NRGY 235: Building Energy Efficiency
Week 13 Quiz

1. What is the minimum AFUE standard imposed by the US government for all residential furnaces and boilers sold for homes (excluding mobile homes) today?
    a) 78%
    b) 68%
    c) 84%
    d) 92%
2. What is the minimum SEER standard imposed by the US government for all split systems DX A/C and air-source heat pump systems sold for homes (excluding mobile homes) today?
    a) SEER = 13
    b) SEER = 18
    c) SEER = 9
    d) SEER = 3.412
3. Choose the list of systems that would result in the highest overall efficiency.
    a) Boiler (AFUE = 86%) and radiant floor system, SEER = 13 DC A/C, Exhaust fan to provide 60 CFM continuous ventilation rate
    b) Furnace (AFUE = 84%) with DX A/C (SEER = 16) and Exhaust Fan to provide 60 CFM continuous ventilation rate
    c) Furnace (AFUE = 78%) with DX A/C (SEER = 18.8) and Exhaust Fan to provide 120 CFM ventilation rate @ 50% runtime
    d) Boiler (AFUE = 84%) and radiant floor system, no mechanical cooling, HRV and Economizer bypass to provide 60 CFM continuous ventilation rate, and Economizer cooling when desired
4. People sometimes say that heat pump systems are more than 100% efficient. I don't like that way of stating their performance. I don't use the term "efficiency" in this case, I choose "performance" or simply use the term for the specific metric such as EER or COP. The notion of > 100% "efficiency" comes from a direct conversion of EER to a ratio of equivalent units, or of COP to a percentage. For instance, and EER of 12 BTU/Wh, when converted to units of BTU/BTU is a ratio equal to 352% (COP = 3.5). In both cases these are ratios of the heating or cooling output to the electrical energy input. How can it be that these performance ratios are greater than 100%? Doesn't that violate a fundamental law of thermodynamics: can can't get more energy out than you put in? Choose the best explanation,
    a) Since COP and EER are ratios of heating energy output to electrical energy input, they ignore the non-electrical energy input to the system in

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the form of the heat that is taken from the ground or air (depending on whether the heat pump is a geothermal or air-source type). If one were to take the ratio of total heating or cooling energy output to the total energy input (electric and ground/air source heat), then the ratio would be less than 100% and would thus not violate the laws of thermodynamics.

b) There is no conflict here. There is nothing in the laws of thermodynamics that says you can't get more energy out of a closes system than enters the closed system. It is entirely possible for energy to be created within the closed system.

c) COP cannot be greater than 1 (COP = 1 is the COP of electric resistance which has an efficiency of 100% and is the highest possible efficiency), and you cannot have any EER > 3.412 which is equal to a COP = 1. Reports of EER > 3.412 or COP > 1 are false

d) This is a stupid question, far too long, and you need to find better things to do with your life.

5. According to the IECC 2012 energy code as adopted and amended by the state of MT, if the continuous ventilation rate for a home is 80 CFM based on the square footage of the home and the number of bedrooms, which choice below does NOT satisfy the requirement?

a) Run a 100 CFM exhaust fan for 20 hours per day
b) Run a 320 CFM exhaust fan for 15 minutes of every hour
c) Install an HRV that moves 40 CFM of supply air and 40 CFM of exhaust air
d) Run a 160 CFM exhaust fan for 30 minutes of every hour

6. What are pneumatic controls in the context of a building controls system?

a) Controls where the signal between control elements is a pressure signal transmitted by a light hydraulic oil in the lines
b) Older type electro-mechanical controls that consist mainly of line-voltage and low-voltage relays powered off of transformers
c) Controls where the signal between control elements is an air pressure signal
d) Controls that are specifically responsible for maintaining appropriate static pressure offsets between rooms in a building such as keeping Operating Rooms in a hospital at positive static pressure relative to adjacent areas

7. What does DDC stand for in the context of building HVAC and controls systems?

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a) Direct Drive Coupled – a specific type of coupling between a motor shaft and fan or pump shaft that is needed in variable speed systems
b) Directional Diode Control – a binary electronic filter circuit that passes signals based on specific conditions
c) Direct Digital Control – a specific type of electronic controls system that is based on network of controls elements that can communicate to one another to pass inputs, or commands (outputs) based on programmed logic
d) Dual Direction Cam – a specific type of actuator that efficiently strokes air handler dampers with high precision

8. In a Demand Controlled Ventilation controls strategy, if the CO_2 level measured in the return of air at an air handler rises above a setpoint of 1,000 PPM, how will the controls and air handler mechanical parts respond?
   a) CO_2 over 1,000 PPM indicates a high occupancy or inadequate ventilation rate for the given level of occupancy. The air handler supply fan should speed up to provide more total airflow. To avoid introducing too much potentially too-cold outside air that could freeze a heating or cooling coil, the outside air damper should modulate more closed as the fan speeds up to avoid bringing in too much outside air.
   b) CO_2 over 1,000 PPM indicates a malfunction of the furnace burner. The burner gas valve will shut, and the igniter will be locked out.
   c) CO_2 over 1,000 PPM indicates a high occupancy or inadequate ventilation rate for the given level of occupancy. The air handler air damper should modulate further open to provide more fresh air for ventilation.
   d) CO_2 over 1,000 PPM indicates that too much outside air is being introduced to the space, which bring an energy penalty due to the need to heat or cool the extra outside air. The air handler outside air damper should modulate to a more closed position to provide only the fixed minimum of outside air for ventilation.
9. If a centrifugal fan is slowed down to 75% speed, approximately (theoretically) how much power will the fan motor draw as a fraction of the power draw at 100% speed?
   a) 133%
   b) 50%
   c) 1.8
   d) 42%
10. What is a good Energy Conservation Measure (ECM) for a system of a boiler

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and hot water radiant heating terminal systems (e.g. radiant floor, radiant baseboard)?

a) Allow the boiler to make a higher HW supply temperature at night when space temperature setpoints are setback and there is less demand for heat. Then the system can coast longer through the morning when the setpoints go back to normal daytime setpoints.
b) Install a larger pump to increase the flow rate of hot water so that the temperature differential between entering and leaving ports of each radiant system is lower.
c) Control the boiler to make a lower HW supply temperature when the outside air temperature is colder.
d) Control the boiler to make a higher HW supply temperature when outside air temps are lower, and vice versa.

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