
Moisture			
Dew Point	**22** °C		
Average Humidity	64		
Maximum Humidity	83		
Minimum Humidity	23		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**1005.69** hPa		
Wind			
Wind Speed	**12** km/h ()		
Max Wind Speed	**26** km/h		
Max Gust Speed	-		
Visibility	**9.0** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of May (May 20, 2015)

Daily Weather History Graph



Hi-Tech

Temperature readings in Dubai on hottest day in the month of May (May 20, 2015)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

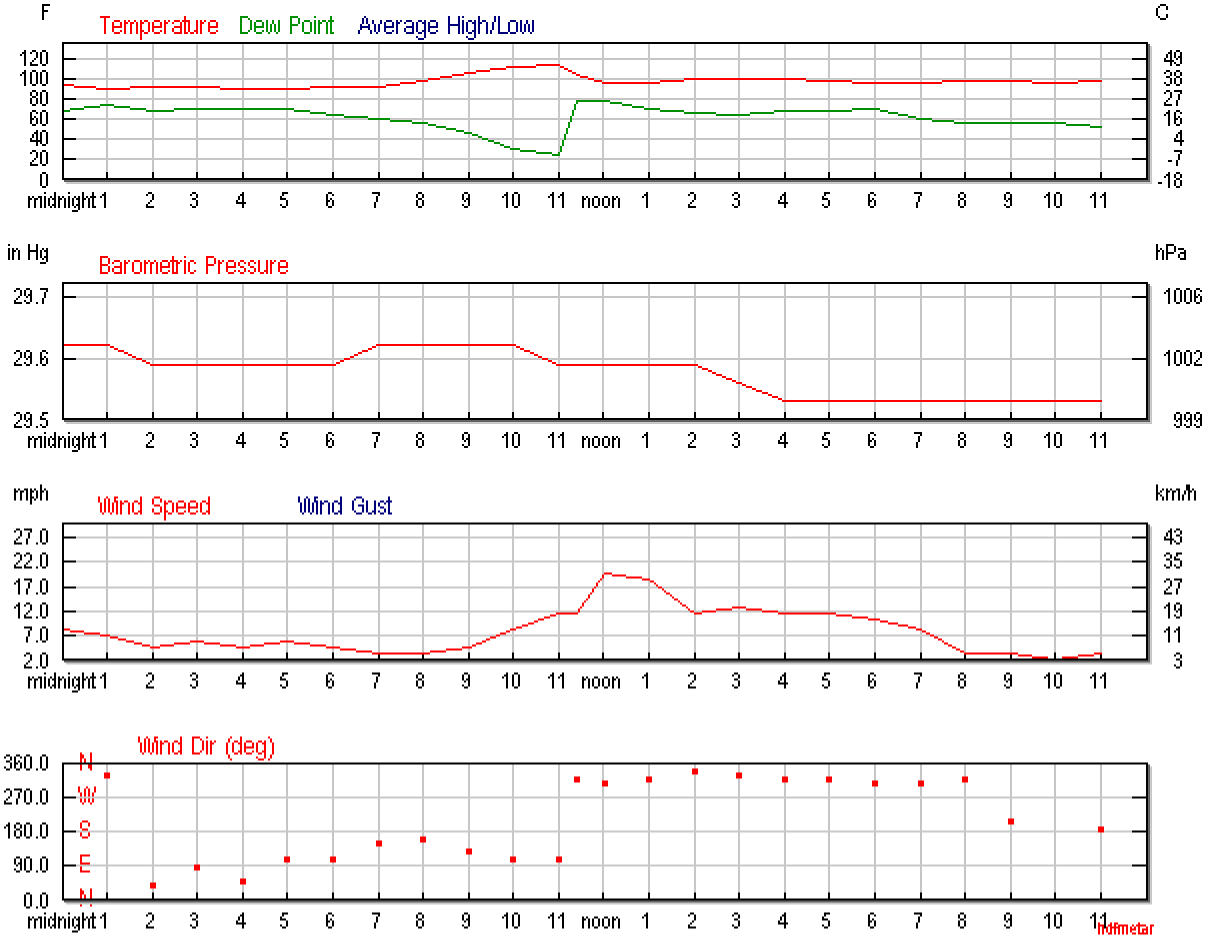
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	28.0 °C	31.2 °C	23.0 °C	74%	11.1 km/h /3.1 m/s
1:00 AM	28 °C	-	24 °C	72%	14.8 km/h /
1:00 AM	28.0 °C	31.9 °C	24.0 °C	79%	14.8 km/h /4.1 m/s
2:00 AM	27.0 °C	29.6 °C	23.0 °C	79%	14.8 km/h /4.1 m/s
3:00 AM	26.0 °C	-	23.0 °C	83%	13.0 km/h /3.6 m/s
4:00 AM	26 °C	-	22 °C	73%	11.1 km/h /
4:00 AM	26.0 °C	-	22.0 °C	78%	11.1 km/h /3.1 m/s
5:00 AM	25.0 °C	-	22.0 °C	83%	13.0 km/h /3.6 m/s
6:00 AM	25.0 °C	-	22.0 °C	83%	11.1 km/h /3.1 m/s
7:00 AM	**26.0 °C**	**-**	**22.0 °C**	**78%**	**14.8 km/h /4.1 m/s**
8:00 AM	**28.0 °C**	**30.2 °C**	**21.0 °C**	**66%**	**18.5 km/h /5.1 m/s**
9:00 AM	**30.0 °C**	**31.9 °C**	**20.0 °C**	**55%**	**16.7 km/h /4.6 m/s**
10:00 AM	**33.0 °C**	**34.0 °C**	**18.0 °C**	**41%**	**13.0 km/h /3.6 m/s**
11:00 AM	**36.0 °C**	**34.7 °C**	**12.0 °C**	**23%**	**9.3 km/h /2.6 m/s**
12:00 PM	**34.0 °C**	**39.1 °C**	**23.0 °C**	**52%**	**18.5 km/h /5.1 m/s**
1:00 PM	**33.0 °C**	**36.9 °C**	**22.0 °C**	**52%**	**22.2 km/h /6.2 m/s**
2:00 PM	**35.0 °C**	**39.5 °C**	**22.0 °C**	**47%**	**16.7 km/h /4.6 m/s**
3:00 PM	**33.0 °C**	**36.9 °C**	**22.0 °C**	**52%**	**25.9 km/h /7.2 m/s**
4:00 PM	**32.0 °C**	**36.8 °C**	**23.0 °C**	**59%**	**22.2 km/h /6.2 m/s**
5:00 PM	**32.0 °C**	**35.6 °C**	**22.0 °C**	**55%**	**18.5 km/h /5.1 m/s**
6:00 PM	**31.0 °C**	**35.4 °C**	**23.0 °C**	**62%**	**18.5 km/h /5.1 m/s**
7:00 PM	**30.0 °C**	**34.1 °C**	**23.0 °C**	**66%**	**11.1 km/h /3.1 m/s**
8:00 PM	30.0 °C	34.1 °C	23.0 °C	66%	7.4 km/h / 2.1 m/s
9:00 PM	30.0 °C	34.1 °C	23.0 °C	66%	7.4 km/h / 2.1 m/s
10:00 PM	31.0 °C	34.4 °C	22.0 °C	58%	5.6 km/h /1.5 m/s
11:00 PM	30.0 °C	33.2 °C	22.0 °C	62%	5.6 km/h /1.5 m/s

Temperature readings in Dubai on hottest day in the month of June (June 3, 2015)

	Actual	Average	Record
Temperature			
Mean Temperature	**40** °C	-	
Max Temperature	**47** °C	**38** °C	**47** °C (2015)
Min Temperature	**32** °C	**27** °C	**25** °C (1997)
Cooling Degree Days	40		
Growing Degree Days	54 (Base 50)		
Moisture			
Dew Point	**17** °C		
Average Humidity	33		
Maximum Humidity	59		
Minimum Humidity	4		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**1001.72** hPa		
Wind			
Wind Speed	**11** km/h ()		
Max Wind Speed	**32** km/h		
Max Gust Speed	-		
Visibility	**9.2** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of June (June 3, 2015)

Daily Weather History Graph



Temperature readings in Dubai on hottest day in the month of June (June 3, 2015)

Hourly Weather History & Observations

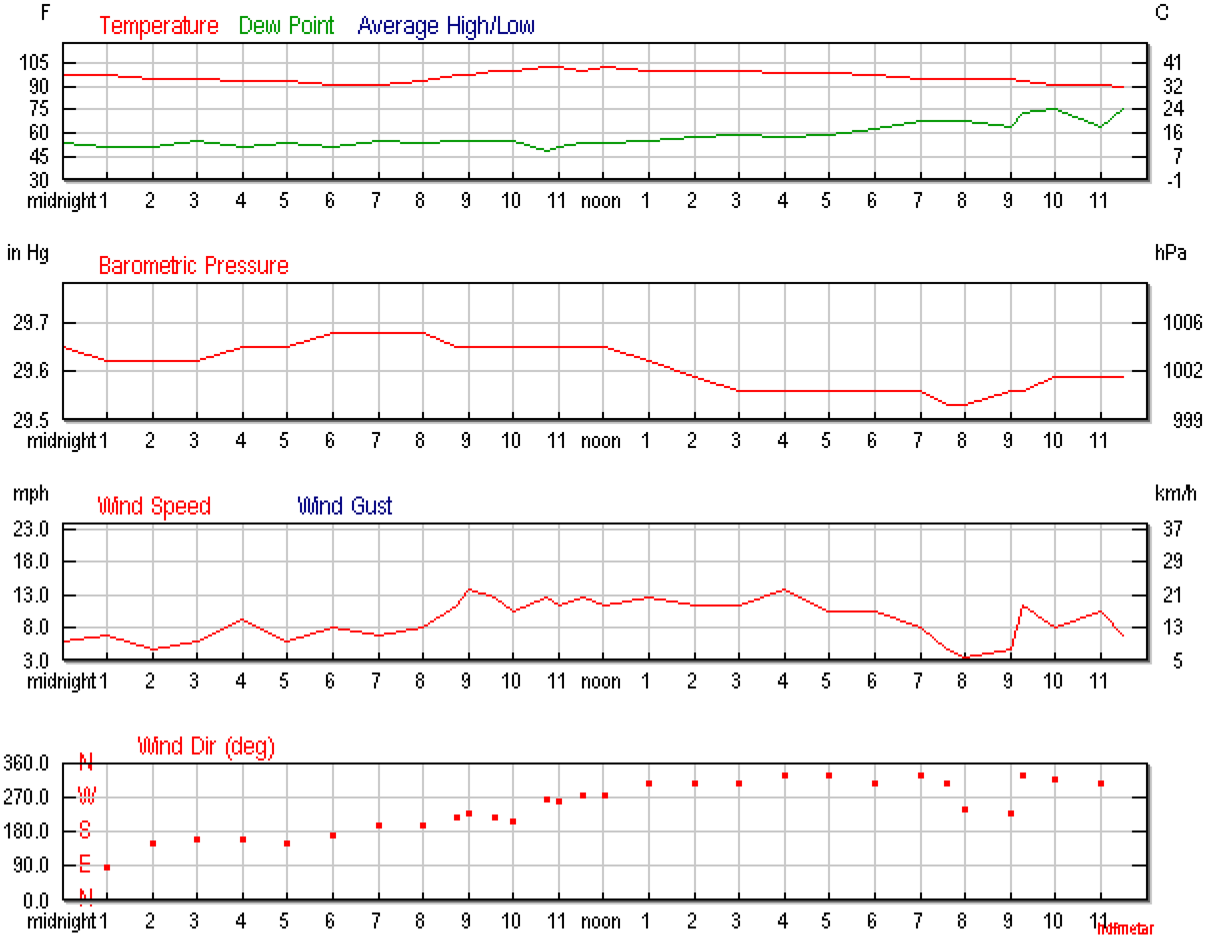
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	35.0 °C	38.5 °C	21.0 °C	44%	13.0 km/h /3.6 m/s
1:00 AM	33 °C	-	24 °C	50%	9.3 km/h /
1:00 AM	33.0 °C	39.2 °C	24.0 °C	59%	11.1 km/h /3.1 m/s
2:00 AM	34.0 °C	37.1 °C	21.0 °C	46%	7.4 km/h /2.1 m/s
3:00 AM	34.0 °C	38.1 °C	22.0 °C	49%	9.3 km/h /2.6 m/s
4:00 AM	33 °C	-	22 °C	41%	7.4 km/h /
4:00 AM	33.0 °C	36.9 °C	22.0 °C	52%	7.4 km/h /2.1 m/s
5:00 AM	33.0 °C	36.9 °C	22.0 °C	52%	9.3 km/h /2.6 m/s
6:00 AM	34.0 °C	35.7 °C	19.0 °C	41%	7.4 km/h /2.1 m/s
7:00 AM	34 °C	-	16 °C	24%	5.6 km/h /
7:00 AM	34.0 °C	34.0 °C	16.0 °C	34%	5.6 km/h /1.5 m/s
8:00 AM	38.0 °C	37.6 °C	14.0 °C	24%	5.6 km/h /1.5 m/s
9:00 AM	42.0 °C	-	9.0 °C	14%	7.4 km/h /2.1 m/s
10:00 AM	45 °C	-	0 °C	4%	13.0 km/h /
10:00 AM	45.0 °C	-	0.0 °C	6%	13.0 km/h /3.6 m/s
11:00 AM	47.0 °C	-	-4.0 °C	4%	18.5 km/h /5.1 m/s
11:24 AM	41.0 °C	52.9 °C	26.0 °C	43%	18.5 km/h /5.1 m/s
12:00 PM	36.0 °C	46.0 °C	26.0 °C	56%	31.5 km/h /8.7 m/s
1:00 PM	37 °C	-	22 °C	31%	29.6 km/h /
1:00 PM	37.0 °C	42.0 °C	22.0 °C	42%	29.6 km/h /8.2 m/s
2:00 PM	39.0 °C	42.5 °C	20.0 °C	33%	18.5 km/h /5.1 m/s
3:00 PM	39.0 °C	41.6 °C	19.0 °C	31%	20.4 km/h /5.7 m/s
4:00 PM	39 °C	-	21 °C	27%	18.5 km/h /
4:00 PM	39.0 °C	43.3 °C	21.0 °C	35%	18.5 km/h /5.1 m/s
5:00 PM	38.0 °C	42.1 °C	21.0 °C	37%	18.5 km/h /5.1 m/s
6:00 PM	37.0 °C	42.0 °C	22.0 °C	42%	16.7 km/h /4.6 m/s
7:00 PM	37.0 °C	37.8 °C	17.0 °C	30%	13.0 km/h /3.6 m/s
8:00 PM	38.0 °C	37.6 °C	14.0 °C	24%	5.6 km/h /1.5 m/s
9:00 PM	38.0 °C	37.6 °C	14.0 °C	24%	5.6 km/h /1.5 m/s
10:00 PM	37 °C	-	14 °C	16%	3.7 km/h /

Temperature readings in Dubai on hottest day in the month of June (June 7, 2015)

	Actual	Average	Record
Temperature			
Mean Temperature	**36** °C	-	
Max Temperature	**39** °C	**38** °C	**43** °C (2004)
Min Temperature	**32** °C	**27** °C	**26** °C (2001)
Cooling Degree Days	32		
Growing Degree Days	47 (Base 50)		
Moisture			
Dew Point	**15** °C		
Average Humidity	28		
Maximum Humidity	62		
Minimum Humidity	13		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**1002.92** hPa		
Wind			
Wind Speed	**12** km/h ()		
Max Wind Speed	**22** km/h		
Max Gust Speed	-		
Visibility	**3.7** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of June (June 7, 2015)

