По полученным ранее данным была созданы карты, в трехмерном пространстве с учетом рельефа и проницаемости почв. Для этого были взяты две карты: карта с рельефом и карта почв с преобладающим механическим составом почв, в базу данных которой были внесены рассчитанные ранее коэффициенты фильтрации. Моделирование осуществлялось в ArcView GIS. Написаны скрипты, позволяющий объединить две выбранные темы. Исходными данными для отображения разлива жидкостей являются: карта в трехмерном пространстве с учетом рельефа и проницаемости почв, общий объем вытекшей жидкости, влажность, температура воздуха, средняя глубина пропитки грунта, время истечения жидкости из поврежденного трубопровода.

Моделирование рассчитываемого объема с соответствующим расходом нефти по этапам проводилось с использованием скорректированного модуля hydro пространственного анализа (Spatial Analyst) ArcView GIS с учетом геофильтрации грунтов и рельефа местности. При заполнении пространства вокруг места аварии, и, соответственно, определение площади разлива, учитывается объем жидкости впитавшейся в грунт. Проделанная работа позволяет получить площадь загрязненных земель (для нефти, бензина др.), что позволит рассчитать степень загрязнения компонентов окружающей природной среды и величину ущерба, нанесенного окружающей природной среде в результате данной аварии.

В расчетах использовалась нечеткая логика. Применение такого рода систем для решения данной задачи обусловлено следующими причинами:

во-первых, большая часть величин, используемых при расчетах, в силу различного рода упрощений, допущенных при выводе формул, имеют неточный, приблизительный характер, погрешности величин, определяемых путем различного рода оперативных измерений, достаточно велики;

во-вторых, допущения о постоянстве отдельных коэффициентов в расчетных формулах не являются достаточно обоснованными; более корректным является предположение о возможных изменениях этих коэффициентов;

в-третьих, некоторые величины могут быть неизвестны, и в расчете в этом случае используются экспертные оценки, которые, естественно, находятся в некотором интервале и принципиально нечеткий характер.

Таким образом, следует говорить о расчетах в условиях, когда компоненты расчетных формул заданы не точечными значениями, а интервальными. Однако простое использование интервальных оценок недостаточно информативно. Более интересным является использование интервалов в совокупности с вероятностной оценкой – степени принадлежности параметров выбранному интервалу, то есть необходимо осуществить переход к использованию в расчетах нечетких чисел.

Применение аппарата нечетких чисел при расчетах, определяющих величину ущерба при авариях на нефтепродуктопроводах, целесообразно еще и потому, что они дают не только значения наиболее благоприятного, но и наиболее неблагоприятного развития событий. Последнее позволит хотя бы на стадии предварительной проработки подготовить мероприятия для предотвращения наихудшего варианта.

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QUARTZ VARIOMETER

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Abstract. This paper considers a new version of the compact design of the quartz variometer based on quartz magnetic sensors and photoelectric converter, made on the basis of transistor optopara and based on them magneto-measuring converter. The proposed design of the two-component quartz magnetic sensors in the practice of quartz magnetometric instrumentation is carried out for the first time. The two-component sensor is designed for modern magnetic variation stations, which are used for work in field and expeditionary conditions, as well as for special research and work.

Keywords: magnetic observatory, quartz magnetic sensors, magnetic variation stations, magneto-measuring converter, magnetic field

In IZMIRAN for many years and on an ongoing basis, scientific research is being conducted related to the creation of high-precision equipment based on quartz magnetic sensors (**QMS**). This class of instruments is designed to register and study geomagnetic variations. Most of Russia's magnetic observatories (**MO**) are equipped with such equipment, as well as many foreign observatories. The long-term experience allows further improvement of quartz magnetovariation stations (**MVS**), the basis of which is a magneto-measuring converter (**MMC**).

