Elvatech
Advanced XRF equipment and solutions

ElvaX Light
for Petrochemical analysis

Introduction

ElvaX Light is a powerful and productive instrument for analysis of petroleum products, such as automotive fuels (gasoline, diesel), lubricating oil, crude oil, heavy fuel oil and other. This products is analyzed for sulfur and chlorine content, for wear metals and additives.

Due to low detection limits (down to ppm level) and minimal required sample preparation ElvaX Light is an ideal tool for petrochemical analysis.

Application

Key applications include:

- Sulfur in automotive fuel. Sulfur forms damaging sulfates in vehicle exhaust and pollutes the atmosphere by sulfur oxides. Furthermore sulfur reduces fuel stability and effects on engine performance.
  Maximum permissible level of sulfur in fuel decreases from year to year. XRF is a recommended technique in several testing methods, such as ASTM D4294.
  ElvaX Light fully complies ASTM D4294 requirements.
- Unused lubricating oil analysis. Some oils are formulated with organo-metallic additives, which act, for example, as detergents, antioxidants, and antiwear agents. Oil additives usually contain Mg, Si, P, S, Cl, Ca, Cu, Zn, Mo and Ba.
  ASTM D6481 is a method for determining of phosphorus, sulfur, calcium and zinc in unused lubricating oil.
  ElvaX Light fully complies ASTM D6481 requirements and in addition can measure other elements (Mo, Ba, Mn).
- Monitoring of wear metals in used lubricating oils. Concentration of wear metals in the oil may indicate engine damage. For example, Cu and Sn from bearing and bushing wear Cr and Mo from piston rings and seal, Al and Si from catalyst residues.
  ElvaX Light can easily measure low concentrations of wear metals (Fe, Cu, Pb, Sn, Ni, Zn, Al, Cd, Ag, Ti, V and other) in lubricating oil.

Instrumentation

ElvaX Light is an benchtop energy-dispersive x-ray fluorescence spectrometer. It equipped with 40 kV Silver anode tube and large area Fast Silicon Drift Detector (FSDD), which provides excellent energy resolution, low detection limits and high productivity.

Instrument provides excellent sensitivity to light elements (including sulfur and chlorine) because of helium purge facility.

Silver anode x-ray tube prevents line overlaps with chlorine and performs lower chlorine detection limit compared to rhodium or palladium anode tubes.

ElvaX software has a user-friendly interface and requires minimal operator training.

Method

Petrochemical products analysis doesn't require any sample preparation without weighing or volumetric measurements. Liquid samples are poured into the sample cells and assembled with a thin Ultralyne © film.

Several oil standards were used to calibrate spectrometer for Si, S, Ca, V, Cr, Fe, Ni, Cu, Zn, Mo, Ba, Sn, Pb.

Calibration curve for sulfur covers both low (till 1000 ppm) and high (from 0.1% to 5%) ranges.

Measurement time was 120 seconds. Anode voltage in main mode was 10 kV without primary beam filter.

Results

1. Calibration curves.
   Figures 1-14 shows the correlation curves for various wear elements in oil (Si, S, Ca, V, Cr, Fe, Ni, Cu, Zn, Mo, Ba, Sn, Pb).
   This data was approximated with linear function. R^2 is the coefficient of determination which shows how closely lab and XRF results correlate to each other. An ideal correlation would have an R^2 value of 1.
   Obtained results indicate a good correlation between certified and measured concentration values.

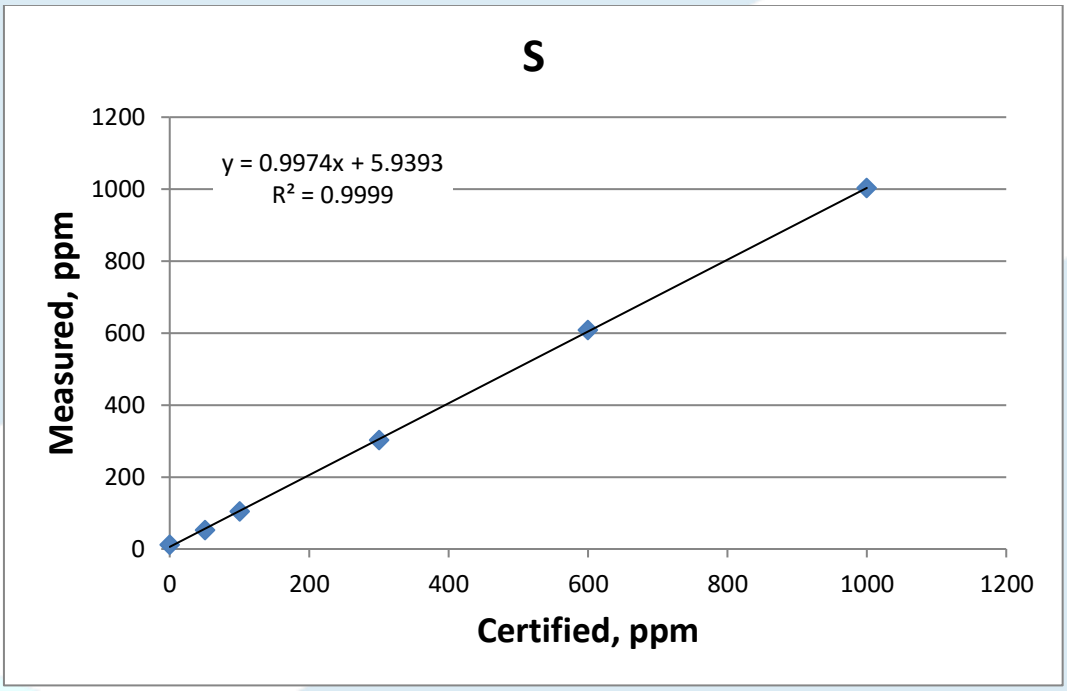

Figure 1. Correlation curve for sulfur in oil from 0 to 1000 ppm concentration range.

