Air Flow Calculations: Choked Flow

Choked air flow will occur when the absolute pressure ratio of the outlet downstream pressure p_o to the upstream inlet pressure p_i is 0.528 or less. That is, $p_o / p_i \leq 0.528$. Choked flow is sometimes referred to as *critical flow* and the air velocity is sonic through the component. Further decreases in downstream pressure will not increase mass flow rate. Mass flow rate will increase proportionally to increases in upstream absolute pressure.

Flow coefficient Cv is used to help calculate flow and pressure drop. Cv can be expressed as:

$$C_v = Q\,[SG\,(T + 460)]^{1/2} / 660\,p_i$$

where:

Q = Air flow rate in standard cubic feet per hour (SCFH)

SG = specific gravity relative to air at standard pressure & temperature: 14.696 psia, 60°F and = 1 for air

T = flowing air or gas temperature (°F)

p_i = inlet gas absolute pressure (psia)

Therefore, for air SCFH flow calculations:

$$Q = C_v \times 660\,p_i / [SG\,(T + 460)]^{1/2}$$

And in terms of q for SFCM flow calculations:

$$q = C_v \times 11\,p_i / [SG\,(T + 460)]^{1/2}$$

where:

q = Air flow rate in standard cubic feet per minute (SCFM)

Air Flow Calculations: Non Choked Flow

For non choked air flow, the absolute pressure ratio of the outlet downstream pressure p_o to the upstream inlet pressure p_i is greater than 0.528. That is, $p_o / p_i > 0.528$. (Choked air flow will occur when $p_o / p_i \leq 0.528$). Non choked flow is sometimes referred to as *non critical flow* and the air velocity is subsonic through the component. The flow coefficient can be expressed as:

$$C_v = Q\,[SG\,(T + 460)]^{1/2} / [1360\,(\Delta p \times p_o)^{1/2}]$$

where

$\Delta p = (p_i - p_o)$

p_o = outlet gas absolute pressure (psia)

Therefore, for air SCFH flow calculations:

$$Q = C_v \times 1360\,(\Delta p \times p_o)^{1/2} / [SG\,(T + 460)]^{1/2}$$

where:

Q = Air flow rate in standard cubic feet per hour (SCFH)

And in terms of q for SFCM flow calculations:

$$q = C_v \times 22.67\,(\Delta p \times p_o)^{1/2} / [SG\,(T + 460)]^{1/2}$$

where:

q = Air flow rate in standard cubic feet per minute (SCFM)