Construction and Industry

Certified-Energy-Manager
Certified Energy Manager (CEM®) exam

Product Version

Latest Version: 6.0

Question: 1

How much waste heat is recovered from a process that reduces the temperature of hot water flowing at 20 gallons per minute from 200CF to 140CF?

A. 542,900 Btu/hour
B. 570,100 Btu/hour
C. 586.020 Btu/hour
D. 600,480 Btu/hour

Answer: D

Explanation:
The amount of waste heat that is available is calculated by:

$$q = \dot{m} \times C_p \times \Delta T$$

Where m is the mass flow rate and Cp is the specific heat. The mass flow rate is:

$$20 \text{ gpm} \times 8.34 \frac{\text{lb}}{\text{gallon}} \times 60 \frac{\text{minute}}{\text{hour}} = 10{,}008 \frac{\text{lb}}{\text{hour}}$$

$$q = 10{,}008 \times 1 \times (200 - 140) = 600{,}480 \frac{\text{Btu}}{\text{hour}}$$

Question: 2

To recover waste heat from a liquid, which of the following technologies should be used?

A. Recuperator
B. Shell and tube heat exchanger
C. Heat pipe
D. Heat wheel

Answer: B

Explanation:
A shell and tube heat exchanger can be used to recover heat from a liquid. The other technologies recover heat from gases.

Question: 3

During a compressed air system audit, a pressure drop of 20 psi was observed over 15 minutes. The system operates at 110 psi and has a total volume of 400 cubic feet. Calculate the average leakage rate in the system.

A. 36 cfm
B. 40 cfm
C. 42 cfm
D. 46 cfm

Answer: A

Explanation:
The leakage rate in a compressed air system is given by:

$$Leakage\ Rate = \frac{V \times \Delta P}{T \times 14.7} = \frac{400 \times 20}{15 \times 14.7} = 36 \text{ cfm}$$

Question: 4

A building is heated with a boiler that has an efficiency of 85%. Last year there were 4,000 heating degree-days and the total natural gas consumption was 500 Mcf. What is the Building Load Coefficient (UA)? (Assume 1 Mcf = 1,037,000 Btu)

A. 4,037
B. 4,591
C. 5,401
D. 6,354

Answer: B

Explanation:
The annual fuel demand for a building can be calculated by:

$$Fuel\ Demand = \frac{BLC \times 24 \times DD}{\eta \times CF}$$

Where DD is the number of degree-days, η is the efficiency, and CF is the fuel conversion factor, in this case Btu/Mcf. Therefore, the BLC can be calculated by:

$$BLC = \frac{500 \text{ Mcf} \times 0.85 \times 1{,}037{,}000 \frac{\text{Btu}}{\text{Mcf}}}{24 \times 4{,}000} = 4{,}591$$

Question: 5

What is the rate of heat loss per square foot through a 4-inch cinderblock wall when the internal temperature is 690F and the outside temperature is 370F?

Assume:

Masonry block conductance $= 0.90 \frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2\cdot{}^\circ\text{F}}$

Inside air film resistance $= 0.68 \frac{\text{hr}\cdot\text{ft}^2\cdot{}^\circ\text{F}}{\text{Btu}}$

Outside air film resistance $= 0.17 \frac{\text{hr}\cdot\text{ft}^2\cdot{}^\circ\text{F}}{\text{Btu}}$

a. $16.3 \frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2}$

b. $18.3 \frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2}$

c. $56.0 \frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2}$

d. $264.1 \frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2}$

Answer: A

Explanation:
The rate of heat loss through a building element is given by:

$$q = U \times A \times \Delta T$$

The conductance, U, is the reciprocal of the sum of the resistances:

$$U = \frac{1}{R_1 + R_2 + R_3 + \cdots} = \frac{1}{0.68 + \frac{1}{0.9} + 0.17} = 0.51$$

Therefore,

$$\frac{q}{A} = 0.51 \times (69 - 37) = 16.3 \frac{\text{Btu}}{\text{hr} \cdot \text{ft}^2}$$

Question: 6

Which of the following statements is true of thermally heavy buildings?

A. The R2 value in a regression analysis of fuel consumption vs. degree days is generally higher than 0.8.
B. They heat up and cool down quickly
C. Less energy savings can be expected when the Building Load Coefficient (UA) is improved through building fabric upgrades
D. They are made of materials with low specific heat capacity

Answer: C

Explanation:
Thermally heavy buildings have a high thermal mass, which is achieved by using materials that are dense, have a relatively high specific heat capacity, and moderate thermal conductivity. This enables them to store heat during the day and release it gradually at night. They tend to maintain a relatively constant temperature, so the heating and cooling demands of these buildings is less affected by fluctuations in weather conditions.

Question: 7

What is the heating load required in Btu/hour to heat 5,000 cfm of outside air at 530F and 80% relative humidity to 730F?