Daily Weather History Graph



Hi-Tech

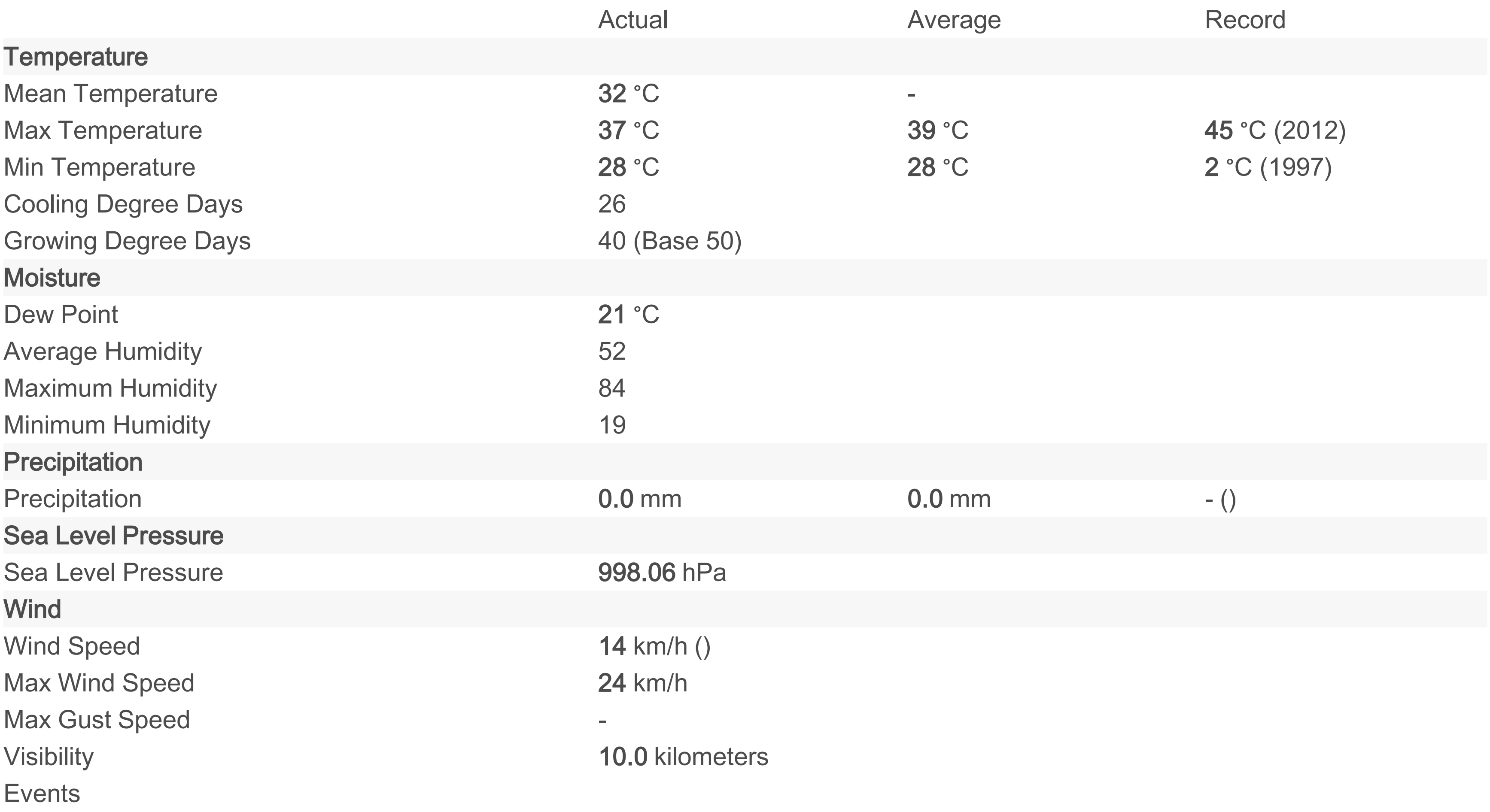
Temperature readings in Dubai on hottest day in the month of June (June 7, 2015)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	36.0 °C	34.7 °C	12.0 °C	23%	9.3 km/h /2.6 m/s
1:00 AM	36 °C	-	11 °C	14%	11.1 km/h /
1:00 AM	36.0 °C	-	11.0 °C	22%	11.1 km/h /3.1 m/s
2:00 AM	35.0 °C	-	11.0 °C	23%	7.4 km/h /2.1 m/s
3:00 AM	35.0 °C	33.9 °C	13.0 °C	26%	9.3 km/h /2.6 m/s
4:00 AM	34 °C	-	11 °C	16%	14.8 km/h /
4:00 AM	34.0 °C	-	11.0 °C	24%	14.8 km/h /4.1 m/s
5:00 AM	34.0 °C	32.7 °C	12.0 °C	26%	9.3 km/h /2.6 m/s
6:00 AM	33.0 °C	-	11.0 °C	26%	13.0 km/h /3.6 m/s
7:00 AM	33 °C	-	13 °C	19%	11.1 km/h /
7:00 AM	33.0 °C	31.9 °C	13.0 °C	29%	11.1 km/h /3.1 m/s
8:00 AM	34.0 °C	32.7 °C	12.0 °C	26%	13.0 km/h /3.6 m/s
8:46 AM	36.0 °C	35.0 °C	13.0 °C	25%	18.5 km/h /5.1 m/s
9:00 AM	36.0 °C	35.0 °C	13.0 °C	25%	22.2 km/h /6.2 m/s
9:35 AM	38.0 °C	37.1 °C	13.0 °C	22%	20.4 km/h /5.7 m/s
10:00 AM	38 °C	-	12 °C	13%	16.7 km/h /
10:00 AM	38.0 °C	37.1 °C	13.0 °C	22%	16.7 km/h /4.6 m/s
10:44 AM	39.0 °C	-	9.0 °C	16%	20.4 km/h /5.7 m/s
11:00 AM	39.0 °C	-	11.0 °C	18%	18.5 km/h /5.1 m/s
11:32 AM	38.0 °C	36.9 °C	12.0 °C	21%	20.4 km/h /5.7 m/s
12:00 PM	39.0 °C	38.0 °C	12.0 °C	20%	18.5 km/h /5.1 m/s
1:00 PM	38 °C	-	12 °C	13%	20.4 km/h /
1:00 PM	38.0 °C	37.1 °C	13.0 °C	22%	20.4 km/h /5.7 m/s
2:00 PM	38.0 °C	37.6 °C	14.0 °C	24%	18.5 km/h /5.1 m/s
3:00 PM	38.0 °C	37.9 °C	15.0 °C	25%	18.5 km/h /5.1 m/s
4:00 PM	37.0 °C	36.4 °C	14.0 °C	25%	22.2 km/h /6.2 m/s
5:00 PM	37.0 °C	36.9 °C	15.0 °C	27%	16.7 km/h /4.6 m/s
6:00 PM	36.0 °C	36.7 °C	17.0 °C	32%	16.7 km/h /4.6 m/s
7:00 PM	35.0 °C	37.5 °C	20.0 °C	41%	13.0 km/h /3.6 m/s
7:36 PM	35.0 °C	37.5 °C	20.0 °C	41%	7.4 km/h /2.1 m/s
8:00 PM	35.0 °C	37.5 °C	20.0 °C	41%	5.6 km/h /1.5 m/s
9:00 PM	35.0 °C	36.1 °C	18.0 °C	36%	7.4 km/h /2.1 m/s
9:17 PM	34.0 °C	39.1 °C	23.0 °C	52%	18.5 km/h /5.1 m/s
10:00 PM	33 °C	-	24 °C	52%	13.0 km/h /
10:00 PM	33.0 °C	39.2 °C	24.0 °C	59%	13.0 km/h /3.6 m/s
11:00 PM	33.0 °C	34.0 °C	18.0 °C	41%	16.7 km/h /4.6 m/s
11:29 PM	32.0 °C	37.7 °C	24.0 °C	62%	11.1 km/h /3.1 m/s

Temperature readings in Dubai on hottest day in the month of June (June 19, 2014)



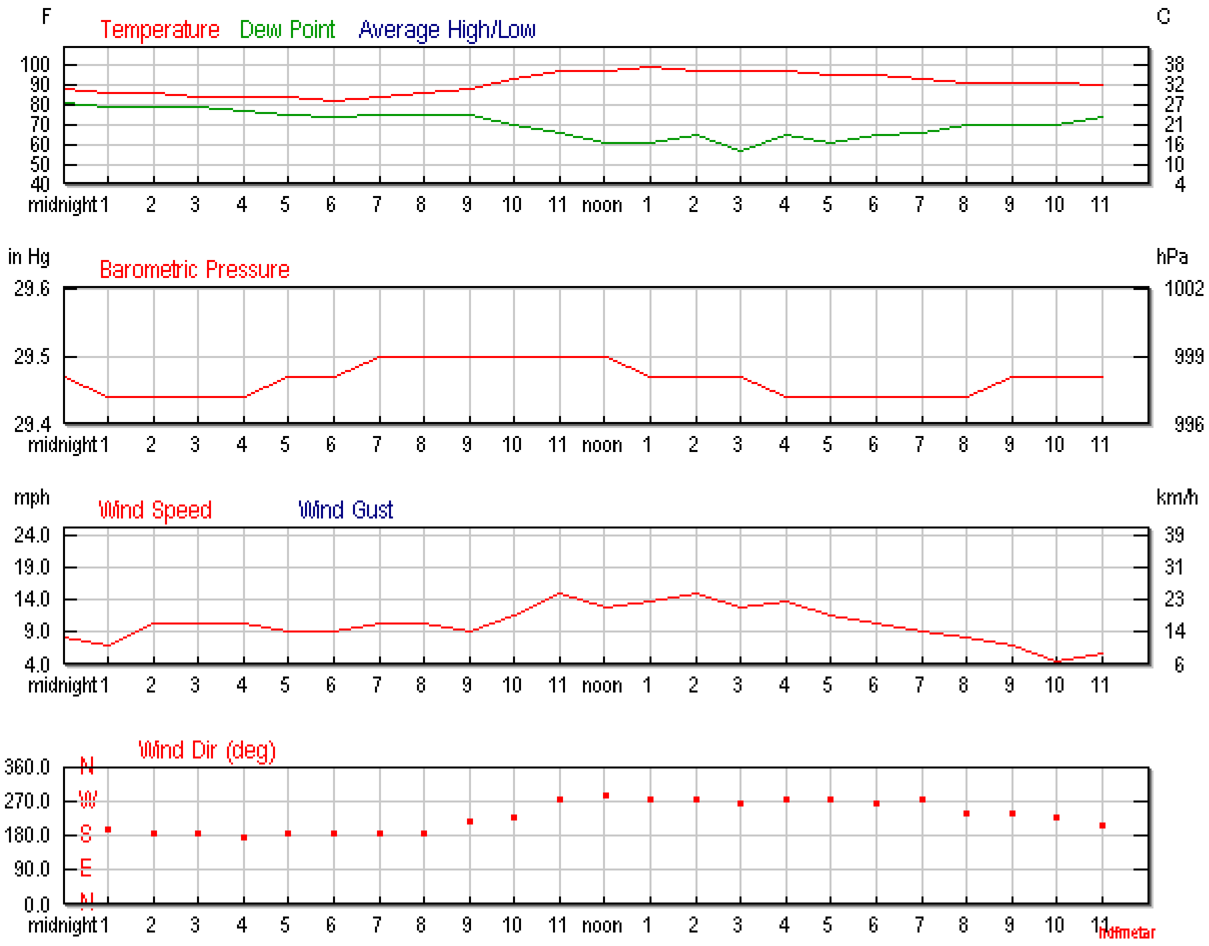
	Actual	Average	Record
Temperature			
Mean Temperature	**32** °C	-	
Max Temperature	**37** °C	**39** °C	**45** °C (2012)
Min Temperature	**28** °C	**28** °C	**2** °C (1997)
Cooling Degree Days	26		
Growing Degree Days	40 (Base 50)		
Moisture			
Dew Point	**21** °C		
Average Humidity	52		
Maximum Humidity	84		
Minimum Humidity	19		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**998.06** hPa		
Wind			
Wind Speed	**14** km/h ()		
Max Wind Speed	**24** km/h		
Max Gust Speed	-		
Visibility	**10.0** kilometers		
Events			

Hi-Tech

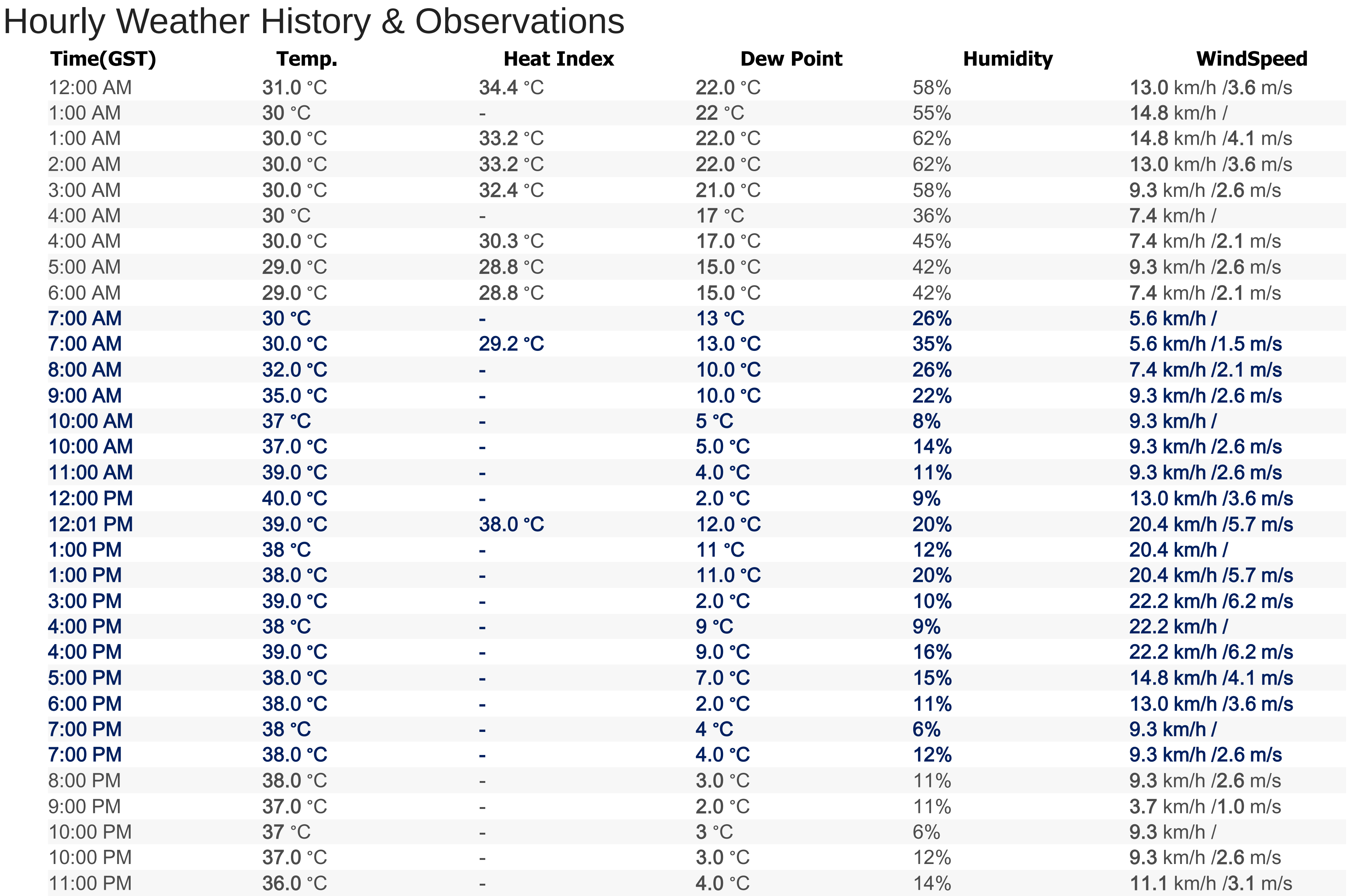
Temperature readings in Dubai on hottest day in the month of June (June 19, 2014)