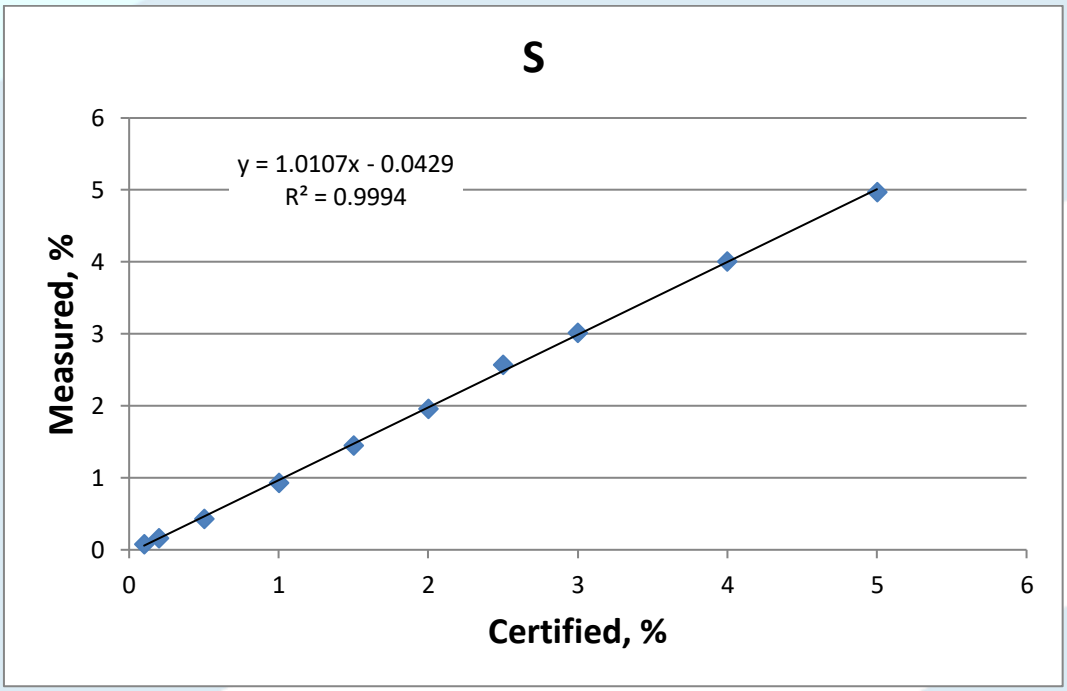

Figure 2. Correlation curve for sulfur in oil from 0.1 to 5 % concentration range.

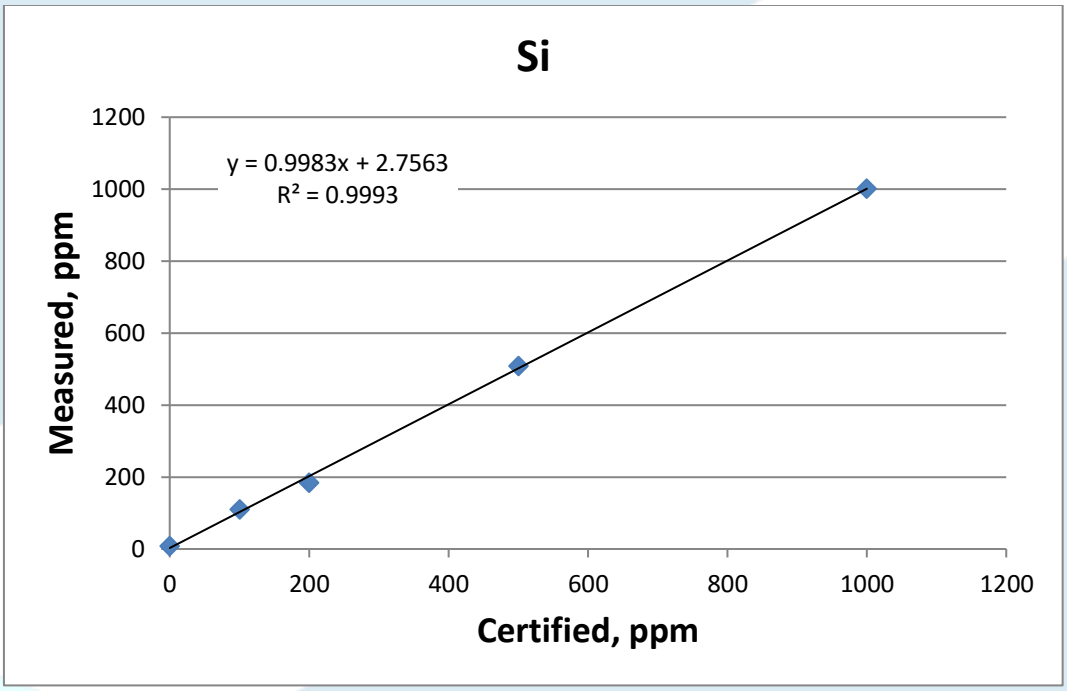

Figure 3. Correlation curve for silicon in oil.

