

# The BTU Accuracy Connection to Profitability; and How to Achieve Improvements

## Terminology Used in This Paper

<b>Accuracy:</b>	achievement of the correct value.
<b>Dekatherm:</b>	one million BTU.
<b>Fractional Analysis:</b>	separation of natural gas mixtures into identifiable components with units in mole percent.
<b>Precision:</b>	statistical term characterizing how repeatable the individual measurements of the same sample are.
<b>Calculation:</b>	SD of measurements (100)/mean of measurements.
<b>Uncertainty:</b>	statistical term representing calculated error resulting from measurement process, including the natural gas calibration standard uncertainty and measurement precision as the usual known error sources.

## The Concept of BTU Accuracy

The natural gas industry uses gas chromatographic (GC) process analyzers to conduct fractional analysis of the natural gas streams. The components and their concentrations are converted to a gross heating value in BTU/cubic foot using the physical constants from reference documents such as GPA 2145.

How accurate are the calculated gross heating values in BTU/SCF? The accuracy depends on the following factors:

1. Document GPA 2145-03 states the accuracy of its physical constants to be no more than 1 part in 1000. Therefore, the accuracy in any reported gross heating value can be no better than  $\pm 1.4$  BTU using GPA 2145-03 reference.
2. Process analyzer precision is also a contributor to accuracy. Analyzer manufacturers have demonstrated that their instruments can achieve within 0.05% relative agreement on repeat measurements; and this correlates to  $\pm 0.5$  BTU in 1000 BTU.

GC process analyzers require calibration with a natural gas reference standard. Natural gas reference standards are provided from the specialty gas industry. There is significant potential for disparity in natural gas reference standards due to the following:

- Inconsistency in the purity and handling of hydrocarbon components of natural gas standards.
- Inconsistency in the natural gas mixture certification practices.
- Failure to apply gaseous NIST reference standards to validate fractional analysis of the natural gas mixtures.

Because of these variables, commercial natural gas standards are purchased with uncertainty anywhere from  $\pm 0.5$  BTU to  $\pm 1\%$  relative (which is  $\pm 10$  BTU in 1000 BTU), and in some situations  $\pm 2\%$  relative or  $\pm 20$  BTU in 1000 BTU. In that the GPA 2145-03 physical constants have  $\pm 1$  BTU in 1000 BTU uncertainty, any claim that a natural gas reference standard has less than 1 BTU accuracy should be subject to review.

## BTU Accuracy and Profitability

Natural gas is purchased in terms of quantity (millions of standard cubic feet per day; SCFD) and quality (BTU per standard cubic foot). The dollar value of BTU accuracy is presented in the following example:

Natural Gas Quantity:	10,000,000 SCFD
Price Delivered:	\$8.00/dekatherm
Gas Gross Heating Value:	1030 BTU/SCF

$$\text{Natural Gas Value} = \frac{\$8.00/\text{dkthrm} \times 10 \text{ MMSCF} \times 1030 \text{ BTU/SCF}}{1 \text{ MMBTU}/\text{dkthrm}}$$

$$\begin{aligned} \text{Natural Gas Value} &= \$82,400.00/\text{Day} \\ &= \$2,472,000.00/\text{Month} \\ &= \$29,664,000.00/\text{Year} \end{aligned}$$

Now assume that the natural gas reference standard supplier has been 10 BTU (or 1% relative) low in the gross heating value for the natural gas reference standard provided to the natural gas supplier. The natural gas supplier is losing approximately \$296,640 a year using these price and quantity values. Table 1 provides a correlation of error in BTU Accuracy versus the volume of gas sold or purchased, and the impact on the profitability of the supplier or purchaser.



**MATHESON**

ask. . .The Gas Professionals™

**Table 1 BTU Accuracy and Impact on Profitability Per Year**

BTU Accuracy	Relative Uncertainty*	Gas Volume in MMSCFD			
		10	20	30	50
1.4	0.1%	41,500	83,000	124,500	207,500
2	0.2%	59,330	118,700	177,900	296,500
4	0.4%	118,700	237,300	356,200	593,500
10	1.0%	296,640	593,280	889,920	1,483,200

Table 1 provides the direct cost analysis of BTU inaccuracy, but should there be a change of custody dispute on BTU value and accuracy, there is significant cost associated with the time and resources needed to resolve disputes.

**The Impact of Other Measured Quantities on Profitability**

If the BTU value has significant inaccuracy, then it is likely that the CO<sub>2</sub> and N<sub>2</sub> component measurements are in error as well. These components contribute to the specific gravity and thus to the flow volume calculations which will have proportional error. Using the relative uncertainty column of Table 1, the dollar value of the flow measurement error can also be assessed.

**MATHESON Improvements to BTU Accuracy**

MATHESON recognizes the significant contribution of BTU accuracy to natural gas industry profitability. MATHESON has addressed the variables necessary to assure achievement of the highest accuracy natural gas reference standard in the industry: ± 1.4 BTU, in the MaxiTherm™ natural gas standard. MATHESON has done this by addressing the following critical issues:

1. Engineering the mixtures to assure that the raw material impurities are insignificant.
2. Refining of blending procedures to assure highly accurate gravimetric additions of both gas and liquid minor components.
3. Utilizing laboratory instruments capable of statistically valid measurements and fractional analysis.
4. Achieving and applying the first Natural Gas NIST Traceable Reference Material to assure the accuracy of the laboratory measurements - across multiple MATHESON facilities. Thus the natural gas reference standards that MATHESON supplies to the natural gas industry have a dual pedigree from the gravimetric preparation and the laboratory certification.
5. Dual certification of the BTU value which requires that gravimetric BTU content match the BTU content from laboratory fractional analysis is within ± 1.4 BTU/cubic foot.

**Summary**

This paper has shown that the BTU accuracy resulting from the natural gas fractional analysis contributes significantly to the profitability of the natural gas industry and its customers. Through the careful engineering of natural gas reference standards and their subsequent laboratory certification to Natural Gas NIST NTRM, MATHESON can provide a state-of-the-art natural gas reference standard which can achieve ± 1.4 BTU accuracy. Fractional analysis is one of a number of variables used to assess the accuracy of the gas flow and BTU per cubic foot content.

\*BTU accuracy ÷ 1030 BTU = relative uncertainty