In some ways, this branch of magnetic instrumentation has always been related to nano technologies in terms of creating and manufacturing QMS, the sensitive element of which was hung in various ways on quartz thread, the thickness of which, as a rule, was less the thickness of the human hair and was about 15...30 microns. At the same time, the suspension of QMS in the latest models of variometers was performed in anti-seismic and anti-slant versions of performance. The quartz variometers have always differed from other type of magnetometers in that they had significantly higher characteristics in thermostability, interference and stable operation at a long interval of time.

This paper considers a new version of the compact design of the two-component quartz variometer (**TQV**) based on QMS and photoelectric converter (**PEC**), made on the basis of transistor optopara (**TOP**) and based on them MMC.

The proposed design of the compact QMS in the practice of quartz magnetometric instrumentation is carried out for the first time and is intended for modern MVS, which are used for work in field and expeditionary conditions, as well as for the special studies and works. Some results of tests of the prototype of the device under the conditions of the MOSCOW observatory are presented.

NEW DESIGN OF THE MVS

The concept of the new QMS design was born out of the considerations of maximum miniaturization and minimal consumption of the MVS, coupled with new methods of obtaining digital information, storing it and/or wireless transmission MVS data located in the field. At the same time, QMS should have a sufficiently high resolution ability and stable characteristics at a fairly large time interval of their application.

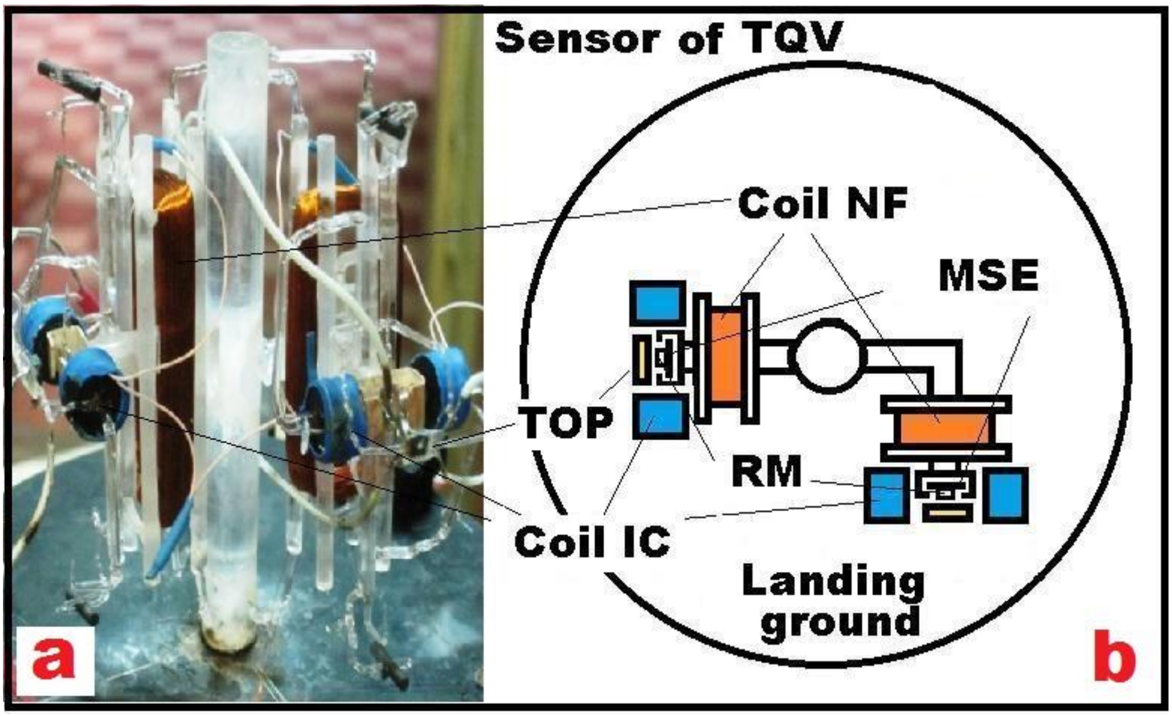

Figure 1. The general view of the two-component QMS design.

