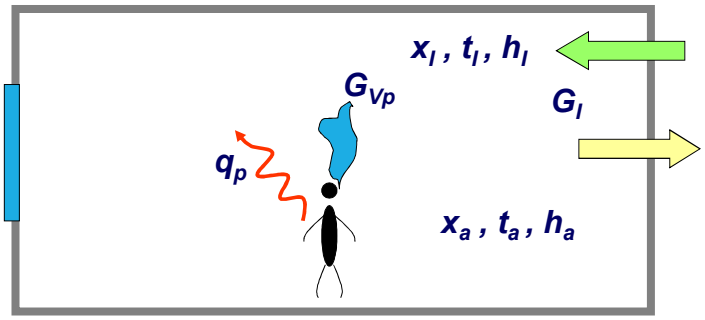
FULL AIR SYSTEMS

FULL AIR SYSTEMS

PROS	CONS
Good possibility to control indoor conditions Complete absence of pipng etc. Localization in a unique Air Handling Unit (AHU) the main components of the plant Easy installation of heat recovery units	Poor energy efficiency Size of air ducts Need of accurate balancing of air ducts

BALANCEOF A ROOM



THERMAL AND VAPOUR BALANCE OF A ROOM

$$q_p = G_I \; c_P \; (t_a - t_I) \qquad (1)$$

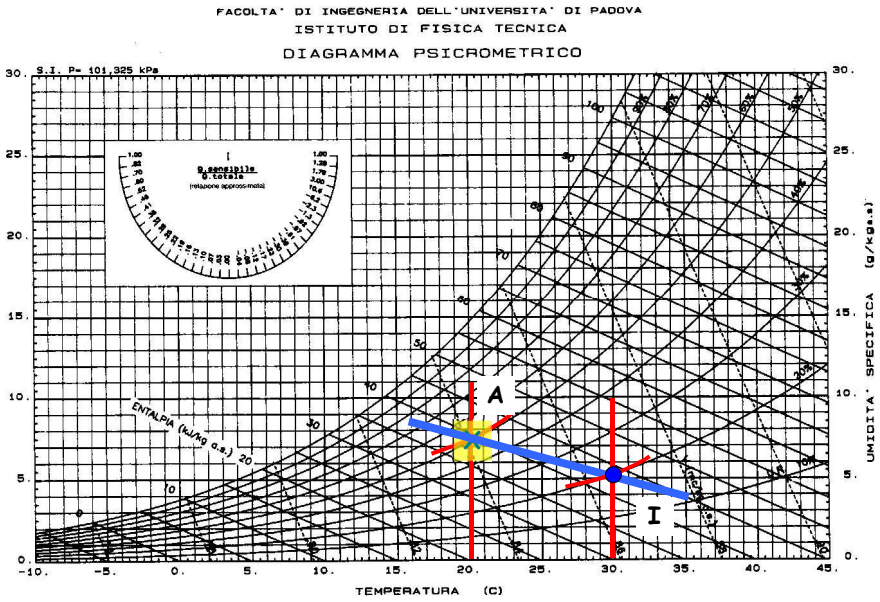
$$G_{vp} = G_I \; (x_a - x_I) \qquad (2)$$

$$q_p + r \, G_{vp} = G_I \; (h_a - h_I) \qquad (3)$$

$$\frac{(3)}{(2)} \rightarrow \frac{q_{tp}}{G_{vp}} = \frac{h_a - h_I}{x_a - x_I}$$

$$\frac{(1)}{(3)} \rightarrow \frac{q_p}{q_{pt}} = \frac{c_P \; (t_a - t_I)}{h_a - h_I}$$

WINTER



The greater the distance from I and A the lower the air flow rate

→ **LOW CAP-EX**

Lower flow rate ⟶ ***IAQ ?***

$t_I - t_a = 15 \div 25\ ^\circ C$ *in* **HEATING**

$t_a - t_I = 10 \div 12\ ^\circ C$ *in* **COOLING**

IN THESE PLANTS:

✓ if $G_{a,fresh} < G_I$ ⟶ $G_{recirculation} = G_I - G_{a,fresh}$

✓ se $G_{a,fresh} > G_I$ ⟶ Just fresh air $G_I = G_{a,fresh}$

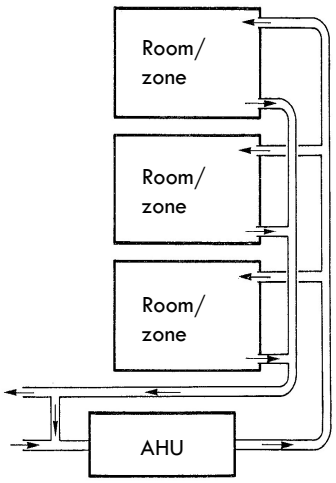
In a plant the design conditions occur rarely

