



HVAC Processes

Lecture 7

Targets of Lecture

- General understanding about HVAC systems:
 - Typical HVAC processes
 - Air handling units, fan coil units, exhaust fans
 - Typical plumbing systems
 - Transfer pumps, sump pumps, water tanks
 - Typical chilled water systems
 - Chillers, secondary pumps, HEX systems
 - Field equipment
 - Sensors, valves, actuators, relays, variable frequency drives



What is HVAC?

- Heating, Ventilation, Air conditioning
- Controls temperature, humidity and air quality inside a building
- Especially important in medium to large buildings such as office/residential towers
- All preferably integrated into one system
- In warm climates usually no need for a heating system

Heating

- Central heating often used in cold climates to heat private houses and public buildings
- Heating systems usually comprise of a boiler, furnace, heat pump or district hot water to heat water, steam or air
- Piping distributes heated fluid and radiators transfer this heat to air and structures, e.g. floor heating system

Ventilation

- The process of "changing" or replacing air in any space to control temperature or remove moisture, smoke, carbon dioxide, etc
- Ventilation includes both the exchange of air to the outside as well as circulation of air within the building
- One of the most important factors for maintaining acceptable indoor air quality in buildings
- Supply air used for ventilation is filtered and cooled and/or heated inside air handling units

Air conditioning

- Refers to the cooling and dehumidification of indoor air for thermal comfort
- Air conditioning systems are designed to stabilise the air temperature and humidity within an area
- Excess heat from the circulating air is usually removed by a cooling coil that is supplied with cold water
- To decrease relative humidity the circulating air needs to be cooled to a temperature below the dew point and then heated back to meet the requirement

Major terms

- Air handling unit (AHU) – a central unit consisting of a blower, heating and cooling elements, filters, etc. that are in direct contact with the airflow
- Chiller – a device that removes heat from a liquid. The cooled liquid flows through pipes and passes through coils in air handling units, FCUs, etc
- Coil – equipment that performs heat transfer inside an AHU etc.
- Damper – a plate or gate placed in a duct to control airflow



Major terms

- Fan coil unit (FCU) – a small terminal unit that is often composed of only a blower and a cooling coil
- Variable air volume (VAV) – an HVAC system that has a stable supply air temperature and varies the airflow rate with dampers and adjusting fan speeds to meet the temperature requirements



