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ASSESSMENT OF POSSIBILITIES OF X-RAY FLUORESCENT METHOD FOR ANALYSIS OF HYDRAULIC FLUID OF MINING MACHINES

A. Muzaffarov[1], J. Toshov[2] and N. Abduazizov[3]*

[1]Central Research Laboratory, Navoi Mining and Metallurgical Combine, Navoi, Uzbekistan.
[2]Faculty of Energy, Tashkent State Technical University, Tashkent, Uzbekistan.
[3]Rectorate, Navoi State Mining Institute, Navoi, Uzbekistan.

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***Corresponding Author**
N. Abduazizov
Rectorate, Navoi State Mining Institute, Navoi, Uzbekistan.

ABSTRACT

The objective of the study is to assess the capabilities of the spectral analysis of motor oils of mining and metallurgical production machines for an existing industry (NMMC). **Methodology**. For the analysis of hydraulic fluids, samples were taken from machines of various sections of mining and metallurgical industries and their quality was determined in laboratory conditions by the X-ray fluorescence method on an EDX-7000 instrument (SHMADZU, Japan). To conduct a semi-quantitative X-ray fluorescence analysis of the hydraulic fluid of mining and metallurgical production machines on the EDX-7000 instrument (SHMADZU, Japan), an improved version of the spectral analysis method has been developed. A specific sample of the soil (sand) of the area was taken as a matrix composition and an analysis was carried out in laboratory conditions. **Results.** Based on the studies and developed methods for measuring the spectral analysis of the hydraulic fluid of mining and metallurgical industries, the possibilities of using the X-ray fluorescence spectral analysis method for determining – concentration are determined. A new method for preparing the test sample was developed. The results of analyzes of chemical elements and their concentration in the matrix mass obtained by x-ray fluorescence method. **Scientific novelty**. A new method of preparation of the test sample was developed, which includes sampling 100 grams of soil, calcining in a laboratory oven of the CNOL-24/200 brand at a temperature of 80 ° C for 1 hour, grinding to the class of 0.074 microns, adding

100 grams of used oils to it, mixing until a uniformly distributed mass is obtained and fed to a spectral analysis. **Practical significance.** Based on the studies and the developed methods for measuring the spectral analysis of the hydraulic fluid of mining and metallurgical industries, the possibilities of using the X-ray fluorescence spectral analysis method to determine the concentration of SiO_2, Fe, Al, Ti, Mn, Sr, V, Ca, K, Cr, Zn, Cu, Zr, etc. **Main goals.** Classification of hydraulic fluid, the main determined values in the composition of the hydraulic fluid, methods of sampling hydraulic fluid samples, detailing the possibility of spectral analysis methods to determine a specific value, the classification of hydraulic fluid analysis methods suitable for each object.

KEYWORDS: hydraulic fluid, spectral analysis, X-ray fluorescence method, expressivity, mining machines.

RELEVANCE

The evaluation of the possibility of spectral analysis with engine oils of mining and metallurgical industries, to accurately identify changes in the quality and composition of engine oils, as well as to predict their dynamics depending on various factors, encourages scientific and methodological interest. Based on the assessment of the possibilities of spectral analysis, it is possible to achieve the intended goals by studying the qualities and properties of motor oils in mining and metallurgical industries. An analysis of the literature devoted to this problem shows that there is: - a method for testing density, relative density, density in degrees ANI using a digital density meter, a method for determining the flash point and ignition in an open Cleveland crucible and using a Pensky-Martens instrument, a method for determining kinematic viscosity of transparent and opaque liquids, a method for determining the absolute and relative density of liquids using a digital density meter, a method for determining the relative density (specific gravity) and density in degrees API hydrometer, method for technical diagnosis and prediction of residual life by spectral analysis, method for determining mechanical impurities, method for determining total stiffness, method for determining kinematic viscosity and calculation of dynamic viscosity, methods for determining the presence of water, methods for determining the fractional composition, etc.[1,10]

In recent years, methods for analyzing motor oils from mining and metallurgical production machines have been significantly increased and improved in terms of instrumental and expressiveness, but so far there is no comprehensive approach to choosing a method that satisfies modern requirements. There is no universal method determining the quality of motor oils taking into account changes in ambient temperatures, the aerosol composition of open-pit air, dust concentration, etc.[11-14] Therefore, the assessment of the spectral analysis capabilities of an improved version of motor oils from mining and metallurgical industries is an urgent task in engineering, hydrodynamics, and mining and metallurgy in general.