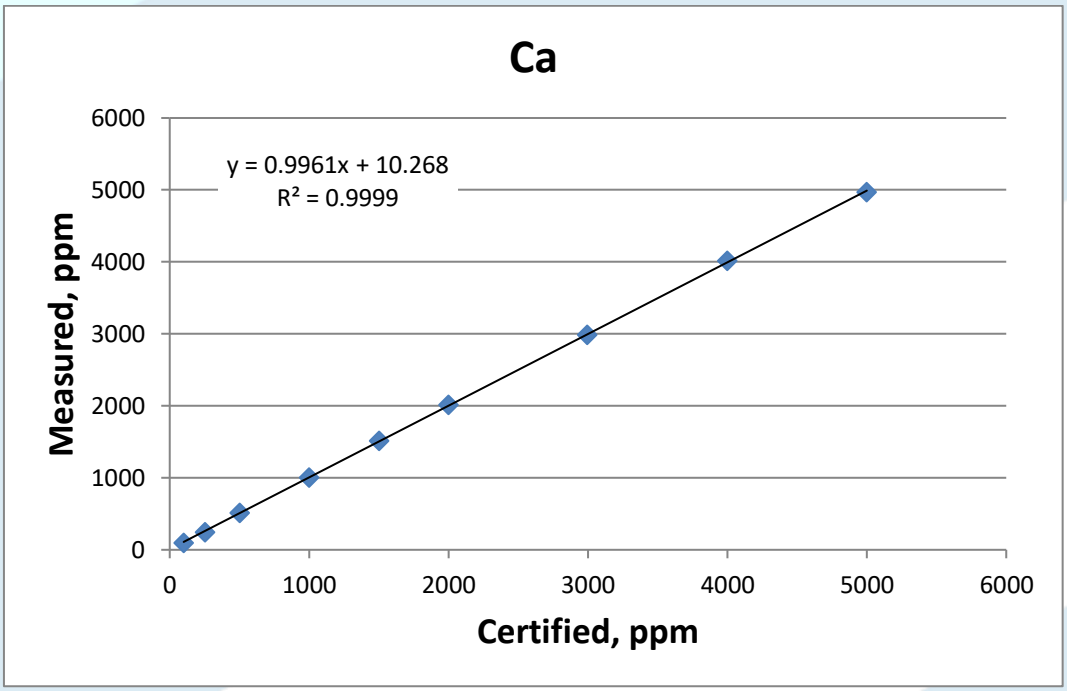

Figure 4. Correlation curve for calcium in oil.

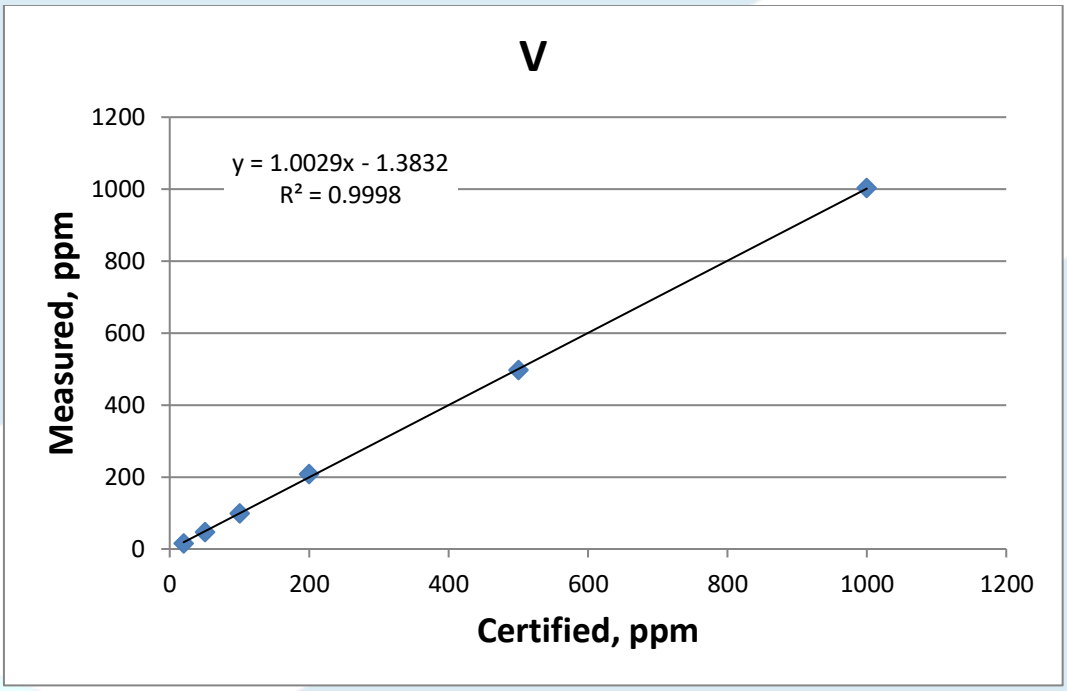

Figure 5. Correlation curve for vanadium in oil.