Figure 1 shows the general look of QMS and individual sensor elements design and elements of the PEC. Both QMS (see ***Figure 1a***) are located orthogonally together at the lowest possible distance, which excludes their interinfluence, and are fixed rigidly on the basis that has the ability to level both QMSs simultaneously in a horizontal plane. ***Figure 1b*** shows the design of individual elements of QMS and PEC (*top view*) and a fragment of the suspension of one of the magnets on the quartz thread (**QT**). Two variants of QMS execution were created during the development process. They differed only by the design and installation of the PEC. The first variant of the use of PEC is shown on ***Figure 1b***, when the reflective mirror (**RM**) was attached to the most magnetosensitive element (**MSE**), - on the magnet. To eliminate the effect on the MSE of the PEC power source, the QMS suspension design has been modified, as shown in ***Figure 2***. That is, the RM was made on a quartz thread (**QT**) at some distance below the MSE. This made it possible to exclude the effect of the PEC power source on the results of measurements.

FUNCTIONAL SCHEME OF THE TQV

The functional scheme of the TQV is shown in ***Figure 2***. This scheme includes three successive converters: magnetic field/constant current,

current/voltage and voltage/digital code. At the same time, the TQV has a digital output of measured data to connect (using interface RS-232) to a personal computer (**PC**).

The magnetic field/current converter is designed on the basis of QMS and PEC. The current/voltage converter is made on the basis of a DC amplifier (**DCA**), and the voltage converter/digital code is made on the basis of an analog-digital converter (**ADC**). At the same time, the blocks of QMS and PEC in the design of the MMC, as a rule, are (to exclude electromagnetic influence on the results of measurements) at some distance from the electronic unit (**EU**). MMC consists of the following main blocks - the QMS and the EU, which are powered by an external DC source.

The EU includes DCA, ADC and power supply (**PS**) schemes. A network adapter (**NA**) or accumulator battery (**AB**) is used to power all TQV schemes. EU also includes a temperature sensor (**TS**), a sensitive element of which is installed near one of the QMS's and allows you to control the temperature of the QMS inside the protective casing with an accuracy of 0.1°C.

The QMS block includes a quartz frame (**QF**) on which the MSE and RM is fixed with the help of the QT, as well as the PEC installed in and opposite in the immediate vicinity. Unlike the PEC scheme (shown in ***Figure 1b***, where the MSE is fixed on the mobile RM and is located in the co-center of the PCE), the proposed scheme of the RM is located with a shift from the center of the MSE - at the distance of 25 mm. This significantly reduces the impact on the MSE of the source of current feeding the PEC scheme (***Figure 2*** designated as **SC**). In this design, the MMC scheme of linear and angular movements is made on the basis of the TOP with an open optical channel [5].

