This problem corresponds to MEHRPE2 problem number 28.

❮ Return to Questions (/admin/questions/0?sfield=magento_id&stext=0000004604&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

To reduce the load on a chiller plant, an air washer recirculates water that is at 57°F and uses evaporation to precool outdoor air at a rate of 20,000 ft^3/min. The outdoor air is introduced at 92°F dry-bulb temperature and 57°F wet-bulb temperature. The density of the air is 0.075 lbm/ft^3. The saturation efficiency of the process is 84%. The cooling requirement reduction is most nearly

Answers

(A) 45 tons

(B) 49 tons

(C) 53 tons

(D) 63 tons

The answer is (C).

Solution

Content in blue refers to the NCEES Handbook.

The saturation efficiency for an air washer describes the extent to which the dry-bulb temperature is reduced to the theoretical minimum wet-bulb temperature.

Direct Evaporative Air Coolers

$$\epsilon_e = (100)\,\frac{T_1 - T_2}{T_1 - T_s'}$$

T_1 is the dry-bulb entering, T_2 is the dry-bulb leaving, and T_s is the thermodynamic wet-bulb entering. The leaving dry-bulb temperature for this process is

$$\begin{aligned} T_2 &= T_1 - \epsilon_e\,(T_2 - T_s') \\ &= 92^\circ\text{F} - (0.84)\,(92^\circ\text{F} - 57^\circ\text{F}) \\ &= 62.6^\circ\text{F} \end{aligned}$$

The sensible precooling benefit is

$$\begin{aligned} q_{\text{sensible}} &= \dot{m}c_p\,(T_1 - T_2) \\ &= \dot{V}\rho c_p\,(T_1 - T_2) \\ &= \left(20{,}000\ \frac{\text{ft}^3}{\text{min}}\right)\left(60\ \frac{\text{min}}{\text{hr}}\right)\left(0.075\ \frac{\text{lbm}}{\text{ft}^3}\right) \\ &\quad \times \left(0.24\ \frac{\text{Btu}}{\text{lbm-}^\circ\text{F}}\right)(92^\circ\text{F} - 62.6^\circ\text{F}) \\ &= 635{,}040\ \text{Btu/hr} \end{aligned}$$

Chiller loads are typically expressed in units of tons of refrigeration. [Measurement Relationships]

QUESTION DATA

Vendor
0000004604

Solving Time

Difficulty
easy

Quantitative?
Yes

Status
Active

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08/27/2020 10:23:08 PM

OTHER VERSIONS

10/23/2019 08:12:52 P (/admin/questions/pre

05/06/2020 01:28:30 P (/admin/questions/pre

DISCIPLINES

FE Other Disciplines (/admin/questions/ind sfield=discipline&stext Other Disciplines)

FE Mechanical (/admin/questions/ind sfield=discipline&stext Mechanical)

PE Mechanical: HVAC a Refrigeration (/admin/questions/ind sfield=discipline&stext Mechanical: HVAC and Refrigeration)

$$q_{\text{sensible}} = \frac{635{,}040\ \frac{\text{Btu}}{\text{hr}}}{12{,}000\ \frac{\text{Btu}}{\text{hr-ton}}} = 52.92\ \text{tons} \quad (53\ \text{tons})$$

PE Mechanical: Therma
and Fluid Systems
(/admin/questions/ind
sfield=discipline&stext
Mechanical: Thermal a
Fluid Systems)

KNOWLEDGE AREAS

Thermodynamics and
(/admin/questions/ind
sfield=area&stext=The
and Heat Transfer)

Thermodynamics
(/admin/questions/ind
sfield=area&stext=The

Psychrometrics
(/admin/questions/ind
sfield=area&stext=Psy

Supportive Knowledge
(/admin/questions/ind
sfield=area&stext=Sup
Knowledge)

