33.39 A hydronic piping system has a normal operating pressure of $100psia$ and is composed of nominal $5in$ pipe with a typical flow rate of $400gpm$. In the event that a valve suddenly closes and creates additional surge pressure due to water hammer, what maximum pressure will be experienced by the system?

A. $180psia$

B. $290psia$

C. $400psia$

D. $510psia$

The maximum Surge Pressure caused by Water Hammer is given by the equation below where the speed of sound in water is taken as $C_s = 4720fps$.

$$\Delta p_h = \frac{\rho C_s v}{g_c}$$

Use the Steel Pipe Friction Tables to obtain the velocity of $400gpm$ flowing in a nominal $5in$ pipe.

$$v = 6.41fps$$

Solve for Δp_h. Convert from $\frac{lb_f}{ft^2}$ to $\frac{lb_f}{in^2}$.

$$\Delta p_h = \frac{\left(62.4\frac{lb_m}{ft^3}\right)\left(4720\frac{ft}{s}\right)\left(6.41\frac{ft}{s}\right)}{32.2\frac{lb_m \cdot ft}{lb_f \cdot s^2}} = 58,631\frac{lb_f}{ft^2}$$

$$\Delta p_h = 58,631\frac{lb_f}{ft^2}\left(\frac{1ft^2}{144in^2}\right) = 407\frac{lb_f}{in^2}$$

Since Δp_h is the *pressure rise* due to water hammer, add this figure to the original pressure to determine the maximum pressure that will be experienced by the system.

$$p_{max} = p_1 + \Delta p_h = 100psia + 407psi = 507psia$$

Answer D