Question 1

*Moist air at 15°C, 1.3 atm, 63% relative humidity and a volumetric flow rate of 770 m3/h enters a control volume at steady state and flows along a surface maintained at 187°C, through which heat transfer occurs. Liquid water at 15°C is injected at a rate of 7 kg/h and evaporates into the flowing stream. For the control volume, Wcv = 0, and kinetic and potential energy effects are negligible. If moist air exits at 45°C, 1.3 atm, determine the rate of heat transfer, in kW.*

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Question 2

*An air conditioner operating at steady state takes in moist air at 28°C, 1 bar, and 70% relative humidity. The moist air first passes over a cooling coil in the dehumidifier unit and some water vapor is condensed. The rate of heat transfer between the moist air and the cooling coil is 11 tons. Saturated moist air and condensate streams exit the dehumidifier unit at the same temperature. The moist air then passes through a heating unit, exiting at 24°C, 1 bar, and 40% relative humidity. Neglecting kinetic and potential energy effects, determine (a) the temperature of the moist air exiting the dehumidifier unit, in °C. (b) the volumetric flow rate of the air entering the air conditioner, in m3/min. (c) the rate water is condensed, in kg/min. (d) the rate of heat transfer to the air passing through the heating unit, in kW.*

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(a)

(b)

(c)

(d)

Question 3

*Moist air entering at 5°C, 1 atm, 90% relative humidity, and a volumetric flow rate of 60 m3/min. The incoming air is first heated at essentially constant pressure to 24°C. Superheated steam at 1 atm is then injected, bringing the moist air stream to 25°C, 1 atm, and 45% relative humidity. Determine for steady-state operation (a) the rate of heat transfer to the air passing through the heating section, in kJ/min, (b) the mass flow rate of the injected steam, in kg/min, (c) If the injected steam expands through a valve from a saturated vapor condition at the valve inlet, determine the inlet pressure, in bar. Neglect kinetic and potential energy effects.*

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(a)

(b)

(c)

For superheated steam with , .

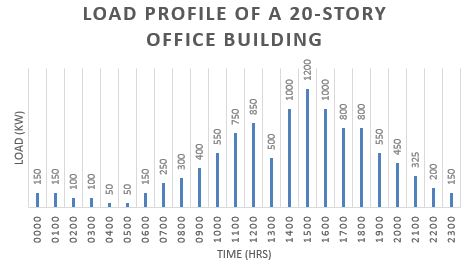
For which

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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
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| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
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| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
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| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |

1. 1) UFAD, Under-Floor Air Distribution systems would cater for thermal comfort (like fully mixed space distributions), and improve Indoor Air Quality in an energy efficient manner. (Sesnsible cooling in required spaces (occupied sections of the room) and returned through ceiling grilles. They provide control to the occupants so that the air is distributed as required and unnecessary power is not consumed. They can also favour Passive Chilled Beam implementation due to the under-floor air passages.

Parallel Configuration offers lower pumping costs than a series configuration, further if one fails the other(s) can meet the cooling load deficit. Specifically, *primary-secondary* loops should be used to set up the parallel arrangement.

The primary (production) loop would have one pump per chiller, to prevent adjacent chiller streams from mixing. The secondary (distribution) loop would have a VFD driven pump that would vary the flow rate as required; saving unnecessary pumping costs.

x

|  |  |  |
| --- | --- | --- |
| 0 | 150 | 451.1 |
| 1 | 150 | 451.1 |
| 2 | 100 | 451.1 |
| 3 | 100 | 451.1 |
| 4 | 50 | 451.1 |
| 5 | 50 | 451.1 |
| 6 | 150 | 451.1 |
| 7 | 250 | 451.1 |
| 8 | 300 | 451.1 |
| 9 | **400** | 451.1 |
| 10 | **550** | 451.1 |
| 11 | **750** | 451.1 |
| 12 | **850** | 451.1 |
| 13 | ***500a*** | 451.1 |
| 14 | **1000** | 451.1 |
| 15 | **1200** | 451.1 |
| 16 | **1000** | 451.1 |
| 17 | **800** | 451.1 |
| 18 | **800** | 451.1 |
| 19 | 550 | 451.1 |
| 20 | 450 | 451.1 |
| 21 | 325 | 451.1 |
| 22 | 200 | 451.1 |
| 23 | 150 | 451.1 |
| Total | 10,825 kW  3078.199 tons | 451.1 kWh  128.26 ton-h |