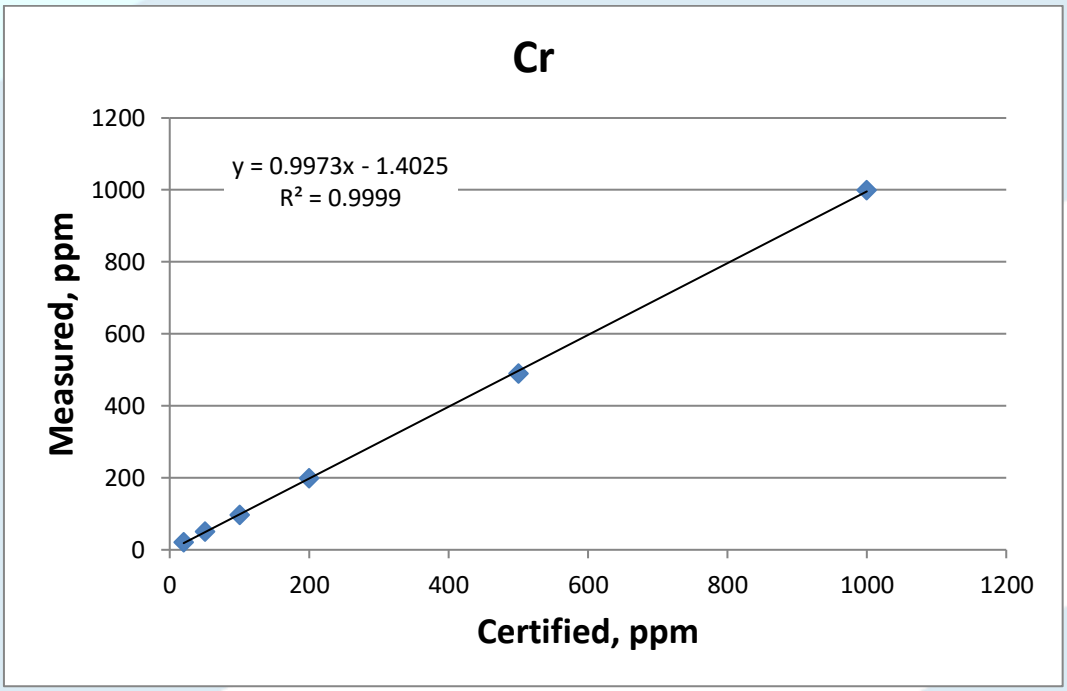

Figure 6. Correlation curve for vanadium in oil.

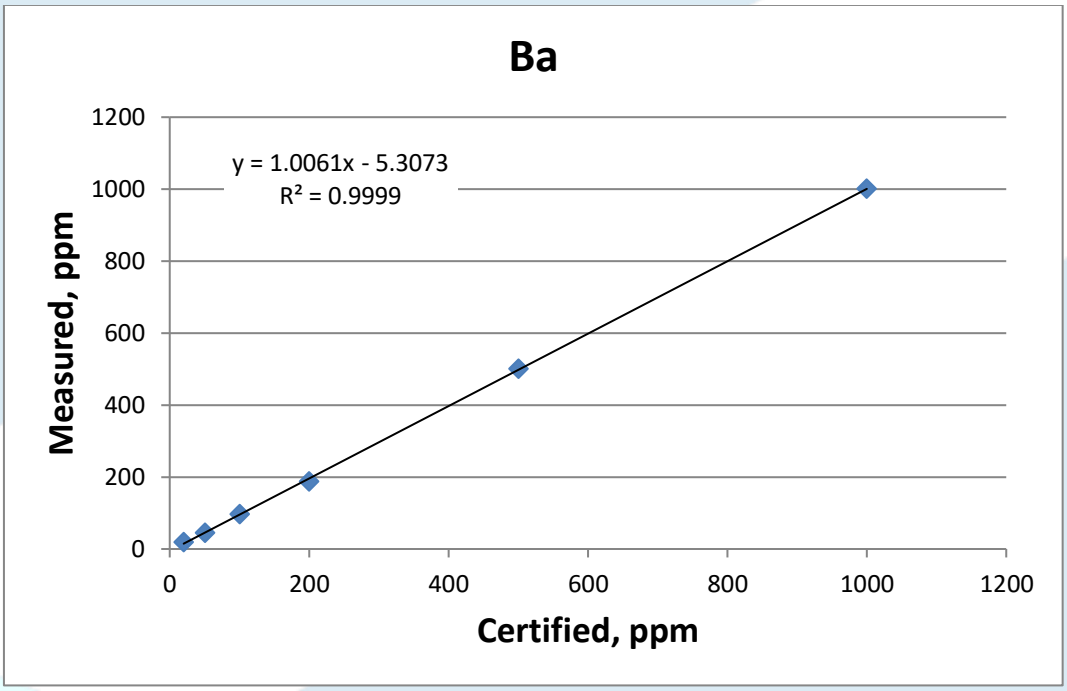

Figure 7. Correlation curve for barium in oil.

