RVP4550
Reid Vapor Pressure (RVP) analyzer

Increasing gasoline blending profits with process Reid Vapor Pressure measurements and automatic air saturation of the sample

Measurement made easy

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RVP4550 -
0-20 psi with air
saturation

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Introduction

Gasoline Blenders have been using process RVP analyzers since the early 1990's to make sure the gasoline produced meets the regulatory requirements. The continuous process analysis improved the profitability of blending by allowing the optimization of the blend on the less expensive components. A general bias has always been observed between the process analyzer and the laboratory analysis. Some of this bias is to be expected due to the process analyzers and their automated sample systems not having the issue of potential loss of lights from the manual handling of the sample associated with the laboratory method. The real problem with this is that the bias is a variable bias that is affected by the seasonal blend, regional blend and octane blend. This variable bias creates issues for the blenders in optimizing the

blend and the issue is magnified during blend changes. To try to get the best results possible the refiners have developed complicated control algorithms for each blend, which are difficult and expensive to build and maintain. In order to make sure the gasoline meets the regulatory requirements, the refiners blend to the 'safe' side on RVP value and thus create a 'RVP giveaway'. It has long been thought that the variable bias is caused by different levels of dissolved air in the process samples. The laboratory methods for measuring a RVP of gasoline all have an air saturation step in them while the process analyzers have not had that capability.

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Optimize blending with air saturation

Blend on the less expensive feeds by safely blending closer to the sweet spot

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Analytical system method and design

In the laboratory method, the sample is collected in a container and then chilled to between 0 °C and 1 °C (32 °F and 34 °F)in an ice bath or refrigerator. The chilled sample is removed from the chiller, shaken vigorously and returned to the chiller for the sample to be cooled again. This is repeated two times and then the sample is taken to the lab analyzer. A portion of aerated sample is transferred to a vessel which provides a 4:1 vapor to liquid ratio. The vessel is then heated to 100 °F ± 0.2 °F (38 °C ± 0.2 °C) and agitated until equilibrium is reached. The pressure, which is termed Reid Vapor Pressure (RVP) is then recorded.

ABB has developed a new on-line process analyzer, the RVP4550 that has the capability to saturate the gasoline with air prior to making the RVP measurement. This air saturation step in the on-line analyzer is to remove or reduce the variable bias with the laboratory measurements between blends. The analyzer has an integral sample handling system to deliver the sample to the analyzer's Air Saturation Unit (ASU). The sample is cooled to 33 °F (1 °C)with a thermo electric cooler. The ASU contains a two chamber aeration cell – one for air and the other for the gasoline.
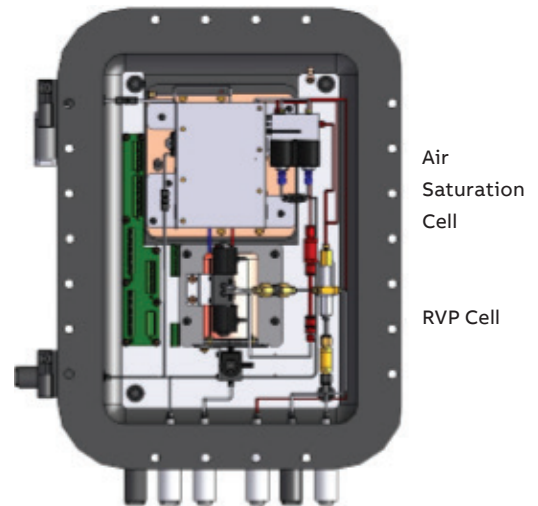

Air Saturation Cell

RVP Cell

Figure 1 RVP4550 Interior

The cooled sample is cycled between the two chambers until the gasoline is saturated with air. The cooled air saturated gasoline sample is made available to the RVP measuring cell for two purges to make sure the measuring cell has the proper sample. The cooled air saturated sample is delivered to the RVP cell a third time and is heated to 100 °F (38 °C). After stabilizing at that temperature the RVP measurement is made.

Test results

Tests were run on a blending process in a refinery with an ABB RVP analyzer that did not have air saturation and with the ABB RVP4550 with Air saturation and the results of both units were compared to the lab analysis on different seasonal blends with both regular and premium gasoline. The units were tested on gasoline blends with RVP values from approximately 6 to 16 psi. The field test included over 30 premium blends and over 80 regular blends.

A linear regression of the field data for the RVP without air saturation to the lab results the following equations were obtained:

- Regular unleaded Y = 0.931X + 0.66
- Premium unleaded Y = 0.917X + 1.11

The same regression for the RVP with air saturation to the lab results the following equations were obtained:

- Regular unleaded Y = 0.954X + 0.33
- Premium unleaded Y = 0.956X + 0.49

If the correlation were perfect, the slope would be 1 and the intercept would be 0. While that was not obtained in the field test, it does show that the slope was the same for both the regular and premium unleaded samples on the unit with the air saturation and the slope was closer to 1. This indicates that the bias is constant and the results are not affected by the sample blend. This is further confirmed in that the intercept was closer to 0 and between the regular and premium blends themselves when the sample was saturated with air.

Economic benefits

The test indicated that the blenders can use more simple control algorithms by using the RVP4550 with sample air saturation and can expect to be able to blend closer to the RVP regulated levels and reduce the RVP giveaway by between 0.02 and 0.04 psi. Calculations show that by reducing the RVP giveaway by 0.02 psi a refinery that has a capacity of 150,000 barrels per day can expect to save almost $250,000 annually, while a 400,000 barrels per day plant can expect to save approximately $650,000 annually.

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Save significant money with a process RVP analyzer that has sample air saturation capability.

Conclusion

Refiners can save significant money on their blending operation by incorporating a process RVP analyzer that has sample air saturation capability on their final gasoline blending operations. This allows the gasoline blend to be safely optimized on the more economical components and blended closer to the legislated RVP limit.

ABB

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ABB Inc.
Measurement & Analytics
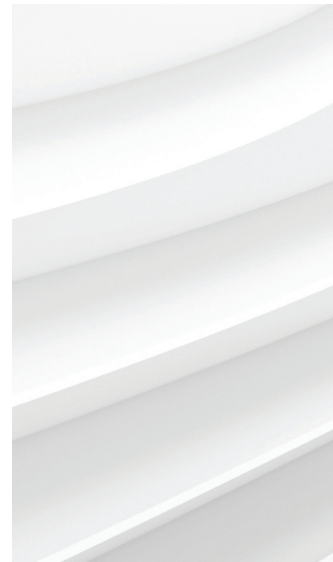3567 Jefferson Street North
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