Typical HVAC processes - AHU

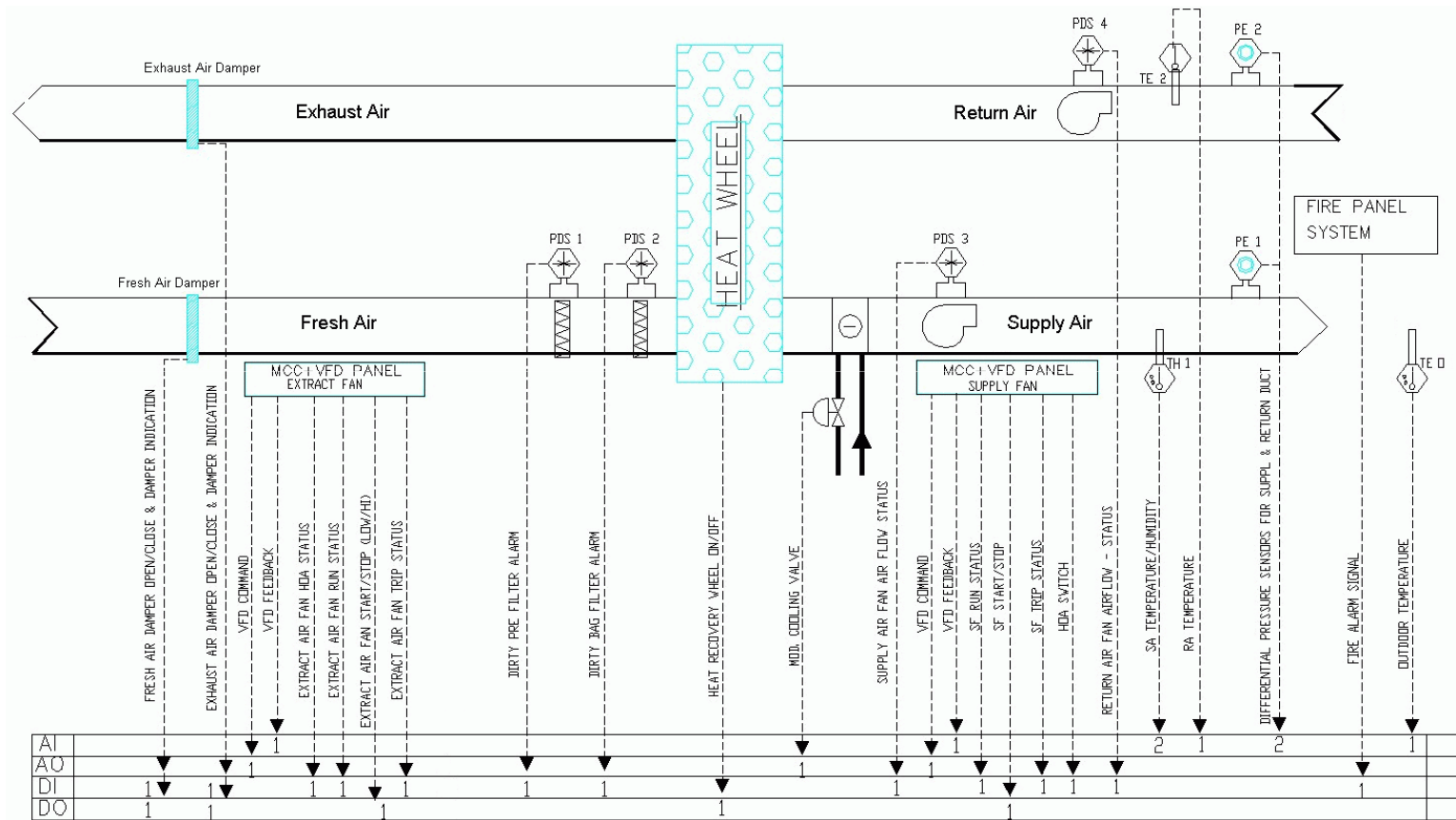
- Air handling units are used for circulating air inside a building or a part of a building
- Typically consists of two fans (exhaust and supply), filters, a heat recovery unit, and one or more coils for heating/cooling
- To improve air quality circulating air is mixed with fresh air
- Usually equipped with a heat recovery unit for energy saving purposes
- Supply air temperature kept constant so that temperature can be adjusted locally with thermostats

Typical HVAC processes - FAHU

- Fresh air handling units are used for supplying fresh air inside a building or part of a building
- Indoor air quality is improved as the serving area is treated with 100% fresh air
- Usually takes more energy to heat/cool fresh air to target temperature
- Usually equipped with a heat recovery unit for energy saving purposes
- Can also be used for supplying precooled air for FCUs



FAHU Control Diagram



Typical HVAC processes – Exhaust fans

- Used for extracting air from the building or part of a building
- Ventilated areas are usually toilets, kitchens and other areas where fumes should be extracted directly outside
- Parking areas are usually equipped with exhaust fans that are controlled according to carbon monoxide measurements or time schedules

Typical HVAC processes – FCUs

- Fan coil units are used for cooling purposes in small areas
- Consist of a blower and a cooling coil
- Can either circulate the air inside the serving area or are supplied with precooled air from an air-handling unit
- Controlled with a Lonix room module and a thermostat for local setpoint adjustment



Typical HVAC processes - VAV

- Variable air volume systems are used for controlling the air flow of constant temperature in different parts of the building
- Dampers inside ducts regulate the flow of air to different serving areas
- Pressure difference measurements accross supply and exhaust fans are used for maintaining a constant pressure inside ducts
- Thermostats inside serving areas are used for local setpoint adjustments that affect the air flow through dampers



Typical plumbing processes – Transfer pumps

- Transfer pumps are used for pumping liquid from one place to another
- In residential and office buildings they are typically used for maintaining adequate supply of water in water tanks
- Usually On/Off controlled according to liquid level switches



