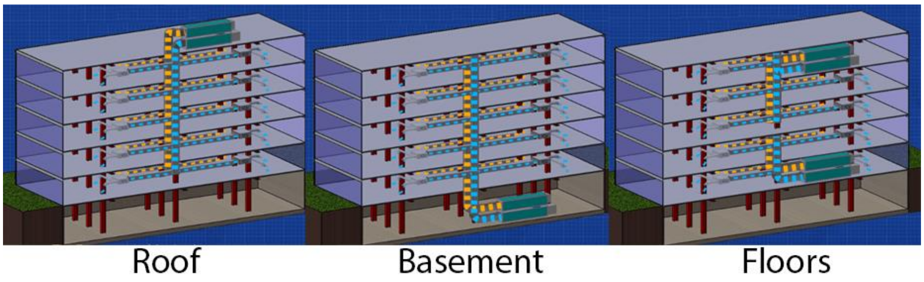
AIR HANDLING UNITS (AHU)

Air handling units, which usually have the acronym of A.H.U. are found in medium to large commercial and industrial buildings.

They are usually located in the basement, on the roof or on the floors of a building. AHU's will serve a specified area or zone within a building such as the east side, or floors 1 – 10 or perhaps a single purpose such as just the buildings toilets. Therefore, it is very common to find multiple AHU's around a building.

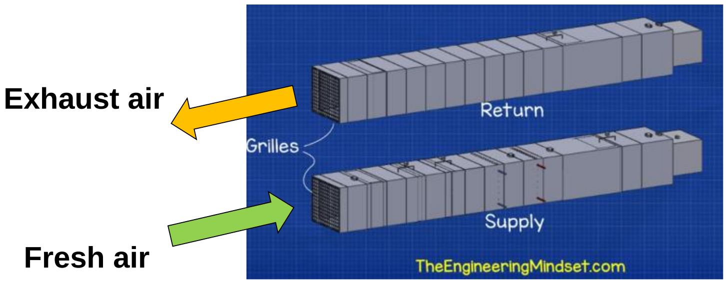


Some buildings, particularly old high rise building, will have just one large AHU, usually located on the roof. These will supply the entire building. They might not have a return duct, some older designs rely on the air just leaking out of the building. This design is not so common anymore in new buildings because it is very inefficient, now its most common to have multiple smaller AHU's supplying different zones. The buildings are also more air tight so we need to have a return duct to regulate the pressure inside the building.

Scope of an air handling unit

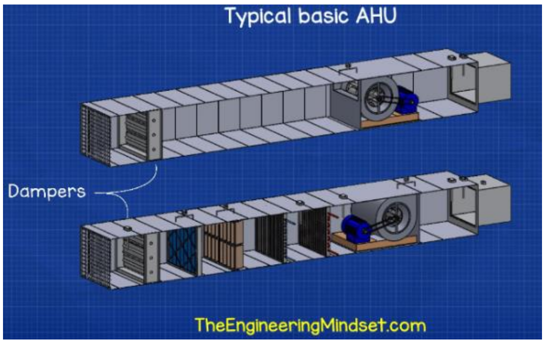
Air handling units' condition and distribute air within a building. They take fresh ambient air from outside, clean it, heat it or cool it, maybe humidify it and then force it through some ductwork around to the designed areas within a building. Most units will have an additional duct run to then pull the used dirty air out of the rooms, back to the AHU, where a fan will discharge it back to atmosphere. Some of this return air might be recirculated back into the fresh air supply. To save energy a heat recovery unit may be installed (sensible or latent load).

Let us have a look at a simple, typical designs, and then look at some more advanced ones.

