**FULL AIR SYSTEMS**

<table>
<thead>
<tr>
<th><strong>PROS</strong></th>
<th><strong>CONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Good possibility to control indoor conditions</td>
<td>Poor energy efficiency</td>
</tr>
<tr>
<td>Complete absence of pipng etc.</td>
<td>Size of air ducts</td>
</tr>
<tr>
<td>Localization in a unique Air Handling Unit (AHU) the main components of the plant</td>
<td>Need of accurate balancing of air ducts</td>
</tr>
<tr>
<td>Easy installation of heat recovery units</td>
<td></td>
</tr>
</tbody>
</table>
BALANCE OF A ROOM

THERMAL AND VAPOUR BALANCE OF A ROOM

\[ q_p = G_I \ c_p \ (t_a - t_I) \]  

\[ G_{vp} = G_I \ (x_a - x_I) \]  

\[ q_p + r \ G_{vp} = G_I \ (h_a - h_I) \]

\[ \frac{q_{tp}}{G_{vp}} = \frac{h_a - h_I}{x_a - x_I} \]  

\[ \frac{q_p}{q_{pt}} = \frac{c_p \ (t_a - t_I)}{h_a - h_I} \]
The greater the distance from I and A the lower the air flow rate

Lower flow rate → IAQ ?

\[
t_I - t_a = 15 \div 25 \degree C \quad \text{in HEATING}
\]

\[
t_a - t_I = 10 \div 12 \degree C \quad \text{in COOLING}
\]
**IN THESE PLANTS:**

- If $G_{a,fresh} < G_I$  
  \[ G_{recirculation} = G_I - G_{a,fresh} \]

- If $G_{a,fresh} > G_I$  
  Just fresh air $G_I = G_{a,fresh}$

**In a plant the design conditions occur rarely**

*Conditions change over the time*

*Different zones may 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

Heat recoery 70%
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 second 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)

\[ G_I c_p (t_D - t_M) = \text{heat supplied as preheating} \]

- **Reheat coil:**
  - For cooling: \[ t_I = t_A \] (sensible load = 0)
  - \[ G_I c_p (t_I - t_C) = \text{heat supplied in winter} \]
  - \[ G_I c_p (t_A - t_B) = \text{heat supplied in summer} \]
  - Whichever is greater

**MULTIZONE SYSTEMS WITH REHEAT COILS**

- Zones with different loads
- There is just one AHU 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
4. Droplet separator
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.

   ![Graph showing humidity and temperature control](image)

• **Sizing the ventilation rate:**

\[
G_a^\text{TOT} = \sum_j G_{aj}
\]

\[
\frac{G_a^\text{FRESH}}{G_a} = \text{Room by room}
\]

The maximum ratio \( M \) determines the sharing of fresh air

\[
G_a^\text{FRESH} = M G_a
\]
Example:

1850 W

26°C

16°C $G_a$

550 m³/h

$G_{a, EST}$ 300 m³/h

$\frac{G_{a, EST}}{G_a} = 0.54$

5050 W

26°C

16°C $G_a$

1500 m³/h

$G_{a, EST}$ 500 m³/h

820 m³/h

$\frac{G_{a, EST}}{G_a} = 0.33$

7550 W

26°C

16°C $G_a$

2250 m³/h

$G_{a, EST}$ 800 m³/h

1230 m³/h

$\frac{G_{a, EST}}{G_a} = 0.36$

$G_{a, EST, tot} = 1600$ m³/h

2350 m³/h

+47%