HVAC Hacks #6:

Climate Control with Air Handling Units – Essential Tips & Rules of Thumb

An Online Continuing Education Course for Engineers

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CLIMATE CONTROL WITH AIR HANDLING UNITS - ESSENTIAL TIPS & RULES OF THUMB

Unlock the secrets of efficient climate control!

This course focuses on Air Handling Units (AHUs), the backbone of centralized HVAC systems. AHUs play a pivotal role in regulating temperature, humidity, ventilation, and air quality in buildings. In this comprehensive 6-hour course, you'll understand:

a. The Fundamentals of AHUs: Gain a solid understanding of how AHUs function and their key components.
b. Know Your Options: Choose the perfect AHU type (horizontal/vertical, blow-through/draw-through, packaged/FCU/custom units).
c. Fan Fundamentals: Select the right fan/blower and control options for optimal airflow.
d. Heating & Cooling Coils: Understand coil performance and choose the best type for efficient comfort control.
e. Filter Finesse: For optimal air quality in your project, select the right air filter (MERV rating).
f. Centralized vs. Decentralized: Decide between centralized or decentralized AHUs for energy efficiency and flexibility.
g. AHU Location and Mech. Room Planning: Plan the perfect AHU room size, layout, and location (noise isolation, ventilation, safety).
h. Fresh Air Focus: Understand DOAS benefits for fresh air ventilation and healthy indoor air quality.
i. Noise Mitigation: Apply noise control measures and acoustic design to minimize AHU and air distribution noise.

The course includes essential metrics, practical tips, and handy rules of thumb to help you make well-informed decisions and avoid costly mistakes with your AHU design.

Let's get started with essential metrics and rules of thumb.

AHU DESIGN CONSIDERATIONS

The key parameters affecting AHU design are:

a. Airflow rate (CFM)
b. Heating & cooling load (Btu/h or tons of refrigeration)
c. Space constraints (affects the design configuration)

	AHU Selection Parameters	***Rules of Thumb***
	Airflow rate (CFM)	*Influences the physical size, i.e., the length x width x height of an AHU.*
	Airflow (CFM) in cooling mode	*a. Comfort: 400 CFM per ton* *b. High Heat: >500 CFM per ton* *c. High Humidity: 350 CFM per ton*
	Airflow (CFM) in heating mode	*a. Combustion AHUs (Furnaces):* • *Natural Draft: 100 CFM per 10,000 BTU* • *Induced Draft: 130 CFM per 10,000 BTU* • *Condensing: 150 CFM per 10,000 BTU* *b. Electric AHU (Furnace): 50-70 CFM per kW*
	Ventilation rates (CFM)	*a. ASHRAE:* • *15-20 CFM per person* • *5-17 CFM/person + 0.35-0.60 CFM/ft² (varies by space type, ASHRAE 62.1)* *b. Air Changes per Hour (ACH):* • *0.5 -12 ACH (depends on space type; consult building codes).*
	Airflow (CFM) rates per square feet of floor area	*AHU CFM per square foot:* *a. Comfort: 1.0 to 1.5 CFM/sq ft.* *b. High Occupancy: 1.5 to 2.0 CFM/sq ft.* *c. High Heat: 2 to 3 CFM/sq ft.* *d. Interior: 0.5 to 1.5 CFM/sq ft.* *e. Perimeter (lots of glass): 2.0 to 3.0 CFM/sq ft.*
	Heating & cooling load	*Building heating and cooling loads vary by location, climate, construction, and usage. For conceptual design, refer to specific heat load values for the 8 climate zones in the USA.*

	AHU Selection Parameters	*Rules of Thumb*
		Building Loads (BTU/ft²) *Cooling:* *a. Zone 1 (Hottest): 50-60 (BTU/ft²)* *b. Zone 2 (Hot): 45-50 (BTU/ft²)* *c. Zone 3 (Warm): 40-45 (BTU/ft²)* *d. Zone 4 (Mixed): 30-40 (BTU/ft²)* *Heating:* *a. Zone 5 (Cold): 45-50 (BTU/ft²)* *b. Zone 6 (Cold): 50-55 (BTU/ft²)* *c. Zone 7 (Very Cold): 55-60 (BTU/ft²)* *d. Zone 8 (Subarctic): 60-65 (BTU/ft²)* ***AHU Sizing Tips:*** *Use CFM per sq ft based on space type (see previous summaries).* *a. 1-ton cooling = 12,000 BTU/hour.* *b. 1-ton cooling ≈ 400 CFM air.*
	Static Pressure	*The AHU fan size is chosen to meet CFM needs with the correct pressure, considering total static pressure (TSP) = ESP + ISP, where ESP is ductwork resistance and ISP is pressure losses in AHU components.*
	External Static Pressure (ESP)	*ESP varies with duct layout. Longer runs, smaller cross-sections, and higher air velocity increase static pressure. Typical values in inches of water gauge (in. W.G) at 1500 fpm:* *a. Ductwork: 0.10-0.15 in. WG per 100ft* *b. Fittings: +50% of ductwork pressure drop* *c. Others (silencers, coils, VAV, plenum, diffusers, etc.): 0.04-0.20 in. WG* *ESP is calculated by HVAC designers based on the plan layouts.*