Conditions change over the time

Different zones my require different loads

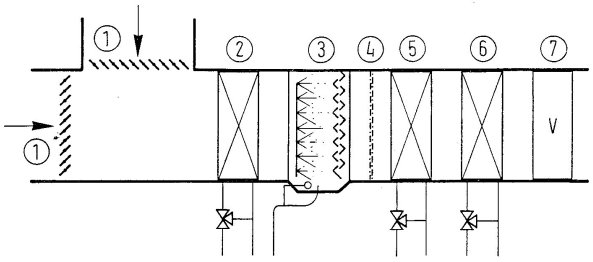
(living room/bedrooms, South-North, West-East, etc.)

SINGLE DUCT



- *A single duct connects the AHU to the rooms/zones*
- *The air flow rate may be different from zone to zone, but the inlet conditions are the same (temperature and relative humidity)*
- *Same straight line for each room/zone*
- *The set of the rooms supplied by a single duct represent the same climatic zone*

SCHEME OF AN AHU



1. *Equalizing dampers*
2. Pre-heating coil
3. Atomizing humidifier
4. Droplet separator
5. Cooling coil
6. Reheat coil
7. Fan

AHU:

HEATING OPERATION

The pre-heat coil determines the inlet humidity ratio in the room.

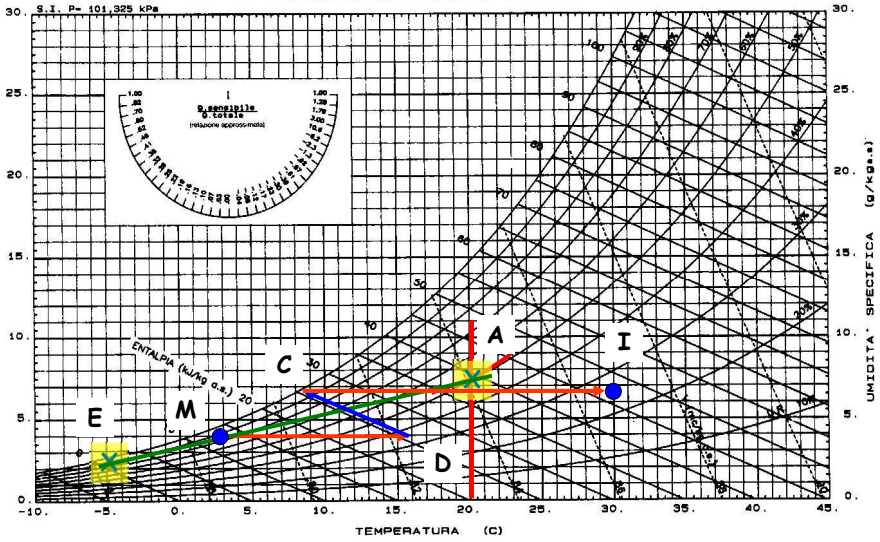
The reheat coil has the goal to control t_{IMM}

COOLING OPERATION

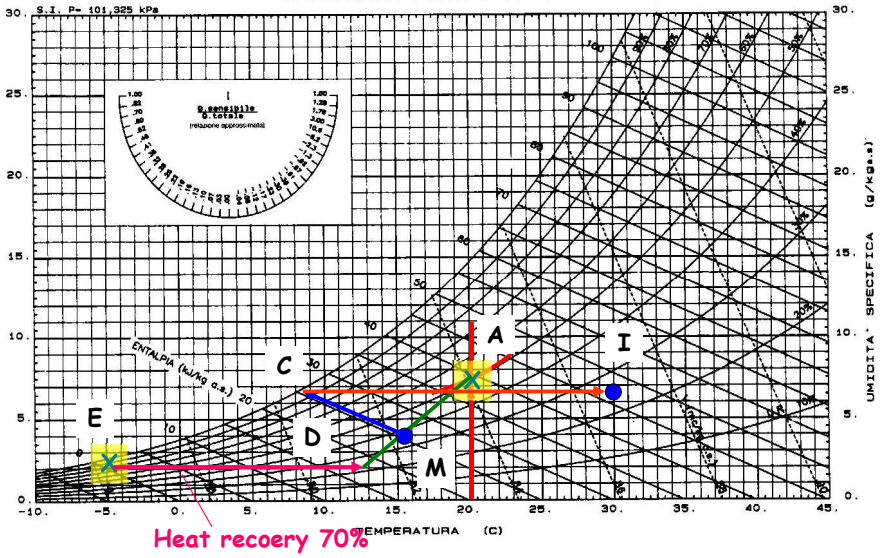
The cooling coil varies the inlet humidity ratio.

