The density measured with an instrument ([such as our FKT series meter](#)) is a direct relation to temperature and ambient pressure sensor readings. Density is given by the ideal gas law:

$$\rho = \frac{P}{R \cdot T}$$

Where ρ is density, P is the ambient (static) pressure, T is the temperature of the flow and R is the gas constant. The temperature should be in absolute units (Kelvin or Rankine). Each sensor reading $(P$, and $T)$ has an uncertainty (U) associated with it, so the full density uncertainty is expressed below: (see http://www.flowkinetics.com/uncertainty-analysis.htm)

$$U_\rho = \sqrt{\left(\frac{\partial \rho}{\partial P}\right)^2 U_P{}^2 + \left(\frac{\partial \rho}{\partial T}\right)^2 U_T{}^2}$$

Substituting the differentials, based on the ideal gas law above, the above expression becomes:

$$U_\rho = \sqrt{\left(\frac{U_P}{R \cdot T}\right)^2 + \left(\frac{P \cdot U_T}{R \cdot T^2}\right)^2}$$

The uncertainty for each reading depends on the characteristics of each sensor and should be determined from the manufacture's specifications.

As an example, assume an instrument with the following uncertainties:

As an example, assume a test with the following test conditions and parameters:

$$P = 15 \; to \; 115 \; kPa$$

$$T = \; 73 \; to \; 1050 \; K \; (-200 \; to \; 777°C)$$

$$R = 287.026 \frac{Joule}{kg \cdot K}$$
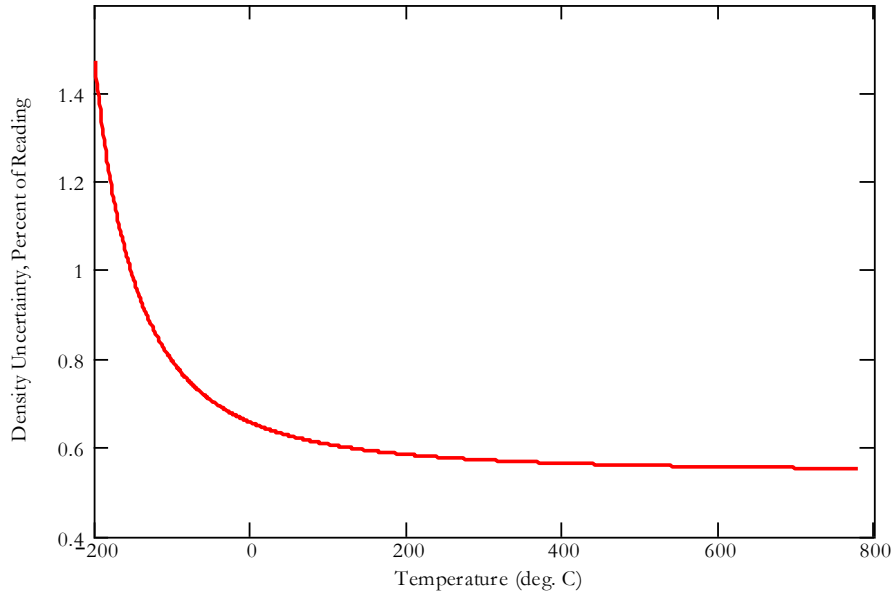
$$P \; full \; scale = 115000 \; Pa \; \text{(Full scale pressure for absolute/ambient sensor)}$$
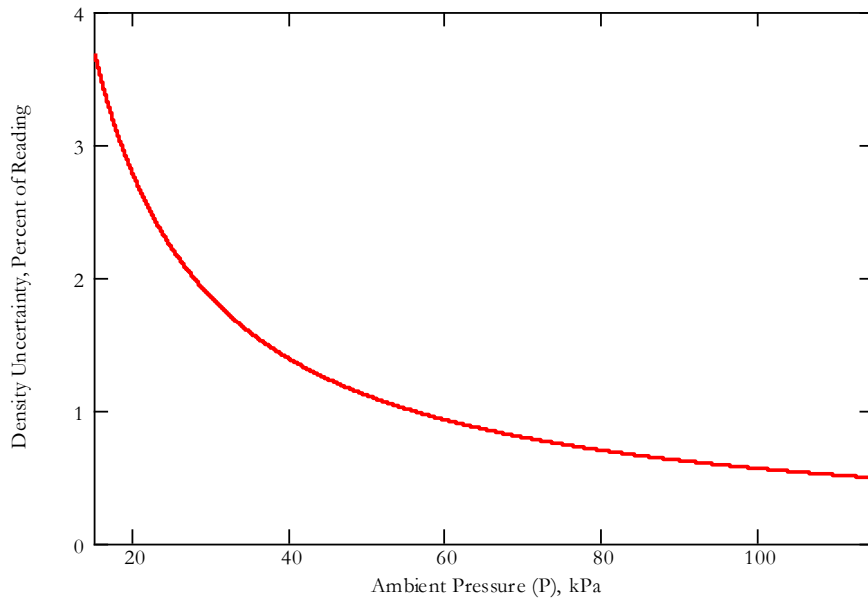
The uncertainties are:

$$U_T = \pm 1°C \; or \; \pm 1K$$

$$U_P = \pm 0.5\% \; of \; P \; full \; scale = \; \pm 552 \; Pa$$

Using the above values the plot of density uncertainty as a fraction of reading for different temperatures is shown below. The ambient pressure is 101325 Pa.

If the temperature is kept at 20°C the density uncertainty variation with ambient pressure is shown below:

The plots show the uncertainty in the density increases significantly for low temperature and ambient pressure. For this example, at standard ambient conditions, the density uncertainty is about 0.6% of reading.