2.demand 750 tons

Available 600 tons

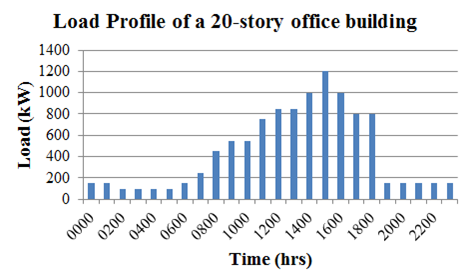
The engineer’s claim has some merit. Cooling systems like Active Chilled Beams are energy efficient and may be used to meet the remaining demand. The supply air from the 600 ton chiller can be routed to the chilled beam (making them ‘active’) and distributed to supplement the cooling load deficit.

3.150 ton on peak, optimise; thermal storage schedule

Parallel Configuration offers lower pumping costs than a series configuration, and if one chiller fails the other(s) can meet the cooling load deficit. Specifically, *primary-secondary* loops should be used to set up the parallel arrangement.

The primary (production) loop would have one pump per chiller, to prevent adjacent chiller streams from mixing. The secondary (distribution) loop would have a VFD driven pump that would vary the flow rate as required; saving unnecessary pumping costs.

|  |  |  |
| --- | --- | --- |
| Hour | Load / kW | Chiller Load / kW |
| 0 | 150 | 437.1 |
| 1 | 150 | 437.1 |
| 2 | 100 | 437.1 |
| 3 | 100 | 437.1 |
| 4 | 100 | 437.1 |
| 5 | 100 | 437.1 |
| 6 | 150 | 437.1 |
| 7 | 210 | 437.1 |
| 8 | 410 | 437.1 |
| 9 | **550** | 437.1 |
| 10 | **550** | 437.1 |
| 11 | **750** | 437.1 |
| 12 | **810** | 437.1 |
| 13 | **810** | 437.1 |
| 14 | **1000** | 437.1 |
| 15 | **1200** | 437.1 |
| 16 | **1000** | 437.1 |
| 17 | **800** | 437.1 |
| 18 | **800** | 437.1 |
| 19 | 150 | 437.1 |
| 20 | 150 | 437.1 |
| 21 | 150 | 437.1 |
| 22 | 150 | 437.1 |
| 23 | 150 | 437.1 |
| Total | 10,490 kW  2982.938 tons | 437.1 kWh  124.3 ton-h |



4. *Saturated Liquid* state. As heat absorption mainly depends on the mass fraction of saturated liquid in the saturated liquid-vapor mixture. The liquid state requires latent heat to vaporise. It is in this saturated state that constant temperature heat exchange occurs; which is the means of the maintaining the refrigerated space at the saturation temperature of the refrigerant fluid.

5. I would select the lowest-cost, ozone friendly refrigerant available based on my requirement. For domestic uses, non-toxic refrigerants would top the list; with the typical properties of high saturation pressures, relative to the ambient pressure it is being used in; to prevent contaminants leaking into the refrigerant stream. Then it should also not require excessive pressures

For commercial purposes, it should be easy to handle, store and transport.

It should also have a low density and viscosity, and a high enthalpy of vaporisation to minimise the required mass flow rate. High heat transfer coefficients would simplify the design of evaporators and condensors.

Then the refrigerant should also be be chemically inert and stable; not reacting with the piping or corroding it.

6. Hybrid (cooling ventilation)

Cooling is concerned to provide thermal comfort of the major proportion of occupants of a given space. Ventilation is a means of providing physical comfort maintaining a healthy environment; eliminating drafts and stuffiness, ejecting harmful pollutants, contaminants and micro-organisms etc. . Both are essential for a healthy and lively occupancy.

Commercially, this is observed to increase the productivity of occupants. Minus psychological equlibrium, people can not work to thier full potential. This directly affects the company and its’ revenue; *‘Health is wealth’*. The HVAC system costs are only a fraction of what may be achieved through better mental and physical health of occupants. Seen the other way round, the decrease in productivity would cost many times more than the cost for installing a hybrid ventilation system.

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for the open duct, the wetted parameter would be computed from 3 sides of the duct (2 on the sides and the base). Dh=4ab/(2a+b)

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You need to show static pressure. However for backflow verification try to plot streamlines/velocity vectors in your postprocessing it will provide u a better idea

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