The reheat coil controls the inlet temperature

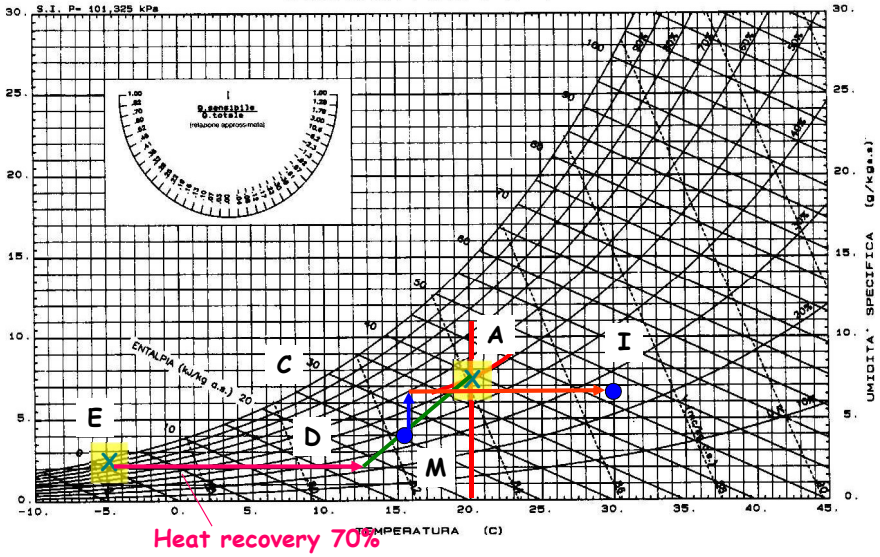
Winter no heat recovery, atominzing humidifier



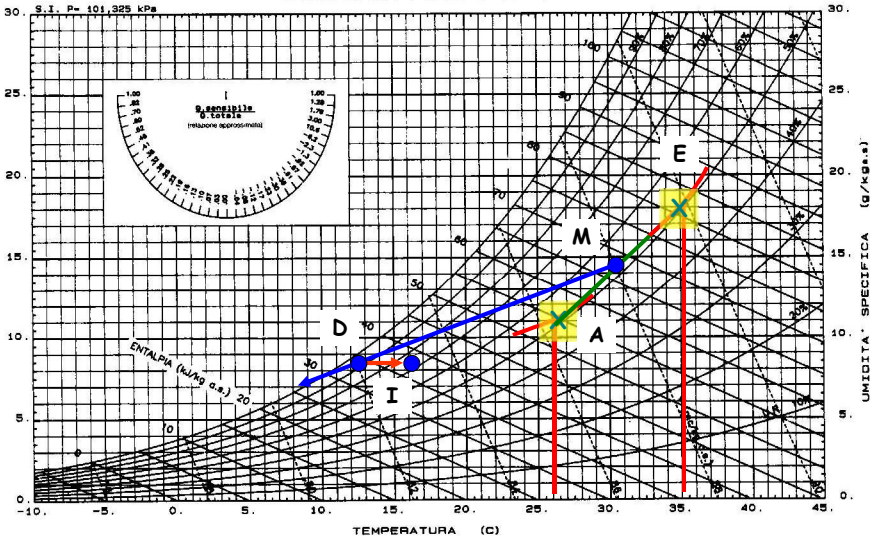
Winter with heat recovery (70%), atominzing humidifier