Aqua cool
healthy fresh air

Daily Weather History Graph



Temperature readings in Dubai on hottest day in the month of June (June 19, 2014)



Hourly Weather History & Observations

Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	31.0 °C	34.4 °C	22.0 °C	58%	13.0 km/h /3.6 m/s
1:00 AM	30 °C	-	22 °C	55%	14.8 km/h /
1:00 AM	30.0 °C	33.2 °C	22.0 °C	62%	14.8 km/h /4.1 m/s
2:00 AM	30.0 °C	33.2 °C	22.0 °C	62%	13.0 km/h /3.6 m/s
3:00 AM	30.0 °C	32.4 °C	21.0 °C	58%	9.3 km/h /2.6 m/s
4:00 AM	30 °C	-	17 °C	36%	7.4 km/h /
4:00 AM	30.0 °C	30.3 °C	17.0 °C	45%	7.4 km/h /2.1 m/s
5:00 AM	29.0 °C	28.8 °C	15.0 °C	42%	9.3 km/h /2.6 m/s
6:00 AM	29.0 °C	28.8 °C	15.0 °C	42%	7.4 km/h /2.1 m/s
7:00 AM	30 °C	-	13 °C	26%	5.6 km/h /
7:00 AM	30.0 °C	29.2 °C	13.0 °C	35%	5.6 km/h /1.5 m/s
8:00 AM	32.0 °C	-	10.0 °C	26%	7.4 km/h /2.1 m/s
9:00 AM	35.0 °C	-	10.0 °C	22%	9.3 km/h /2.6 m/s
10:00 AM	37 °C	-	5 °C	8%	9.3 km/h /
10:00 AM	37.0 °C	-	5.0 °C	14%	9.3 km/h /2.6 m/s
11:00 AM	39.0 °C	-	4.0 °C	11%	9.3 km/h /2.6 m/s
12:00 PM	40.0 °C	-	2.0 °C	9%	13.0 km/h /3.6 m/s
12:01 PM	39.0 °C	38.0 °C	12.0 °C	20%	20.4 km/h /5.7 m/s
1:00 PM	38 °C	-	11 °C	12%	20.4 km/h /
1:00 PM	38.0 °C	-	11.0 °C	20%	20.4 km/h /5.7 m/s
3:00 PM	39.0 °C	-	2.0 °C	10%	22.2 km/h /6.2 m/s
4:00 PM	38 °C	-	9 °C	9%	22.2 km/h /
4:00 PM	39.0 °C	-	9.0 °C	16%	22.2 km/h /6.2 m/s
5:00 PM	38.0 °C	-	7.0 °C	15%	14.8 km/h /4.1 m/s
6:00 PM	38.0 °C	-	2.0 °C	11%	13.0 km/h /3.6 m/s
7:00 PM	38 °C	-	4 °C	6%	9.3 km/h /
7:00 PM	38.0 °C	-	4.0 °C	12%	9.3 km/h /2.6 m/s
8:00 PM	38.0 °C	-	3.0 °C	11%	9.3 km/h /2.6 m/s
9:00 PM	37.0 °C	-	2.0 °C	11%	3.7 km/h /1.0 m/s
10:00 PM	37 °C	-	3 °C	6%	9.3 km/h /
10:00 PM	37.0 °C	-	3.0 °C	12%	9.3 km/h /2.6 m/s
11:00 PM	36.0 °C	-	4.0 °C	14%	11.1 km/h /3.1 m/s

Hi-Tech

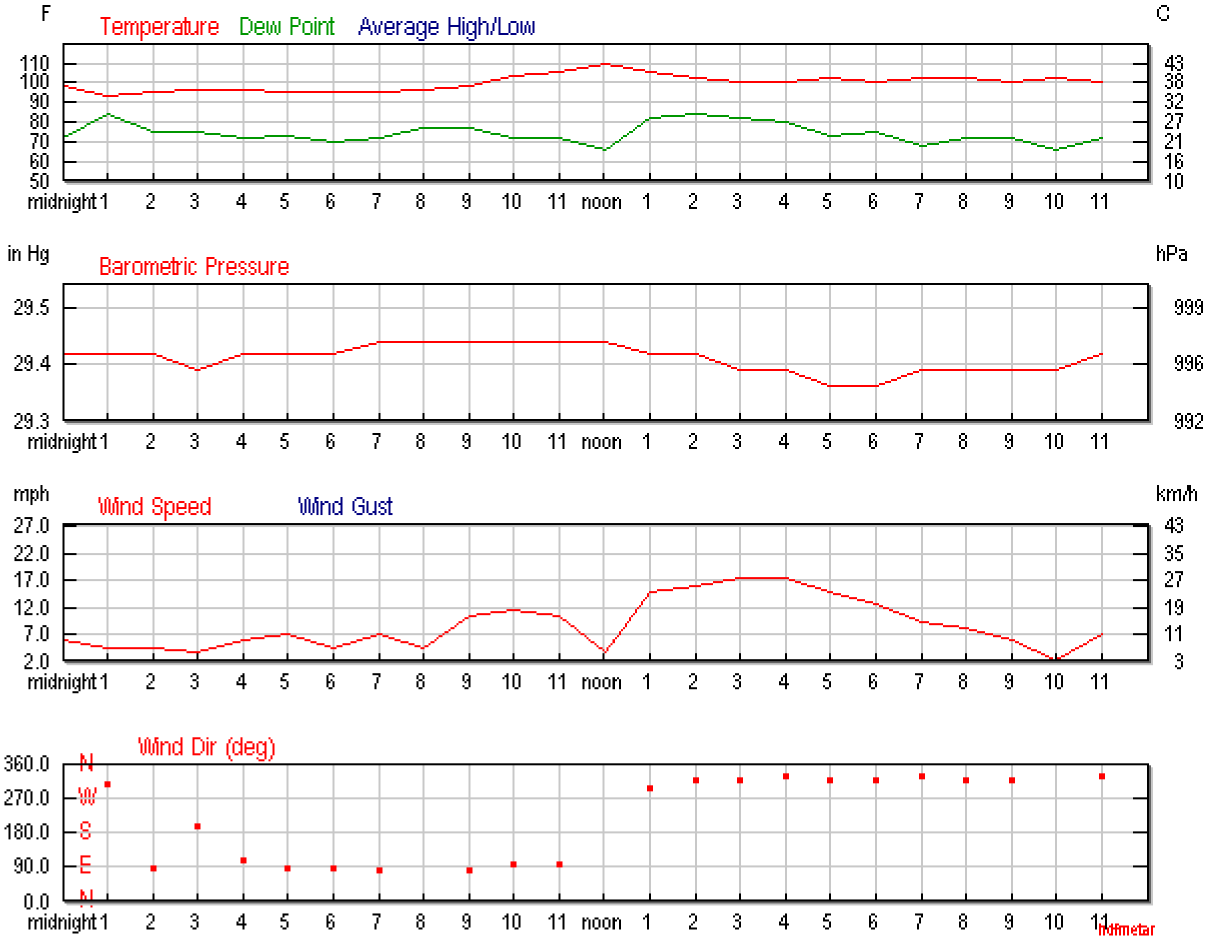
Temperature readings in Dubai on hottest day in the month of July (July 14, 2014)

Aqua cool
healthy fresh air

	Actual	Average	Record
Temperature			
Mean Temperature	**38** °C	-	
Max Temperature	**43** °C	**39** °C	**45** °C (1998)
Min Temperature	**34** °C	**29** °C	**27** °C (1997)
Cooling Degree Days	36		
Growing Degree Days	52 (Base 50)		
Moisture			
Dew Point	**24** °C		
Average Humidity	43		
Maximum Humidity	75		
Minimum Humidity	23		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**995.87** hPa		
Wind			
Wind Speed	**11** km/h ()		
Max Wind Speed	**28** km/h		
Max Gust Speed	-		
Visibility	**8.6** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of July (July 14, 2014)

Daily Weather History Graph



Hi-Tech

Temperature readings in Dubai on hottest day in the month of July (July 14, 2014)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

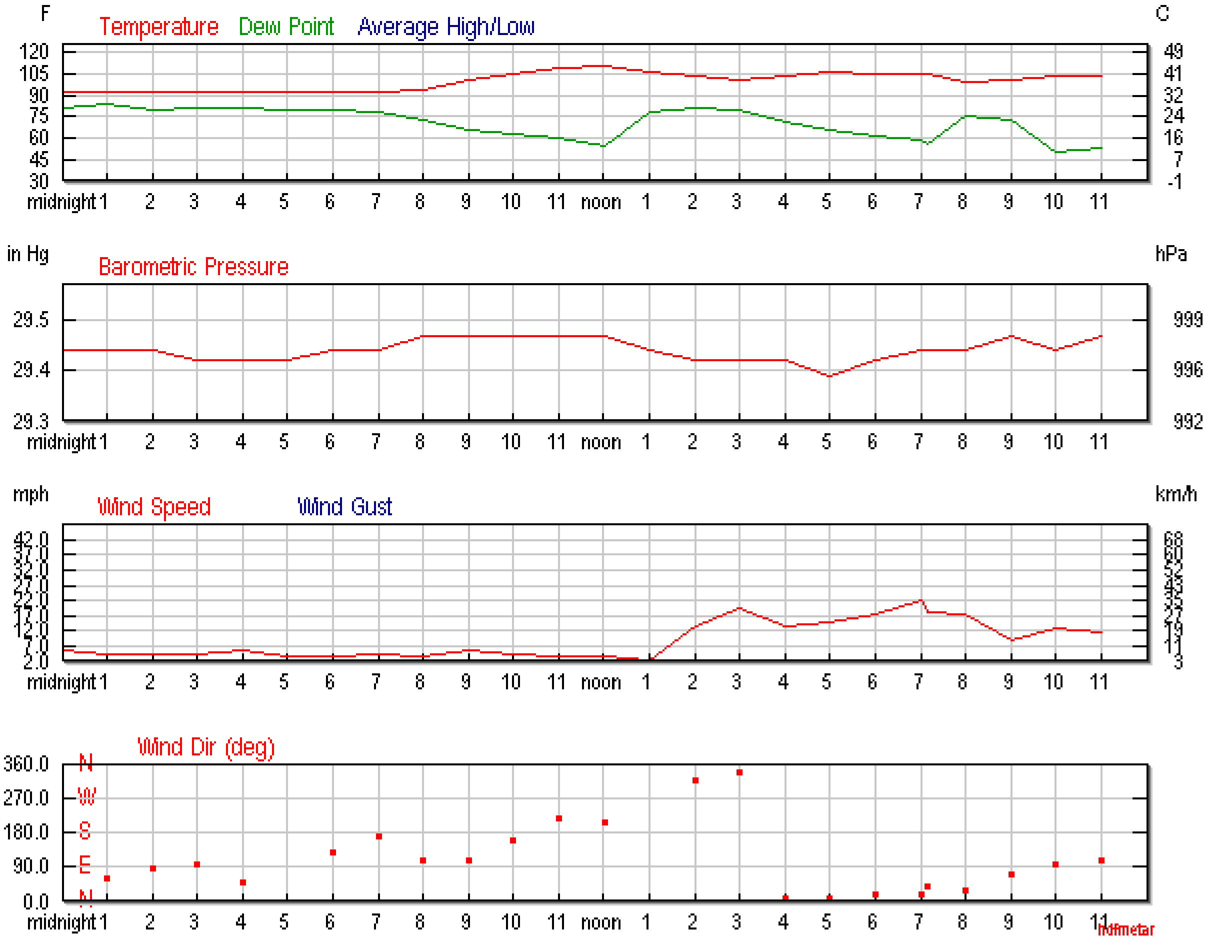
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	37.0 °C	42.0 °C	22.0 °C	42%	9.3 km/h /2.6 m/s
1:00 AM	34 °C	-	29 °C	69%	7.4 km/h /
1:00 AM	34.0 °C	49.4 °C	29.0 °C	75%	7.4 km/h /2.1 m/s
2:00 AM	35.0 °C	41.9 °C	24.0 °C	53%	7.4 km/h /2.1 m/s
3:00 AM	36.0 °C	43.1 °C	24.0 °C	50%	5.6 km/h /1.5 m/s
4:00 AM	36 °C	-	22 °C	36%	9.3 km/h /
4:00 AM	36.0 °C	40.6 °C	22.0 °C	44%	9.3 km/h /2.6 m/s
5:00 AM	35.0 °C	40.3 °C	23.0 °C	49%	11.1 km/h /3.1 m/s
6:00 AM	35.0 °C	38.5 °C	21.0 °C	44%	7.4 km/h /2.1 m/s
7:00 AM	**35 °C**	**-**	**22 °C**	**37%**	**11.1 km/h /**
7:00 AM	**35.0 °C**	**39.5 °C**	**22.0 °C**	**47%**	**11.1 km/h /3.1 m/s**
8:00 AM	**36.0 °C**	**44.5 °C**	**25.0 °C**	**53%**	**7.4 km/h /2.1 m/s**
9:00 AM	**37.0 °C**	**45.8 °C**	**25.0 °C**	**50%**	**16.7 km/h /4.6 m/s**
10:00 AM	**40 °C**	**-**	**22 °C**	**27%**	**18.5 km/h /**
10:00 AM	**40.0 °C**	**45.5 °C**	**22.0 °C**	**35%**	**18.5 km/h /5.1 m/s**
11:00 AM	**41.0 °C**	**46.7 °C**	**22.0 °C**	**33%**	**16.7 km/h /4.6 m/s**
12:00 PM	**43.0 °C**	**46.5 °C**	**19.0 °C**	**25%**	**5.6 km/h /1.5 m/s**
1:00 PM	**41 °C**	**-**	**28 °C**	**40%**	**24.1 km/h /**
1:00 PM	**41.0 °C**	**56.6 °C**	**28.0 °C**	**48%**	**24.1 km/h /6.7 m/s**
2:00 PM	**39.0 °C**	**56.4 °C**	**29.0 °C**	**57%**	**25.9 km/h /7.2 m/s**
3:00 PM	**38.0 °C**	**52.3 °C**	**28.0 °C**	**56%**	**27.8 km/h /7.7 m/s**
4:00 PM	**38 °C**	**-**	**27 °C**	**44%**	**27.8 km/h /**
4:00 PM	**38.0 °C**	**50.4 °C**	**27.0 °C**	**53%**	**27.8 km/h /7.7 m/s**
5:00 PM	**39.0 °C**	**45.8 °C**	**23.0 °C**	**40%**	**24.1 km/h /6.7 m/s**
6:00 PM	**38.0 °C**	**45.3 °C**	**24.0 °C**	**44%**	**20.4 km/h /5.7 m/s**
7:00 PM	**39 °C**	**-**	**20 °C**	**23%**	**14.8 km/h /**
7:00 PM	**39.0 °C**	**42.5 °C**	**20.0 °C**	**33%**	**14.8 km/h /4.1 m/s**
8:00 PM	39.0 °C	44.3 °C	22.0 °C	37%	13.0 km/h /3.6 m/s
9:00 PM	38.0 °C	43.0 °C	22.0 °C	39%	9.3 km/h /2.6 m/s
10:00 PM	39 °C	-	19 °C	23%	3.7 km/h /
10:00 PM	39.0 °C	41.6 °C	19.0 °C	31%	3.7 km/h /1.0 m/s
11:00 PM	38.0 °C	43.0 °C	22.0 °C	39%	11.1 km/h /3.1 m/s

