X-RAY FLUORESCENCE ANALYSIS OF COAL

Elvatech

Advanced XRF equipment and solutions

Elvatech

Different types of coal differ in individual characteristics that affect the quality and application of solid fuels. The main characteristics of coal depend on the conditions of formation of deposits and are directly related to its elemental composition. X-ray fluorescence spectrometers have proven themselves in the coal industry as a reliable and accurate tool for analyzing the elemental composition of raw materials and finished products. A wide range of Elvatech analyzers allows you to choose the device that best suits your needs and tasks. The powerful universal ElvaX Plus and ElvaX Pro spectrometers are perfect for laboratory research and provide the highest analysis accuracy and performance. Handheld analyzers ElvaX Geo and the revolutionary ProSpector 3 will become indispensable helpers for working in the field, guaranteeing accuracy, reliability and ease of use. You can also analyze coal with the ElvaX S Lab, a specialized benchtop analyzer.

Main characteristics affecting the quality and properties of coal

Humidity is the mass fraction of water in coal. Water molecules bind to coal as a result of absorption, hydration, and the entry of minerals into crystalline hydrates. In any case, the coal moisture is determined according to the standard procedure: the crushed coal sample is weighed on an analytical balance, then placed in an oven and heated at a temperature of 105 ° C until the loss of mass ceases.

Ash content is one of the main characteristics of solid fuels. Coal ash consists of inorganic substances that do not burn after burning a combustible part of the fuel. The increase in ash reduces the thermal effect of fuel combustion, increases the cost of their transportation, negatively affects the technology of processing and the quality of the resulting products. The method of x-ray fluorescence analysis allows you to quickly and accurately determine all components of the ash (Al, Si, Mg, Ca, Fe, etc).

The content of sulfur and phosphorus in coal determines the requirements for the processing and use of raw materials. When coal is burned, the sulfur contained in it is converted to sulfur dioxide (SO_2), which pollutes the atmosphere. Significant emissions of sulfur dioxide occur at coal-fired power plants. Therefore, an accurate analysis of sulfur in coal is crucial in the energy sector. Coke used for steelmaking should contain as little phosphorus as possible, as it is an undesirable element in most steels. The concentration of phosphorus in coke directly depends on its concentration in the "parent" angle. The content of sulfur and phosphorus in coal is determined by the XRF method simultaneously with the ash analysis.

Melting of ash depends on the ratio of low-melting (MgO, CaO, Fe_2O_3) and refractory (Al_2O_3, SiO_2) oxides and is an important characteristic that must be considered when choosing a method of burning this type of fuel. So, liquid slag can fill the grate and thereby impede the access of air to the fuel layer, which worsens or stops the combustion process. The fusibility of the ash also determines the choice of method of slag removal. ElvaX X-ray spectrometer software allows you to evaluate the melting point of ash by its chemical composition.

The specific calorific value is the most important characteristic of coal, which determines the amount of energy released during the combustion of a unit mass of fuel. Traditionally, this characteristic is determined using a long and laborious calorimetric technique. ElvaX spectrometers use a specially developed express method for determining the specific heat of combustion of coal.

The ElvaX line of instruments is equipped with a helium feed and filter change system, which in combination with the SDD detector allows the analysis of light elements with high sensitivity. The spectrometer allows you to analyze all the elements from sodium to uranium. The device comes with proprietary software that does not require special training to get started, and also has a full range of features for experienced users.


Methodology. Calculation of element concentrations is based on the method of fundamental parameters. It is not possible to directly measure moisture using the X-ray fluorescence method, therefore it must be determined by the standard method and the measurement must be amended. Typical analysis time: 30 seconds. The time can be increased to achieve greater measurement accuracy.