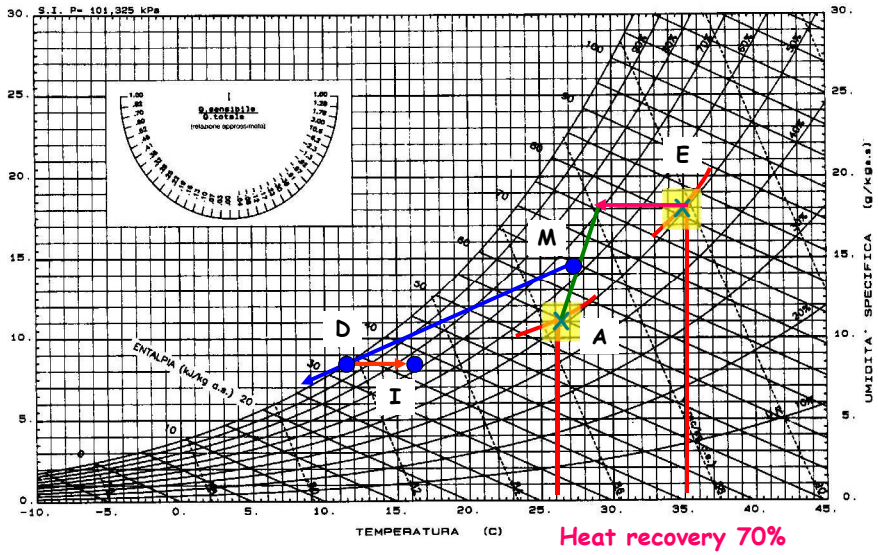
Winter with heat recovery (70%), steam humidifier



Summer no heat recovery



Summer with heat recovery



Heat recovery 70%

- *Adaptable* and *Precise* in controlling temperature and humidity
- **With different zones ⟶ each with a un SINGLE DUCT & AHU**
- **Sizing** { **heating** / **cooling**
- **Select the greater flow rate as design flow rate**

  ↳ **If there is a difference between the 2 flow rates:**

  - **maximum**
  - **reduced (by means of a fan with variable flow rate)**

  ↳ **In the seocond case (reduced flow rate) it is necessary to set again the inlet conditions (the inlet conditions change)**

HOW TO SIZE THE COILS:

Preheating coil:

$x_D = x_I$ (latent load = 0)

$G_I c_p (t_D - t_M)$ = heat supplied as preheating

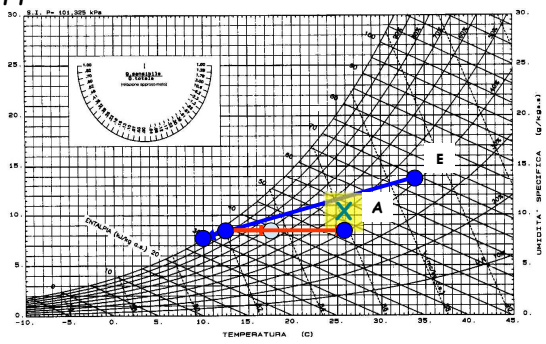
- Reheat coil:

  For cooling: $t_I = t_A$ (sensible load = 0)

  $G_I c_p (t_I - t_C)$ = heat supplied in winter

  $G_I c_p (t_A - t_D)$ = heat supplied in summer

  Whichever is greater



MULTIZONE SYSTEMS WITH REHEAT COILS

✓ Zones with different loads

✓ There is just one AHU e and the reheat coils are in stalled locally

✓ The control can be either on the temperature or on the relative humidity (just one of them)

1. *Equalizing dampers*
2. Pre-heating coil
3. Atomizing humidifier
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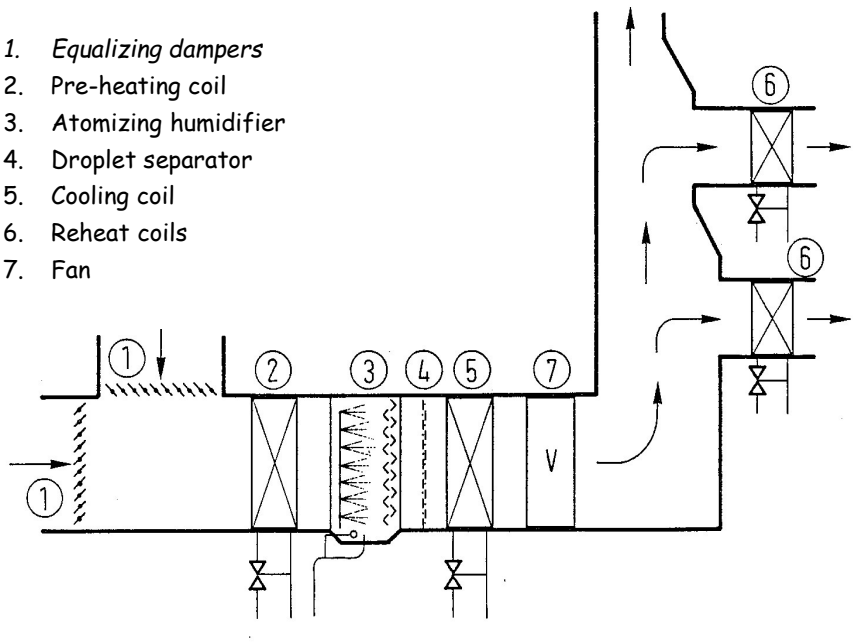
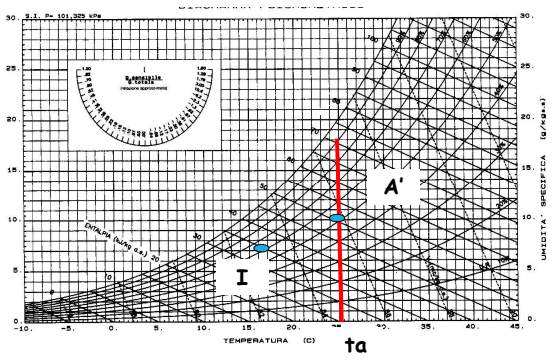
5. Cooling coil
6. Reheat coils
7. Fan



