The metrological assurance of quality petroleum products. Methods for determining octane and sulfur numbers in the petroleum products

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Abstract. At present, solving environmental problems in industrially developed regions with a large concentration of mining and machine building enterprises is one of the main socially important tasks. Taking into account the increase in the volume of mining, there is an increase in the environmental burden, which affects the internal migration of the population. This is particularly evident in the examples of single-industry towns, in which a gradual decrease in the young workable population occurs. The article presents an analysis of the sources of maximum pollution of the environment by coal mining enterprises. Modern methods of controlling automobile fuel were analyzed. The analysis of fuel quality and the environmental assessment of combustion products was carried out. The equipment used in the article makes it possible to exclude substandard fuel and to reduce harmful emissions of vehicles to the atmosphere.

Introduction

A research aim is development of the metrological assurance of account of amount and quality of petroleum products in depositories, namely in reservoirs.

Because measuring of two parameters is in-process conducted: qualities and amounts of petroleum products, then it is necessary clearly to put the aims of researches, to obtain successful results. In hired next tasks are put.

For determining the amount of petroleum products:
1) to investigate the existent methods of implementation of gaging and conduct a comparative analysis;
2) to analyze the modern metrological assurance of petroleum storage depot, both in Republic of Kazakhstan and in other countries.

For measuring of quality of petroleum products:
1) to investigate the methods of determination of quality of petroleum products in oil storage tanks;
2) to offer the method of determination of quality of petroleum products, suitable for petroleum storage depot.

Analyzing and comparing methods, it is necessary to choose most exact and going near the terms of measuring in static reservoirs method.

Results and Discussion

On petroleum storage depots at the use of reservoirs for measuring of mass of petroleum products in the commercial account of measuring error caused by the construction of reservoir, exploitation and setting of measuring equipment, and also by methods and procedures of measuring of level, closeness and temperature. The considerable errors, conditioned by measuring instruments, are usually small. Most errors at measuring are stipulated by a human factor at the hand method of measuring, especially if the chosen method is used without the proper supervision.

Presently most enterprises use the hand method of implementation of measuring. In this case the best error protection is complete or partial replacement of method of implementation of measuring automatic.
CAS of control and account of mass of petroleum products in stationary reservoirs is used for determining the amount of petroleum products in every controlled reservoir on storage of fuel. Software and devices of account of amount of petroleum products are usually included in the system. The device used for development of methodology of account of amount of petroleum products in a reservoir in dissertation is radar liquid level indicator.

Thus, the use of CASS considerably simplifies the account of petroleum products and allows realizing the any, even most difficult methods of implementation of measuring of mass in him.

What amount is important any consumer (in this case to the motor-car enthusiast) and what quality a fuel he inundates in the tank of the car. Therefore for a consumer the not lab test of fuel is needed, and methods of express analysis directly at the NGV-refueling station. Various devices are presently developed for this purpose, including portable octane meters. Principle of work of Octane meters is simple. On the size of measureable inductivity of fuel determine an antiknock value.

Together with the scientific laboratory of motor transport of the Kuzbass State Technical University the problem of determination of quality of commodity brands of petrol was set. Studies of quality of trade petrol were undertaken by the method of determination of antiknock value.

As to trace the way of fuel from OR (Oil Refinery) it is practically impossible to the NGV-refueling station, then petrol must be subject to the obligatory certification and certain party of petrol must have a passport of quality.

Petrol is composition more than 250 meaningful components of hydrocarbon connections and not all of them are useful. According to ecological requirements in the fuel of sulphur must not exceed 0.05 %, and benzol (strongest poison of blood) no more than 5%.

Metals, such as lead, iron, manganese in automotive gasoline determined by optical methods on atomic-absorbing spectrometers. Analyses show that forbidden octane-increasing of metal-containing additions is not present.