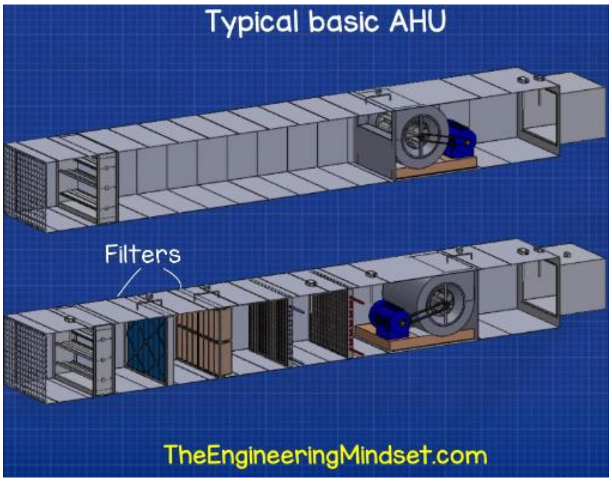


In this very basic model we have the two AHUs housing for flow and return air. At the very front on the inlet and outlet of each housing we have a **grille to prevent objects and wild life** entering into the mechanical components inside the AHU.

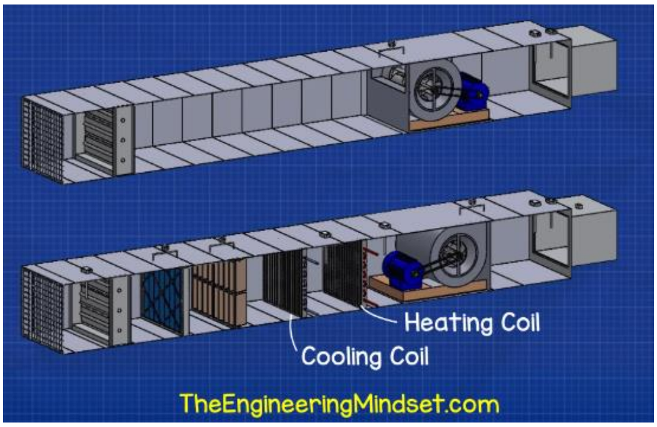
At the inlet of the fresh air housing and the discharge of the return air housing we have some dampers. The **dampers are multiple sheets of metal which can rotate**. They can close to prevent air from entering or exiting, they can open to fully allow air in or out, and it can also vary their position somewhere in between to restrict the amount of air that can enter or exit.



After the dampers there are some **filters**. These are there **to try and catch all the dirt and dust etc. from entering the AHU and the building**. If we do not have these filters the dust is going to build up inside the ductwork and within the mechanical equipment. It is also going to enter the building and be breathed in by the occupants as well as make the building dirty. So, we want to remove as much of this as possible. Across each bank of filters, there must be a pressure sensor. This will measure how dirty the filters are and warn the engineers when it is time to replace the filters. As the filters pick-up dirt, the amount of air that can flow through is restricted and this causes a pressure drop across the filters. Typically, we have some panel filters or pre-filters to catch the largest dust particles. Then we have some bag filters to catch the smaller dust particles.



The next thing we find are the **cooling and heating coils**. These are there to heat or cool the air. The air temperature of the supply air is measured as it leaves the AHU and enters the ductwork. This needs to be at a designed temperature to keep the people inside the building comfortable. The coils are heat exchangers; inside a hot or cold fluid, usually heated or chilled water, refrigerant or steam. Depending on the type of plant (full-air or air and water based solution) the coils have to heat, cool and dehumidify the air.



Besides the coils there is (as optional, depending on the climate) a **humidifier**. There are two types of humidifiers:

Adiabatic humidifier

Source: Condair

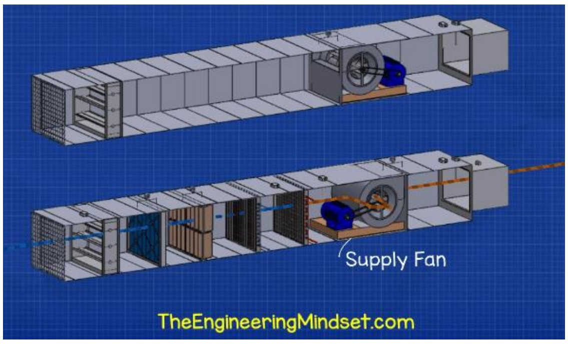
Isothermal humidifier

Source: Carel

1) adiabatic (or evaporative) humidification systems which use mechanical energy to generate water particles and/or evaporate water to/from media.