A. 86,100 Btu/ hour
B. 112,500 Btu/hour
C. 167,300 Btu/hour
D. 222,900 Btu/hour

Answer: B

Explanation:
The Btu/hour heating load is calculated by:

$$q = \text{cfm} \times 4.5 \times \Delta h$$

The enthalpy of air at 53°F and 80% RH is found on a psychrometric chart to be 20 Btu/lb. The enthalpy of the air increases to 25 Btu/lb at 73°F. Therefore:

$$q = 5{,}000 \times 4.5 \times (25 - 20) = 112{,}500 \text{ Btu/hour}$$

Question: 8

Which of the following statements regarding net zero energy buildings is true?

A. Net zero energy buildings do not need to purchase electricity from the grid
B. There are no net greenhouse gas emissions from net zero energy buildings
C. All the energy used in a net zero energy building is produced using renewable sources
D. Net zero energy buildings generate at least as much energy as they use each year

Answer: D

Explanation:
Net zero energy buildings are constructed to be very energy efficient so that their annual energy demands are low. The energy needs are met through utility connections and on-site generation from renewable energy sources such as solar (PV panels). Over the course of a year, the on-site renewable generation is at least as much as the energy that is imported.

Question: 9

Which of the following is not a financial mechanism commonly employed by utilities to encourage the development of distributed energy technologies?

A. Net metering

B. Power-Purchase Agreement
C. Energy performance contract
D. Rebate

Answer: C

Explanation:
Energy performance contracts can be used to finance distributed energy projects, but they are not usually offered by utilities for this purpose. An energy performance contract will generally be focused on energy efficiency improvements with some form of financial and performance risk sharing mechanism.

Question: 10

Calculate the annual heating cost savings per square foot for a facility that adds insulation which drops the overall U-value of the building from 0.25 to 0.18. The heating system is a natural gas boiler with an efficiency of 85%, the cost of gas is $8.50/Mcf, and there are 5,000 heating degree days each year. (Assume 1 Mcf = 1,037,000 Btu)

A. SO.048/ft2
B. SO.053/ft2
C. SO.069/ft2
D. SO.081/ft2

Answer: D

Explanation:
The annual heating system energy is calculated by:

$$q = U \times A \times 24 \times HDD$$

Therefore, the annual energy savings per square foot are:

$$\frac{q}{A} = (0.25 - 0.18) \times 24 \times 5{,}000 = 8{,}400\ \frac{\text{Btu}}{\text{ft}^2}$$

The cost savings are:

$$Savings\left(\frac{\$}{\text{ft}^2}\right) = \frac{8{,}400\ \text{Btu}}{0.85\ \text{ft}^2} \times \frac{1\ \text{Mcf}}{1{,}037{,}000\ \text{Btu}} \times \frac{\$8.50}{1\ \text{Mcf}} = \$0.081\ \text{per ft}^2$$

Question: 11

The results of an efficiency test of a natural gas fired boiler indicate 8% of the flue gas is oxygen and the stack temperature is 6200F with a combustion air inlet temperature of 7 OOF. If the amount of combustion air to the boiler is adjusted so that only 3% oxygen is present in the flue gas, what is the potential boiler efficiency improvement?

A. 3%

B. 4%
C. 5%
D. 6%

Answer: B

Explanation:
The stack temperature rise is 6200F - 700F = 5500 F. A combustion efficiency chart for natural gas shows that at 8% flue gas oxygen the efficiency is 76%. When the flue gas oxygen is reduced to 3%, the efficiency when the stack temperature rise is 5500F is 80%. Therefore, there is a 4% improvement in efficiency.

Question: 12

A natural gas fired boiler operates with a combustion air inlet temperature of 80CF with flue gas at 7300F and 3% flue gas oxygen. It is proposed that an economizer be installed that will reduce the flue gas temperature to 6300F. The annual gas consumption of the boiler is 7,000 Mcf and gas costs $8.00/Mcf. What are the expected fuel cost savings by installing the economizer?

A. SI,400/year
B. Sl,650/year
C. Sl,825/year
D. S2,030/year

Answer: A

Explanation:
The stack temperature rise is 7300 F - 800F = 6500 F. A combustion efficiency chart for natural gas shows that at 3% flue gas oxygen the efficiency is 78%. When the flue gas temperature is decreased to 6300F, the stack temperature rise is reduced to 5500F and the efficiency is 80%. The percentage of fuel savings is calculated by:

$$Fuel\ Savings = \frac{New\ Efficiency - Old\ Efficiency}{New\ Efficiency} = \frac{80 - 78}{80} = 2.5\%$$

Therefore, the savings are $2.5\% \times 7{,}000\,\frac{\text{Mcf}}{\text{year}} = 175\,\frac{\text{Mcf}}{\text{year}}$

and $175\,\frac{\text{Mcf}}{\text{year}} \times \$8.00 = \$1{,}400$ per year in fuel cost savings.