

Diana 700: Distillation of Gasoline/Diesel Mixtures

Relevant for: Refineries, Tank terminals, R&D

Tank terminals might use the same pipeline to transport various oil and petroleum products to and from the refinery, leading to changing mixtures and impurities in the arriving products.

Atmospheric distillation can be used to analyze the ratio of gasoline/diesel mixtures and to measure impurities to guarantee fuel quality according to the respective specification.



GPS Amsterdam Terminal, facility for storing and blending gasoline, oil, and bio fuels (Source: Wikipedia)

1 Introduction

Tank or oil terminals consist of a number of tanks for storing different products like motor gasoline, diesel fuel, heater oil, heavy oil, or naphtha.

Oil terminals, located close to or as part of refineries are connected through a pipeline to draw or send the products.

If different products are transported through the same pipeline, the product quality and purity need to be carefully supervised to avoid residues of unwanted mixtures or contaminations.

This application report describes the use of the automatic distillation unit Diana 700 for quality control of storage tanks which are supplied with gasoline and diesel through the same pipeline.

The product change between gasoline and diesel is usually supervised by an inline density meter. With the help of the density values it is decided how and when to cut the products.

Impurities of the second product that is transferred to the tanks can be identified by flash point determination and / or atmospheric distillation.

The intermediate product (the cut) is stored in extra tanks and can be reused in the refinery for new production. Usually, this cut contains diesel and gasoline in an approximate ratio of 50/50.

To check the cut, a distillation is performed determining the approximate ratio of gasoline and diesel by a distillation in distillation group 1, finishing at approx. 190 °C and evaluating the recovery of the distillation. With this approach it is anticipated that the gasoline has distilled over until 190 °C whereas the diesel will only start to boil at approximately 180 °C.

Diana 700 is also able to perform a complete distillation of such a mixture by adapting the parameters in the course of the measurement according to the requirements of the respective distillation group.

Smaller impurities of diesel in gasoline or gasoline in diesel can also be determined by atmospheric distillation:

Diesel impurities in gasoline:

According to the gasoline specification standard EN 228

- the final boiling point of gasoline must not be above 210 °C
- the residue of the gasoline distillation shall not be above 2 mL

Diesel impurities will result in a higher final boiling point and higher distillation residue.

Gasoline impurities in diesel:

According to the diesel specification standard EN 590, the flash point value for diesel which has to be determined according to the method EN ISO 2719 has

to be above 55 °C. Impurities of gasoline will cause a significantly lower flash point.

Impurities of gasoline in diesel can also be determined by atmospheric distillation.

As the criteria of EN 590 for the distillation properties of diesel in most cases will not detect a low gasoline content, this application report will describe how to use the initial boiling point (IBP) for this purpose.

This application report describes the distillation of different mixtures of gasoline with diesel with the automatic distillation unit Diana 700.

2 Accessories

To test the gasoline/diesel mixture samples, we used the following accessories:

- **186744** Distillation flask, 125 mL
- **237547** Multi-plug with metal Pt100
- **195234** Receiving cylinder, 100 mL
- **194531** Drip plate
- **106219** Boiling stones
- **184290** Flask support board, 38 mm
- **194645** Flask support board, 50 mm
- **191097** Condenser tube stopper
- **172676** Residue cylinder

3 Samples

- Gasoline/diesel mixtures 25/75, 50/50, 75/25
- Gasoline plus 1 %/2 %/5 %/ 10 % diesel
- Diesel plus 1 %/2 %/5 %/ 10 % gasoline

4 Settings

Depending on the gasoline/diesel mixtures, different methods were used.

4.1 25/75, 50/50 and 75/25 Gasoline/Diesel Mixtures

A user-defined method has been created to test the 25/75, 50/50 and 75/25 gasoline/diesel mixtures.

This user-defined test method will switch the condenser temperature from distillation group 1 conditions (0-1 °C) to distillation group 4 conditions at a vapor temperature of 180 °C, that is considered as the approximate initial boiling point for diesel.

The parameters were set according to the following table:

Parameter	Setting
Temperature acquisition	Automatic
Flask support board	38 mm
Distillation flask volume	125 mL
Timing	
Time to IBP	300 s to 600 s
Time from IBP to 5 % recovery	Min: 1 min, Max: 1 min 40 s
Time from 5 % residue to FBP	Min: 0 min, Max: 5 min
Heater	
Heater control mode	Automatic
Heater control type	ASTM D86 group 1
Distillation rate mode	Automatic
Distillation rate (mL/min)	Min: 4 mL/min, Max: 5 mL/min
Final heat adjustment at	90.5 %
Change heater power by	25 %
Temperature	
<i>Condenser</i>	
Condenser mode	Switch at vapor temperature
Condenser temperature	Min. 0.0 °C, Max. 1.0 °C
Vapor temperature	180 °C
Final condenser temperature	Final min. 49.0 °C, Final max. 51.0 °C
<i>Chamber</i>	
Relative to ambient temperature	No
Chamber mode	Automatic
Chamber temperature	Min. 13.0 °C, Max. 18.0 °C
Stem error emulation	8C
Distillation end	
Stop condition/End of distillation	FBP or DP
End point threshold	1.0 °C
Follow-up time	<= 0.1 mL/2min

All other parameters were left to their default values.