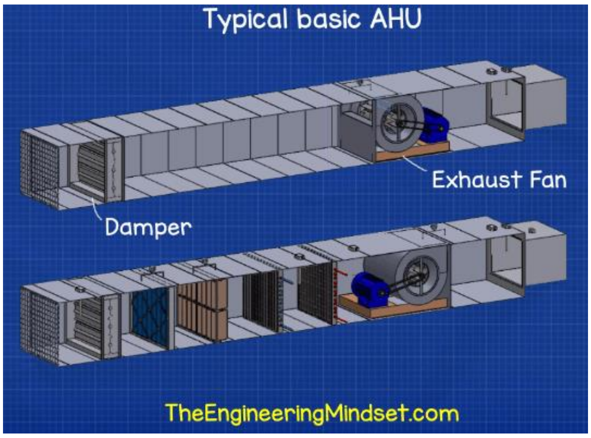
2) Isothermal (or steam) humidification systems which use electricity or fuel as an external heat source to change water to steam.

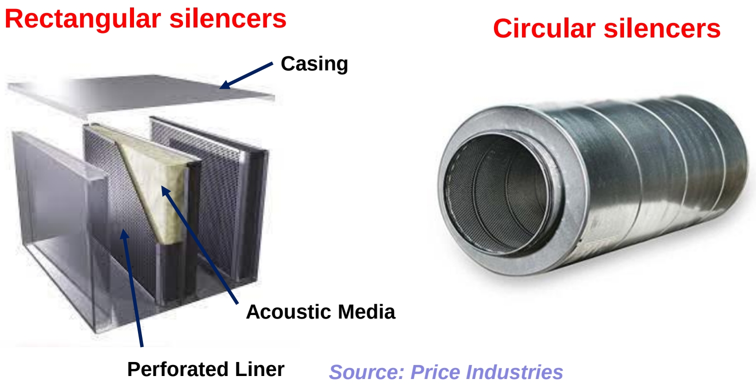
Next there is the **fan**. This is going to pull the air in from outside and then (through the dampers, filters, humidifier and coils) push this out into the ductwork around the building. Centrifugal fans are very common in old and existing AHU's but EC fans are now being installed and also retrofitted to increase the energy efficiency. Across the fan there is a pressure sensor, this will sense if the fan is running. If it is running then it will create a pressure difference, to detect a failure in the equipment and warn the engineers of the problem.



It would be also likely to have a duct pressure sensor shortly after the fan, to read the static pressure and, in some AHUs, the speed of the fan is controlled as a result of the pressure in the duct (for VAV and DCV solutions). How to size and design the ductwork will be seen in the next lecture.

Then we have the ductwork which will send the air around the building to the designed areas. We'll also have some ductwork coming back which is brining all the used air from the building back to a separate part of the AHU. This **return/exhaust AHU** is usually located near the supply, but sometimes it can be located elsewhere. The return AHU in its simplest form has just a fan and damper inside. The fan is pulling the air in from around the building and then pushing it out of the building. The damper is located at the exit of the AHU housing and will close when the AHU turns off.





Source: Price Industries

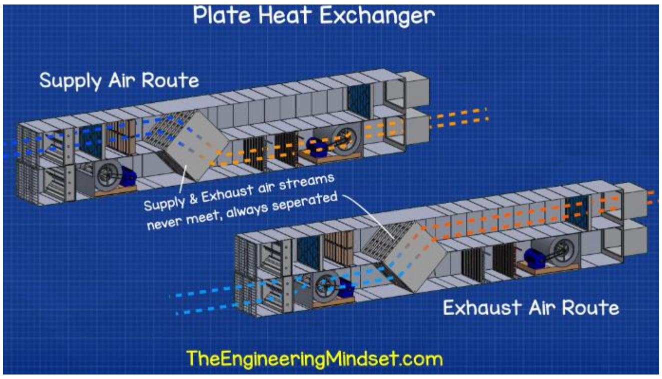
In order to avoid annoyance one **silencer** is installed after the supply fun and one silencer is installed before the exhaust fan. There are many options for the silencers since they may be rectangular or circular. If the AHU is located in a quiet urban area and may affect the neighbours a silencer has to be installed also after the intake air grill and before the exhaust grill to reduce the noise to the surroundings. If the AHU is installed outside (usually in the room or on the ground) also the noise from the casing has to be taken into account.