PRODUCTS USED IN
PEMEHV2EX
PEMEHVQB
PEMETSQB

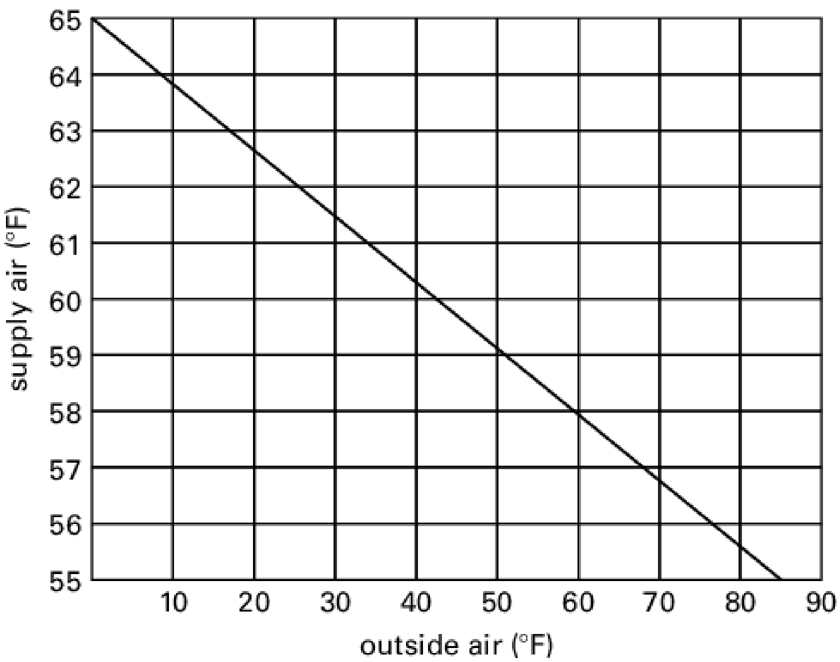
This problem corresponds to MEHRPE2 problem number 35.

Return to Questions (/admin/questions/0?sfield=magento_id&stext=0000004616&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

The reheat coil in a variable air volume terminal box is being replaced. The maximum airflow capacity of the box is 2400 ft^3/min. A minimum stop setting of 30% (of the maximum flow) has been established to maintain the required ventilation when cooling loads are at a minimum. The supply air temperature for the building system is reset with respect to the outside air temperature, according to the graph shown.



During the winter, the outdoor design temperature of 10°F and the indoor space temperature of 72°F result in a space heat loss of 45,000 Btu/hr. The minimum capacity of the reheat coil is most nearly

Answers

(A) 45,000 Btu/hr

(B) 47,000 Btu/hr

(C) 51,000 Btu/hr

(D) 66,000 Btu/hr

The answer is (C).

Solution

The reheat coil must have sufficient heating capacity to offset both the winter space heat loss and the colder supply air.

$$q_{\text{coil}} = q_{\text{space}} + q_{\text{reheat}}$$

The reheat load is given by

QUESTION DATA

Vendor

0000004616

Solving Time

Difficulty

easy

Quantitative?

Yes

Status

Active

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DISCIPLINES

PE Mechanical: HVAC a Refrigeration (/admin/questions/ind sfield=discipline&stext Mechanical: HVAC and Refrigeration)

KNOWLEDGE AREAS

Systems and Compon (/admin/questions/ind sfield=area&stext=Sys and Components)

PRODUCTS USED IN

PEMEHV2EX

PEMEHVQB

$$\begin{aligned} q_{\text{reheat}} &= \dot{m}c_p\left(T_{\text{room}} - T_{\text{supply}}\right) \\ &= Q_{\text{min}}\rho_{\text{air}}c_p\left(T_{\text{room}} - T_{\text{supply}}\right) \end{aligned}$$

The lowest airflow is the product of the minimum stop fraction and the maximum flow.

$$\begin{aligned} Q_{\text{min}} &= F_{\text{min}}Q_{\text{max}} = (0.30)\left(2400\ \frac{\text{ft}^3}{\text{min}}\right) \\ &= 720\ \text{ft}^3/\text{min} \end{aligned}$$

~~The reset chart indicates that the supply air temperature will be reset to 64°F when the outdoor temperature is 10°F.~~

$$\begin{aligned} q_{\text{reheat}} &= Q_{\text{min}}\rho_{\text{air}}c_p\left(T_{\text{room}} - T_{\text{supply}}\right) \\ &= \left(720\ \frac{\text{ft}^3}{\text{min}}\right)\left(60\ \frac{\text{min}}{\text{hr}}\right)\left(0.075\ \frac{\text{lbm}}{\text{ft}^3}\right) \\ &\quad \times \left(0.24\ \frac{\text{Btu}}{\text{lbm-}^\circ\text{F}}\right)(72^\circ\text{F} - 64^\circ\text{F}) \\ &= 6220\ \text{Btu/hr} \end{aligned}$$

The total reheat coil load is

$$\begin{aligned} q_{\text{coil}} &= q_{\text{space}} + q_{\text{reheat}} \\ &= 45{,}000\ \frac{\text{Btu}}{\text{hr}} + 6220\ \frac{\text{Btu}}{\text{hr}} \\ &= 51{,}220\ \text{Btu/hr} \quad (51{,}000\ \text{Btu/hr}) \end{aligned}$$

This problem corresponds to MEHRPE2 problem number 48.