A question about quality of fuel every day becomes all more actual, because the expense of fuel, resource of thruster-on, ecological safety, depends on quality. A question about the amount of fuel also plays a not insignificant role the trade and economic aspect of production and consumption of oil product. It would be desirable to mark that determinations of quality and amount in petroleum industry are very associate.

The quality of petroleum products depends on the amount of impurities contained in its composition. The main impurities determination in the oil products are:

- determination of sulfur mass fraction;
- determination of benzene volumetric fraction;
- determination of iron concentration;
- determination of manganese concentration;
- determination of lead concentration;
- determination of oxygen mass fraction and oxygenate volumetric fraction;
- determination of hydrocarbon volumetric fraction (aromatic, olefin);
- determination of octane number.

In this article we estimate the petrol quality on such characteristics as the sulfur mass fraction and octane number. The organic compounds of sulfur appear to be the natural constituent of crude oil [8]. During thermal influence in the process of crude oil refining, the sulfur and its compounds fall into oil products in different concentrations. The basic forms of sulfur compounds presence in oil products are:

- hydrogen sulfide H2S produced by high-temperature deterioration of sulfur-containing compounds;
- elemental sulfur, sulfide oxidation product;
- mercaptans R-SH;
- sulfides or thioether or R-S-R;
- disulfides and polythioesters R-S....S-R;
- thiophen C4H2S and its derivatives;
- bicyclical and polycyclic sulfur-containing compounds;
• acid and middle esters of sulfuric acid and, sulfuric acids produced in the process of the petroleum distillates refining \[1\].

The presence of these compounds is undesirable as they impart an unpleasant odor oils products cause corrosion of equipment and pollute the atmosphere when burned. Sulfur compounds poison expensive catalysts of oil refining and releasing sulfur oxides into the atmosphere during combustion pose environmental issues \[1\].

Methods of determination of sulphur in an oil product it is possible conditionally to divide into 3 groups:

1. Methods based on oxidization of sulphur and subsequent determination of oxides: ASTM D129, D1266, D1551, D1552, D3120, D5453, D6920 and their analogues.
2. Methods based on renewal of sulphur to H\(_2\)S: ASTM D4045, UOP 357, STATE 13380.
3. Spectral methods:
   a) based on the x-rayed radiation: ASTM D2622, D4294, D6334, D6443, D6445, D7039, D7212, D7220 and their analogues;
   b) atomic-emission: ASTM D4951, D5185 \[1\].

The conducted laboratory researches are in the Kuzbass State Technical University; on the energy dispersible analyzer of «Spectroskan S» (St. Petersburg) showed that in a fuel producible maintenance of sulphur is considerably exceeded in Russian Federation. According to the standard of Evro-5 in petrol maintenance of sulphur must not exceed 0.0001 \%. . The analyses repeatedly conducted by us on maintenance sulphur in petrol of AI-92 and AI-95 made the 3 mg/ kg ± of 1 mg/ kg, which corresponds to the brand of Evro-5. We will mark that on this description of AI-92 near to the fuel of AI-95.

An antiknock value is determined by the selection of mixture of standard hydrocarbons - isoctane, at that an antiknock value is equal to 100 and N-Heptane (normal heptane) at that an antiknock value is equal to 0. At the equal terms of test detonation firmness is equal to detonation firmness of the tested petrol \[7\]. A percentage of isoctane in the got mixture just is the antiknock value of petrol.

A research method is determined on the single-cylinder setting with the variable degree of compression, called UIT-65 or UIT-85, at frequency of rotation of crankshaft 600 turn/min, to the temperature of the sucked in air 52° with and coal of passing of lighting 13 hails. It shows, as petrol behaves in the modes of the small and middle loading.

A motor method is determined similarly on the single-cylinder setting, at frequency of rotation of crankshaft 900 turn/min, to the temperature of the sucked in mixture 149° with and variable coal of passing of lighting. MON has more subzero values, than RON.

MON characterizes behavior of petrol on the modes of the large loading. Has influence on high-rate and detonation at a partial choke acceleration and thruster-on on-loading, motion uphill and etc.

