



HVAC SYSTEMS - CEM REFRESHER ONLINE TRAINING COURSE

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ENERGY SPECIALIST CURRICULUM





TYPES AND FUNCTIONS OF HVAC SYSTEMS FOR ENERGY PROFESSIONALS

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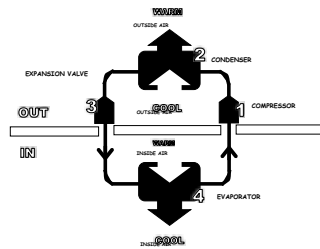
WHAT SHOULD YOU LEARN





- Introduction to vapor compression cycle
- HVAC Systems Performance Measures
- Sensible and latent Heat
- Systems improvement options

VAPOR COMPRESSION CYCLE

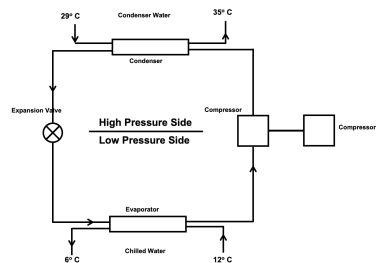


HRU - DESUPERHEATER

✓ Adding a small plate and frame heat exchanger into this system allows heat recovery from the 85 degree C hot refrigerant gas coming out of the compressor. Cold water (10 -20 degrees) goes through the other side of the HRU, and is heated to 55 to 65 degrees C.

✓ The amount of heat recovery is about 1300 kJ/h per kW of capacity of the AC unit or air cooled chiller.

DIAGRAM OF A TYPICAL CHILLER



HVAC SYSTEM PERFORMANCE MEASURES



Energy Efficiency Ratio (EER)

$$\begin{aligned} \text{EER} &= \frac{\text{kJ of cooling output}}{\text{Wh of electric input}} \\ &= \frac{\text{kJ/h of cooling output}}{\text{W of electric power input}} \end{aligned}$$

Coefficient of Performance (COP)

$$\text{COP} = \frac{\text{EER}}{3.6 \text{ kJ/Wh}}$$

$$\text{kWin} = 3.6 / \text{EER} =$$



SOME MAGIC NUMBERS FOR EER AND COP



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$$\text{kWin} = 3.6 / \text{EER} = 1 / \text{COP}$$



EXAMPLE



1. A 30 kW cooling roof top A/C unit has an EER of 7.2. What is its COP?
2. A 30 kW cooling roof top A/C unit has an EER of 7.2. What is its kW input load at full capacity?
3. A 30 kW cooling roof top A/C unit has an EER of 8.5. What is its COP?
4. A 30 kW cooling roof top A/C unit has an EER of 8.5. What is its kW input load at full capacity?



HEATING SEASONAL PERFORMANCE FACTOR



✓ For heating with an electric heat pump, the test is conducted at a different temperature than for the SEER, and this performance measure is called the HSPF – the Heating Seasonal Performance Factor.

✓ A typical electric heat pump may have an HSPF of 8.65, and an SEER of 11.6. Corresponding to the HSPF of 8.65 is the heating COP of 2.4.



SENSIBLE AND LATENT HEAT



✓ Sensible heat - The heat associated with a temperature change of a substance at a constant moisture level.

✓ Latent heat - The heat associated with the phase change of a substance.

✓ Enthalpy - Total heat content of a substance, including both sensible heat plus latent heat.



SYSTEM IMPROVEMENT OPTIONS



✓ Make building envelope improvements to reduce HVAC load

- insulation, high performance windows and roofs

✓ Replace old HVAC units and chillers with more efficient models

✓ Possibly downsize units and chiller

- Energy Star (US) and ASHRAE say chillers are oversized 60% in US.



EUI COMPUTATION EXAMPLE +



This value of 1400 MJ/square metre/year is larger than the EUI for an average US building of 850 MJ/square metre/year, and also larger than the average EUI for a US office building of 905 MJ/square metre/year.

US National average information on the Energy Use Index for different types of commercial buildings is shown on the next slide.

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CBECs EUI DATA - USA MJ/M2/YR



All Bldgs	850		
Education	750	Vacant	160
Food Sales	2020	Food Service	2410
Health Care	1765	Lodging	1000
Retail Stores	720	Office	905
Assembly	820	Safety	870
Churches	320	Service	1245
Warehouse	440	Other	1440

ENERGY COST INDEX



The EUI has some fairly obvious limitations.

Problem with mix of fuel and electricity

Looks only at site energy - not source energy

With site energy, 1 kWh is valued at 3.6 MJ, but back at the thermal power plant, it took around 11-12 MJ of primary energy to produce the 3.6 MJ value of that 1 kWh