Typical plumbing processes – Booster pumps

- Booster pumps are used in applications where the normal system pressure is low and needs to be increased
- Typical in high rise buildings where domestic water pipeline pressure needs to be high to better serve tenants in the upper floors
- Pipeline usually divided into a high and low pressure zone (lower and higher floors)
- Either PRV or VSD controlled

Typical plumbing processes – Sump pumps

- Sump pumps are used to remove water that has accumulated in a sump pit
- Sump pumps are usually controlled with two level switches: higher switch for indicating when the pump should start and a lower switch for indicating when the pump should stop
- Pump should not be let run dry so the lower level switch should be above the pump, upper level switch should be located near the top



Typical plumbing processes – Water tanks

- Water tanks are used for storing e.g. domestic water in high rise buildings
- High and low level switches are used for alarming and controlling transfer pumps
- More accurate level indication can be obtained with a pressure difference transducer



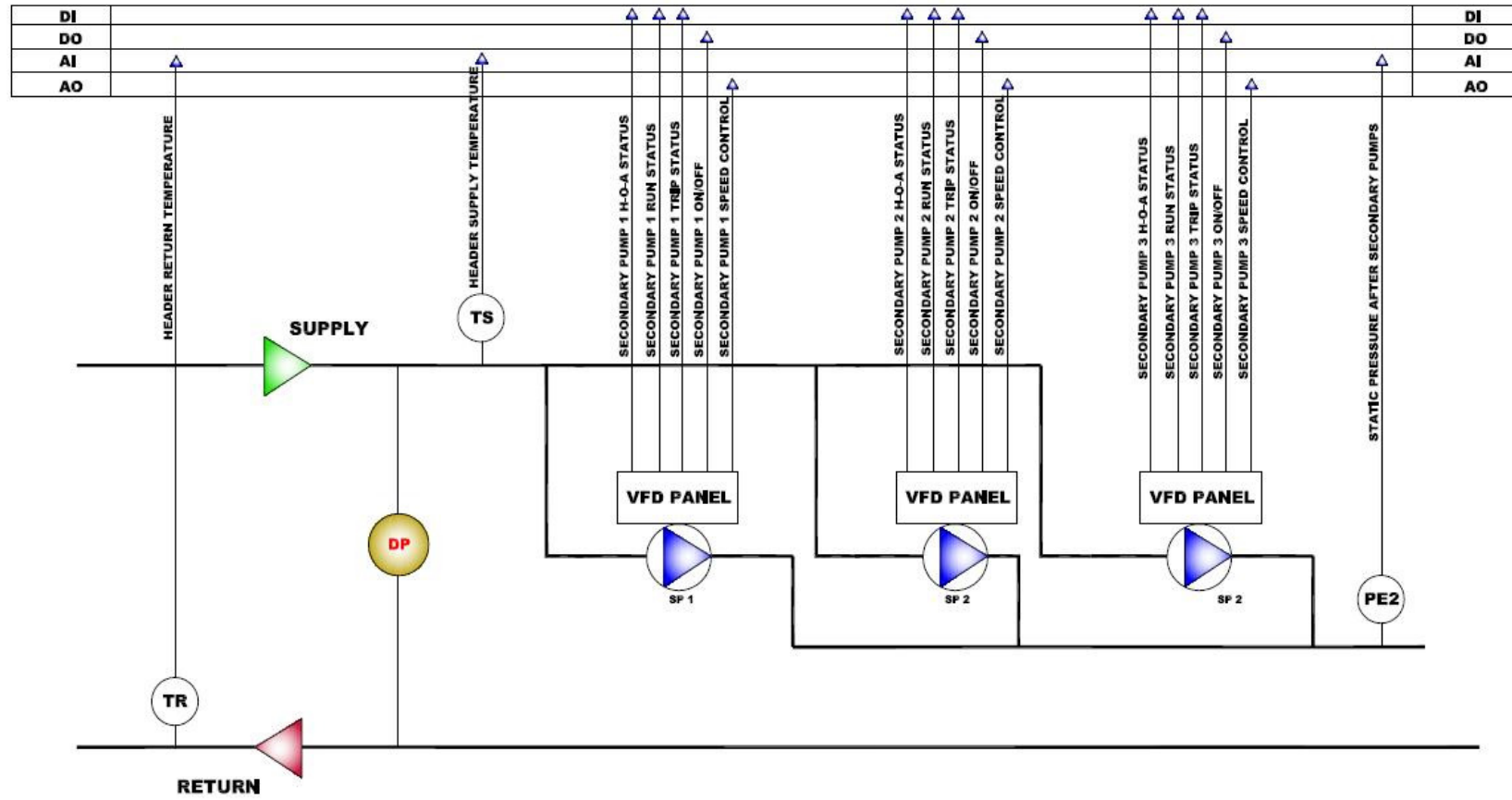
Typical chilled water processes – Chillers