Return to Questions (/admin/questions/0?sfield=magento_id&stext=0000004621&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

An east-facing vertical window at a latitude of 40 degrees north has an area of 12 ft^2. The solar heat gain coefficient for the window is 0.87. The overall heat transfer coefficient is 1.2 Btu/hr-ft^2-°F. The table shown gives the incident total irradiance for 40 degrees north.

	solar time	incident total irradiance (Btu/hr-ft^2)							solar time	
	a.m.	N	NE	E	SE	S	SW	W	NW	p.m.
May	0500	0	2	2	0	0	0	0	0	1900
	0600	35	127	140	70	11	11	11	11	1800
	0700	27	164	208	130	21	20	20	20	1700
	0800	26	148	218	163	30	26	26	26	1600
	0900	30	104	198	176	52	29	31	31	1500
	1000	35	53	149	164	82	34	35	35	1400
	1100	35	39	80	131	104	42	35	35	1300
	1200	38	36	41	83	112	81	39	39	1200
half day total		214	665	1023	880	357	199	175	174	
June	0500	9	20	21	5	2	2	2	2	1900
	0600	47	144	150	71	12	12	12	12	1800
	0700	36	171	206	121	21	20	20	22	1700
	0800	31	155	215	153	30	28	28	28	1600
	0900	32	113	191	160	44	33	31	31	1500
	1000	34	64	146	149	70	35	35	36	1400
	1100	37	41	80	115	89	40	39	37	1300
	1200	37	37	42	73	96	73	40	37	1200
half day total		252	735	1037	819	314	203	187	186	

QUESTION DATA

Vendor
0000004621

Solving Time

Difficulty
easy

Quantitative?
Yes

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DISCIPLINES

PE Mechanical: HVAC a Refrigeration (/admin/questions/ind sfield=discipline&stext Mechanical: HVAC and Refrigeration)

PE Mechanical: Therm and Fluid Systems (/admin/questions/ind sfield=discipline&stext Mechanical: Thermal a Fluid Systems)

KNOWLEDGE AREAS

Heating/Cooling Loads (/admin/questions/ind

On a day in May at solar time 0800, the indoor temperature is 75°F, and the outdoor temperature is 42°F. The total instantaneous heat gain for the window is most nearly

sfield=area&stext=Hea
Loads)

Cooling/Heating
(/admin/questions/ind
sfield=area&stext=Coo

PRODUCTS USED IN
PEMETSQB
PEMEHVQB
PEMEHV2EX

Answers

(A) 480 Btu/hr

(B) 1800 Btu/hr

(C) 2300 Btu/hr

(D) 2800 Btu/hr

The answer is (B).

Solution

Content in blue refers to the NCEES Handbook.

From the table, the incident total irradiance for an east-facing window in May at 0800 is

$$E_t = 218 \text{ Btu/hr-ft}^2$$

The solar heat gain coefficient, SHGC, is given as 0.87, and the overall heat transfer coefficient, *U*, is 1.2 Btu/hr-ft^2-°F. The instantaneous heat gain is

Fenestration

$$q = UA_{\text{pf}}\left(T_{\text{out}} - T_{\text{in}}\right) + (\text{SHGC})\,A_{\text{pf}}E_T \\ +C\,(\text{AL})\,A_{\text{pf}}\rho C_p\left(T_{\text{out}} - T_{\text{in}}\right)$$

No air leakage is given in the problem; assume it to be 0. The total instantaneous heat gain for the window is

$$\begin{aligned} q &= UA_{\text{pf}}\left(T_{\text{out}} - T_{\text{in}}\right) + (\text{SHGC})\,A_{\text{pf}}E_T \\ &= \left(1.2\ \frac{\text{Btu}}{\text{hr-ft}^2\text{-}^\circ\text{F}}\right)(12\ \text{ft}^2)(42^\circ\text{F} - 75^\circ\text{F}) \\ &\quad +(0.87)(12\ \text{ft}^2)\left(218\ \frac{\text{Btu}}{\text{hr-ft}^2}\right) \\ &= 1800.7\ \text{Btu/hr} \quad (1800\ \text{Btu/hr}) \end{aligned}$$

$$
\begin{aligned}
q &= UA_{\text{pf}}(T_{\text{in}} - T_{\text{out}}) + (SHCG)A_{\text{pf}}E_T \\
&\quad + C(AL)A_{\text{pf}}\rho C_p(T_{\text{in}} - T_{\text{out}}) \\
&= \left(1.2\ \frac{\text{Btu}}{\text{hr-ft}^2\text{-°F}}\right)(12\ \text{ft}^2)(75\text{°F} - 42\text{°F}) \\
&\quad + (0.87)(12\ \text{ft}^2)\left(218\ \frac{\text{Btu}}{\text{hr-ft}^2\text{-°F}}\right) + 0 \\
&= 2751\ \frac{\text{Btu}}{\text{hr}} \quad \left(2800\ \frac{\text{Btu}}{\text{hr}}\right)
\end{aligned}
$$

This problem corresponds to MEHRPE2 problem number 54.

