46.51 A pump is driven by a 4-pole synchronous motor. What is the nominal rotational speed? Ignore slip.

A. $1200rpm$

B. $1800rpm$

C. $2400rpm$

D. $3600rpm$

The number of poles of a Synchronous Speed Motor determines the speed in rpm. Read directly from the table for 4 poles.

$$N = 1800rpm$$

Answer B

46.52 The pressure drop through a chilled water coil at the design flow rate of $25gpm$ is $8psi$. During normal operation, the actual flow rate is $4gpm$. What is the pressure drop in normal operation?

A. $0.2psi$

B. $1.3psi$

C. $4.1psi$

D. $8.0psi$

The pressure drop is a function of the physical design of the coil and the velocity pressure from the water. Static pressure in a hydronic system tends to be relatively stable and gravitational effects are likely to be minimal in the vicinity of the coil. The primary driver is the operation of the control valve which allows more or less flow into the coil. Recall $Q = vA$. Since the coil cross-sectional area is constant, the velocity is proportional to the volume flow rate. Since velocity pressure depends on the *square* of the velocity, relate the ratio of the pressure drops to the ratio of the velocities *squared*. Then substitute flow rate for velocity since flow rates are given. Substitute and solve for ΔP_{actual}.

$$\frac{\Delta P_{actual}}{\Delta P_{design}} = \left(\frac{v_2}{v_1}\right)^2 = \left(\frac{Q_2}{Q_1}\right)^2 = \left(\frac{4gpm}{25gpm}\right)^2 = 0.0256$$

$$\Delta P_{actual} = 0.0256\,(\Delta P_{design}) = 0.0256\,(8psi) = 0.2psi$$

Answer A

46.53 Air exits a nozzle at $500\frac{ft}{s}$ into a $70°F$ room at atmospheric pressure. What is the Mach number?

A. 0.39

B. 0.44

C. 2.3

D. 2.5

The Mach Number is the velocity of the air divided by the speed of sound in air. The speed of sound in air can be determined in at least three ways. First, it can be memorized. $c \approx 1130\frac{ft}{s}$

Second, it can be looked up in the Properties of Air at Low Pressure table. Interpolate or estimate as necessary.

Third, it can be calculated using the equation below. However, to make the units work, the gravitational constant, g_c, must also be included for US customary units. Substitute the ratio of specific heats for air, the Specific Gas Constant for air, and the absolute temperature in degrees Rankine.

$$c = \sqrt{kRT}$$

$$c = \sqrt{kRTg_c}$$

$$c = \sqrt{(1.4)\left(53.35\frac{ft \cdot lb_f}{lb_m \cdot R}\right)(530R)\left(32.2\frac{lb_m \cdot ft}{lb_f \cdot s^2}\right)} = 1128\frac{ft}{s}$$

Calculate the Mach number.

$$M = \frac{V}{c}$$

$$M = \frac{500\frac{ft}{s}}{1128\frac{ft}{s}} = 0.44$$

Answer B