- How many square feet of collector are required to provide all the thermal energy needed to heat a house for one day when the heat load is 20,000 Btu/h? Take the mean daily insolation on the collector surface as 1800 Btu/ft²/d and the collector's efficiency as %50.

SOLUTION

Recall that $\Theta = I \times \varepsilon \times A$. The thermal energy $\Theta$ needed for a day will be 20,000 Btu/h x 24h/d = 480,000 Btu/d. The solar energy collected in one day will be

1800 Btu/ft² X 0.50 X collector area A. Therefore,

$$A = \frac{480,000 \text{ Btu/d}}{900 \text{ Btu/ft}^2\text{/d}} = 533 \text{ ft}^2$$

- Using the house and collector of the previous example, how many gallons of water would be necessary to store enough thermal energy for three days of space heating? Assume the water in the storage tank begin at 150°F and has a useful lower limit of 90°F (the temperature change the water will undergo will be $\Delta T = 60°F$).

SOLUTION

The heat that must be provided by the storage system is

$$\Theta = 3d \times 480,000 \text{ Btu/d} = 1,440.000 \text{ Btu}$$

We can use the relationship $\Theta = mc\Delta T$, where in this case $\Theta$ is the heat taken from the storage container as its temperature is lowered by $\Delta T = 60°F$.

For water, the specific heat is 1.0 Btu/lb/F°.

Therefore, 1,440,000 Btu = mass × 1.0 × 60 F°.

We find that the mass = 25,000 lbs; because there are 8.3 lbs/gal, the amount of water required is ~ 3000 gal. At 7.48 gal/ft³, this is 400 cubic feet, or a tank of approximately 7ft × 7ft × 7ft.