Temperature readings in Dubai on hottest day in the month of July (July 24, 2015)

	Actual	Average	Record
Temperature			
Mean Temperature	**39** °C	-	
Max Temperature	**45** °C	**39** °C	**45** °C (1996)
Min Temperature	**33** °C	**30** °C	**30** °C (1996)
Cooling Degree Days	38		
Growing Degree Days	52 (Base 50)		
Moisture			
Dew Point	**21** °C		
Average Humidity	36		
Maximum Humidity	63		
Minimum Humidity	13		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**998.42** hPa		
Wind			
Wind Speed	**13** km/h ()		
Max Wind Speed	**30** km/h		
Max Gust Speed	-		
Visibility	**7.5** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of July (July 24, 2015)

Daily Weather History Graph



Hi-Tech

Temperature readings in Dubai on hottest day in the month of July (July 24, 2015)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

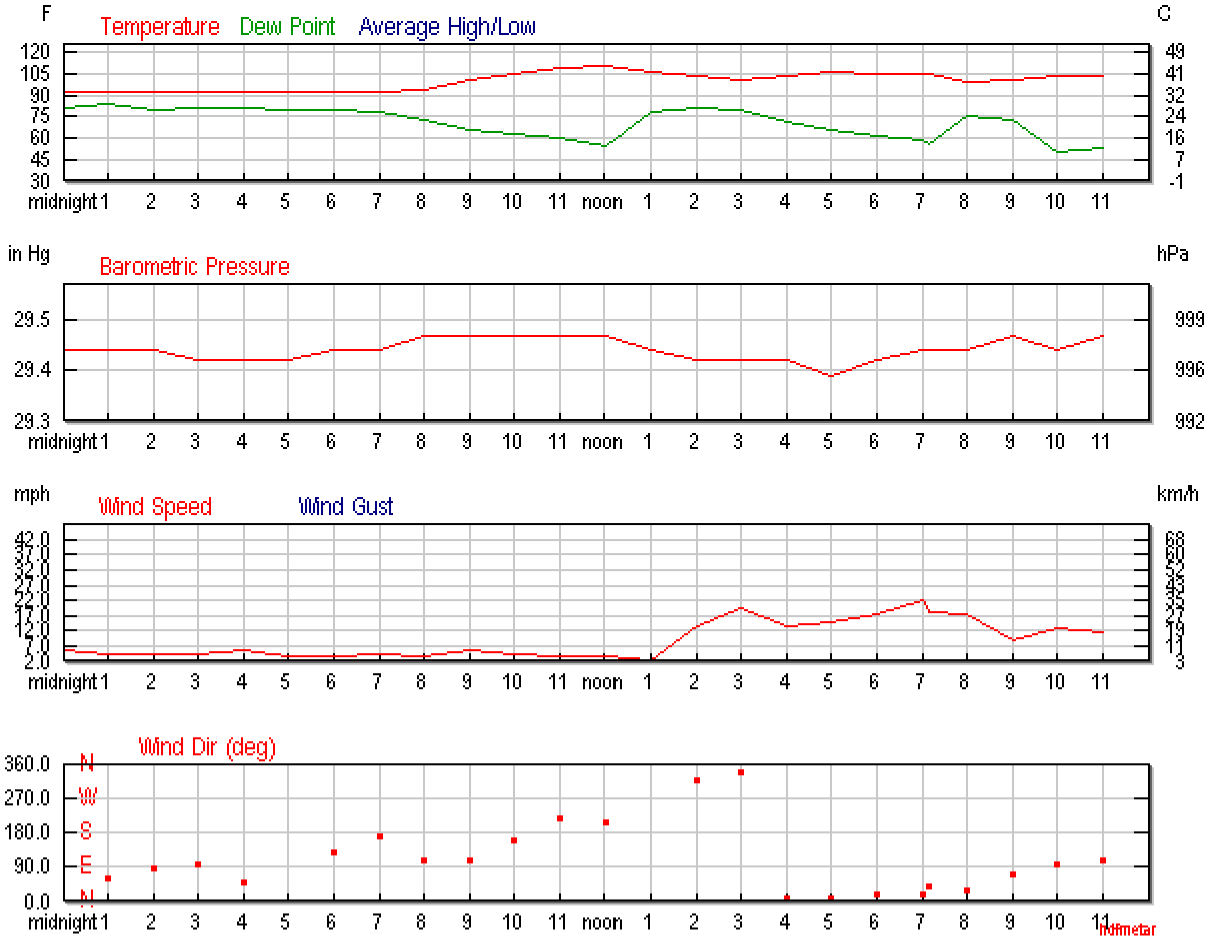
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	35.0 °C	40.3 °C	23.0 °C	49%	5.6 km/h /1.5 m/s
1:00 AM	35 °C	-	24 °C	42%	7.4 km/h /
1:00 AM	35.0 °C	41.9 °C	24.0 °C	53%	7.4 km/h /2.1 m/s
2:00 AM	35.0 °C	38.5 °C	21.0 °C	44%	9.3 km/h /2.6 m/s
3:00 AM	34.0 °C	41.8 °C	25.0 °C	59%	9.3 km/h /2.6 m/s
4:00 AM	34 °C	-	26 °C	54%	11.1 km/h /
4:00 AM	34.0 °C	43.5 °C	26.0 °C	63%	11.1 km/h /3.1 m/s
5:00 AM	34.0 °C	40.6 °C	24.0 °C	56%	9.3 km/h /2.6 m/s
6:00 AM	34.0 °C	38.1 °C	22.0 °C	49%	9.3 km/h /2.6 m/s
7:00 AM	34 °C	-	23 °C	42%	14.8 km/h /
7:00 AM	34.0 °C	39.1 °C	23.0 °C	52%	14.8 km/h /4.1 m/s
8:00 AM	35.0 °C	38.5 °C	21.0 °C	44%	18.5 km/h /5.1 m/s
9:00 AM	37.0 °C	40.1 °C	20.0 °C	37%	25.9 km/h /7.2 m/s
10:00 AM	39 °C	-	18 °C	19%	22.2 km/h /
10:00 AM	39.0 °C	40.9 °C	18.0 °C	29%	22.2 km/h /6.2 m/s
11:00 AM	41.0 °C	42.0 °C	16.0 °C	23%	16.7 km/h /4.6 m/s
12:00 PM	42.0 °C	41.9 °C	14.0 °C	19%	13.0 km/h /3.6 m/s
1:00 PM	44.0 °C	44.5 °C	15.0 °C	18%	13.0 km/h /3.6 m/s
2:00 PM	45.0 °C	-	11.0 °C	13%	16.7 km/h /4.6 m/s
3:00 PM	43.0 °C	48.2 °C	21.0 °C	28%	24.1 km/h /6.7 m/s
4:00 PM	41 °C	-	24 °C	29%	25.9 km/h /
4:00 PM	41.0 °C	49.6 °C	24.0 °C	38%	25.9 km/h /7.2 m/s
5:00 PM	40.0 °C	48.3 °C	24.0 °C	40%	24.1 km/h /6.7 m/s
6:00 PM	43.0 °C	43.4 °C	15.0 °C	19%	29.6 km/h /8.2 m/s
6:34 PM	41.0 °C	43.2 °C	18.0 °C	26%	22.2 km/h /6.2 m/s
7:00 PM	40 °C	-	19 °C	20%	18.5 km/h /
7:00 PM	41.0 °C	44.2 °C	19.0 °C	28%	18.5 km/h /5.1 m/s
8:00 PM	39.0 °C	41.6 °C	19.0 °C	31%	13.0 km/h /3.6 m/s
9:00 PM	38.0 °C	40.5 °C	19.0 °C	33%	20.4 km/h /5.7 m/s
10:00 PM	37 °C	-	21 °C	29%	16.7 km/h /
10:00 PM	37.0 °C	40.8 °C	21.0 °C	39%	16.7 km/h /4.6 m/s
11:00 PM	36.0 °C	39.5 °C	21.0 °C	41%	14.8 km/h /4.1 m/s

Temperature readings in Dubai on hottest day in the month of August (August 16, 2014)

	Actual	Average	Record
Temperature			
Mean Temperature	**40** °C	-	
Max Temperature	**46** °C	**38** °C	**46** °C (2014)
Min Temperature	**33** °C	**28** °C	**3** °C (1997)
Cooling Degree Days	38		
Growing Degree Days	54 (Base 50)		
Moisture			
Dew Point	**22** °C		
Average Humidity	42		
Maximum Humidity	75		
Minimum Humidity	10		
Precipitation			
Precipitation	**0.0** mm	**0.0** mm	- ()
Sea Level Pressure			
Sea Level Pressure	**997.09** hPa		
Wind			
Wind Speed	**11** km/h ()		
Max Wind Speed	**35** km/h		
Max Gust Speed	**59** km/h		
Visibility	**7.9** kilometers		
Events			

Temperature readings in Dubai on hottest day in the month of August (August 16, 2014)

Daily Weather History Graph



Hi-Tech

Temperature readings in Dubai on hottest day in the month of August (August 16, 2014)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

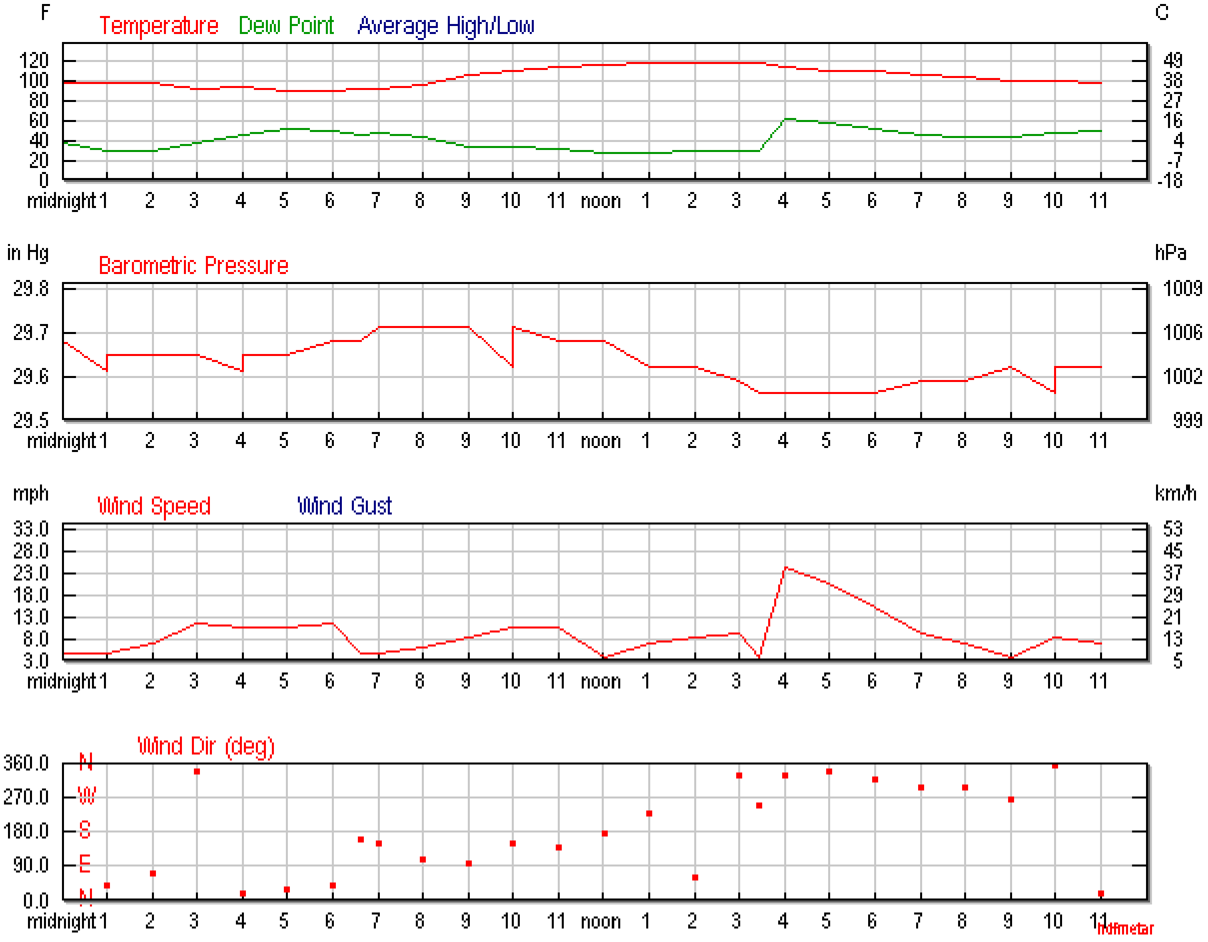
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	34.0 ° C	47.3 ° C	28.0 ° C	71%	9.3 km/h /2.6 m/s
1:00 AM	34 ° C	-	29 ° C	68%	7.4 km/h /
1:00 AM	34.0 ° C	49.4 ° C	29.0 ° C	75%	7.4 km/h /2.1 m/s
2:00 AM	34.0 ° C	45.3 ° C	27.0 ° C	67%	7.4 km/h /2.1 m/s
3:00 AM	34.0 ° C	47.3 ° C	28.0 ° C	71%	7.4 km/h /2.1 m/s
4:00 AM	34 ° C	-	28 ° C	66%	9.3 km/h /
4:00 AM	34.0 ° C	47.3 ° C	28.0 ° C	71%	9.3 km/h /2.6 m/s
5:00 AM	34.0 ° C	45.3 ° C	27.0 ° C	67%	5.6 km/h /1.5 m/s
6:00 AM	34.0 ° C	45.3 ° C	27.0 ° C	67%	5.6 km/h /1.5 m/s
7:00 AM	34 ° C	-	26 ° C	57%	7.4 km/h /
7:00 AM	34.0 ° C	43.5 ° C	26.0 ° C	63%	7.4 km/h /2.1 m/s
8:00 AM	35.0 ° C	40.3 ° C	23.0 ° C	49%	5.6 km/h /1.5 m/s
9:00 AM	39.0 ° C	41.6 ° C	19.0 ° C	31%	9.3 km/h /2.6 m/s
10:00 AM	40 ° C	-	18 ° C	18%	7.4 km/h /
10:00 AM	41.0 ° C	43.2 ° C	18.0 ° C	26%	7.4 km/h /2.1 m/s
11:00 AM	43.0 ° C	44.4 ° C	16.0 ° C	21%	5.6 km/h /1.5 m/s
12:00 PM	44.0 ° C	43.5 ° C	13.0 ° C	16%	5.6 km/h /1.5 m/s
1:00 PM	42 ° C	-	26 ° C	33%	3.7 km/h /
1:00 PM	42.0 ° C	53.7 ° C	26.0 ° C	40%	3.7 km/h /1.0 m/s
2:00 PM	40.0 ° C	55.5 ° C	28.0 ° C	51%	22.2 km/h /6.2 m/s
3:00 PM	39.0 ° C	51.6 ° C	27.0 ° C	50%	31.5 km/h /8.7 m/s
4:00 PM	40 ° C	-	22 ° C	24%	22.2 km/h /
4:00 PM	40.0 ° C	45.5 ° C	22.0 ° C	35%	22.2 km/h /6.2 m/s
5:00 PM	42.0 ° C	45.1 ° C	19.0 ° C	26%	24.1 km/h /6.7 m/s
6:00 PM	41.0 ° C	42.4 ° C	17.0 ° C	24%	27.8 km/h /7.7 m/s
7:00 PM	41 ° C	-	15 ° C	14%	35.2 km/h /
7:00 PM	41.0 ° C	41.6 ° C	15.0 ° C	22%	35.2 km/h /9.8 m/s
7:10 PM	41.0 ° C	40.8 ° C	14.0 ° C	20%	29.6 km/h /8.2 m/s
8:00 PM	38.0 ° C	46.9 ° C	25.0 ° C	47%	27.8 km/h /7.7 m/s
9:00 PM	39.0 ° C	45.8 ° C	23.0 ° C	40%	14.8 km/h /4.1 m/s
10:00 PM	40 ° C	-	11 ° C	10%	20.4 km/h /
10:00 PM	40.0 ° C	-	11.0 ° C	17%	20.4 km/h /5.7 m/s
11:00 PM	40.0 ° C	39.1 ° C	12.0 ° C	19%	18.5 km/h /5.1 m/s