If you're in a cold part of the world where the air temperature reaches freezing point or close to it. Then likely we'll find a pre-heater at the inlet of the fresh air intake. This is usually an electrical heater. When the outside air gets to around 6*c (42.8F) the heater will come on and heat the air up to protect the components inside from frost. Otherwise this could freeze the heating and cooling coils inside and burst them.

A very common configuration uses a duct sit in between the exhaust and the fresh air intake. This allows some of the exhaust air to be recirculated back into the fresh air intake, to offset the heating or cooling demand. This may be done when the required air flow rate in the building is high compared to the fresh air. The resulting quality of the air has to be evaluated and a filter in the recirculation air may be needed (e.g. in operating theatres).

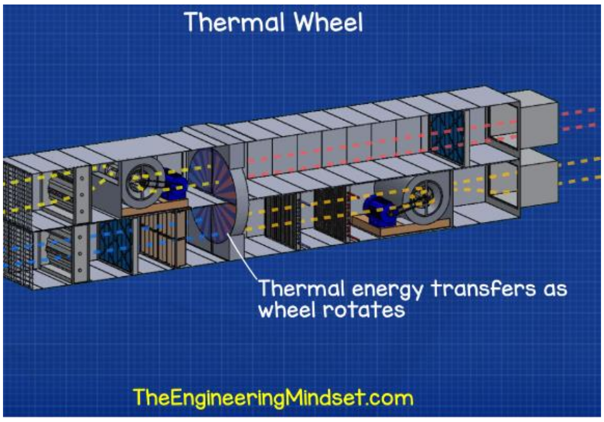
Heat recovery units

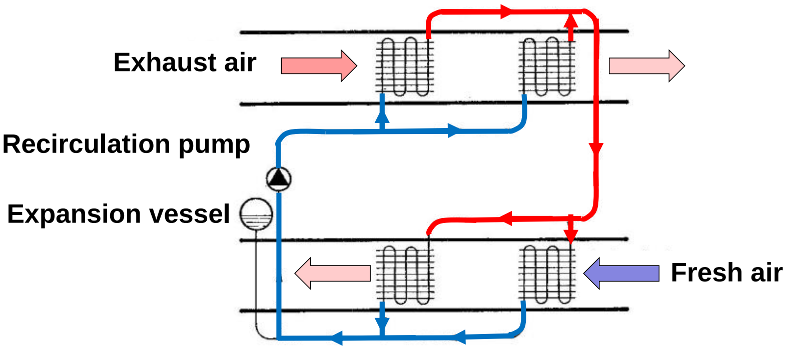
The most common and widely used system for recovering the heat from exhaust air is the plate heat exchanger. This uses thin sheets of metal to separate the two streams of air so they do not come into contact or mix at all, the temperature difference between the two air streams will cause heat to transfer over from the hot exhaust stream through the metal walls of the heat exchanger and into the cold intake stream. The efficiency rate is about 50%.



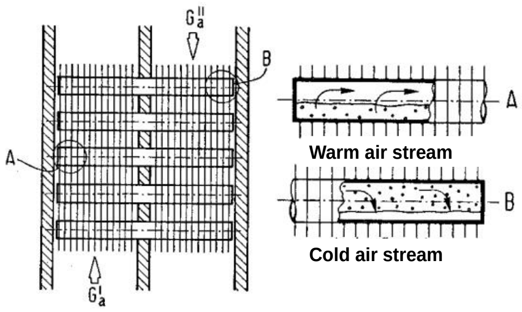
A recent type of plate heat exchanger is the counter-flow plate heat exchangers. This heat recovery unit allows high efficiency (nominally up to 93%). It is a very common solution for small and medium air volumes for residential or commercial applications to provide air to air heat recovery at the highest level. It could be made of plastic or aluminium.

