Abstract
The Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF) is a fast, simple, and non-destructive analysis technique, used for the measurement of liquids, powders, and solids. It is widely applied throughout the petroleum industry for various purposes, including but not limited to upstream at the well site, mid-stream at pipelines, storage facilities, and blending operations, and down-stream at the refinery.

Recently, with the Environmental Protection Agency (EPA) mandating new regulations on the composition of fuel, the maximum allowable sulfur content has been scaled down to 10 parts per million (ppm). Therefore, the EDXRF is an ideal analytical tool for refiners - with good lab practices to accurately determine the sulfur content in fuel samples, conforming to not only ASTM D7220, but also meeting the testing requirements for the EPA Tier 3 program for ultra-low sulfur fuels such as gasoline and diesel.

Furthermore, the EDXRF can be used to determine concentration of some elements such as manganese, lead, zinc, phosphorus, and sulfur. EDXRF is also ideal for the determination of M, C, H, F, and Ni in crude, resid, and bunker fuel. The determination of manganese and lead content gives an indication of the anti-knock agent added to motor gasoline and avgas to improve octane rating. Whilst the determination of zinc, phosphorus, calcium, and sulfur give an indication of the antioxidant, and antiwear agents in lubricating oils. The versatile application of the EDXRF allows end-users to effectively ascertain correct results for this desired use, and conform to international testing standards.

Koehler EDXRF Systems
Sulfur (S) measurement is one of the most important measurements to make in the petroleum industry. The Koehler line of benchtop EDXRF systems are designed with unique features to give best sulfur results from crude oil, diesel and middle distillates by ASTM D4294, to ULSD and U.S. EPA Tier 3 gasoline by ASTM 7220. Features include simple software operation for the non-technical and technical operators alike. Koehler uses high performance Si PIN diode and SID detectors giving the ability for multi-element analysis as well, measuring not only S but also other petro apps as well, including Mn and Pb in gasoline, metals in crude and resid, and CI measurement from high levels to ultra-low levels.

To achieve this range of performance, Koehler system employs either direct excitation or indirect excitation. Koehler direct excitation systems produce polychromatic source X-Rays and background correction is achieved with a unique multi-layer filters which remove extra background of X-Rays. Indirect excitation provides monochromatic polarized source X-rays for the near complete removal of all background.

EDXRF Technology’s Applications to Measure the Sulfur Content in Ultra-Low-Sulfur Fuels and to Measure Organometallic Additives in Lubrication Oils and Motor Gasoline

EDXRF Quick Facts

- A fast, simple and non-destructive analysis technique
- Enables measurement of liquids, powders, and solids
- ASTM D4294 and ISO 13032: 2000 provides ASTM D4294 performance with 10 ppm S to 1% levels, while D6200 adds ultra-low performance to 8 ppm S by ISO 13032
- Usages in the Petroleum Industry
  - Crude Oil
  - Diesel
  - ULSD
  - Gasoline
  - Biofuels
  - Jet Fuel & Aviation
  - Kerosene & Heating Oil
  - Metalworking Fluids

EDXRF Quick Facts

- Features
  - Indirect excitation using secondary target and full collimated polarization providing monochromatic radiation for optimal background removal

EDXRF Quick Facts

- ASTM D4294
- ISO 13032
- Ultra-Low-Sulfur Fuel

Table: Standard Value vs. Calculated Value

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Actual Value</th>
<th>Calculated Value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>97</td>
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<tr>
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<td>803</td>
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<tr>
<td>STD 6</td>
<td>1000</td>
<td>999</td>
</tr>
</tbody>
</table>

Sample Preparation
First, the user ensures that each sample is homogeneous and stable. Then the user simply shakes the sample gently, allows the bubbles to settle, and fills an XRF sample cup with 4.0 grams of sample to ensure consistent sample depth. Prolene film (or 4µm polypropylene) is used for diesel and other similar fuels, and Etnom™ film is used for gasoline and aromatic hydrocarbons. Cap and vent the cup, and make sure to check for leaks using lab tissue. The measurement should be made immediately after preparing the sample.

(Etnom™ is a registered trade mark of Chemplex Industries.)

EDXRF Quick Facts

- EDXRF D6200 and D6200A analyses use direct excitation and special filters to provide optimum polychromatic and full.

EDXRF Quick Facts

- ASTM D2494
- ASTM D7220
- ISO 13032
- U.S. EPA Tier 3 Gasoline

Koehler System

- EDX1000
- EDX2000
- EDX3000

EDXRF Quick Facts

- ASTM D4294
- ASTM D7220
- ISO 13032
- U.S. EPA Tier 3 Gasoline

Koehler System

- 16 ppm – 5% Sulfur
- 3 – 942 mg/kg Ultra-low Sulfur
- 8 – 50 mg/kg Ultra-low Sulfur
- 2-12 mg/kg Cl in Crude by Naphtha Wash
- 10 ppm S in Gasoline

EDXRF Quick Facts

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- ASTM D7220
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