	AHU Selection Parameters	*Rules of Thumb*
	Internal Static Pressure (ISP)	*ISP, typically provided by the AHU supplier. Typical values in inches W.G @500 fpm face velocity are provided below:* *a. Filters:* • *Pre-filter: 0.1 - 0.3 in W.G.* • *Fine filter: 0.2 - 0.5 in W.G.* *b. Coils:* • *Heating Coil: 0.3 - 0.7 in W.G.* • *Cooling Coil: 0.5 - 1.0 in W.G.* *c. Other components:* • *Heat Recovery Device: 1.0 - 2.0 in W.G.* • *Humidifier: 0.1 - 0.3 in W.G.* • *Silencer: 0.3 - 1.0 in W.G.* *Consider additional static pressure for high-efficiency filters, reheaters, dampers, mixing boxes, inlet louvers, and other AHU components.*
	Performance Standards	*ASHRAE Std 70, ASHRAE Std 90.1, ASHRAE Std 62.1, ASHRAE Std 52.2, AHRI Std 430, Euro vent Certification.*

AHU DESIGN CONFIGURATIONS

	AHU Configuration	*Rules of Thumb*
	100% Makeup AHU	*Brings in all fresh air from outside, with no room for air recirculation.*
	Recirculation type AHU	*Mixes fresh outdoor air with conditioned return air from the space (typically 15 to 20%).*
	Draw-Through AHU	*Draws air through filters and coils. The fan is positioned after the coil.*
	Blow-Through AHU	*Forces air through filters and coils. The fan is positioned before the coil.*
	Horizontal AHUs	*Horizontal AHUs offer easier access. Typically used in large commercial spaces.*
	Vertical AHUs	*Stand upright, common for smaller applications or where space is limited.*
	Package Type AHUs	*Pre-assembled, self-contained units with all components integrated.*
	Terminal AHUs (FCUs)	*Smaller units are designed for single-zone applications and provide individual control.*

	AHU Configuration	*Rules of Thumb*
	Large Custom-Built AHUs	*Designed and built for large and specific projects such as hospitals, industrial facilities, and data centers.*
	Dedicated Outdoor Air System (DOAS)	*DOAS conditions only outdoor air for distribution to multiple zones.*
	Pool Dehumidification AHUs	*Specialized units for removing moisture from indoor pool environments.*
	Laboratory AHUs	*Prioritize high-efficiency HEPA filtration and precise temperature, humidity, and pressure control systems for specific needs.*
	Explosion-Proof AHUs	*It is constructed for safety in environments with explosion hazards, such as paint booths, flammable material storage areas, oil and gas facilities, etc.*

KEY COMPONENTS – FANS & BLOWERS

	Fans & Blowers	*Rules of Thumb*
	Fan selection criteria	*AHU Fan Selection:* *Airflow (CFM): Start with 1 CFM per square foot of floor area and adjust for building type.* *Static Pressure: Match fan curve to system pressure requirements, i.e., resistance from ductwork + AHU components.* *Efficiency: Prioritize high-efficiency fans (backward curved airfoil) for lower energy use.* *Speed & Noise: Consider noise limitations, lower speed fans are generally quieter.* *Application: Choose fans suited for the pressure range (e.g., forward-curved up to 3" W.G., backward-curved up to 5" W.G., and backward-inclined up to 8" W.G. pressure).*
	Centrifugal fans	*They are commonly used in AHUs for their high-pressure handling (up to 10" WG) and moderate-to-high airflow (up to 100000+ CFM). They come in various blade designs, such as forward-curved, backward-curved, radial, and airfoil.*
	Forward curve fans	*Blades curve in the direction of wheel rotation.*

	Fans & Blowers	*Rules of Thumb*
		a. *High airflow, low pressure (typically 1 - 3 in. W.G pressure).* b. *Least efficient and noisy.*
	Backward curve fans	*Blades curved opposite to wheel rotation.* a. *Backward curved: High efficiency (up to 84%), good for medium pressure, typically 2 to 5 in. W.G. Runs a quiet, non-overloading horsepower curve.* b. *ckward inclined: Simil… backward curved but …lly 4 – 8 in. W.G.*
	R…	*…n shaft.* *…mpared to forward-…ns.* *…l fans. Requires …ame air volume as*
	Aerof…	*…ressure* *…industrial clean …ency.*
	Axial fan…	*…r low-pressure* *…CFM and 0.1 - 2 in. WG …ssure.* b. *Application: Supply and exhaust ventilation.*
	Fan performance laws	*Higher airflow (CFM) typically comes with lower static pressure (W.G.) and vice versa.* a. *Airflow (CFM) varies directly with fan speed (RPM), double speed = 2x CFM* b. *Pressure (in-WG) varies with the square of fan speed (double speed = 4x pressure).*