Temperature readings in Al-Ain on hottest day in the month of June (June 3, 2015)

	Actual	Average	Record
Temperature			
Mean Temperature	39 °C	-	
Max Temperature	47 °C	43 °C	- ()
Min Temperature	31 °C	27 °C	- ()
Cooling Degree Days	38		
Growing Degree Days	54 (Base 50)		
Moisture			
Dew Point	5 °C		
Average Humidity	13		
Maximum Humidity	27		
Minimum Humidity	4		
Precipitation			
Precipitation	0.0 mm	-	- ()
Sea Level Pressure			
Sea Level Pressure	1003.40 hPa		
Wind			
Wind Speed	12 km/h ()		
Max Wind Speed	39 km/h		
Max Gust Speed	-		
Visibility	7.7 kilometers		
Events			

Temperature readings in Al-Ain on hottest day in the month of June (June 3, 2015)

Daily Weather History Graph



Temperature readings in Al-Ain on hottest day in the month of June (June 3, 2015)

Hourly Weather History & Observations

Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	36.0 °C	-	3.0 °C	13%	7.4 km/h /2.1 m/s
1:00 AM	36 °C	-	-1 °C	4%	7.4 km/h /
1:00 AM	36.0 °C	-	-1.0 °C	10%	7.4 km/h /2.1 m/s
2:00 AM	36.0 °C	-	-1.0 °C	10%	11.1 km/h /3.1 m/s
3:00 AM	33.0 °C	-	3.0 °C	15%	18.5 km/h /5.1 m/s
4:00 AM	34 °C	-	7 °C	11%	16.7 km/h /
4:00 AM	34.0 °C	-	7.0 °C	19%	16.7 km/h /4.6 m/s
5:00 AM	32.0 °C	-	11.0 °C	27%	16.7 km/h /4.6 m/s
6:00 AM	32.0 °C	-	10.0 °C	26%	18.5 km/h /5.1 m/s
6:37 AM	33.0 °C	-	8.0 °C	21%	7.4 km/h /2.1 m/s
7:00 AM	33.0 °C	-	9.0 °C	23%	7.4 km/h /2.1 m/s
8:00 AM	35.0 °C	-	6.0 °C	16%	9.3 km/h /2.6 m/s
9:00 AM	41.0 °C	-	1.0 °C	8%	13.0 km/h /3.6 m/s
10:00 AM	43 °C	-	1 °C	4%	16.7 km/h /
10:00 AM	43.0 °C	-	1.0 °C	7%	16.7 km/h /4.6 m/s
11:00 AM	45.0 °C	-	0.0 °C	6%	16.7 km/h /4.6 m/s
12:00 PM	46.0 °C	-	-2.0 °C	5%	5.6 km/h /1.5 m/s
1:00 PM	47.0 °C	-	-2.0 °C	5%	11.1 km/h /3.1 m/s
2:00 PM	47.0 °C	-	-1.0 °C	5%	13.0 km/h /3.6 m/s
3:00 PM	47.0 °C	-	-1.0 °C	5%	14.8 km/h /4.1 m/s
3:26 PM	47.0 °C	-	-1.0 °C	5%	5.6 km/h /1.5 m/s
4:00 PM	45.0 °C	46.6 °C	16.0 °C	19%	38.9 km/h /10.8 m/s
5:00 PM	43.0 °C	43.0 °C	14.0 °C	18%	33.3 km/h /9.3 m/s
6:00 PM	43.0 °C	-	11.0 °C	15%	24.1 km/h /6.7 m/s
7:00 PM	41.0 °C	-	8.0 °C	14%	14.8 km/h /4.1 m/s
8:00 PM	40.0 °C	-	6.0 °C	12%	11.1 km/h /3.1 m/s
9:00 PM	38.0 °C	-	6.0 °C	14%	5.6 km/h /1.5 m/s
10:00 PM	38 °C	-	9 °C	10%	13.0 km/h /
10:00 PM	38.0 °C	-	9.0 °C	17%	13.0 km/h /3.6 m/s
11:00 PM	36.0 °C	-	10.0 °C	20%	11.1 km/h /3.1 m/s

Hi-Tech

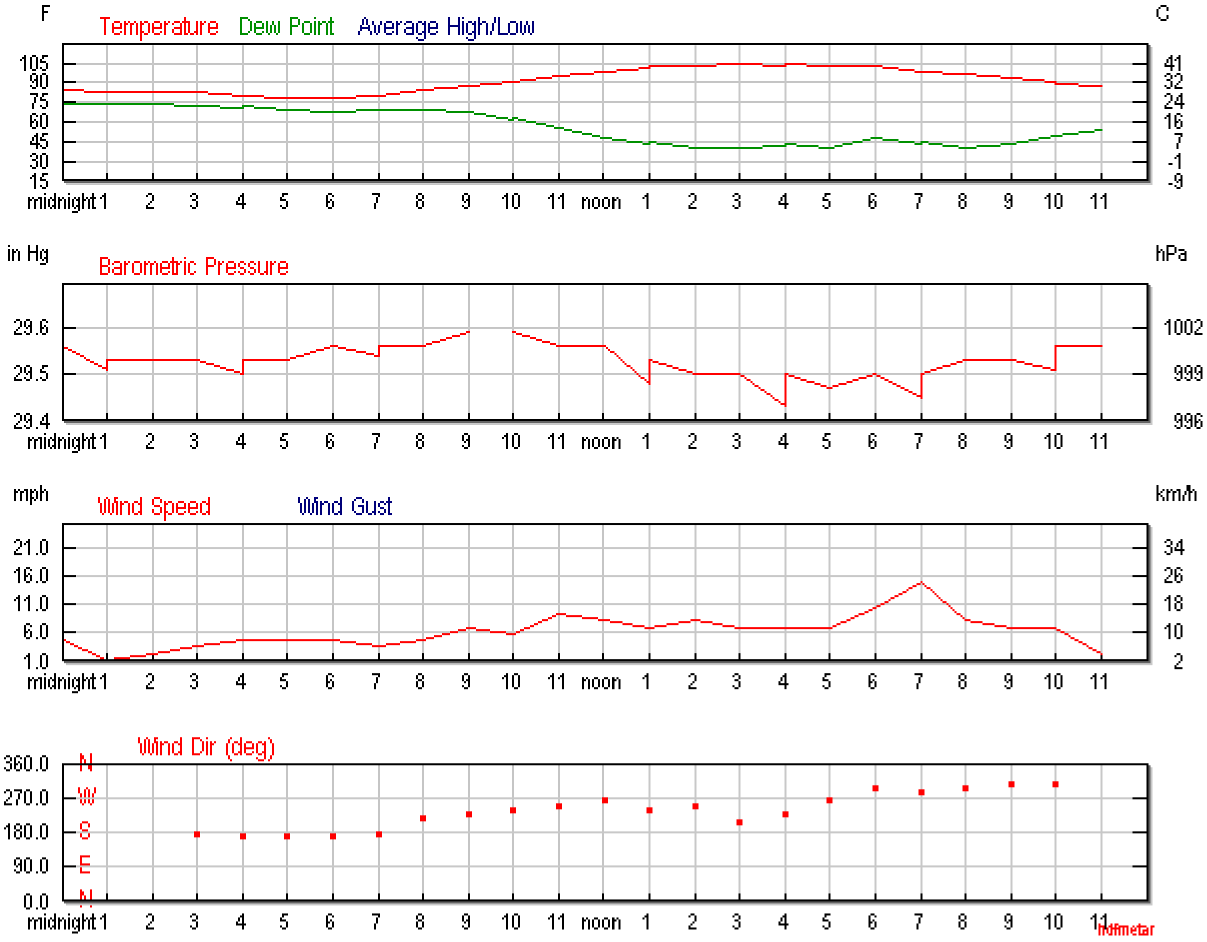
Temperature readings in Al-Ain on hottest day in the month of June (June 19, 2014)

Aqua cool
healthy fresh air

	Actual	Average	Record
Temperature			
Mean Temperature	32 °C	-	
Max Temperature	40 °C	43 °C	- ()
Min Temperature	25 °C	28 °C	- ()
Cooling Degree Days	26		
Growing Degree Days	42 (Base 50)		
Moisture			
Dew Point	14 °C		
Average Humidity	38		
Maximum Humidity	74		
Minimum Humidity	6		
Precipitation			
Precipitation	0.0 mm	-	- ()
Sea Level Pressure			
Sea Level Pressure	999.81 hPa		
Wind			
Wind Speed	8 km/h ()		
Max Wind Speed	24 km/h		
Max Gust Speed	-		
Visibility	10.0 kilometers		
Events			

Temperature readings in Al-Ain on hottest day in the month of June (June 19, 2014)

Daily Weather History Graph



Hi-Tech

Temperature readings in Al-Ain on hottest day in the month of June (June 19, 2014)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	29.0 °C	32.7 °C	23.0 °C	70%	7.4 km/h /2.1 m/s
1:00 AM	28 °C	-	23 °C	68%	1.9 km/h /
1:00 AM	28.0 °C	31.2 °C	23.0 °C	74%	1.9 km/h /0.5 m/s
2:00 AM	28.0 °C	31.2 °C	23.0 °C	74%	3.7 km/h /1.0 m/s
3:00 AM	28.0 °C	30.7 °C	22.0 °C	70%	5.6 km/h /1.5 m/s
4:00 AM	27 °C	-	22 °C	66%	7.4 km/h /
4:00 AM	27.0 °C	29.2 °C	22.0 °C	74%	7.4 km/h /2.1 m/s
5:00 AM	26.0 °C	-	21.0 °C	74%	7.4 km/h /2.1 m/s
6:00 AM	26.0 °C	-	20.0 °C	69%	7.4 km/h /2.1 m/s
7:00 AM	27 °C	-	21 °C	65%	5.6 km/h /
7:00 AM	27.0 °C	28.9 °C	21.0 °C	70%	5.6 km/h /1.5 m/s
8:00 AM	29.0 °C	31.3 °C	21.0 °C	62%	7.4 km/h /2.1 m/s
9:00 AM	31.0 °C	33.0 °C	20.0 °C	52%	11.1 km/h /3.1 m/s
10:00 AM	33 °C	-	16 °C	28%	9.3 km/h /
10:00 AM	33.0 °C	33.4 °C	17.0 °C	38%	9.3 km/h /2.6 m/s
11:00 AM	35.0 °C	33.9 °C	13.0 °C	26%	14.8 km/h /4.1 m/s
12:00 PM	37.0 °C	-	9.0 °C	18%	13.0 km/h /3.6 m/s
1:00 PM	39 °C	-	7 °C	8%	11.1 km/h /
1:00 PM	39.0 °C	-	7.0 °C	14%	11.1 km/h /3.1 m/s
2:00 PM	39.0 °C	-	5.0 °C	12%	13.0 km/h /3.6 m/s
3:00 PM	40.0 °C	-	5.0 °C	12%	11.1 km/h /3.1 m/s
4:00 PM	40 °C	-	6 °C	6%	11.1 km/h /
4:00 PM	40.0 °C	-	6.0 °C	12%	11.1 km/h /3.1 m/s
5:00 PM	39.0 °C	-	5.0 °C	12%	11.1 km/h /3.1 m/s
6:00 PM	39.0 °C	-	9.0 °C	16%	16.7 km/h /4.6 m/s
7:00 PM	37 °C	-	6 °C	8%	24.1 km/h /
7:00 PM	37.0 °C	-	7.0 °C	16%	24.1 km/h /6.7 m/s
8:00 PM	36.0 °C	-	5.0 °C	15%	13.0 km/h /3.6 m/s
9:00 PM	34.0 °C	-	6.0 °C	17%	11.1 km/h /3.1 m/s
10:00 PM	32 °C	-	10 °C	15%	11.1 km/h /

Hi-Tech

Temperature readings in Al-Ain on hottest day in the month of June (June 27, 2014)

Aqua cool
healthy fresh air

	Actual	Average	Record
Temperature			
Mean Temperature	36 °C	-	
Max Temperature	45 °C	43 °C	- ()
Min Temperature	28 °C	29 °C	- ()
Cooling Degree Days	32		
Growing Degree Days	48 (Base 50)		
Moisture			
Dew Point	17 °C		
Average Humidity	32		
Maximum Humidity	58		
Minimum Humidity	7		
Precipitation			
Precipitation	0.0 mm	-	- ()
Sea Level Pressure			
Sea Level Pressure	1002.40 hPa		
Wind			
Wind Speed	10 km/h ()		
Max Wind Speed	24 km/h		
Max Gust Speed	-		
Visibility	8.6 kilometers		
Events			

