ElvaX ProSpector for Car Catalyst analysis

Introduction

Catalytic converters in cars are used for reduction of hazardous emissions, such as carbon monoxide (CO), hydrocarbons (H_xC_y) and nitrogen oxides (NO_x). These harmful substances are converted into carbon dioxide (CO_2), water and nitrogen by some chemical reactions, which are accelerated by three platinum group metals (PGM): platinum, palladium and rhodium.

Application

Due to great amount of car catalyst types, an amount of PGM's varies significantly. Then rapid and accurate testing method is required. ElvaX ProSpector provides precise and fast catalytic converters analysis for simple sorting and price evaluation. Usually, a concentration of PGM's in car catalyst is much higher, than in ores.

Instrumentation

ElvaX ProSpector is a handheld ED-XRF spectrometer equipped with 40kV tungsten anode tube and Silicon drift detector (SDD) or PIN detector. Tungsten anode tube is a best choice for platinum group metals analysis because of absence of overlapping Rh, Pd K-lines with scattered lines.

ElvaX ProSpector is rugged and light (around 1.5 kg) and provides full-day (8 hours) of constant operations on battery. Device has intuitive user interface and requires very little operation training. Typical measurement screen in Car catalyst analysis mode is shown at Fig. 1.
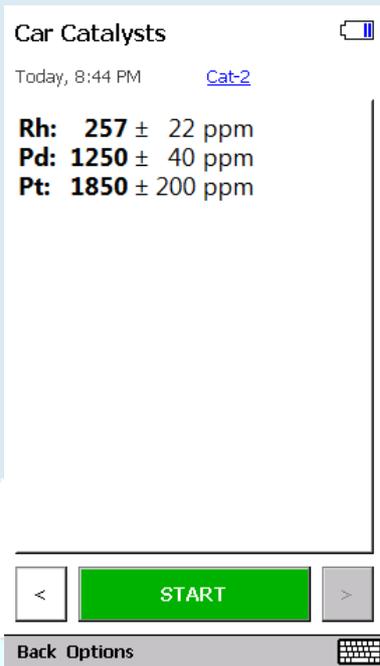
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Car Catalysts

Today, 8:44 PM   Cat-2

Rh: 257 ± 22 ppm
Pd: 1250 ± 40 ppm
Pt: 1850 ± 200 ppm

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Figure 1. Measurement screen in Car catalyst testing mode.

Method

Car catalyst is a non-homogeneous material, than sample preparation is required for accurate analysis. Catalyst is crushed, milled, pulverized to a maximum 250 um powder and loaded into XRF 32 mm sample cups.

ProSpector was calibrated for platinum, palladium and rhodium using 10 commercially available catalytic converters standards.

Anode voltage is 40 kV with Ni300+Al300 primary beam filter. Typical measurement time is 10 seconds for ProSpector with SDD detector and 30 seconds with PIN detector. Duration can be increased for better precision.

Testing results

Figures 2-4 show the correlation curves between certified concentrations and measured by ElvaX ProSpector for platinum, palladium and rhodium in catalytic converters.

