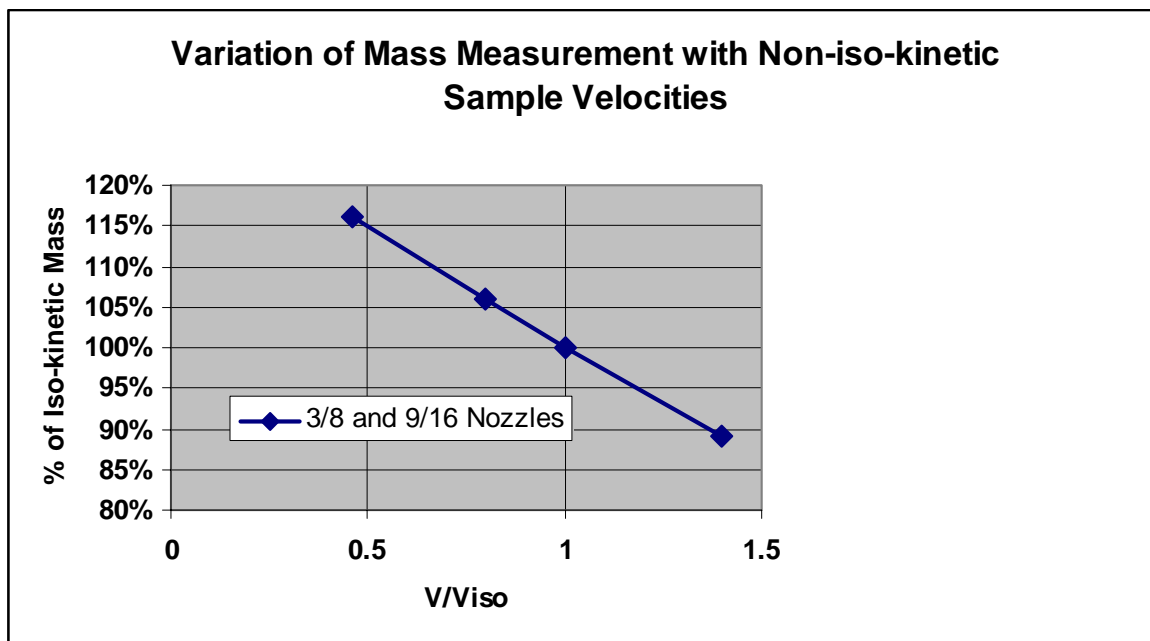


PPC Note: Importance of Iso-kinetic Sampling

To ensure that PPC extractive sampling measurements accurately represent the particle distributions of the flow they are sampling, the user must ensure that iso-kinetic sampling conditions occur. That is, the velocity of the flow into the sampling nozzle must be matched to the velocity of the main flow at the sampling point. If the sampling velocity exceeds the iso-kinetic velocity, then smaller particles will be over-sampled and more small particles per unit volume will exist in the sample flow than in the main flow. This will result in a lower mass concentration measurement than in the main flow. Conversely, if the sampling velocity is less than the iso-kinetic velocity, larger particles will be over-sampled, and the mass concentration measured by the PPC will be higher than the true value.

How important is iso-kinetic sampling? The following graph illustrates how errors in mass result if iso-kinetic sampling is not achieved:



Iso-kinetic sampling velocity can be determined by the following equation:

$$V_{iso} = \frac{Q_{main}}{A_{main}} \quad (1)$$

where:

V_{iso} is the iso-kinetic velocity, in m/s

Q_{main} is the flow rate in the main flow path in m³/s

A_{main} is the area of the main flow path, in m²/s

Once the iso-kinetic velocity is calculated, the user should determine that a corresponding velocity is measured by the PPC instrument. When the cross-sectional flow area, temperature, or pressure are different at the sampling point than in the center of the PPC flow cell, the velocity in the flow cell will relate to the iso-kinetic sampling velocity as follows:

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$$V_f = V_{iso} \cdot \frac{A_s}{A_f} \cdot \frac{T_f}{T_s} \cdot \frac{P_s}{P_f} \quad (2)$$

where:

V_f is the velocity in the flow cell in m/s corresponding to an iso-kinetic velocity at the sample nozzle

A_s is the cross-sectional area of the sampling nozzle in m^2 .

A_f is the cross-sectional area of the PPC flow cell nozzle or flow path in m^2 .

T_f is the temperature of the flow cell particle flow, in K

T_s is the temperature of the particle flow at the sample point, in K

P_s is the pressure at the sampling point in Pa

P_f is the pressure at the flow cell, in Pa

Flow through the sampling system should always be controlled by a (throttling) valve downstream of the PPC instrument, to avoid disturbances to the system, and irregular particle flow or condensation. Therefore, in most cases, the pressure should remain approximately the same between the sampling point and the flow cell, so equation (2) above becomes:

$$V_f = V_{iso} \cdot \frac{A_s}{A_f} \cdot \frac{T_f}{T_s} \quad (3)$$

The cross-sectional area of the flow through the PPC will depend on what nozzle, if any, is used in the flow cell, and will vary by instrument as well as installation. In systems with low particle concentrations, a nozzle should be used to direct all the particles through the laser beams.

In addition, sampling systems produce the most accurate results when the inlet of the sampling nozzle is pointed directly into the main flow. Minimizing the number of turns and the length of the path the sample must travel before reaching the PPC system, as well as changes to the pressure and temperature of the sample will also produce the best results. Please contact Process Matrix if you have any questions about the geometry of your system.