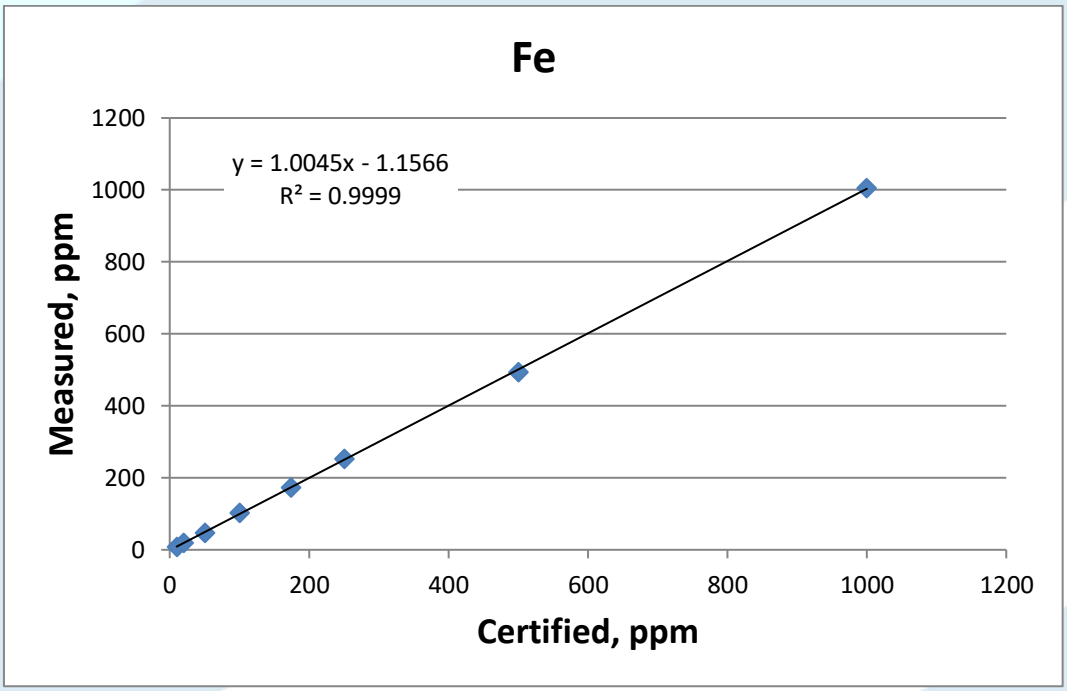

Figure 8. Correlation curve for iron in oil.

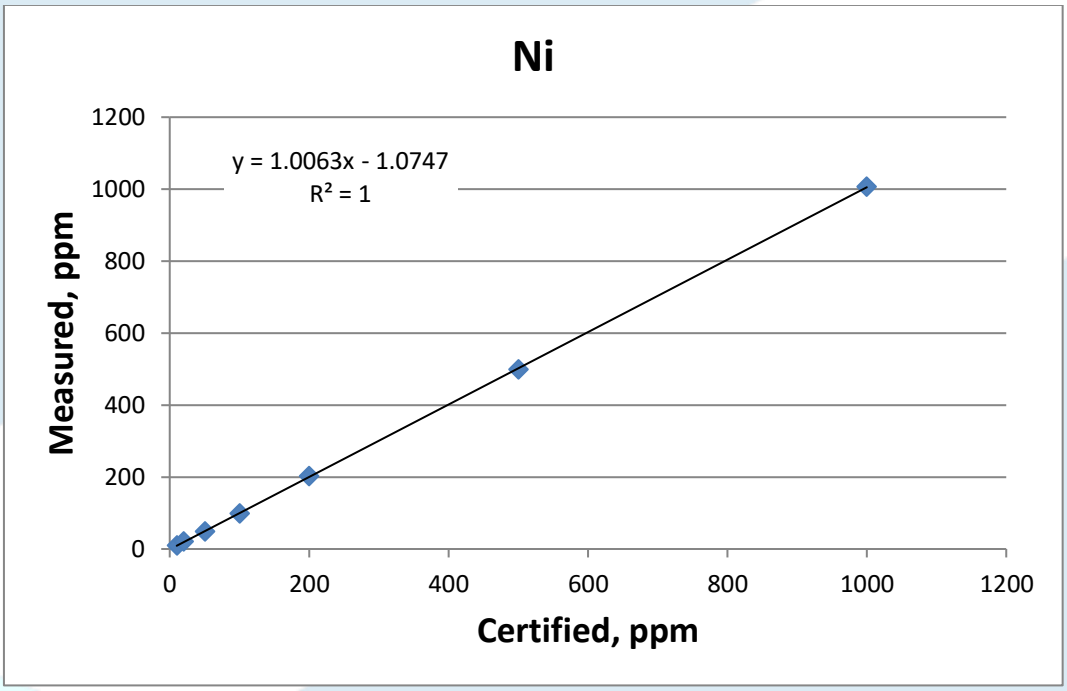

Figure 9. Correlation curve for nickel in oil.

