OptiDist Helps Maintain a Distillation Rate of 4-5 mL/Minute Throughout the Distillation Process

PAC's OptiDist™ is an advanced optimal solution for performing atmospheric distillation, offering precision and ease of use. It offers:

- Straightforward operation with superior precision
- Unparalleled versatility for significant laboratory time and cost savings
- Enhanced built-in instrument safety features
- Compliance with ASTM D86 (group 0,1,2,3,4), D1078, D850, EN ISO3405, ISO 918, IP123, IP195, DIN51751, JIS K2254, and NFN 07-002

APPLICATION

Distillation optimization throughout the atmospheric distillation analysis

CHALLENGE

Per the ASTM D86 test method, the atmospheric distillation rate during the analysis must be maintained within 4-5 mL per minute. There are several challenges that come with maintaining a rate of 4-5 mL/minute. First, as the distillation progresses, the heating rate needs to be adjusted because heavier components require higher temperatures to evaporate. Samples that are heated too fast risk overshooting 5 mL/minute, while samples that aren't heated fast enough will underperform. Many automated distillation units solve this problem by keeping the distillation rate under control with neat fuels (non-additivated fuels), but they still require operator inputs for the initial heat rate

Some common blends such as ethanol oxygenated gasoline present specific challenges that can affect distillation results significantly and thus negatively influence the decision-making process in refinery and blending operations. Adding ethanol to gasoline, a common oxygenate, to improve combustion performance and increase octane number, creates what is known as an azeotropic blend. Azeotropes are blends that become hard to distill because the slope of the boiling curve flattens at a certain point in the process. In some cases, the physical boiling stops even when heat is applied. When boiling stops and the distillation rate falls below the 4 mL/minute market, it's typical for operators and automated instruments to increase heating power. However, this can create the opposite effect, because the azeotropic point will eventually break, and the excess heat causes vapors to suddenly form in the flask, making their way to the condenser tube, and increasing the distillation rate above the 5 mL/min.

Maintaining distillation rates within the method-specified limits is such a critical parameter for repeatability and reproducibility (r & R) of the test that Section 10.12 of ASTM D86 clearly states: *"Repeat any distillation that did not meet the requirements described in 10.9, 10.10, and 10.11."* Sections 10.9 to 10.11 dictate times to reach IBP, FBP and distillation rates, which shall be kept as constant as possible throughout the test.

Refineries, blending operations, R&D labs, and third-party testing labs must find an instrument that can maintain extremely tight control of the distillation rate, even with challenging samples.

SOLUTION

PAC's product management and R&D teams identified the frequent challenge many customers faced when controlling the distillation rate of some samples. As a result, the optimizer's innovative technology was developed and patented for precise, reliable laboratory atmospheric distillation. OptiDist is fully compliant with all atmospheric distillation methods. Its versatile design supports multiple methods and non-standard capability, for easy adaptability for many different applications. OptiDist™ enables straightforward, one-button operation. The easy-to-use distillation analyzer with advanced man-machine interface (MMI) features, such as the built-in optimizer, contributes to a trouble-free operation, requiring less operator expertise. Without manual heater settings and preliminary trials, the operator selects the test method and starts the distillation by just pressing the "Start" button.

OptiDist continually monitors the liquid temperature via a non-intrusive IR sensor on the side of the flask and feeds this information to a proprietary algorithm to determine the best heating power. The end result is a distillation that keeps a controlled distillation rate within the 4 and 5 mL/min limits.

This continuous monitoring allows OptiDist to regulate the initial heat in a fully automated way without requiring any input from the operator. Initial heat is controlled by a proprietary algorithm with input from the optimizer readings.

Additionally, the optimizer function improves the distillation rate by controlling the heating power to avoid surges or decreases in the distillation rate. This predictive control maintains the distillation rate within the 4 to 5 mL specified in the D86 method.

The final heat adjustment is also controlled by the optimizer, avoiding the guesswork in this difficult step. OptiDist frees operator time while giving repeatable results every time from the first run and eliminates the need of running duplicate samples to find the optimized parameters.