Purpose of the Study

The purpose of the study is to assess the capabilities of the spectral analysis of hydraulic fluid of hydroficated mining machines of mining and metallurgical industries for a specific operating industry (NMMC). To achieve this goal, the main tasks are identified.

The main tasks of assessing the possibilities of spectral analysis of an improved version of motor oils from mining and metallurgical industries are:

- Carrying out classifications of motor oils used in NMMC;
- The main determinable values in the composition of motor oils used in the NMMC;
- Sampling methods;
- Detailing the possibility of spectral analysis methods to determine a specific value;
- Classification of methods for the analysis of motor oils suitable for each object.

Technique and experimental methodologies. For the analysis of motor oils, samples were taken from machines of various sections of mining and metallurgical industries and their quality was determined in laboratory conditions by the X-ray fluorescence method on an EDX-7000 instrument (SHMADZU, Japan). The main part of motor oils is hydrocarbons and liquids. For this reason, the determination of the chemical component in them is a difficult task for analytics.

To carry out a semi-quantitative X-ray fluorescence analysis of motor oils from mining and metallurgical production machines on an EDX-7000 instrument (SHMADZU, Japan), an improved version of the spectral analysis method was developed. A specific sample (weighing 1 kg) of soil (sand) of the area was taken as a matrix composition and prepared for analysis in laboratory conditions. To do this, they were dried in drying ovens at a temperature of 80 0C for 1 hour and rubbed on an IDA-250 laboratory hardener to a fraction of 0.074 mm. Three parallel initial samples are weighed from the matrix mixture, each weighing 15 grams, packed into a cuvette, installed in the measuring cell of an EDX-7000 X-ray fluorescence device (SHMADZU, Japan), and the concentration of chemical elements is determined in them. Then, from the remaining mass of the soil sample, 100 grams of a sample and 100 grams of spent motor oil are taken and thoroughly mixed. Three parallel samples will be weighed out from the resulting mass, weighing 15 grams each, packed into a cuvette, and installed in the EDX-7000 measuring cell.

The obtained results and their discussion. Based on the research and developed methods for measuring the spectral analysis of motor oils from mining and metallurgical industries, the possibilities of using the X-ray fluorescence spectral analysis method to determine the concentration of SiO2, Fe, Al, Ti, Mn, Sr, V, Ca are determined, K, Cr, Zn, Cu, Zr, etc.

A new method of preparation of the test sample was developed, which includes sampling 100 grams of soil, calcining in a laboratory oven of the CNOL-24/200 brand at a temperature of 80 0C for 1 hour, grinding to the class of 0.074 microns, adding 100 grams of used oils to it, mixing until a uniformly distributed mass is obtained and fed to a spectral analysis.

The spectral analysis of the initial sample and samples taken from a uniformly distributed mass are carried out on an EDX-7000 spectrometer (SHIMADZU, Japan). The obtained spectra of the sample of the matrix mass and the samples taken after adding the used oils are analyzed and the results obtained are compared in both cases. The matrix mass was analyzed by the X-ray fluorescence spectrum method which is shown in Fig. 1.