Results. Figures 1-5 show comparative graphs between the concentrations certified and measured on an ElvaX Plus spectrometer for various elements in coal, from which the ash and fusibility indices are calculated. Figure 6 shows a similar graph for sulfur content. The data obtained are approximated by a linear function. R^2 is the approximation confidence coefficient, which shows how accurately the measurement results correspond to the certified values. An ideal match occurs when the value of R^2 equals to one.
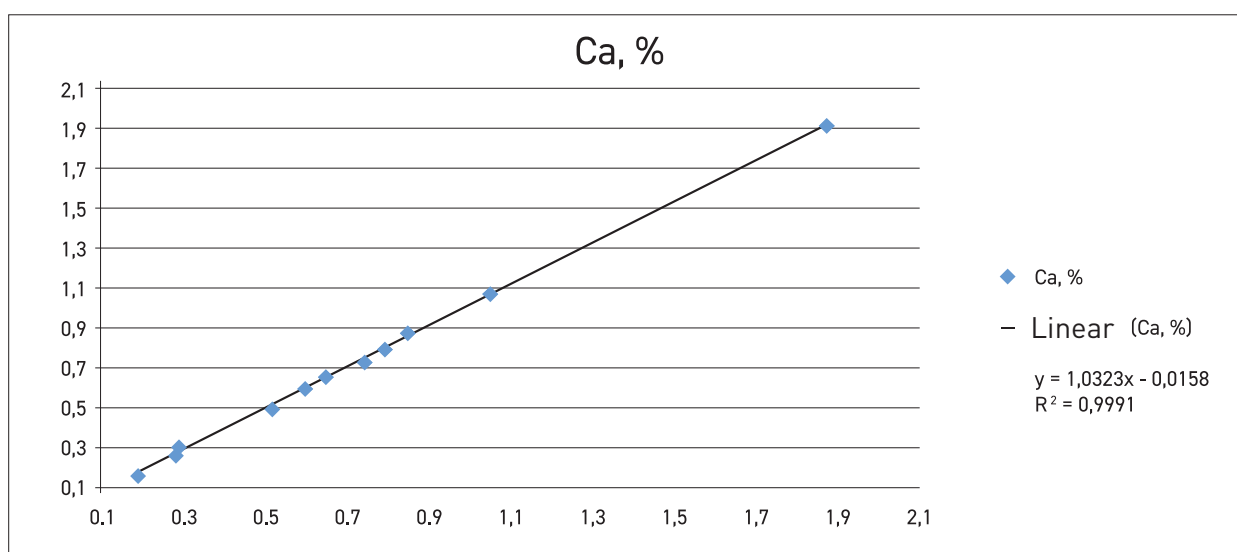
Figures 7 and 8 show the image of the analysis results of two different coal samples with calculated, using software, indicators of ash, fusibility and sulfur.
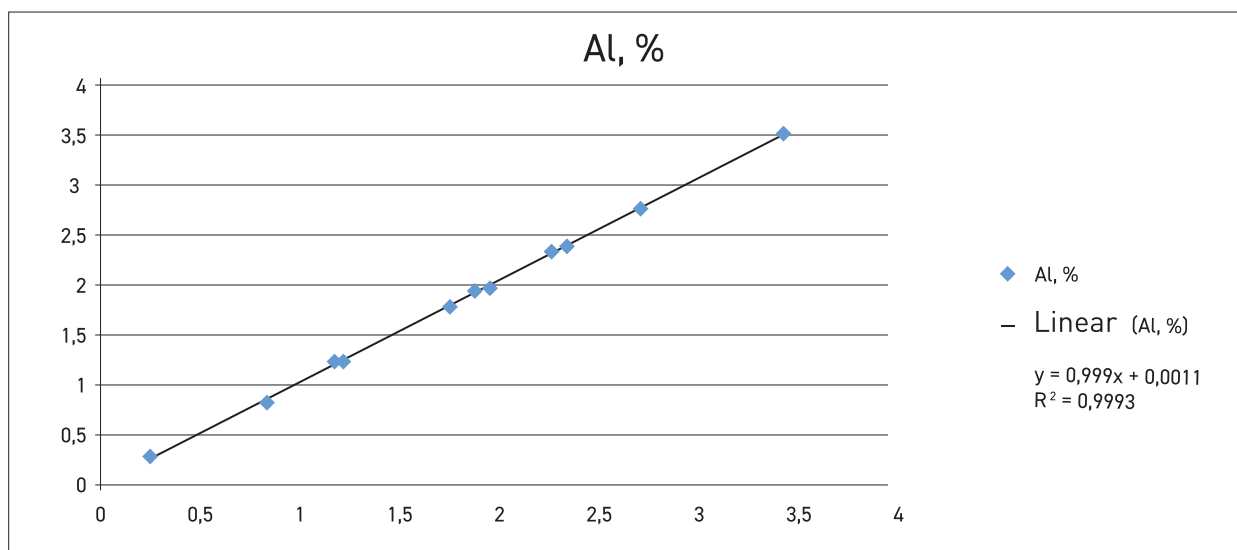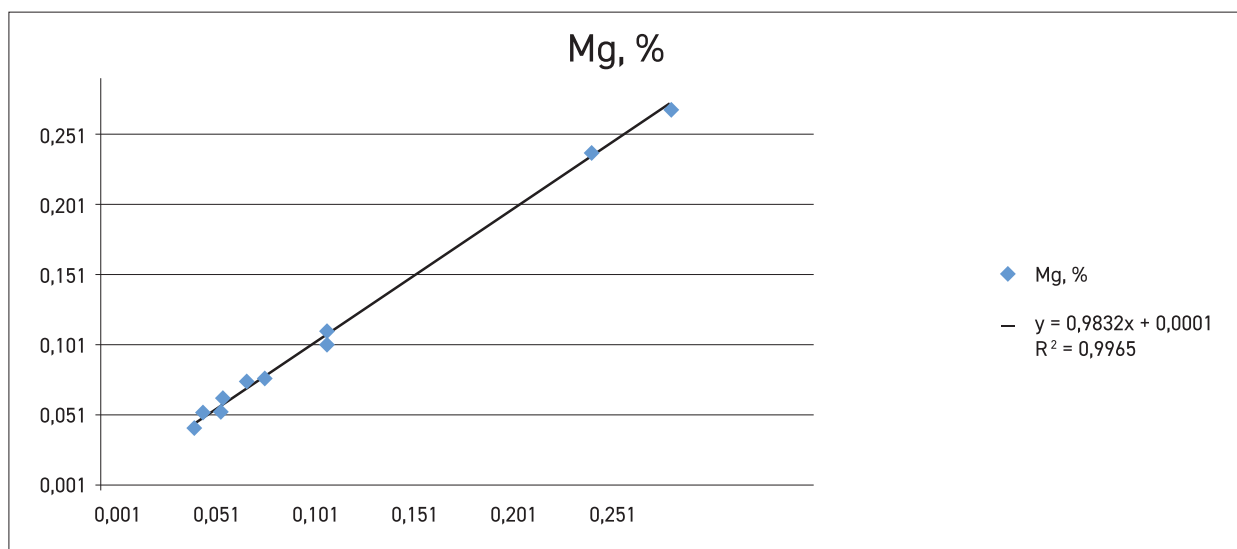
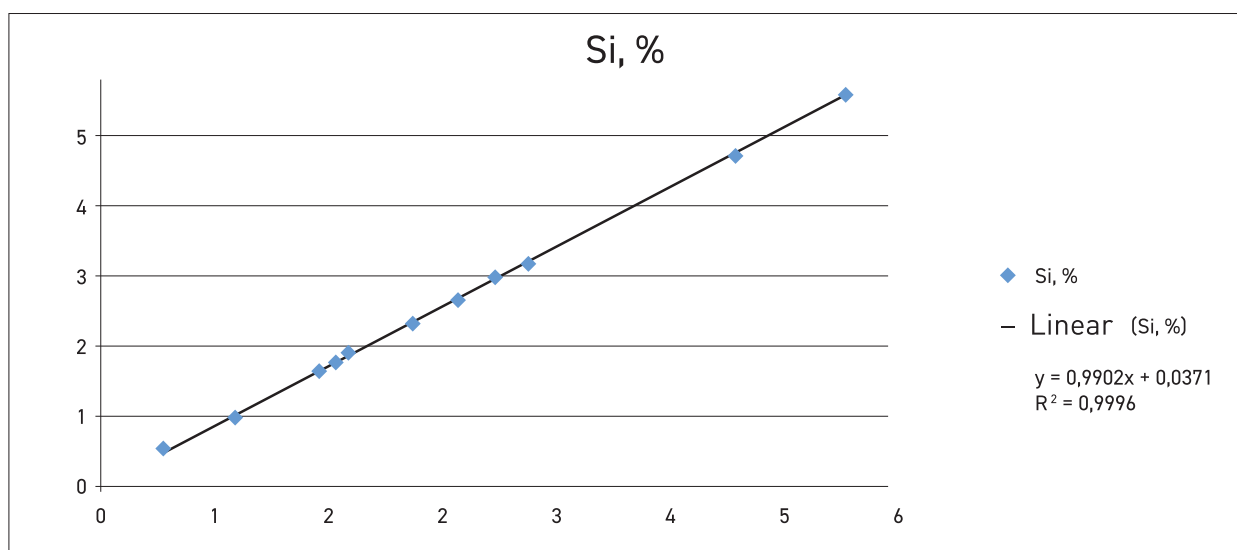Picture 1. Correspondence graph of aluminum in coal