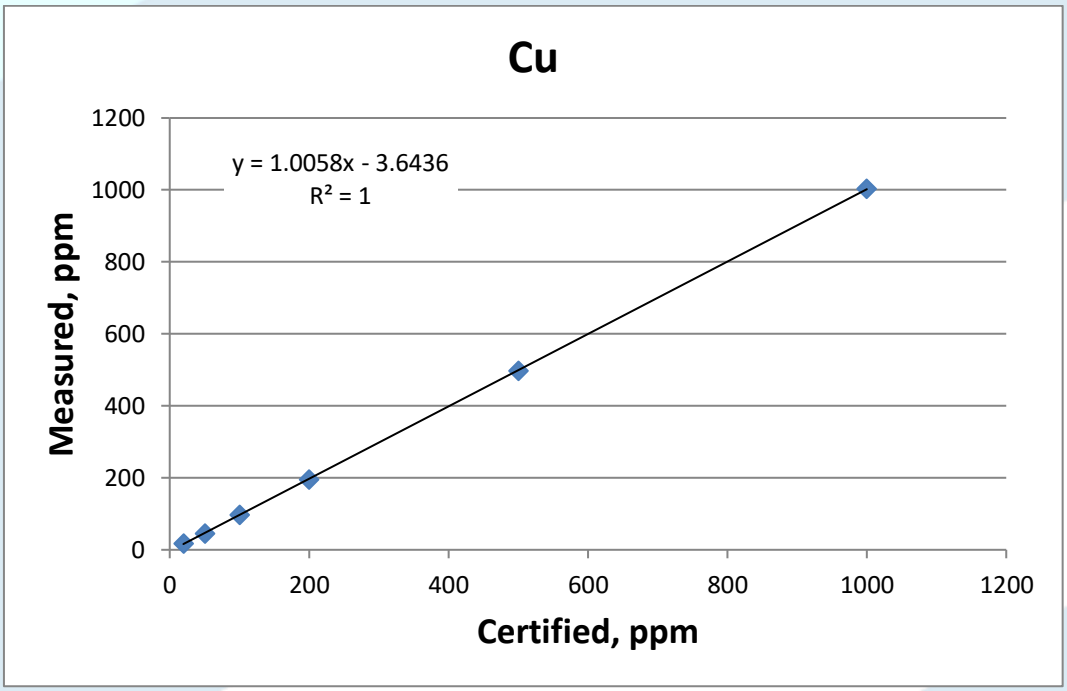

Figure 10. Correlation curve for copper in oil.

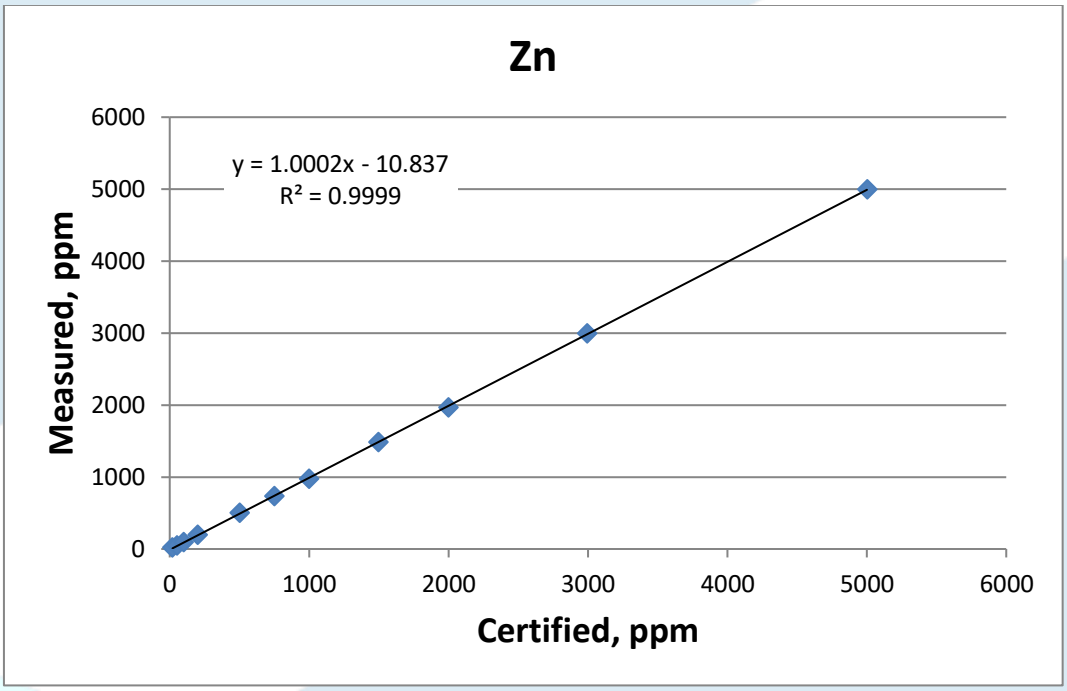

Figure 11. Correlation curve for zinc in oil.