A tent-bed test is a single-cylinder combustion engine with a carburetor. Start him on the investigated petrol, and the level of detonation is fixed by the special sensors. After mixture of standard fuel sneaks up - isoctane and N-Heptane on that an engine works how and on the investigated fuel. Got percentage of isoctane in neat standard mixture and is description of detonation firmness of petrol. Id est if in mixture of 95\% isoctane, an antiknock value will be 95.At test method modes and parameters of the motor installation can detect explosive properties of gasoline in the operation of a vehicle in an urban environment (movement with variable speed) \[6\]. The research method is less rigorous test mode that allows you to explore the process of combustion of gasoline cars in operation at constant engine operation modes. In this way, the octanes number the research method 5-10 units higher than the motor.

In the scientific laboratory of the road’s transport of KSTU (Kuzbass State Technical University) laboratory tests of motor fuel were carried out different brands for compliance to the octane number. Measuring octane petrol was conducted using Octane meter «Octane IM».

The method is based on the measurement of dielectric constant fluids. Below are graphs of the dielectric constant (X-axis) of the octane number (Y-axis) (Figure 1).

This dependence has become possible to obtain due to the fact that now the main stream of petrol is produced by blending (compounding) the large number of components.
The measurements showed that for petrol AI-92 octane the research method of 92.4 units, and by the motor method 84.3 units. For petrol of AI-95 octane the research method of 89.5 units and 82.9 for motor method. So it can be concluded that the fuel AI-95 in the selected part corresponds to the studies STATE.

The methods of metrology control of the oil storage depot, generals of measuring of mass of oil, account of oil products on modern petroleum bases, are in-process studied and investigational [9]. The analysis of existent types of reservoirs, conducted in-process, is applied for the study of quality of product at storage on the oil storage depot. Also on maintenance of quality of oil product the review of the special events was conducted.

![Graphs](image)

Figure 1. Graphs of the dependence of the dielectric constant on the octane number.

Work on the review of methods of account of quality and amount of oil product and facilities of their measuring is conducted. Investigating problems and methods of measuring of amount of oil products, was analyzed and chosen methodology of account of amount of oil product [10]. On undertaken a study of technological process of account of quality and amount of oil product it is possible to draw conclusion in oil storage tanks, that in course of time the automatic devices of account will master the great number of enterprises of petroleum bases, because it will allow quickly and exactly to define the level of oil product real-time.

**Conclusion**
Factors influencing on inaccuracy of gaging in a reservoir and way of their decision were studied. Errors, conditioned by measuring instruments, influences of environment, human factor, it is possible to minimize, using the automatic systems of account.

Work is executed on research of technological process, principle of development of algorithms of
account of quality and quantitative descriptions of oil products.

On petroleum bases can working facilities of measuring be: octanometer - for determination of antiknock value, areometer with a built-in thermometer - for determination of closeness and temperature, radarlevel gage - for the automatic account of level of oil product in a reservoir.

The pre-production model of portable device of «Octane-IM» is investigational for the expressanalysis of antiknock value. This analyzer allows measuring the concentration of antiknock value in an oil product in a range from 67 to 98 units.

The method of determination of closeness of oil product is also investigational by means of areometer of «ANT-1». This device is used as means of measuring of closeness in ranges 650-710, 710-770, 770-830, 830-890, 890-950, 950-1010, 1010-1070 kg/m³.

Radar level gage of BM 70a allows a noncontact method to define the level of oil product in a reservoir. The radar signal released from aerial is reflected from a liquid and acts on aerial. Difference of frequencies between radiated and reflected by signals proportional to distance to the surface of liquid.

On the basis of research of devices methodology of implementation of measuring of antiknock value, closeness and level of oil product is worked out.

The put tasks and aims are in-process attained on the metrology providing of the oil storage depot. Offer methodologies are applicable in the conditions of real OR (Oil Refinery) and NGV-refueling station.

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