Al, %

y = 0,999x + 0,0011
R² = 0,9993
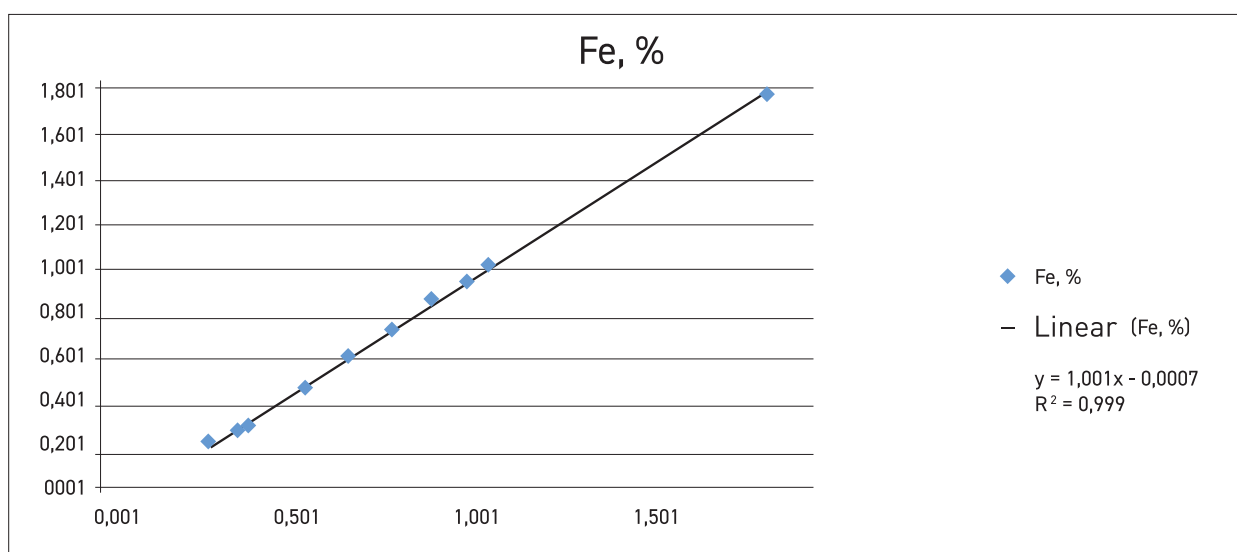
Picture 2. Correspondence graph of iron in coal

