



JETS Challenge 114
Talkin' Turkey

The amount of heat (Q in Btu/hour) released from a single growing turkey as a function of body mass (W in lbs) is given by $Q = 6.6 \cdot W^{0.75}$. This body heat is usually removed by large fans that pull a flow rate of outside air (cfm at T_{out}) through the building to lower the air temperature in the space (T_{in}). The rate of energy removed by this ventilation process is given by the equation

$$Q = 1.09 \cdot cfm \cdot (T_{out} - T_{in})$$

The Challenge: If the summer temperature reaches 92°F and the maximum safe inside temperature before the critters start dying is 96°F, Find the required flow rate of air through a 300x65 ft facility that houses 4,000 turkeys that weigh 15 lbs (W) each and 6,000 turkeys that weigh 20 lbs (W) each.

$$\begin{aligned} Q &= 6.6 \cdot w^{0.75} \text{ and } Q = 1.09 \cdot cfm \cdot (T_{out} - T_{in}) \\ &= 1.09 \cdot cfm \cdot (92 - 96) \\ &= 4.4 \text{ cfm} \end{aligned}$$

so

$$Q = 6.6 \cdot w^{0.75} = 4.4 \text{ cfm}$$

15 lb turkeys

$$= 6.6 \cdot (15)^{0.75} = 4.4 \text{ cfm}$$

11.432 = cfm for each 15 lb turkey

$$4000(11.432) = 45,732 \text{ cfm for 4,000 turkeys}$$

20lb turkeys

$$= 6.6 \cdot (20)^{0.75} = 4.4 \text{ cfm}$$

14.186124 = cfm for each 20 lb turkey

$$6000(14.186124) = 85,117 \text{ cfm for 6,000 turkeys}$$

So...

$$\text{Total cfm} = 45,732 + 85,117 = 130,849 \approx 131,000 \text{ cfm}$$

ANSWER:

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JETS Challenge problems are generously provided by Dave Meredith, Associate Professor, Penn State University-Fayette