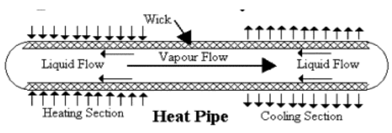
Another common heat exchanger is the heat wheel. This is very common in newer compact AHU's. This uses a large rotating wheel, half of it sits within the exhaust air stream and half of it sits within the fresh air intake. The wheel will rotate, driven by a small induction motor, as it rotates it picks up unwanted heat from the exhaust stream and absorbs this into the wheels material. The wheel then rotates into the fresh air intake stream; this air is at a lower temperature than the exhaust stream so the heat will transfer from the wheel and into the fresh air stream which obviously heats this incoming air stream up and thus reduces the demand on the heating coil. This is very effective but some air will leak from the exhaust into the fresh air stream so this can not be used in all buildings. A particular type of rotating wheel has hygroscopic material coating the wheel material so as to transfer vapour from one stream to the other. This allows the humidification of the fresh air in winter (exhaust air is at higher specific humidity than outdoor air) and dehumidification in summer time (fresh air presents higher vapour content than exhaust air).





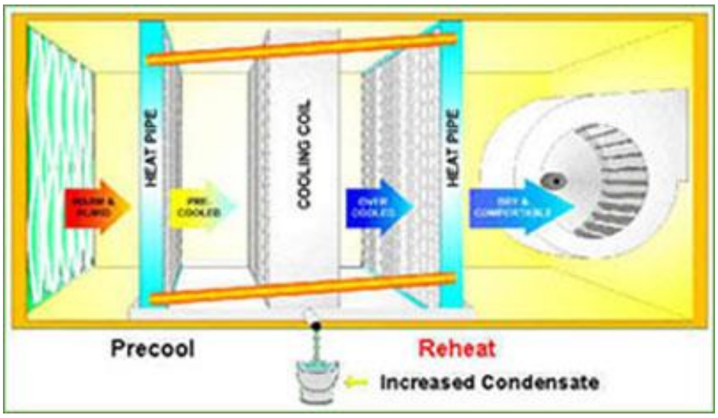
If the supply and extract AHU's are located in different areas then a common way to recover some of the thermal energy is to use a **run around coil**. This uses a coil within both supply and return AHU's which are connected via pipework. A pump circulates water (or water-glycol mixture) between the two. This will pick-up waste heat from the extract AHU and add this to the supply AHU. This will reduce the heating demand of the heating coil when the outside air temperature is lower than the return air temperature. There will be the need of an air temperature sensor in the return AHU at the entrance and it will be likely to have air temperature sensors after the return coil as well as before the fresh air inlet. These will be used to control the pump as well as measure the effectiveness. As the pump will consume electricity, it is only cost effective to turn on if the energy saved is more than the pump would consume.





Another possibility is to use heat pipes to transfer the heat from the warm air stream (where evaporation inside the heat pipe occurs) to the cold air stream (where condensation occurs within the heat pipe).

The heat pipe can be also used in warm and humid climates to increase the efficiency in removing the vapour from fresh air (HPD, Heat Pipe Dehumidifier). The heat pipe is designed to have one section in the warm incoming stream and the other in the cold outgoing stream. By transferring the heat from the warm incoming air to the cold outgoing supply air, the heat pipes create the double effect of pre-cooling the air before it goes to the evaporator and then re-heating it immediately. Activated by temperature difference and therefore consuming no energy, the heat pipe, due to its pre-cooling effect, allows the evaporator coil to operate with lower peak cooling capacity, once fixed the moisture removal capability. The re-heat is usually necessary, hence the re-heating effect is obtained for free.



The last system which can be used as heat recovery unit is a heat pump, which is also known in the market as thermodynamic heat recovery unit. It is basically a heat pump evaporating cooling the exhaust air stream and condensing in the fresh air. There is no cross contamination, since the two fluxes are separated. The original systems are not equipped with a plate heat exchanger; usually the heat pump is used to supply air at temperature greater than 20°C. in this case the heat recovery can be considered as the heat which allows the fresh air temperature to increase from outdoor value to 20°C. In this case an equivalent efficiency of about 50% can be considered. Today a plate heat exchanger is also proposed by some manufacturers before the condenser of the heat pump, increasing the overall efficiency of the machine.