Fe, %

y = 1,001x - 0,0007
R² = 0,999

Picture 3. Correspondence graph of calcium in coal
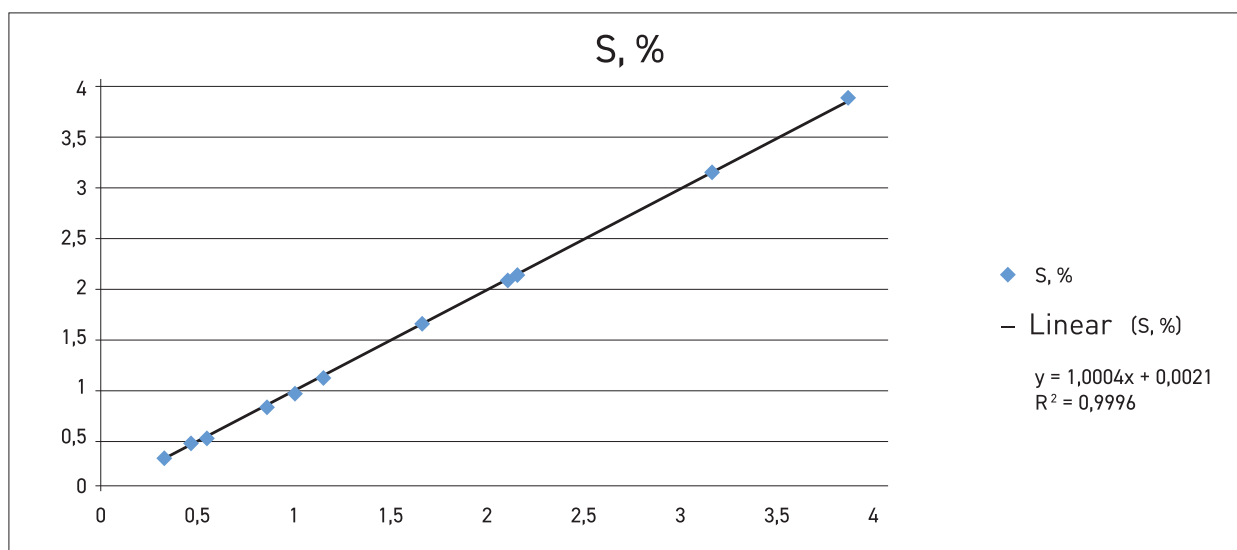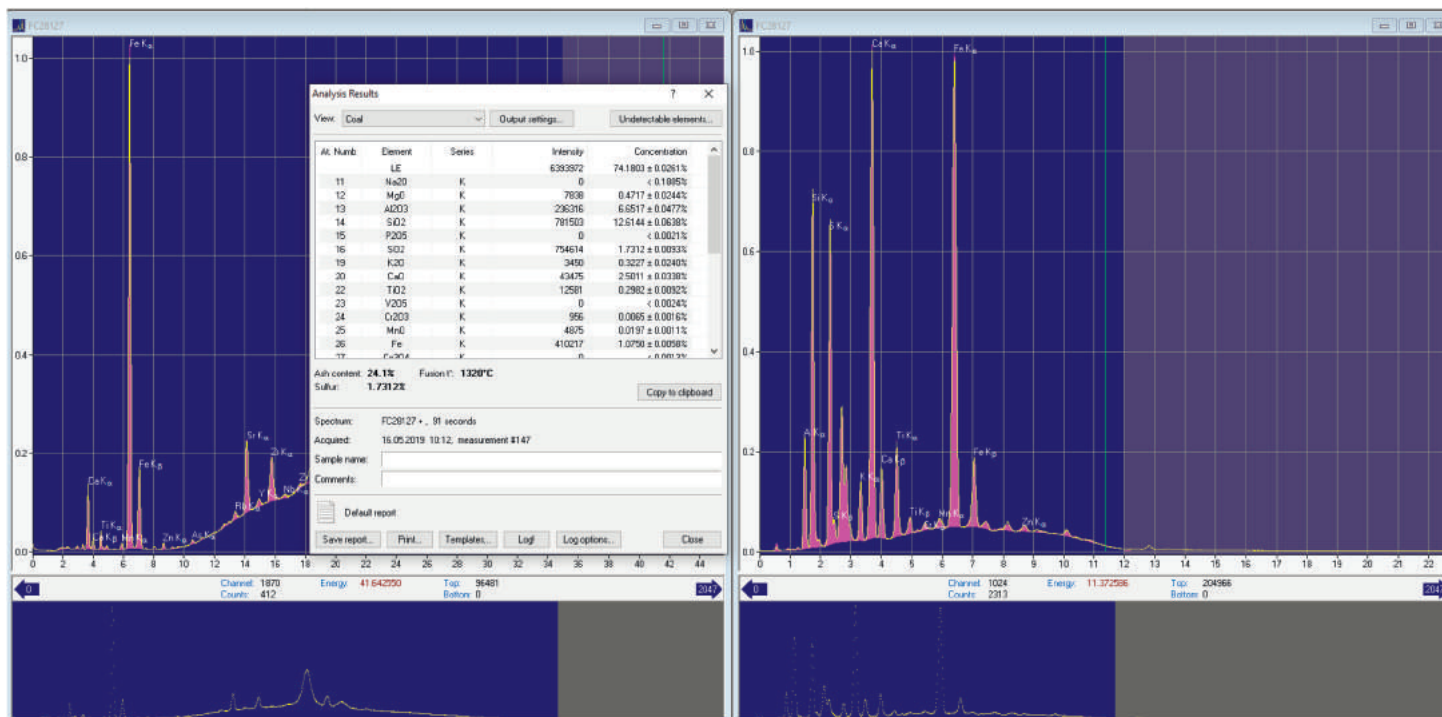
Ca, %