4.2 Gasoline with $\leq 10\%$ Diesel

For mixtures of gasoline with up to 10 % diesel, the following standard methods can be used:

- ASTM D86 group 1
- ISO 3405 group 1

4.3 Diesel with $\leq 10\%$ Gasoline

For mixtures of diesel with up to 10 % gasoline, the following standard methods can be used:

- ASTM D86 group 4
- ISO 3405 group 4

5 Measurement

1. Precool the glassware and sample if required.
2. Launch the **"Easy distill"** feature.
3. Define a sample name.
4. Select the appropriate test method.
5. Clean the condenser tube by threading the cleaning wire with the cleaning material through the tube and pulling it out.
6. Select and place the flask support board in the heating chamber.
7. Slip the stopper onto the condenser tube.
8. Select the distillation flask.
9. Measure 100 mL of the sample in the receiving cylinder.
10. Place the cylinder into the cooling chamber. Tap **"Scan volume"**.
11. Pour the sample into the distillation flask. Add 2 or 3 boiling stones to the sample.
12. Insert the multi-plug into the flask. Attach the flask to the condenser tube.
13. Insert the drip plate into the receiving cylinder.
14. Place the receiving cylinder into the cooling chamber if not already done so. Close the cooling chamber.
15. Tap <DISTILL>.
16. After the distillation, measure the residue in the flask using the 5 mL graduated cylinder or perform an automatic residue scan by tapping **"Automatic volume scanning"**.
17. Tap <Edit> and enter the amount into the "Residue" field.

6 Test Results

All ranges of gasoline/diesel mixtures have been distilled successfully with Diana 700.

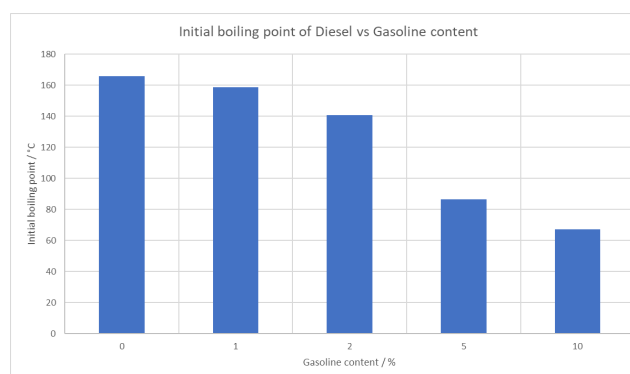
The user-defined method worked perfectly for determining the approximate gasoline/diesel ratio in the cut.

The standard methods were successfully used to analyze the smaller concentrations of diesel in gasoline or gasoline in diesel.

6.1 Distillation of Diesel with $\leq 10\%$ Gasoline

For the mixtures containing 10 % or less gasoline in diesel the evaluation of the initial boiling point (IBP) shows a clear depression of the IBP with increasing gasoline content:

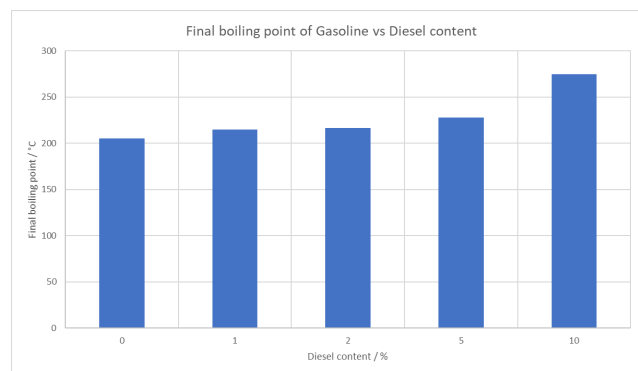
Gasoline content (%)	IBP (°C)
0	165.7
1	158.7
2	140.6
5	86.6
10	67.3



6.2 Distillation of Gasoline with $\leq 10\%$ Diesel

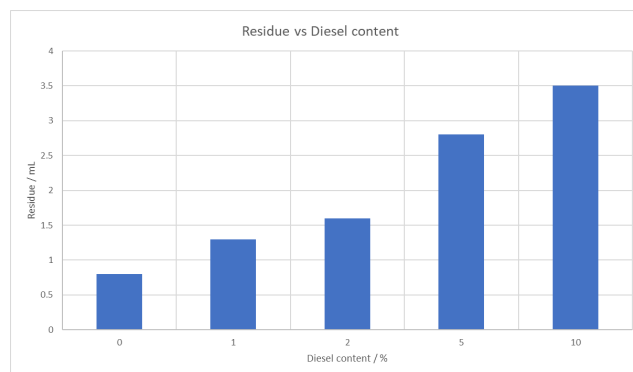
For the mixtures of 10 % or less diesel in gasoline the evaluation of the final boiling point (FBP) shows a significant rise in temperature with increasing diesel content and violation of the 210 °C criterion of EN 228:

Diesel content (%)	FBP (°C)
0	205.1
1	214.7
2	216.3
5	227.6
10	274.9



Furthermore, a significant increase of the distillation residue with rising diesel content could be observed. The violation of the 2 mL criterion of EN 228 became obvious with a diesel content $> 2\%$.

Diesel content (%)	Residue (mL)
0	0.8
1	1.3
2	1.6
5	2.8
10	3.5



Summary:

Diana 700 is a valuable tool for supervising the purity of gasoline and diesel and can be applied in the product quality check in tank terminals.

Contact Anton Paar ProveTec GmbH

Tel: +49 (0)33708 56-300

support.provetec@anton-paar.com

www.anton-paar.com