To: Dr. Fletcher

From: Joe Young, Bill Smith, Cindy Lopez

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Subject: Octane Rating Methods[[1]](#footnote-1)

**Objective**

Two methods[[2]](#endnote-1) for determining the octane ratings of blends of gasoline are found in the standard operating procedures for the plant: (1) the motor method and (2) the research method. Proposed improvements in the control system of the reforming and isomerization units require highly consistent measurements of octane ratings. This memo outlines experiments that we performed to assess the agreement between the two methods.

**Procedure**

We created thirty-two blends of gasoline ($n$ = 32) by combining 2 gallons of normal pentane (62 octane) with varying amounts of toluene (120 octane) to create test samples with octanes in the range 80 – 110. After thorough mixing, each blend was separated into two samples of equal volume. We measured the octane of one sample using Method #1 and the other sample using Method #2.

To determine if the two methods give the same octane rating given the same gasoline blend, we analyzed the results using a paired *t­*-test.[[3]](#endnote-2) This test was performed by defining the $i$th difference as $d\_{i}=y\_{1,i}-y\_{2,i}$ where $y\_{1,i}$ and $y\_{2,i}$ are the octane ratings given by the first and second methods respectively for the $i$-th sample. We tested the hypothesis $δ$ = 0, where $δ$ is the true mean difference between the two methods at the 95% confidence level ($α$ = 0.05).

**Results and Analysis**

Figure 1 shows the results of 32 tests on a parity plot. Each blend appears as one point on the graph. The data points do not lie on the parity line. In each case, Method #2 produces higher octane rating than Method #1. The amount of disparity is not correlated with octane value since similar differences between the two methods are found at both high and low ratings.

The statistical analysis of the results requires the calculation of the difference in the octane values produced using the two methods for each sample. The average difference was -7.1 and the standard deviation of the difference was 3.0. Differences were not dependent upon the magnitude of the octane value since both large and small differences were found throughout the entire range of octanes. The test statistic for the average difference being equal to 0, with 31 degrees of freedom, was -13.2. At the 95% confidence level, the two-tail *t*-statistic for 31 degrees of freedom was 2.040. Since |-13.2| > 2.040, there is sufficient evidence to conclude that the two methods for calculating the octane rating of a sample of gasoline do not produce the same results. The 95% confidence interval for the difference indicates that Method #2 generates ratings between 6.0 and 8.2 octane units higher than Method #1.

Figure 1. Comparison of octane measurements using the motor (Method #1) and research (Method #2) methods.

**Conclusions/Recommendations**

The data indicate that the two methods currently used in the plant to calculate the octane rating of gasoline blends do not produce similar results. The motor research method (Method #1) yields octane readings that are between 6.0 and 8.2 units higher than the motor method (Method #2). Since the proposed control system requires consistent measurements of octane rating, we recommend selecting one method to use throughout the plant. This study did not address the accuracy of each method, nor other factors such as the cost, reliability, or equipment issues. We recommend additional studies with calibrated samples to identify the best method.

1. This is a sample memo report. It is a little short, and could include one more figure or table. The length should be 2 to 3 pages, but should include the types of sections illustrated here. The data and analysis are illustrative and not necessarily accurate. [↑](#footnote-ref-1)
2. R. D. Snee, Developing blending models for gasoline and other mixtures, *Technometrics*, **23**, 119-130 (1981). [↑](#endnote-ref-1)
3. This report was prepared for pedagogical purposes. The data and data analysis were taken from an example in Chapter 4 of *Statistical Methods for Engineers* by G. Geoffrey Vining. [↑](#endnote-ref-2)