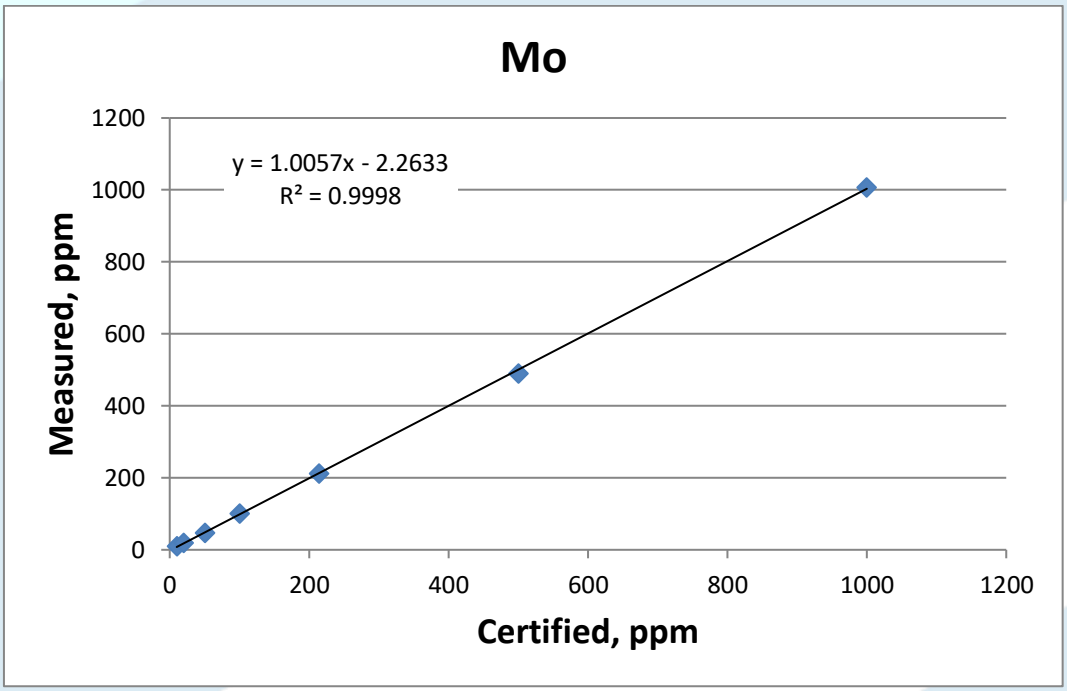

Figure 12. Correlation curve for molybdenum in oil.

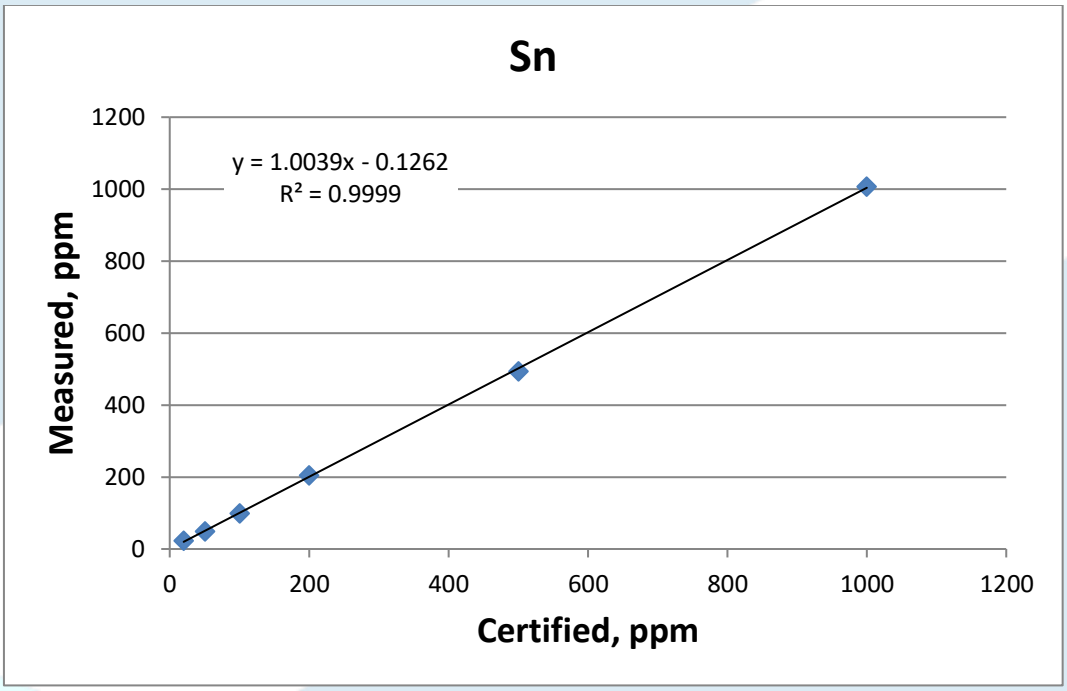

Figure 13. Correlation curve for tin in oil.