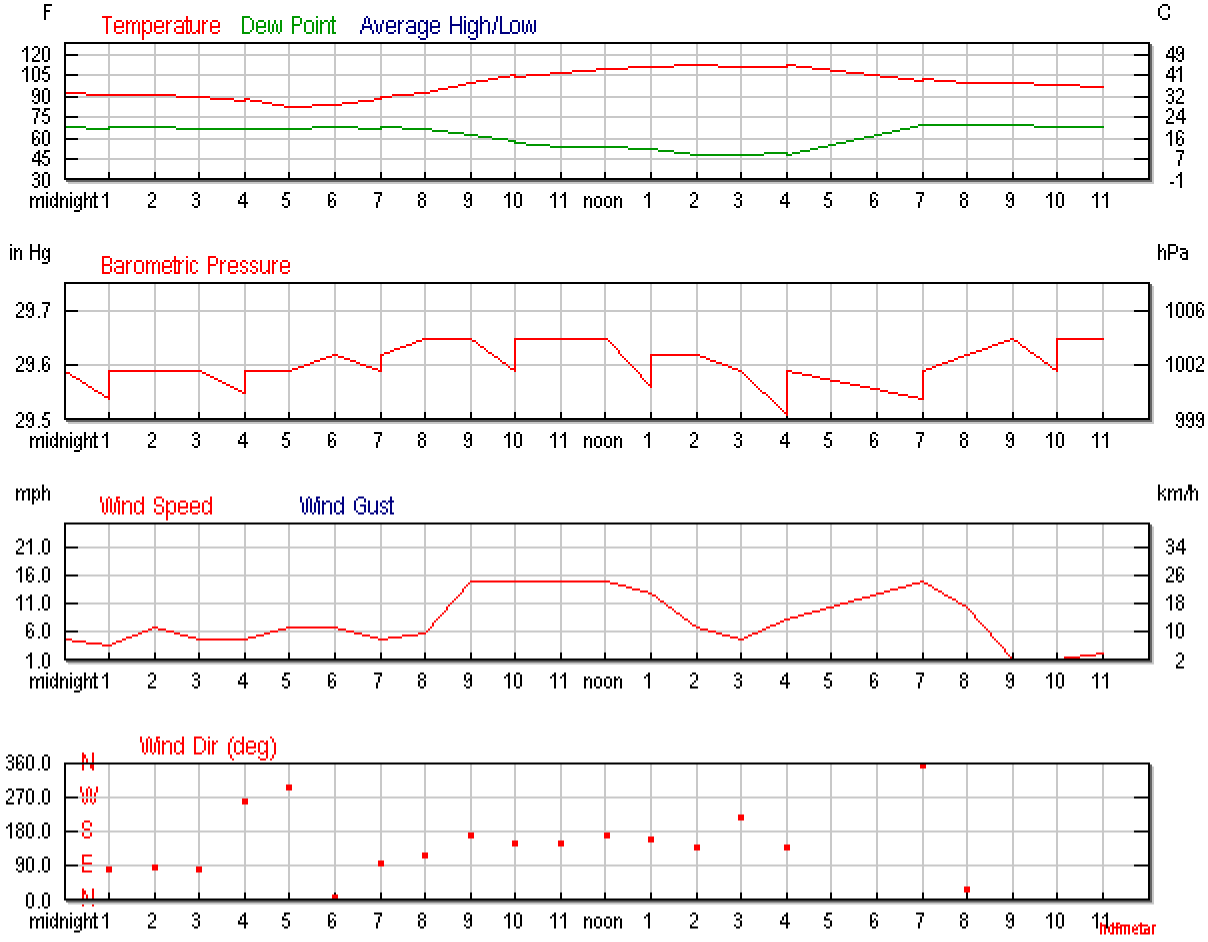
Hi-Tech

Temperature readings in Al-Ain on hottest day in the month of June (June 27, 2014)

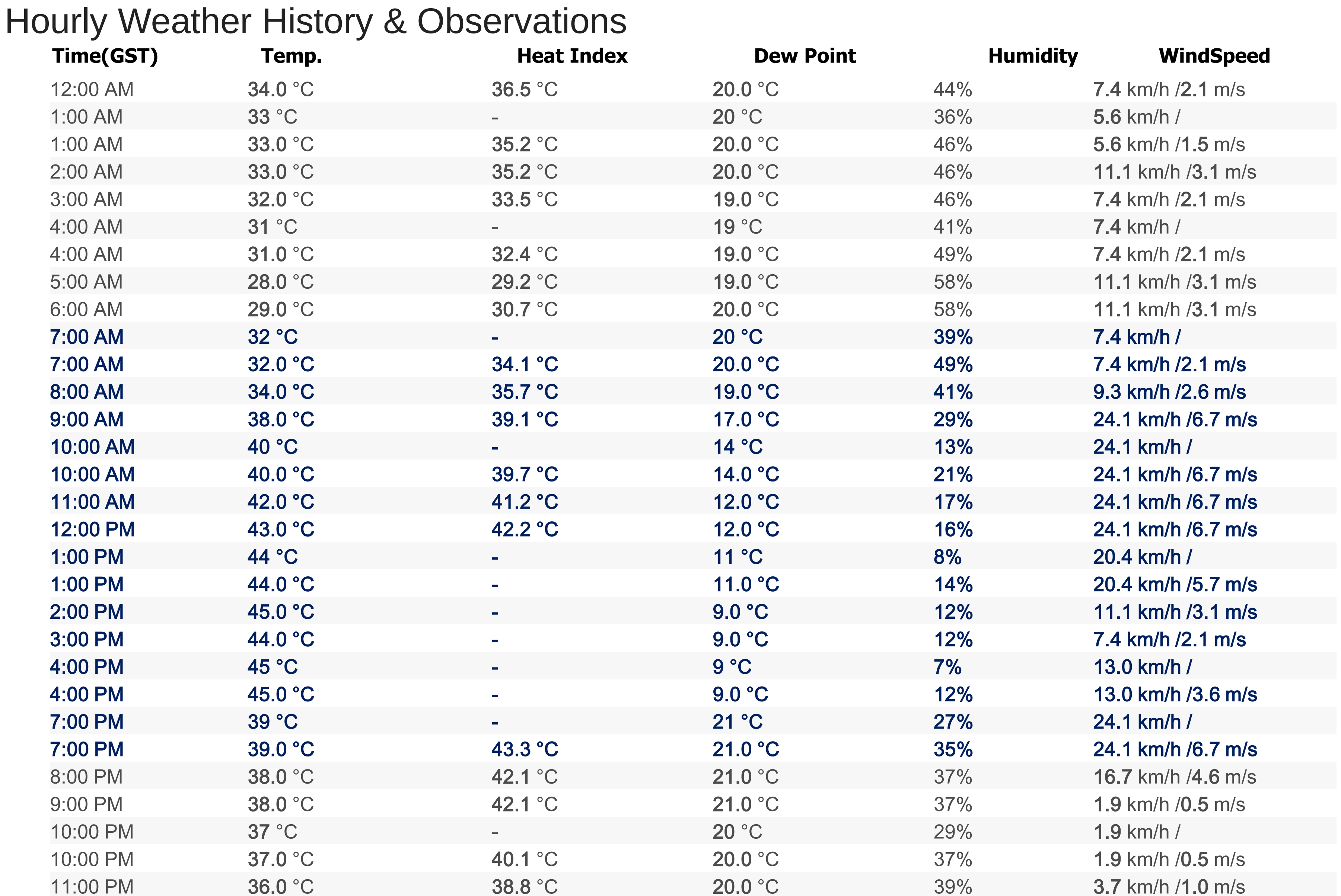
Aqua cool

healthy fresh air

Daily Weather History Graph



Temperature readings in Al-Ain on hottest day in the month of June (June 27, 2014)



Hourly Weather History & Observations

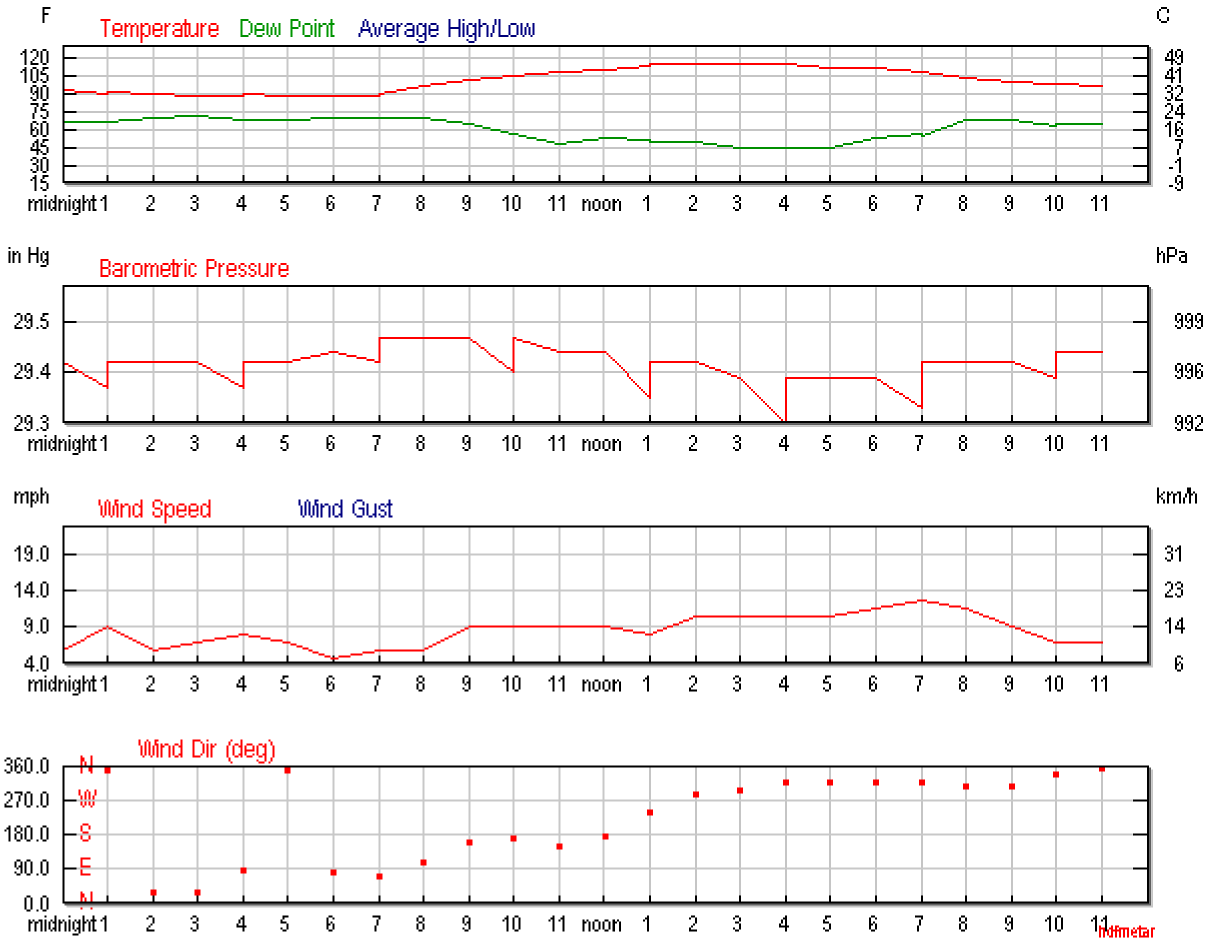
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	34.0 °C	36.5 °C	20.0 °C	44%	7.4 km/h /2.1 m/s
1:00 AM	33 °C	-	20 °C	36%	5.6 km/h /
1:00 AM	33.0 °C	35.2 °C	20.0 °C	46%	5.6 km/h /1.5 m/s
2:00 AM	33.0 °C	35.2 °C	20.0 °C	46%	11.1 km/h /3.1 m/s
3:00 AM	32.0 °C	33.5 °C	19.0 °C	46%	7.4 km/h /2.1 m/s
4:00 AM	31 °C	-	19 °C	41%	7.4 km/h /
4:00 AM	31.0 °C	32.4 °C	19.0 °C	49%	7.4 km/h /2.1 m/s
5:00 AM	28.0 °C	29.2 °C	19.0 °C	58%	11.1 km/h /3.1 m/s
6:00 AM	29.0 °C	30.7 °C	20.0 °C	58%	11.1 km/h /3.1 m/s
7:00 AM	**32 °C**	**-**	**20 °C**	**39%**	**7.4 km/h /**
7:00 AM	**32.0 °C**	**34.1 °C**	**20.0 °C**	**49%**	**7.4 km/h /2.1 m/s**
8:00 AM	**34.0 °C**	**35.7 °C**	**19.0 °C**	**41%**	**9.3 km/h /2.6 m/s**
9:00 AM	**38.0 °C**	**39.1 °C**	**17.0 °C**	**29%**	**24.1 km/h /6.7 m/s**
10:00 AM	**40 °C**	**-**	**14 °C**	**13%**	**24.1 km/h /**
10:00 AM	**40.0 °C**	**39.7 °C**	**14.0 °C**	**21%**	**24.1 km/h /6.7 m/s**
11:00 AM	**42.0 °C**	**41.2 °C**	**12.0 °C**	**17%**	**24.1 km/h /6.7 m/s**
12:00 PM	**43.0 °C**	**42.2 °C**	**12.0 °C**	**16%**	**24.1 km/h /6.7 m/s**
1:00 PM	**44 °C**	**-**	**11 °C**	**8%**	**20.4 km/h /**
1:00 PM	**44.0 °C**	**-**	**11.0 °C**	**14%**	**20.4 km/h /5.7 m/s**
2:00 PM	**45.0 °C**	**-**	**9.0 °C**	**12%**	**11.1 km/h /3.1 m/s**
3:00 PM	**44.0 °C**	**-**	**9.0 °C**	**12%**	**7.4 km/h /2.1 m/s**
4:00 PM	**45 °C**	**-**	**9 °C**	**7%**	**13.0 km/h /**
4:00 PM	**45.0 °C**	**-**	**9.0 °C**	**12%**	**13.0 km/h /3.6 m/s**
7:00 PM	**39 °C**	**-**	**21 °C**	**27%**	**24.1 km/h /**
7:00 PM	**39.0 °C**	**43.3 °C**	**21.0 °C**	**35%**	**24.1 km/h /6.7 m/s**
8:00 PM	38.0 °C	42.1 °C	21.0 °C	37%	16.7 km/h /4.6 m/s
9:00 PM	38.0 °C	42.1 °C	21.0 °C	37%	1.9 km/h /0.5 m/s
10:00 PM	37 °C	-	20 °C	29%	1.9 km/h /
10:00 PM	37.0 °C	40.1 °C	20.0 °C	37%	1.9 km/h /0.5 m/s
11:00 PM	36.0 °C	38.8 °C	20.0 °C	39%	3.7 km/h /1.0 m/s

Temperature readings in Al-Ain on hottest day in the month of July (July 18, 2014)

	Actual	Average	Record
Temperature			
Mean Temperature	**38** °C	-	
Max Temperature	**47** °C	**43** °C	- ()
Min Temperature	**30** °C	**29** °C	- ()
Cooling Degree Days	36		
Growing Degree Days	51 (Base 50)		
Moisture			
Dew Point	**16** °C		
Average Humidity	29		
Maximum Humidity	58		
Minimum Humidity	4		
Precipitation			
Precipitation	**0.0** mm	-	- ()
Sea Level Pressure			
Sea Level Pressure	**995.84** hPa		
Wind			
Wind Speed	**12** km/h ()		
Max Wind Speed	**20** km/h		
Max Gust Speed	-		
Visibility	**9.8** kilometers		
Events			

Temperature readings in Al-Ain on hottest day in the month of July (July 18, 2014)

Daily Weather History Graph



Hi-Tech

Temperature readings in Al-Ain on hottest day in the month of July (July 18, 2014)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