Case with room temperature control:

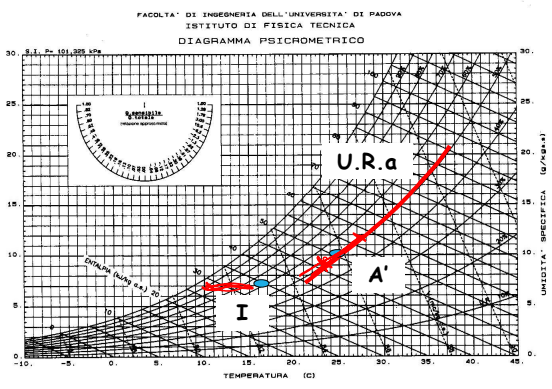
The control is based on a set-point temperature of the room t_a

The humidity ratio can change depending on the actual vapour balance. The humidity ratio can vary and hence the conditions A' can move on the red straight segment t_a *varying the relative humidity.*



- ***Case with relative humidity control:***

The relative humidity is kept constant (on the RH = const. curve) but the temperature can change



t_I

- ***Sizing the ventilation rate:***

$$G_{a\,TOT} = \sum_j G_{aj}$$

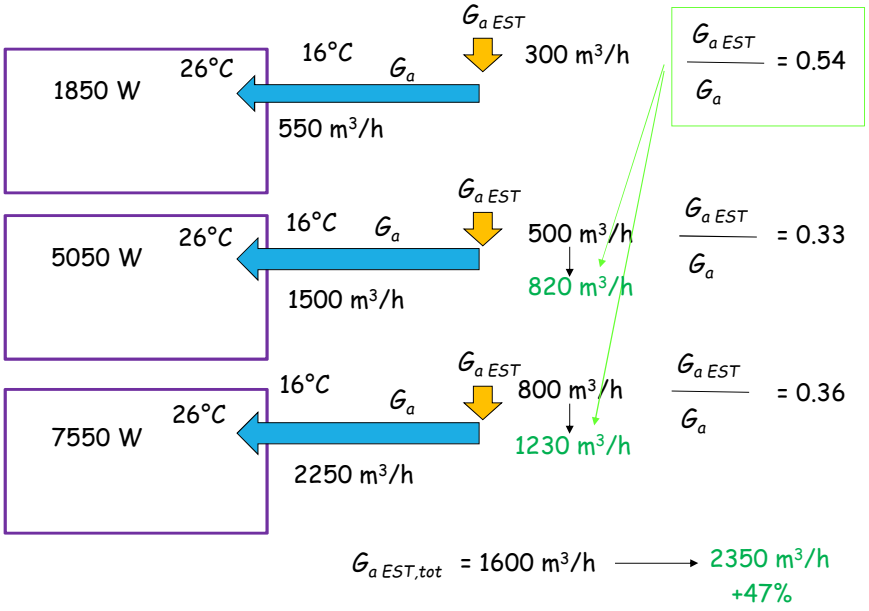
$$\frac{G_{a\,FRESH}}{G_a}$$

Room by room

The maximum ratio M determines the sharing of fresh air

$$G_{a\,FRESH} = M\,G_a$$

Example:


$G_{a\,EST}$
16°C
G_a
26°C
1850 W
300 m³/h
550 m³/h
$\frac{G_{a\,EST}}{G_a}$ = 0.54
5050 W
500 m³/h
820 m³/h
1500 m³/h
$\frac{G_{a\,EST}}{G_a}$ = 0.33
7550 W
800 m³/h
1230 m³/h
2250 m³/h
$\frac{G_{a\,EST}}{G_a}$ = 0.36
$G_{a\,EST,tot}$ = 1600 m³/h
2350 m³/h
+47%