- Chillers transfer heat from a liquid to the surrounding air
- Consist of a primary pump and a heat exchanger
- Chilled fluid is used by air handling units and FCUs to cool supply air temperature
- Usually more than one chiller is used so that some of them are on standby and are taken into use when more cooling power is needed.
- Usually controlled according to return temperature

Typical chilled water processes – Secondary Pumps

- Secondary pumps maintain adequate system pressure in a chilled water system
- Usually a pump set that consists of several pumps equipped with variable frequency drives are used
- As with chillers, when the cooling power (pressure) needed is very low only one pump should be running and the others on standby
- When more cooling is needed more pumps should be started
- Controlled according to the pressure difference between the return and supply headers

Secondary Pumps Control Diagram



SECONDARY PUMP CONTROL SCHEMATIC

Field equipment – Temperature sensors

- Different types
 - Pt1000 Resistance temperature detector (RTD)
 - Ni1000 RTD
 - Active 0-10V transducer
 - (0/4 – 20 mA transducer)
- Duct sensor mounted on duct, probe inside
- Protection pocket for measuring liquids
- Room sensors
- Outdoor



Field equipment – Pressure sensors

- Active 0-10V transducers or pressure switches
- Typically for measuring gases (ventilation) or liquids (plumbing processes)
- Sensor measures the difference between two pressures introduced as inputs to the sensing unit, for example, measuring the pressure drop across a filter in an AHU
- When selecting an appropriate transducer it is important to know the measured range

Field equipment – Relative humidity sensors

- Active 0-10V transducers
- Usually includes temperature measurement as most relative humidity sensors use temperature compensation to reach more accurate results
- In HVAC mostly used to monitor/control relative serving area humidity (measured either locally in the serving area or in the return air duct)

Field equipment – Concentration sensors

- Typically carbon monoxide (CO) or carbon dioxide (CO₂) concentrations are measured
- Active 0-10V transducers
- Carbon dioxide is a good measure of indoor air quality (if concentration exceeds 700 ppm more ventilation is needed)
- Carbon monoxide measurements are usually used in parking areas for controlling exhaust fans. In areas where people stay longer periods a limit of 25 ppm is recommended



Field equipment – Relays

- An electrical switch that is used for controlling electrical circuits with other circuits
- Usually a hard current circuit is controlled with a weak current circuit e.g. a 230Vac circuit can be controlled with 24Vdc
- Used for controlling devices that need to be powered off completely e.g. light groups, pumps, VFDs etc



Field equipment – Valves & valve drives

- Valves are used to control the flow of fluids in pipes
- Valve drives are used to open and close valves with an electrical input command (digital, 0-10V)
- Valve selection can be difficult and usually valve types need to be approved by the designer
- Valve drives are purchased from the valve manufacturer



Field equipment – Variable frequency drives

- Variable frequency drive is a system for controlling the rotational speed of an alternating current (AC) electric motor by controlling the frequency of the electrical power supplied to the motor
- In automation perspective, the speed of the electric motor can be controlled with a 0-10Vdc control signal
- In BMS, variable frequency drives are mostly used for controlling fans and pumps
- variable-frequency motors on e.g. fans save energy by allowing the volume of air moved to match the system demand

Starter panels

- Most motors (fans, pumps) are controlled through starter panels
- Connections: modules -> starter panel -> motor
- Starter panels usually include
 - Run status indication
 - Trip alarm indication (and reset)
 - H-0-A indication
 - On/Off control (power)
 - VFD control signal and feedback



Data Point Schedule

- Describes all the needed I/O points and field devices for BMS
- Very important for a project as some other documents and especially the bill of quantity (BoQ) are based on it
- Should always be kept up to date