Return to Questions (/admin/questions/0?sfield=magento_id&stext=0000004635&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

During a routine inspection, a plant engineer discovers a section of bare overhead steam pipe. Upon checking the plant's maintenance records, the engineer learns that a leaking steam trap had been repaired recently, and the saturated insulation had been removed from the pipe but never replaced. The properties of the pipe are as follows.

length of bare section	120 ft
size	1.5 in outer diameter
	1.37 in inner diameter
thermal conductivity	29 Btu/hr-ft-°F

Saturated steam at atmospheric pressure flows through the pipe at a rate high enough to prevent substantial condensation. The average inside heat transfer coefficient is 1500 Btu/hr-ft^2-°F. The average outside heat transfer coefficient of the bare pipe in still air is 2.0 Btu/hr-ft^2-°F. The air in the plant is at 60°F and 14.7 psia and is normally still. The pipe temperature is too low to consider the effects of radiation. The rate of heat loss from the bare pipe is most nearly

Answers

(A) 14,000 Btu/hr

(B) 18,000 Btu/hr

(C) 19,000 Btu/hr

(D) 21,000 Btu/hr

The answer is (A).

Solution

Content in blue refers to the NCEES Handbook.

Find the total thermal resistance. [Thermal Resistance (R)]

QUESTION DATA

Vendor
0000004635

Solving Time

Difficulty
easy

Quantitative?
Yes

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Active

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DISCIPLINES

FE Other Disciplines (/admin/questions/ind sfield=discipline&stext Other Disciplines)

FE Chemical (/admin/questions/ind sfield=discipline&stext Chemical)

FE Environmental (/admin/questions/ind sfield=discipline&stext Environmental)

PE Chemical (/admin/questions/ind

$$\begin{aligned} R_{\text{total}} &= \frac{1}{h_o A_o} + \frac{1}{2\pi k L}\ \ln\frac{r_o}{r_i} + \frac{1}{h_i A_i} \\ &= \frac{(1)\left(12\ \frac{\text{in}}{\text{ft}}\right)}{\left(2.0\ \frac{\text{Btu}}{\text{hr-ft}^2\text{-}^\circ\text{F}}\right)\pi\,(1.5\ \text{in})\,(120\ \text{ft})} \\ &\quad + \left(\frac{1}{2\pi\left(29\ \frac{\text{Btu}}{\text{hr-ft-}^\circ\text{F}}\right)(120\ \text{ft})}\right)\ln\left(\frac{1.5\ \text{in}}{1.37\ \text{in}}\right) \\ &\quad + \frac{(1)\left(12\ \frac{\text{in}}{\text{ft}}\right)}{\left(1500\ \frac{\text{Btu}}{\text{hr-ft}^2\text{-}^\circ\text{F}}\right)\pi\,(1.37\ \text{in})\,(120\ \text{ft})} \\ &= 0.0106\ \text{hr-}^\circ\text{F/Btu} \end{aligned}$$

The rate of heat transfer from the pipe to the ambient air is

Thermal Resistance (*R*)

$$q = \frac{\Delta T}{R_{\text{total}}}$$

The saturation temperature of steam at 1 atm is 212°F. The heat loss over the entire length of uninsulated pipe is

$$q = \frac{212^\circ\text{F} - 60^\circ\text{F}}{0.0106\ \frac{\text{hr-}^\circ\text{F}}{\text{Btu}}} = 14{,}300\ \text{Btu/hr} \quad (14{,}000\ \text{Btu/hr})$$

sfield=discipline&stext Chemical)

PE Mechanical: HVAC a Refrigeration (/admin/questions/ind sfield=discipline&stext Mechanical: HVAC and Refrigeration)

PE Mechanical: Therma and Fluid Systems (/admin/questions/ind sfield=discipline&stext Mechanical: Thermal a Fluid Systems)

KNOWLEDGE AREAS

Thermodynamics and (/admin/questions/ind sfield=area&stext=The and Heat Transfer)

Heat Transfer (/admin/questions/ind sfield=area&stext=Hea Transfer)

Thermodynamics (/admin/questions/ind sfield=area&stext=The

Mechanisms (/admin/questions/ind sfield=area&stext=Mec

Heat Transfer Principle (/admin/questions/ind sfield=area&stext=Hea Transfer Principles)

PRODUCTS USED IN

PEMETSQB
PEMEHV2EX
PEMEHVQB