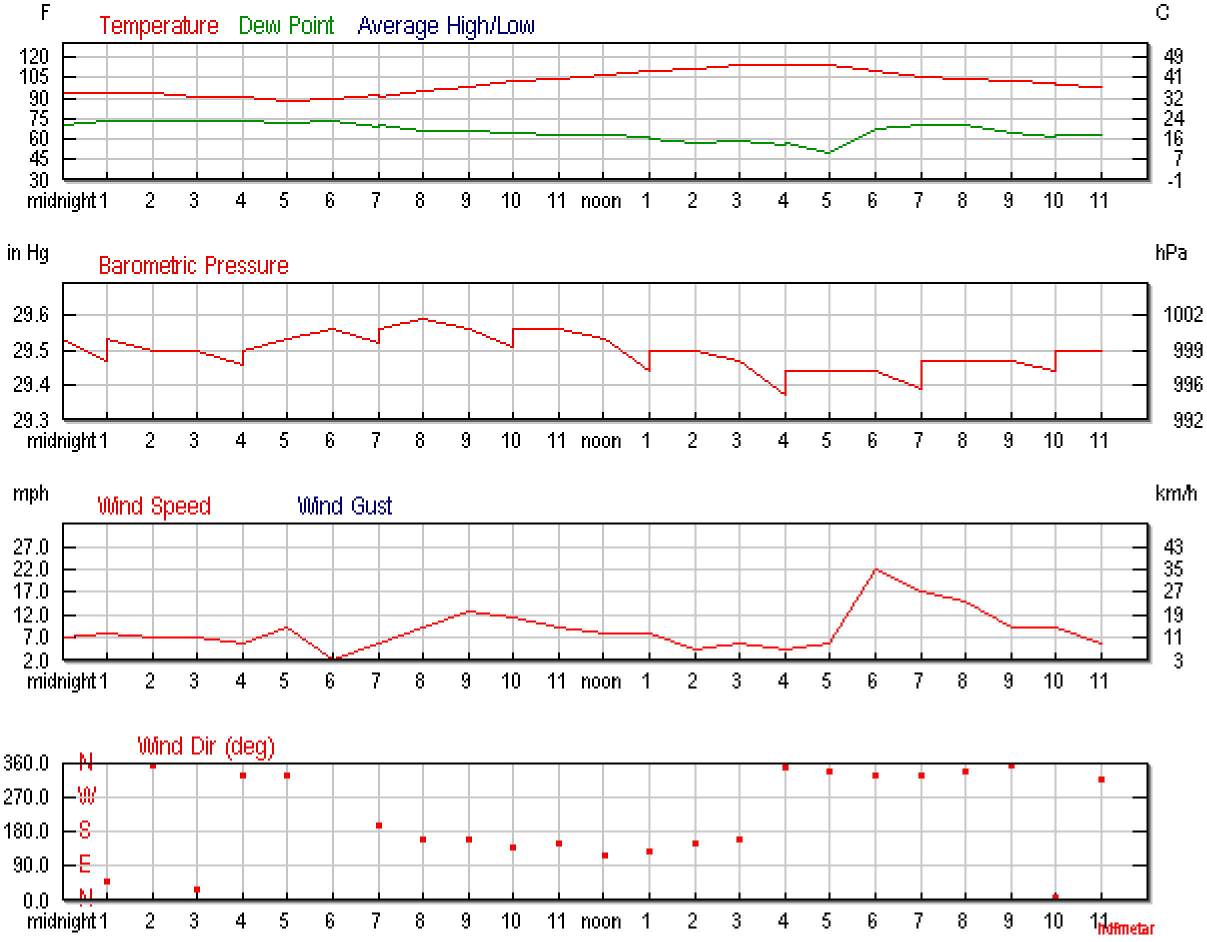
Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	34.0 °C	35.7 °C	19.0 °C	41%	9.3 km/h /2.6 m/s
1:00 AM	33 °C	-	19 °C	35%	14.8 km/h /
1:00 AM	33.0 °C	34.5 °C	19.0 °C	43%	14.8 km/h /4.1 m/s
2:00 AM	32.0 °C	34.9 °C	21.0 °C	52%	9.3 km/h /2.6 m/s
3:00 AM	31.0 °C	34.4 °C	22.0 °C	58%	11.1 km/h /3.1 m/s
4:00 AM	32 °C	-	20 °C	41%	13.0 km/h /
4:00 AM	32.0 °C	34.1 °C	20.0 °C	49%	13.0 km/h /3.6 m/s
5:00 AM	31.0 °C	33.0 °C	20.0 °C	52%	11.1 km/h /3.1 m/s
6:00 AM	31.0 °C	33.7 °C	21.0 °C	55%	7.4 km/h /2.1 m/s
7:00 AM	**32 °C**	**-**	**21 °C**	**44%**	**9.3 km/h /**
7:00 AM	**32.0 °C**	**34.9 °C**	**21.0 °C**	**52%**	**9.3 km/h /2.6 m/s**
8:00 AM	**36.0 °C**	**39.5 °C**	**21.0 °C**	**41%**	**9.3 km/h /2.6 m/s**
9:00 AM	**39.0 °C**	**40.9 °C**	**18.0 °C**	**29%**	**14.8 km/h /4.1 m/s**
10:00 AM	**41 °C**	**-**	**14 °C**	**13%**	**14.8 km/h /**
10:00 AM	**41.0 °C**	**40.8 °C**	**14.0 °C**	**20%**	**14.8 km/h /4.1 m/s**
11:00 AM	**43.0 °C**	**-**	**9.0 °C**	**13%**	**14.8 km/h /4.1 m/s**
12:00 PM	**44.0 °C**	**43.1 °C**	**12.0 °C**	**15%**	**14.8 km/h /4.1 m/s**
1:00 PM	**46 °C**	**-**	**10 °C**	**7%**	**13.0 km/h /**
1:00 PM	**46.0 °C**	**-**	**10.0 °C**	**12%**	**13.0 km/h /3.6 m/s**
2:00 PM	**46.0 °C**	**-**	**10.0 °C**	**12%**	**16.7 km/h /4.6 m/s**
3:00 PM	**46.0 °C**	**-**	**7.0 °C**	**10%**	**16.7 km/h /4.6 m/s**
4:00 PM	**46 °C**	**-**	**6 °C**	**4%**	**16.7 km/h /**
4:00 PM	**46.0 °C**	**-**	**7.0 °C**	**10%**	**16.7 km/h /4.6 m/s**
5:00 PM	**45.0 °C**	**-**	**7.0 °C**	**10%**	**16.7 km/h /4.6 m/s**
6:00 PM	**45.0 °C**	**44.0 °C**	**12.0 °C**	**14%**	**18.5 km/h /5.1 m/s**
7:00 PM	**43 °C**	**-**	**13 °C**	**10%**	**20.4 km/h /**
7:00 PM	**43.0 °C**	**42.6 °C**	**13.0 °C**	**17%**	**20.4 km/h /5.7 m/s**
8:00 PM	40.0 °C	43.6 °C	20.0 °C	31%	18.5 km/h /5.1 m/s
9:00 PM	38.0 °C	41.3 °C	20.0 °C	35%	14.8 km/h /4.1 m/s
10:00 PM	37 °C	-	18 °C	23%	11.1 km/h /

Temperature readings in Al-Ain on hottest day in the month of August (August 15, 2014)

	Actual	Average	Record
Temperature			
Mean Temperature	**38** ° C	-	
Max Temperature	**46** ° C	**42** ° C	- ()
Min Temperature	**30** ° C	**28** ° C	- ()
Cooling Degree Days	36		
Growing Degree Days	50 (Base 50)		
Moisture			
Dew Point	**19** ° C		
Average Humidity	33		
Maximum Humidity	59		
Minimum Humidity	9		
Precipitation			
Precipitation	**0.0** mm	-	- ()
Sea Level Pressure			
Sea Level Pressure	**998.78** hPa		
Wind			
Wind Speed	**12** km/h ()		
Max Wind Speed	**35** km/h		
Max Gust Speed	-		
Visibility	**8.0** kilometers		
Events			

Temperature readings in Al-Ain on hottest day in the month of August (August 15, 2014)

Daily Weather History Graph



Hi-Tech

Temperature readings in Al-Ain on hottest day in the month of August (August 15, 2014)

Aqua cool
healthy fresh air

Hourly Weather History & Observations

Time(GST)	Temp.	Heat Index	Dew Point	Humidity	WindSpeed
12:00 AM	34.0 °C	37.1 °C	21.0 °C	46%	11.1 km/h /3.1 m/s
1:00 AM	34 °C	-	23 °C	41%	13.0 km/h /
1:00 AM	34.0 °C	39.1 °C	23.0 °C	52%	13.0 km/h /3.6 m/s
2:00 AM	34.0 °C	39.1 °C	23.0 °C	52%	11.1 km/h /3.1 m/s
3:00 AM	33.0 °C	37.8 °C	23.0 °C	55%	11.1 km/h /3.1 m/s
4:00 AM	33 °C	-	23 °C	47%	9.3 km/h /
4:00 AM	33.0 °C	37.8 °C	23.0 °C	55%	9.3 km/h /2.6 m/s
5:00 AM	31.0 °C	34.4 °C	22.0 °C	58%	14.8 km/h /4.1 m/s
6:00 AM	32.0 °C	36.8 °C	23.0 °C	59%	3.7 km/h /1.0 m/s
7:00 AM	33 °C	-	21 °C	37%	9.3 km/h /
7:00 AM	33.0 °C	36.0 °C	21.0 °C	49%	9.3 km/h /2.6 m/s
8:00 AM	35.0 °C	36.9 °C	19.0 °C	39%	14.8 km/h /4.1 m/s
9:00 AM	37.0 °C	39.3 °C	19.0 °C	35%	20.4 km/h /5.7 m/s
10:00 AM	39 °C	-	18 °C	20%	18.5 km/h /
10:00 AM	39.0 °C	40.9 °C	18.0 °C	29%	18.5 km/h /5.1 m/s
11:00 AM	40.0 °C	41.5 °C	17.0 °C	26%	14.8 km/h /4.1 m/s
12:00 PM	42.0 °C	43.6 °C	17.0 °C	23%	13.0 km/h /3.6 m/s
1:00 PM	43 °C	-	16 °C	13%	13.0 km/h /
1:00 PM	43.0 °C	44.4 °C	16.0 °C	21%	13.0 km/h /3.6 m/s
2:00 PM	44.0 °C	44.0 °C	14.0 °C	17%	7.4 km/h /2.1 m/s
3:00 PM	46.0 °C	46.4 °C	15.0 °C	16%	9.3 km/h /2.6 m/s
4:00 PM	46 °C	-	14 °C	9%	7.4 km/h /
4:00 PM	46.0 °C	45.9 °C	14.0 °C	15%	7.4 km/h /2.1 m/s
5:00 PM	46.0 °C	-	10.0 °C	12%	9.3 km/h /2.6 m/s
6:00 PM	43.0 °C	47.6 °C	20.0 °C	27%	35.2 km/h /9.8 m/s
7:00 PM	41 °C	-	21 °C	23%	27.8 km/h /
7:00 PM	41.0 °C	45.6 °C	21.0 °C	31%	27.8 km/h /7.7 m/s
8:00 PM	40.0 °C	44.5 °C	21.0 °C	33%	24.1 km/h /6.7 m/s
9:00 PM	39.0 °C	40.9 °C	18.0 °C	29%	14.8 km/h /4.1 m/s
10:00 PM	38 °C	-	16 °C	19%	14.8 km/h /
10:00 PM	38.0 °C	39.1 °C	17.0 °C	29%	14.8 km/h /4.1 m/s
11:00 PM	37.0 °C	37.8 °C	17.0 °C	30%	9.3 km/h /2.6 m/s

Private house with Aqua cool

Alicante, Spain

Various types of locals with Aqua cool

Sports center in Deventer, The Netherlands

School for special education in Hengelo, The Netherlands

Prision in Rotterdam, The netherlands

Offices in Horst, The Netherlands

Possibilities

Non-food industry

Process

Food industry

Hi-Tech

Possibilities

Aqua cool

healthy fresh air

Possibilities

Medical and research facilities

Advantage

Efficiency

Maximum Efficiency

- More Cooling capacity than any other option
- Less water consumption
- 90% of the energy

Reliability

Maximum Reliability

- Rugged
- Built to last
- Best warranty
- 5-year warranty

Flexibility

Maximum Flexibility

- Complete control
- Automated
- Manual override
- All in one AHU
- 5 Operational Modes

Savings

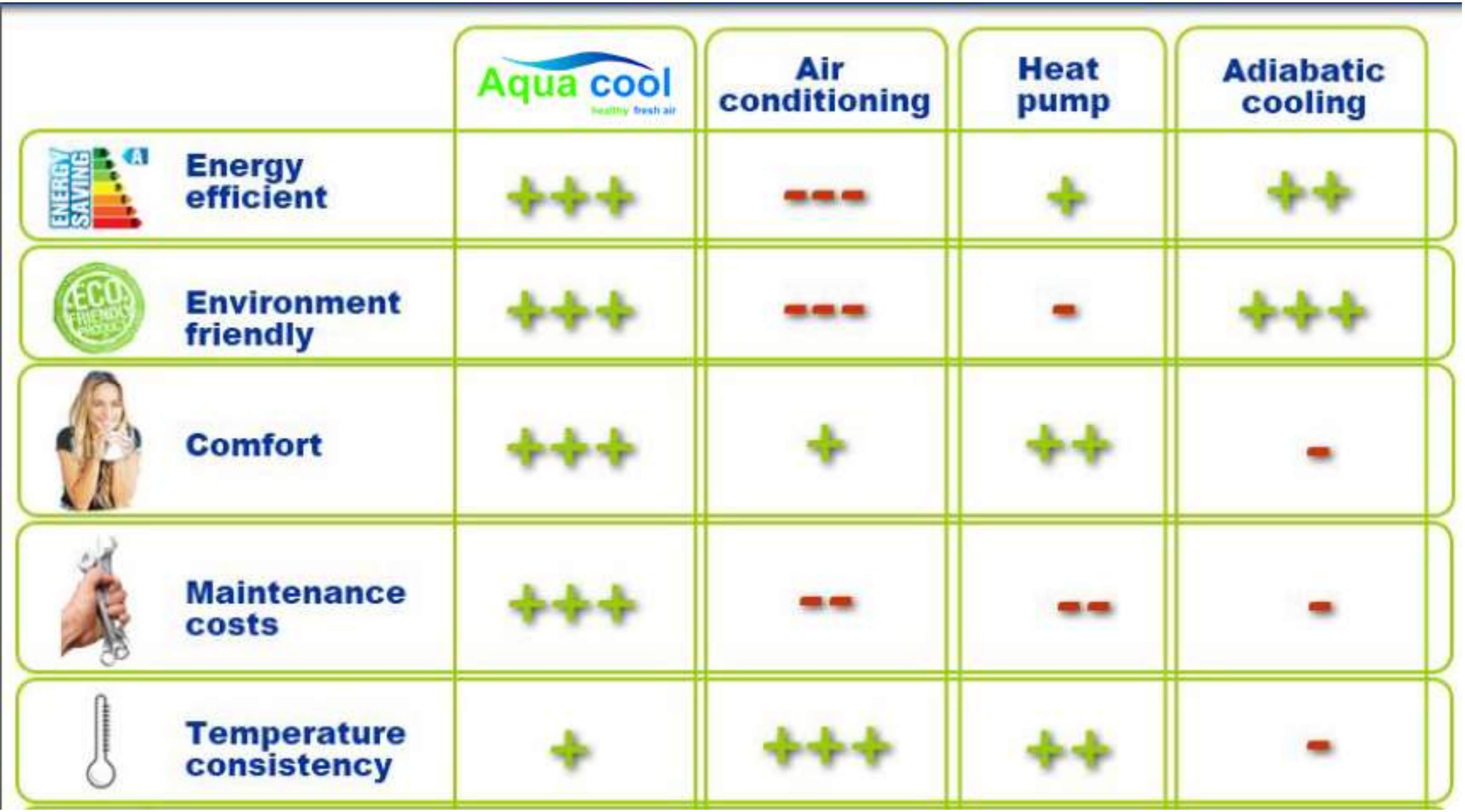
•Maximum Savings

- Manage ALL cost drivers
- Low TCO
- Rapid Payback
- Strong ROI

The most important benefits at a glance

Energy efficient	Up to 80% more energy efficient compared with a traditional air-conditioning system
Low maintenance costs	Because of the unique design and use of high quality materials all Aquacool need minimal maintenance as it has no moving parts
Environmentally friendly	The Aquacool uses water as a refrigerant. In addition, the heat exchanger includes proprietary plates of synthetic material which are designed to be recyclable
Comfortable	Comfort is achieved by producing cooled air which is not artificially void of necessary moisture. This creates a pleasant cooled space.
Increase of cooling capacity in case of low RH	The cooling capacity increases when cooling capacity is needed as the air is heated by the sun.
Free of health risks	Tests by TNO confirm that there is no Legionella risk. The system is also German VDI certified (German hygienic certification)

Aqua cool in comparison with the alternatives



	Aqua cool	Air conditioning	Heat pump	Adiabatic cooling
Energy efficient	+++	---	+	++
Environment friendly	+++	---	-	+++
Comfort	+++	+	++	-
Maintenance costs	+++	--	--	-
Temperature consistency	+	+++	++	-

Installation Projects

Project: Community Deventer, cooled ventilation in a gym

gemeente
Deventer

- In Deventer, The Netherlands in the multi functions building "De Vijfhoek" containing a school, a day-care and two gyms was realized. Three out of the four walls of the gyms are made of glass and the temperature on warm days rose up to 45ºC / 115 ºF. Free cooling alone not bring the required cooling capacity and conventional air conditioning was not an option due to the limited power available. The **Aquacool** offered the solution, with the supply cooled air at a ventilation rate of 5, without significant increase of energy consumption.