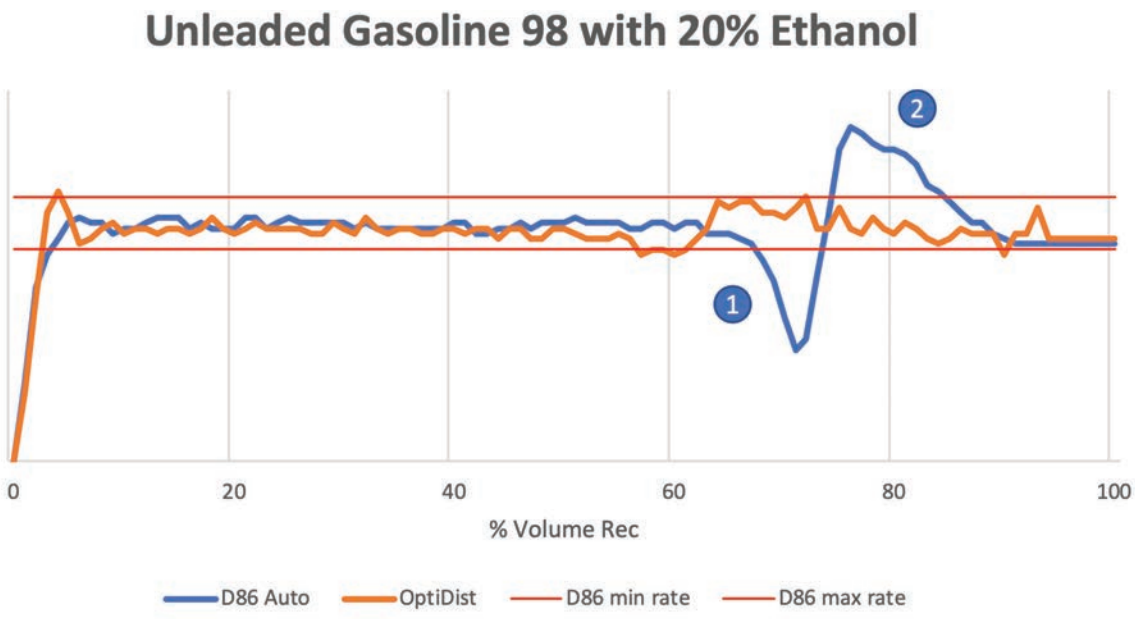

Figure 1:
A comparison of distillation rates for gasoline containing 20% ethanol run in a traditional D86 analyzer and OptiDist with optimizer technology.

RESULTS

OptiDist is the only D86 analyzer capable of running a full distillation, from IBP to FBP, without any sample-related input by the operator. There is no need to select a distillation group or preloaded program, and there is no requirement to control initial or final heat rates.

Figure 1 shows distillation rates for gasoline containing 20% ethanol run both in a traditional D86 automated analyzer (blue) and with OptiDist with its unique optimizer (orange). The azeotropic point for a 20% blend is around the 70% volume. Figure 1 shows a deep decline in the distillation rate ❶ when distilled with a traditional D86 automatic analyzer (blue). This happens as the distillation reaches the azeotropic point, where the boiling stops.

Traditional D86 automated analyzers will increase heating power as a reaction to declining distillation rates. The additional heating increases the sample temperature, but is not reflected until the azeotrope breaks, seen in Figure 1 as a sharp increase in distillation rate. At this point ❷ the distillation rate goes from its lowest point around 2.1 mL/min up to its highest point around 6.3 mL/min in less than 5% of the recovered volume. Figure 1 also shows OptiDist distillation when run with the optimizer (orange). OptiDist, via the optimizer, takes control of the heating rate and predictively controls the heating rate and determines when the sample temperature declines or surges long before the distillation rate dips or spikes, resulting in more stable control and better site repeatability and reproducibility.

CONCLUSION

Lab distillation is used for many purposes, including process monitoring and fuel certification for product release. Product quality is closer to specified limits, which reduces costly giveaway. It also means a faster response time, since repeating tests becomes unnecessary. This adds up when each distillation test takes 40 to 60 minutes, including preparation and cleaning time.

Tests run with OptiDist with the optimizer function result in better distillations, even for difficult samples such as contaminated products, ethanol containing gasolines, and even unknown samples.