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.
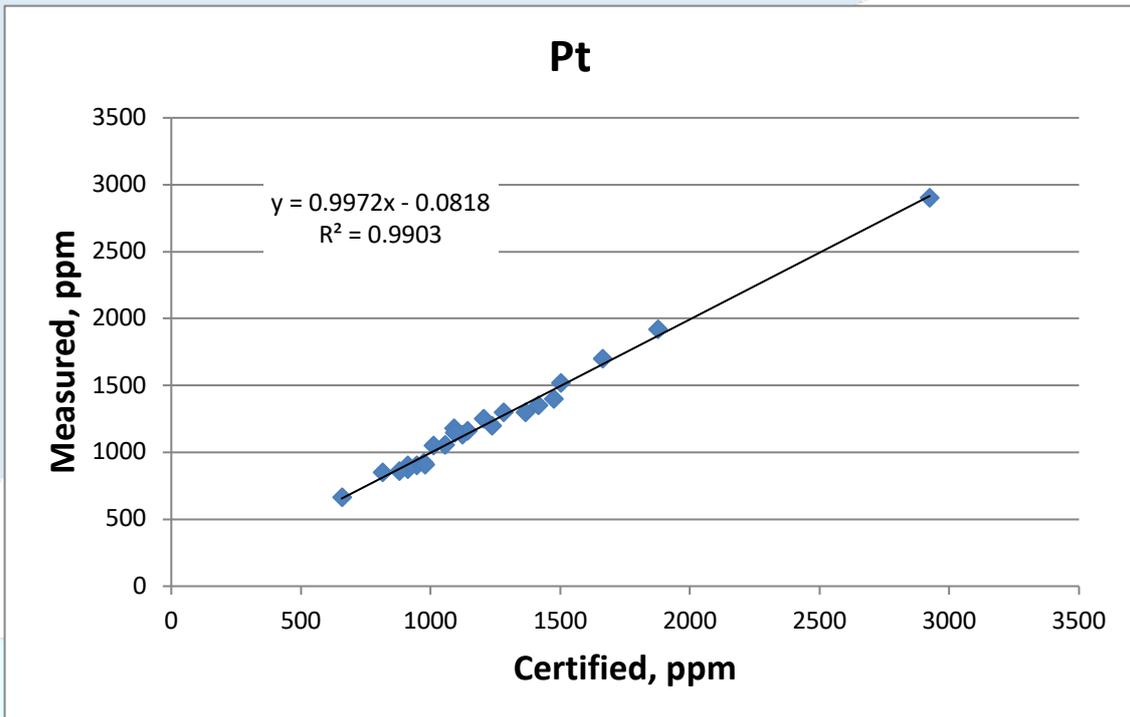
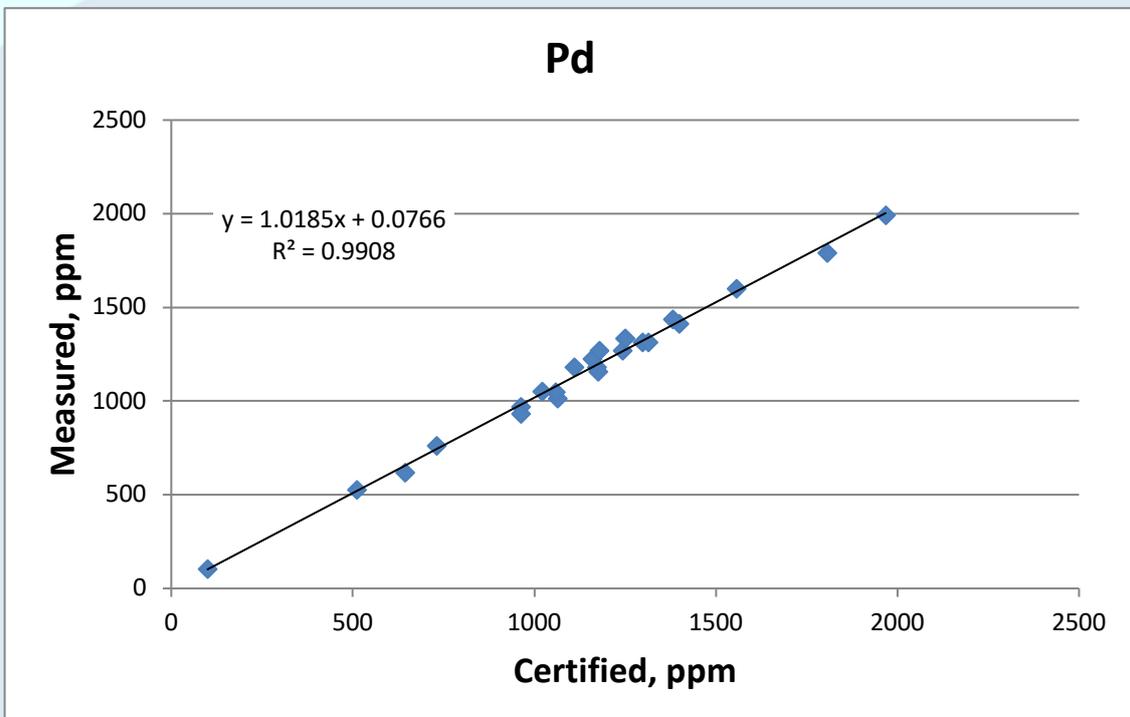*Figure 2. Correlation curve for platinum.*