The government of Deventer provided a solution by the installation of the **Aquacool** for the gyms which were too warm:

- Control of the temperature on warm days
- Acceptable energy consumption and burden on the environment
- Increase of the usable hours of the gyms

Project: SWB Hengelo, cooled ventilation in a workplace

SWB Hengelo wanted to improve the ventilation in its workplaces with the additionally desire to keep the temperature comfortable during the year.

The **Aquacool** with heat recovery provides a comfortable climate the whole year round.

With the **Aquacool** SWB Hengelo fulfilled the desires of the management and personnel:

- Optimal ventilation in het whole building
- Comfortable climate to work on warm en cold days
- Saving on costs for heating and cooling

Hi-Tech

Project: Re-Gent Helmond, climate control in a laboratory

Aqua cool
healthy fresh air

REGENT

Re/GenT is a Research & Development centre specialized in refrigeration, air conditioning and heat pumps in Helmond, The Netherlands. The laboratory has a flat roof and lots of heat is produced by their test equipment inside the building, which resulted in high temperatures on sunny days. The installation of an **Aquacool** in the laboratory turned out to be the solution to improve ventilation and to optimize the working conditions in all circumstances. An unexpected by-effect was the limitation of dust in the lab that could harm the sensitive test equipment, due to the constant overpressure and exhaust of air.

Re/genT improved the working environment in its laboratory by the installation of the **Aquacool** :

- Optimal ventilation and exhaust of warm process air
- A comfortable working climate inside on warm days
- Limitation of dust due to permanent overpressure

Project: Smart DC, cooling of a datacenter

SmartDC

Dataport of Rotterdam

Data centres deliver their services day and night, which means that the cooling technology used must be available at all times. However, as a provider that attaches great importance to sustainability, SmartDC wanted to achieve more.
The **Aquacool** cooling system design, which is based on the **Aquacool** cooling concept was a perfect fit with that objective, says Richard Boogaard, SmartDC's managing director. "We are very happy with the performance of this cooling concept. Not only because the cooling system is always available, but also because the solution is both very energy efficient and environmental friendly.
Aquacool offers us substantial advantages, our experiences with this cooling concept are positive. So good in fact, that we will apply it to the all parts of our Datacenters"

SmartDC improved its reliability and profits by the installation of air cooling based on the **Aquacool** :

- Very high reliability due to the simplicity of the design
- Low operational cost for energy and maintenance
- Very low impact on the environment

Project: Hotraco Horst, climate control in a modern office

Hotraco is market leader in the development and production of measuring and controlling equipment. The company built a new office with the latest technologies. The fitting of the **Aquacool** optimized the working environment at all weather conditions.

Hotraco optimize the climate in the office with the installation of a **Aquacool** :

- Optimized ventilation and exhaust of warm air
- A comfortable working climate inside on warm days

Air conditioning at the same time

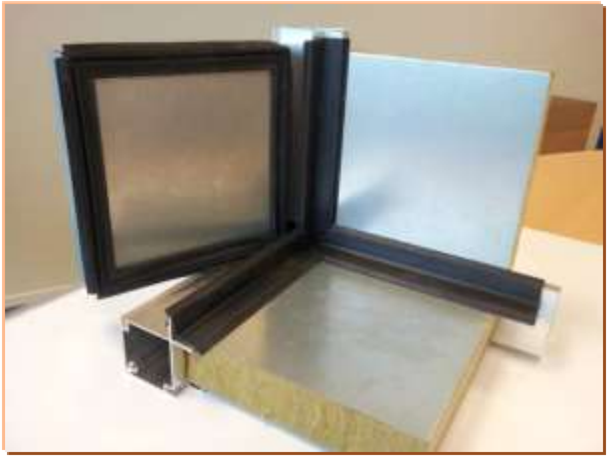
Hi-Tech

Application : Aqua cool technology

Aqua cool
healthy fresh air

Details of equipment

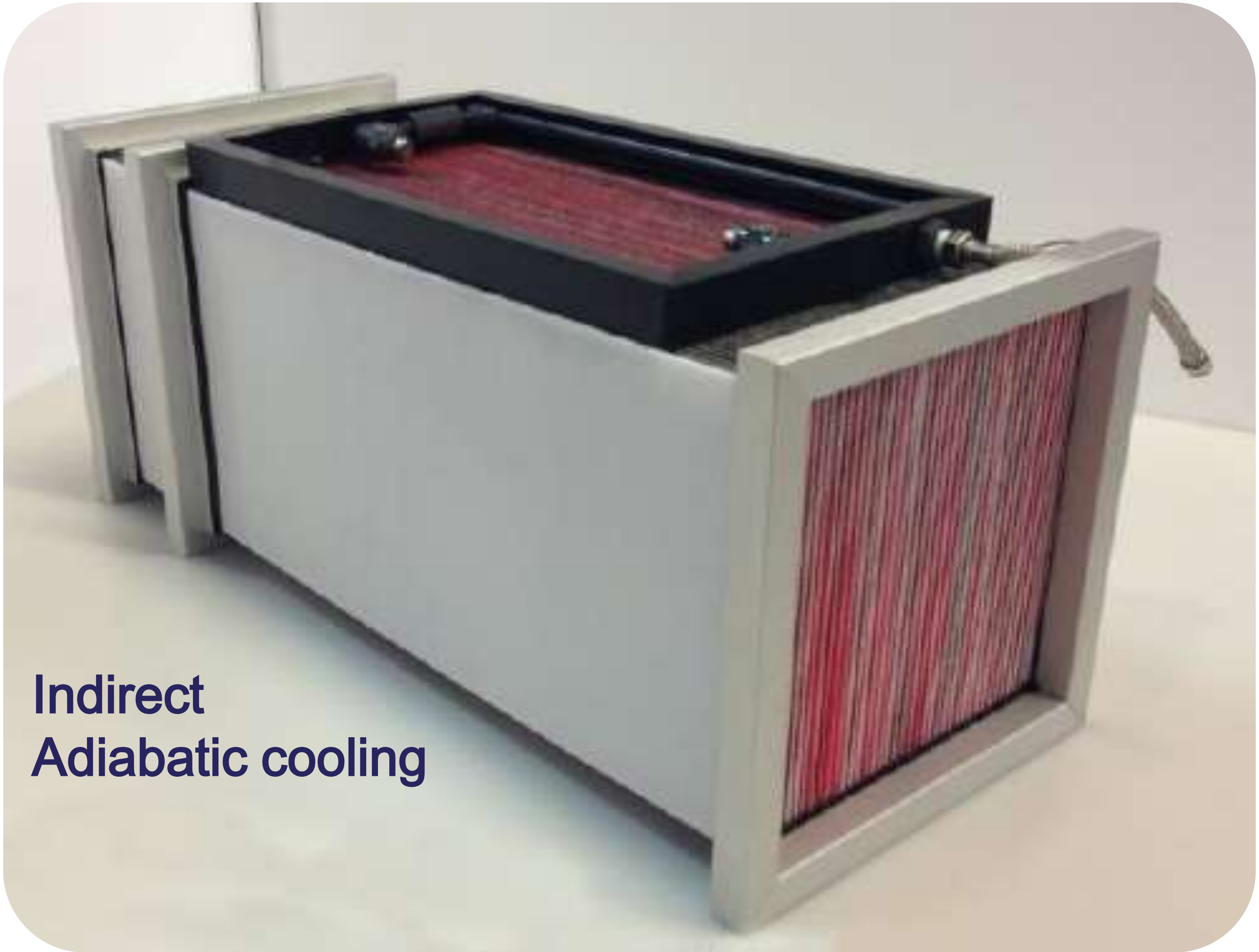
DOBLE WALL PANELS STANDARD



ROBUST ALUMINUM FRAMES

EPOXI COATING STANDARD

Heat exchanger design

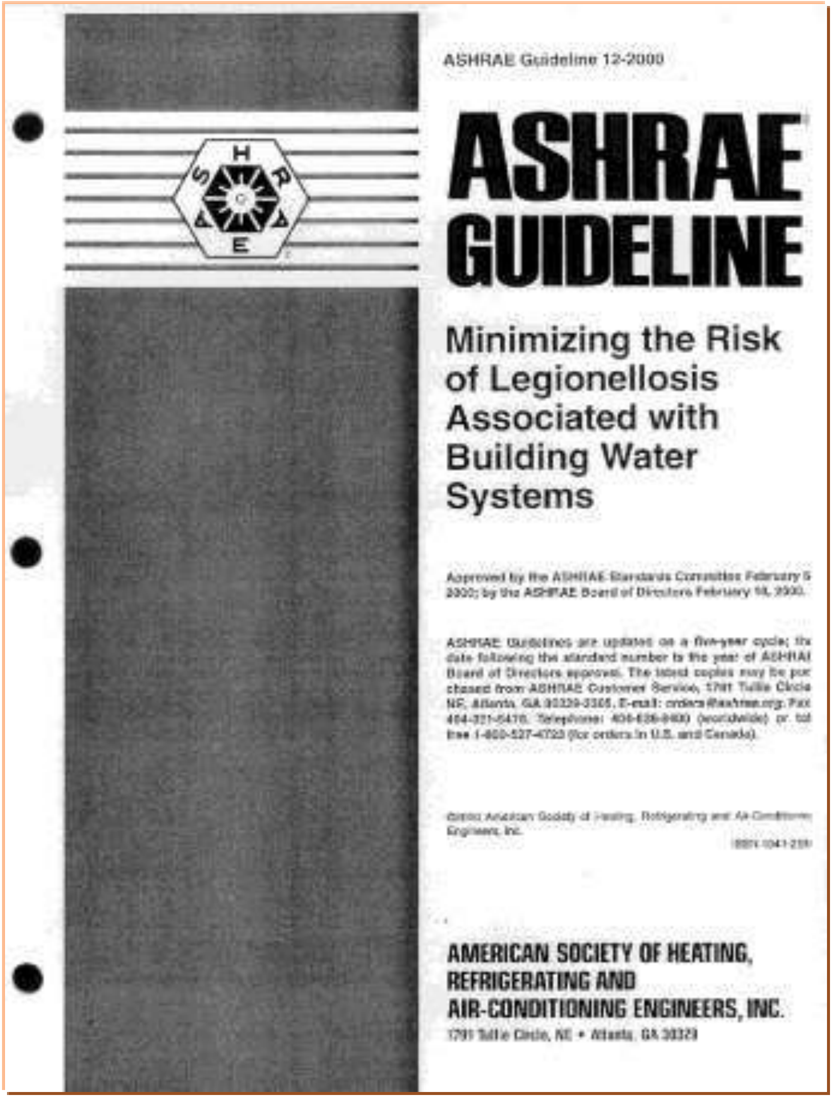


Indirect
Adiabatic cooling

Legionnaires' Disease

"There have been no known cases of Legionnaires' disease with air washers, wetted media evaporative air coolers/humidifiers, or steam humidifiers."

"There has been no positive association of Legionnaires' disease with indirect evaporative air coolers"



ASHRAE Guideline 12-2000

ASHRAE
GUIDELINE

Minimizing the Risk
of Legionellosis
Associated with
Building Water
Systems

AMERICAN SOCIETY OF HEATING,
REFRIGERATING AND
AIR-CONDITIONING ENGINEERS, INC.

Why?

- The water in the sump is not warm enough to allow the Legionella bacteria to proliferate.
- Rigid media evaporative coolers do not produce droplets in a size that is conducive to transporting Legionella bacteria.
- Evaporative coolers have their pumps cleaned on a regular basis.

Water treatment

- The cooling system uses water. By indirect evaporating of the water the air flow will be cooled.
- Softening is recommended to prevent scaling and to reduce water loss.
- To reduce further water loss, it is possible to re-circulate the overflow water. This required a more complex system and is only economically viable for higher flow systems.

System 1: Softener:

- This will remove all Calcium and Magnesium from the feed water.
- Doing so, allows for much lower overflow (which results in a lower water consumption)
- When the softener is saturated with Calcium and Magnesium, it needs to be regenerated.
- During regeneration, brine is used. This will be discharged into a drain.

Water treatment

System 2: Softener + water recirculation:

- Besides a softener, you could also choose to re-circulate the overflow water.
- For this, you would need a buffer vessel where the water can return to. As part of the water has been evaporated, conductivity needs to be measured and drain valve has to be installed in case of high conductivity. After the vessel a pump needs to be installed to feed the cooler.
- The set-up of this system will allow for much lower water consumption.

Conclusions (Part 1)

Classical HVAC system strategies and equipment are not meeting the client's needs. Classical HVAC solutions are the problem

- They are primarily constructed around energy intensive processes
- Reliance on ventilation reduction is the primary cause of air quality problems
- Recirculation compromises indoor air quality and energy efficiency
- They place indoor air quality and energy conservation goals in fundamental conflict

New HVAC system strategies are needed…better engineering is required

Conclusions (Part 2)

Truly “green” HVAC systems are attainable with simple technologies that are readily available.
Benefits of these “green” systems;

- competitive construction costs
- improved indoor air quality
- reduced energy consumption
- reduced heating/cooling plants
- easy to maintain

Both Direct and Indirect evaporative cooling are simple, reliable processes which will take you where you want to go.

Questions?

With respect to the environment

Hi-Tech

Thanks,

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