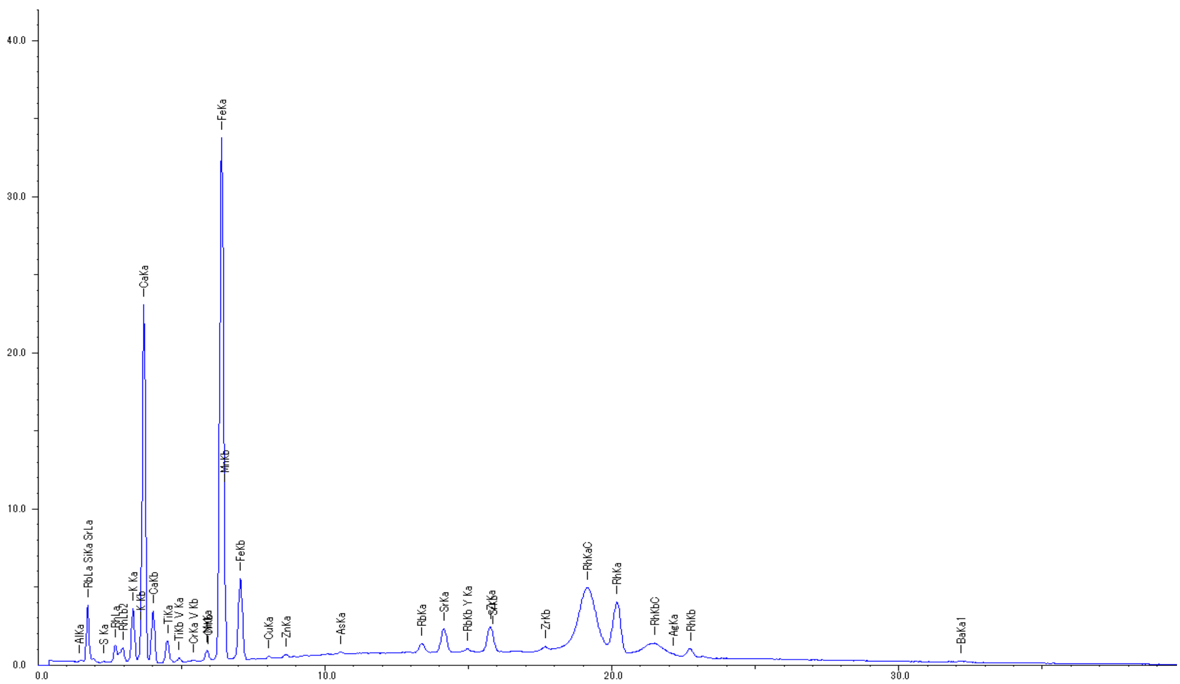

Fig. 1: Spectrum of matrix mass obtained by X-ray fluorescence method.

Chemical elements and their concentrations in the matrix mass are given in table 1.

Table 1: The results of the analysis of chemical elements and their concentration in the matrix mass carried out by X-ray fluorescence method.

Chemical elements	Concentration, (%)	KXV	Elements and exit line	Energy (kV)
Ca	6.231%	0.026	CaKa	145.8608
K	1.601%	0.016	KKa	22.1555
Al	1.519%	0.275	AlKa	0.4646
Fe	1.516%	0.005	FeKa	258.8024
Ti	0.217%	0.003	TiKa	10.0058
S	0.062%	0.013	SKa	0.3393
Mn	0.037%	0.037	MnKa	4.6644
Sr	0.021%	0.000	SrKa	17.3482
Zr	0.018%	0.018	ZrKa	16.7720
V	0.009%	0.009	Vka	0.5812
Rb	0.008%	0.00	RbKa	6.3978
Cr	0.006%	0.001	CrK	0.5495
Ag	0.006%	0.001	AgKa	1.9303
Zn	0.005%	0.000	ZnKa	1.7811
Cu	0.003%	0.000	CuKa	1.0308
Y	0.001%	0.000	YKa	1.2155
SiO	88.740%	-	SiOKa	-

The results of the analyzed samples by X-ray fluorescence method taken after the addition of waste oils are shown in Fig. 2.