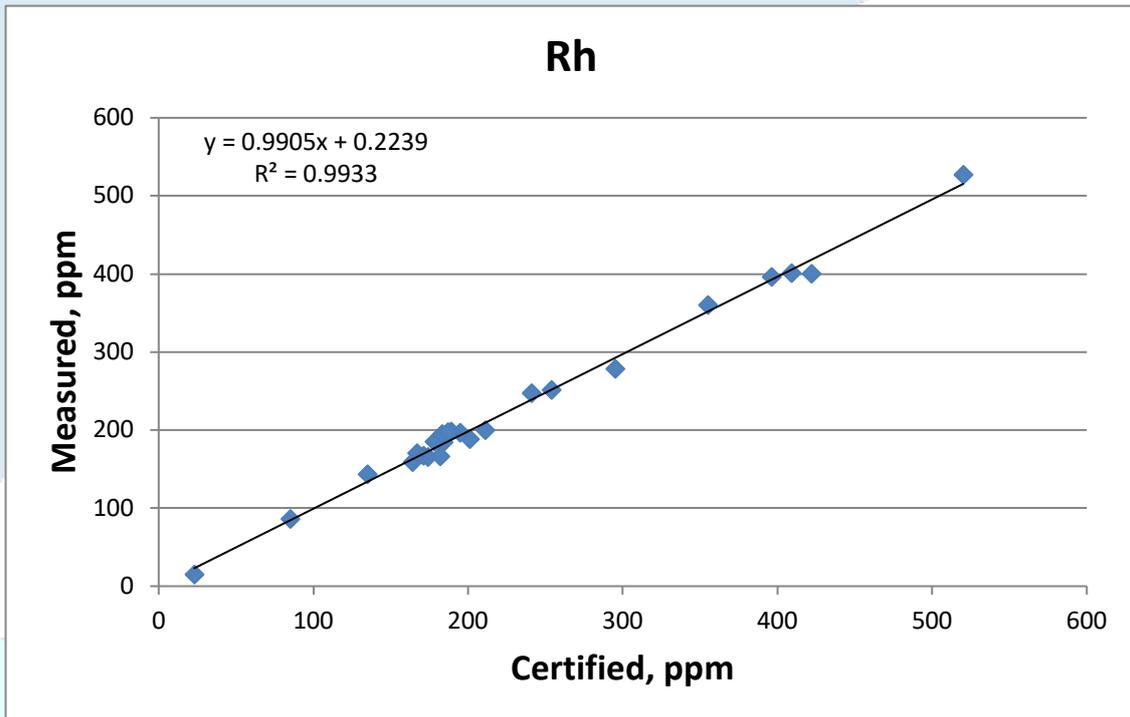*Figure 3. Correlation curve for palladium.*

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Figure 4. Correlation curve for rhodium.

Repeatability test was made to demonstrate the precision of the instrument. One catalytic converter sample was measured 10 times for 20 seconds each time. Average concentration, absolute and relative standard deviation was calculated. Repeatability test results are demonstrated at table 1.

measure #	Rh, ppm	Pd, ppm	Pt, ppm
1	189	1277	1110
2	186	1218	1060
3	193	1239	1080
4	190	1221	1050
5	181	1237	1080
6	187	1235	1080
7	191	1240	1060
8	190	1244	1160
9	185	1243	1090
10	193	1248	1090
Average	**188.5**	**1240.2**	**1086**
Std Dev	**3**	**10.24**	**21.2**
% RSD	**1.592**	**0.826**	**1.952**

Table 1. Repeatability test for one catalyst sample.

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Conclusions

Obtained results indicate a good correlation between lab and measured concentration values for PGM's in car catalytic converters. ElvaX ProSpector gives results in just seconds as opposed to hours or days as in laboratory. Together with simple operation training and easy sample preparation ProSpector is an ideal tool for the daily business for quality control and price evaluation during catalyst's buying and selling.