y = 1,0323x - 0,0158
R² = 0,9991

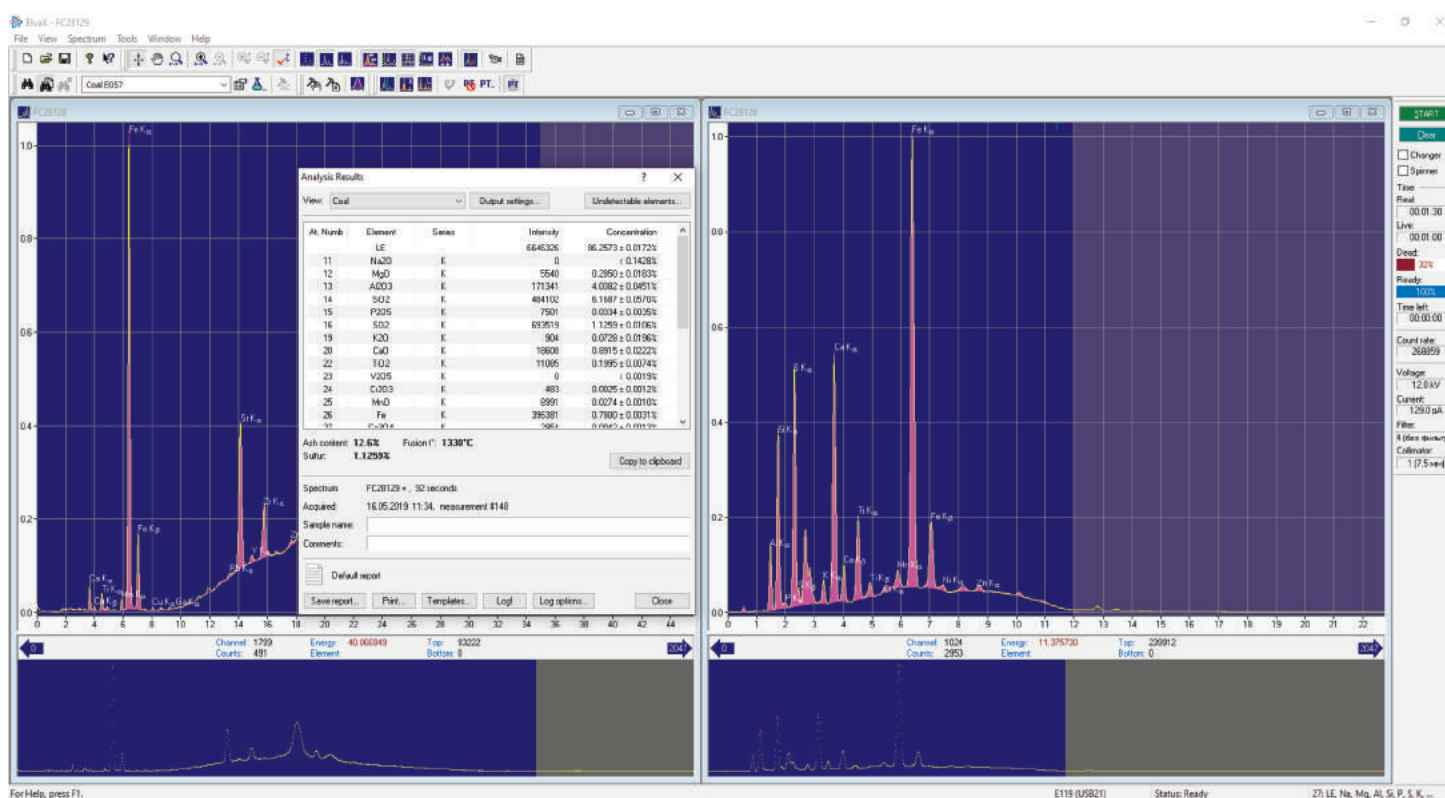Picture 4. Correspondence graph of magnesium in coal

Picture 5. Correspondence graph of silicon in coal

Picture 6. Correspondence graph of sulfur in coal

High ash coal sample analysis results

Low ash coal sample analysis results

A repeatability test was also conducted. One coal sample (anthracite) was analyzed 10 times for 30 seconds. The average value, standard deviation and relative standard deviation (in percent) for the concentrations of basic oxides were calculated. The test results
are given in table.

Element	Average, %	StdDev, %	% RSD
Al	0,83	0,008	1
Si	1,02	0,0092	0,9
Ca	0,65	0,0102	1,6
S	1,12	0,0408	3,7
Mg	0,06	0,0108	19,3
Fe	0,33	0,011	3,4

Table 1. Repeatability test for one sample of coal

Conclusions. The results show an excellent correlation between certified and measured values of the concentration of basic impurities in coal. It has been shown that with the help of X-ray powder diffraction spectrometers from Elvatech, most indicators that affect the quality and characteristics of coal are easily and reliably determined.