Application Note EDXRF3000

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EDXRF3000 - EPA Tier 3 Gasoline

Scope

Compliance with the U.S. EPA Tier 3 Gasoline PBMS testing protocol and performance is demonstrated.

Background

In 2016 the U.S. EPA began phasing in Tier 3 gasoline, mandating the maximum allowable sulfur in gasoline to be 10 ppm (10 mg/kg). To this end, the EPA has established PBMS (performance-based testing requirements) similar to those for ULSD. The EPA allows any testing method that complies with the performance guidelines for accuracy and precision. To meet these needs, Applied Rigaku Technologies offers NEX CG II monochromatic EDXRF using Cartesian Geometry polarization. Ideal for ultra-low sulfur measurements such as Tier 3 gasoline and ULSD, NEX CG II is a multi-element analyzer capable of also measuring other applications throughout the petroleum industry. Powerful yet simple and intuitive to operate, the NEX CG II is an excellent tool for downstream analyses as well as midstream and upstream.

International norms

The Rigaku NEX CG II EDXRF analyzer meets several international norms and EPA testing criteria for measuring sulfur in petroleum oils, fuels, and ULSD using monochromatic EDXRF.

Standard method	Sulfur range
ASTM D7220	3 – 942 mg/kg
U.S. EPA ULSD Testing Criteria	5 – 15 ppm

ISO 13032	8 – 50 mg/kg
ASTM D4294	16 mg/kg – 5%
IP 532	6 – 50 mg/kg
EN ISO 8754	300 mg/kg – 5%
EN ISO 20847	30 – 500 mg/kg

The units ppm and mg/kg can be used interchangeably.

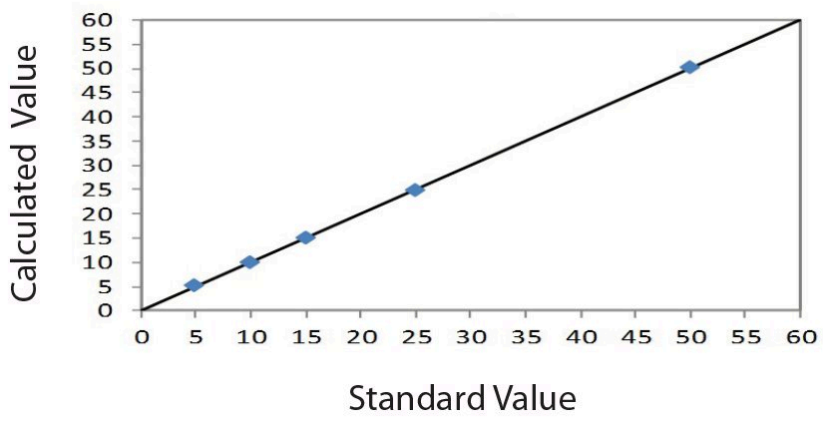
Units

The units ppm and mg/kg are often used interchangeably. The U.S. EPA uses the units ppm.

Calibration

Empirical calibration was built using a suite of commercially available certified gasoline calibration standards.

Element: S **Units: ppm**		
Sample I.D.	**Standard value**	**Calculated value**
2	5	5.1
3	10	9.9
4	15	15.0
5	25	24.9
6	50	50.2



Calibration plot S

U.S. EPA PBMS Testing 40 CFR 80.47

The following results summarize NEX CG II performance using the EPA testing criteria for Tier 3 gasoline as per 40 CFR 80.47 using good lab practice and proper sample preparation and presentation for ultra-low sulfur in fuel samples.

Part 1: Precision

80.47 13.b.1 –

- Use a commercially available certified gasoline sample with sulfur content between 5 – 15 ppm
- Measure 20 aliquots over 20 days and calculate standard deviation(s)
- Criteria: Maximum allowable s ≤ 1.5*r/2.77, where r is the repeatability shown in ASTM D7039
- Example: 10 ppm sulfur: s ≤ 1.75/2.77 = 0.95 ppm

NEX CG II Test Sample: Certified Gasoline Sample 10.0 ppm S			
Average	**Standard deviation (s)**	**Criteria**	**Determination**
10.1 ppm S	0.3 ppm	0.3 ≤ 0.95 ppm	PASS

Part 2: Accuracy

80.47 13.b.2(i) –

- Use a commercially available certified gasoline sample with sulfur content between 1 – 10 ppm
- Measure a continuous series of at least 10 tests and calculate the average of the results (AVG)
- Criteria: The AVG cannot deviate from the accepted reference value (AVR) by more than 0.71 ppm
- |AVR – AVG| ≤ 0.71 ppm

NEX CG II Test Sample: Gasoline certified ARV 10.0 ppm S				
Average of 10 Tests (AVG)	**Standard deviation**	**Difference from certified value |AVR – AVG|**	**Criteria**	**Determination**
10.2 ppm S	0.2 ppm	0.2 ppm	0.2 ≤ 0.71	PASS

80.47 13.b.2(ii) –

- Use a commercially available certified gasoline sample with sulfur content between 10 – 20 ppm

- Measure a continuous series of at least 10 tests and calculate the average of the results (AVG)
- Criteria: The AVG cannot deviate from the accepted reference value (AVR) by more than 1.0 ppm
- |AVR – AVG| ≤ 1.0 ppm

NEX CG II Test Sample: Gasoline certified ARV 15.0 ppm S				
Average of 10 Tests (AVG)	**Standard deviation**	**Difference from certified value |AVR – AVG|**	**Criteria**	**Determination**
15.8 ppm S	0.4 ppm	0.8 ppm	0.8 ≤ 1.0	PASS

Conclusion

Using good lab practices, NEX CG II can be used to comply with U.S. EPA Tier 3 Gasoline performance-based testing protocols. NEX CG II achieves this excellent performance using monochromatic EDXRF with Cartesian Geometry polarization. Ideal for use at refineries and midstream and upstream, the NEX CG II is a multi-element analyzer capable of measuring sodium (Na) to uranium (U) in many petroleum applications.

Related products

NEX CG II Series

High-performance *indirect excitation* EDXRF for complex ap
plications with trace elements and variable base matrices