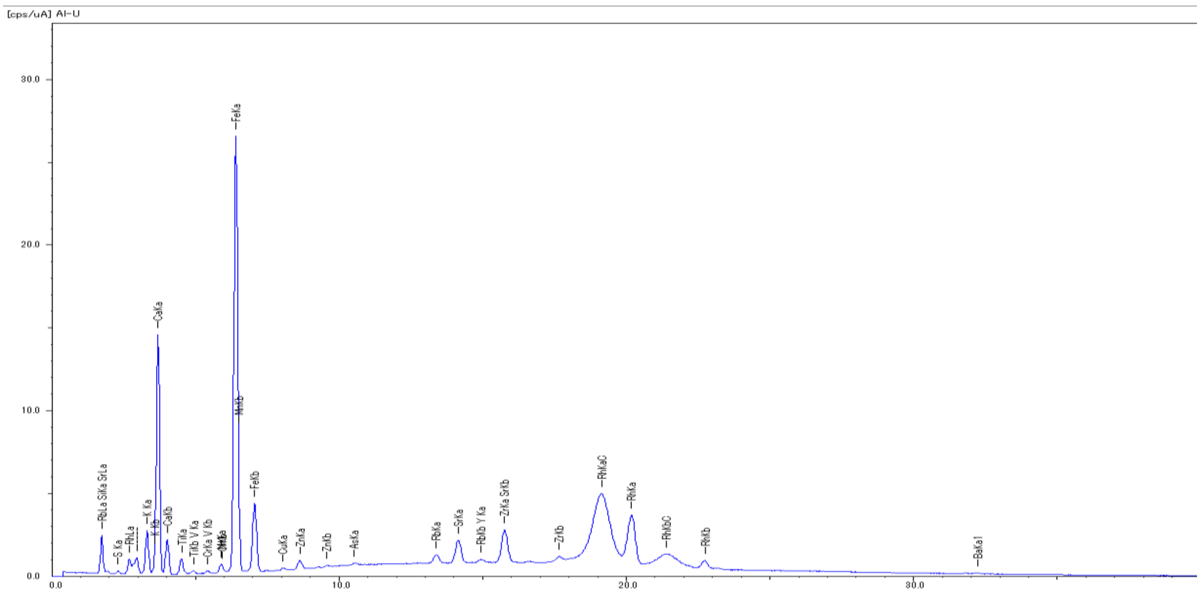

Fig. 2: The spectrum of samples after adding the used oils obtained by X-ray fluorescence method.

Chemical elements and their concentrations in the samples after adding the used oils are given in table 2.

Table 2: The results of the analysis of chemical elements and their concentration in the samples after adding the used oils carried out by x-ray fluorescence method.

Chemical elements	Concentration, (%)	KXV	Elements and exit line	Energy (kV)
Ca	3.847%	0.019	CaKa	91.3975
K	1.175%	0.013	KKa	16.1159
Fe	0.090%	0.004	FeKa	203.8787
Ti	0.134%	0.002	TiKa	6.6864
S	0.178%	0.014	SKa	0.9660
Sr	0.021%	0.000	SrKa	17.3482
Zr	0.018%	0.018	ZrKa	16.7720
V	0.009%	0.009	Vka	0.5812
Rb	0.008%	0.00	RbKa	6.3978
Cr	0.006%	0.001	CrK	0.5495
Zn	0.005%	0.000	ZnKa	4.6142
Cu	0.003%	0.000	CuKa	1.0708
Y	0.001%	0.000	YKa	1.3505
SiO	93.474%	-	SiOKa	-

As can be seen from the results obtained in Table 1, the concentration of chemical elements is - Ca-6.231%, K-1.601%, Al-1.519%, Ti-0.217%, S-0.062%, Mn-0.037%, Sr-0.021%, Zr-0.018 %, V-0.009%, Rb-0.008%, Cr-0.006%, Ag-0.006%, Zn-0.005%, Cu-0.003%, Y-0.001%, SiO-88.740%, respectively. And the results obtained are shown in Table 2, the concentration of chemical elements is - Ca -3.847%, K-1.175%, Al-1.519%, Ti-0.134 %%, S-0.178% Mn-0.021%, Sr-0.021%, Zr-0.018 %, V-0.009%, Rb-0.008%, Cr-0.006%, Zn-0.005%, Cu-0.003%, Y-0.001%, SiO-93.474%.

Thus, on the basis of the conducted research, the possibilities of using the X-ray fluorescence method for the analysis of motor oils of mining and metallurgical industries are estimated. From the spectra obtained, it can be seen that the method of X-ray fluorescence analysis for assessing the quality of motor oils in mining and metallurgical industries is acceptable in analytics. From the results obtained in the tables, the determination of the concentration of chemical elements shows that, after adding the used oils to the matrices, the SiO concentration increases from -88.740% to -93.474%. This fact affects the fact that motor oil is contaminated by particles of a fraction of silicon oxide.

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