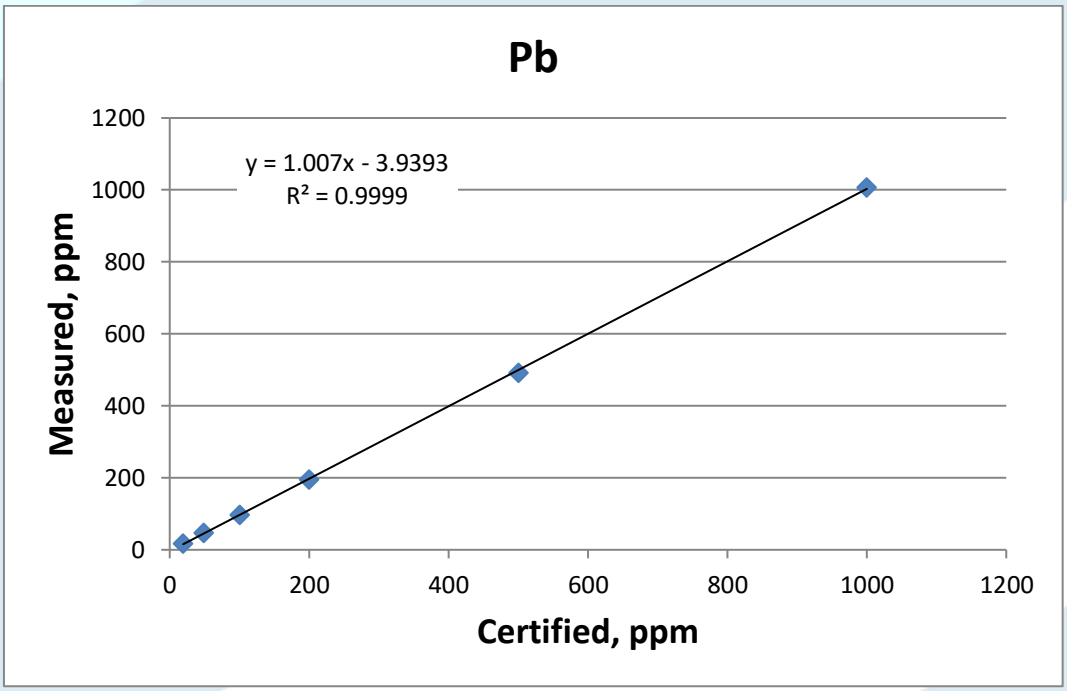

Figure 14. Correlation curve for lead in oil.

2. Detection limits.

Table 1 illustrates limits of detection for various elements (including sulfur and chlorine) in oil obtained by ElvaX Light spectrometer.

Element	LOD, ppm
Si	50
S	2
Ca	15
V	5
Cr	5
Fe	2
Ni	3
Cu	4
Zn	4
Mo	3.5
Ba	10
Sn	20
Pb	5

Table 1. Detection limits for elements in oil.

This data is plotted in logarithmic scale on figure 15.

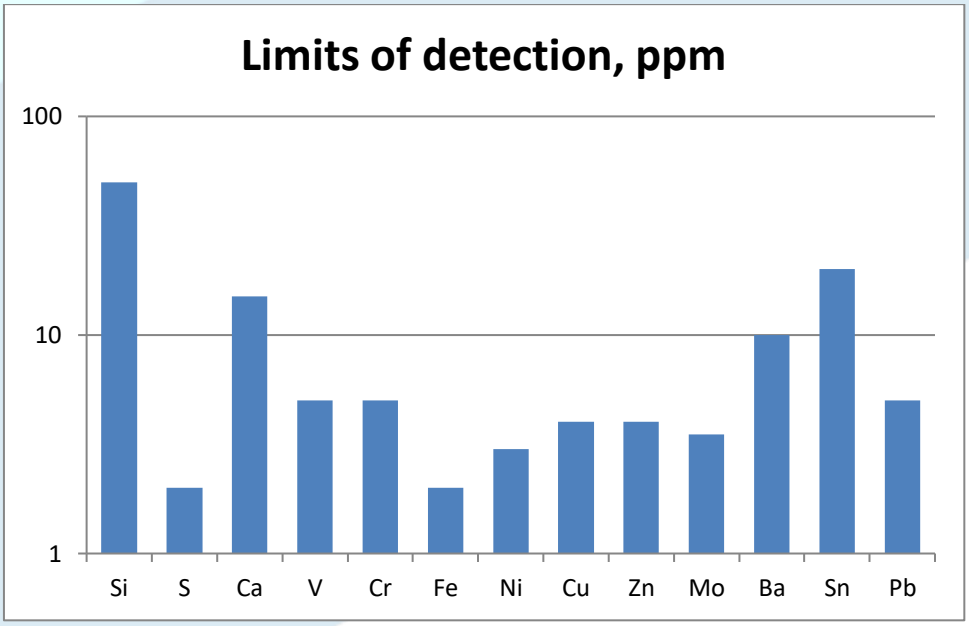

Figure 15. Detection limits for element in oil.

3. Repeatability.

Another important parameter of XRF device is the repeatability of the analysis. The sample of oil was measured 10 times over a period of time. An average, standard deviation (Std Dev) and relative standard deviation (RSD) for Fe, Cr, Ni, Mo content was calculated from this data. Results are given in Table 2.

Conclusions

Obtained results indicate a good correlation between certified and measured concentration values for sulfur, chlorine and wear metals in wide concentration range.

ElvaX Light covers stringent international test methods, such as ASTM D4294 (Determination of sulfur in automotive fuel), ASTM D6481 (Determination of phosphorus, sulfur, calcium, and zinc in lubrication oils).

Detection limit for sulfur reaches several ppm levels.

Due to excellent precision, high performance, ease of use and cost-effectiveness ElvaX Light became a perfect instrument for petroleum products analysis from ppm to % concentration range.