

Example 1

Cooling-ventilated barn with cooling pads

Assumptions:

- 8-row, 800-head freestall
- Dimensions of 210 ft. by 420 ft.
- Baffle height of 8 ft. and one baffle per two rows of stalls
- Design velocity under the baffle of 528 fpm
- Cooling pads result in 0.05 inches of static pressure at air velocity of 400 fpm
- Performance test results show exhaust fan moving 31,000 CFM at 0.12 inches of static pressure

Calculate cross-sectional area:

$$A_{cs} = 8 \text{ ft.} * 420 \text{ ft.} = 3,360 \text{ sq. ft.}$$

Calculate volumetric flow rate to meet design velocity and air exchange per cow:

Calculate airflow based on velocity: $Q = 3,360 \text{ sq. ft.} * 528 \text{ fpm} = 1,774,080 \text{ CFM}$

Calculate airflow based on number of cows:

$$Q = 800 \text{ cows} * 1,000 \text{ CFM/cow} = 800,000 \text{ CFM}$$

Choose larger: 1,774,080 CFM

Size inlets:

$$1,774,080 \text{ CFM}/400 \text{ fpm} = 4,435 \text{ sq. ft.}$$

$$\text{Find inlet height: } 4,435 \text{ sq. ft.}/420 \text{ ft.} = 10.56 \text{ ft. high}$$

Estimate static pressure:

Calculate static pressure per baffle (equation 5 in the companion summary article):

$$S.P._{baffle} = (528 \text{ fpm}/4,000)^2 = 0.0174 \text{ inches of water/baffle}$$

$$\text{Sum static pressures: } 0.05 \text{ in. at inlet} + 0.0174 \text{ in./baffle} * 4 \text{ baffles} = 0.12 \text{ inches of water}$$

Consider fans needed:

$$\text{Number of fans} = 1,774,000 \text{ CFM}/ 31,000 \text{ CFM/fan} = 57 \text{ fans}$$