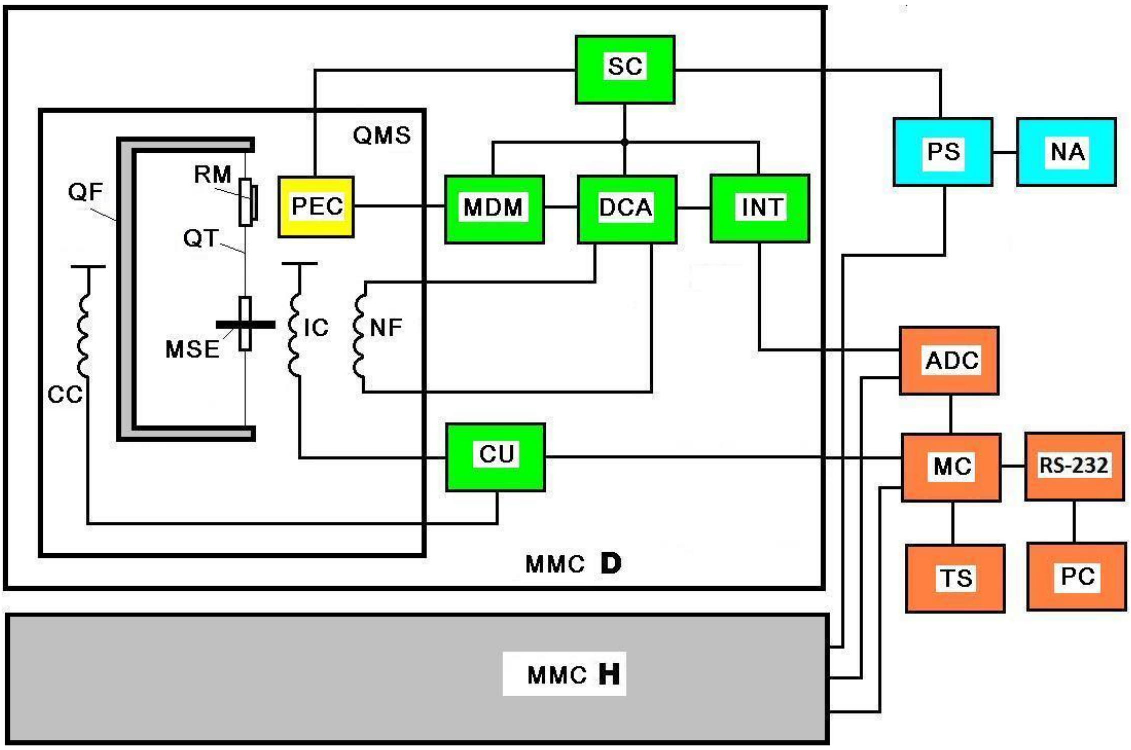

Figure 2. Functional scheme of the TQV.

Figure 2 shows elements of the MMC measuring channel scheme – three coils of copper wire with different number of turns and different thickness of wire, which are screwed on quartz frames and fixed on a common quartz vertical base rod (see ***Figure 1a*** and ***Figure 1b***). These coils are designed for the initial installation (rewind of the **IC**) and calibration (**CC**) of the MSE, as well as maintaining the stability of its work by carrying out negative feedback (coil of the **NF**) of the DCA scheme connected to the exit of the PEC.

The EU scheme (see ***Figure 2***) includes a signal amplifier consisting of three functional nodes: pre-amplifier (**MDM**), DCA and integrator (**INT**). The preliminary amplifier is made on the basis of a low noise DCA with its own internal NF and MDM-transformation. It provides the main amplification of the input from the PEC scheme. The DCA scheme, together with INT, achieves the required output level of analog voltage for ADC and performs filter functions with a cut-off frequency of 3...5 Hz. The use of a special differential amplifier with MDM-conversion in the DCA scheme has led to a decrease (up to 3...5 pT) the MMC's own noises and the overall stability of the DCA, both over time and when the ambient temperature changes widely. At the same time, the NF realizes a dynamic range of geomagnetic variations measurement by the MMC measuring channel ± (4... 6) mkT with the possibility of increasing it.

The 24-bit ADC scheme provides a digitization of analog voltage from the release DCA output at a frequency of 16 Hz. At the same time the resolution of the MMC measuring channels (which are visualized on the connected PC display) is realized at the level of 0.1 nT and more precisely.

The microcontroller (**MC**) transmits digital ADC data, exchanges information and management teams through a sequential port (RS-232) from a PC at a distance of 3 to 25 m. Microcontroller activates the work of the MMC, sends control programs associated with setting up and verifying the health of the QMC work on the control unit (**CU**). MC also manages the built-in timer, and if available and necessary, it supports the GPS receiver connected to the PC, has a GPS synchronization channel and the ability to correct of the real-time clock. The PS is built using DC-DC converters, powered by both an external DC source (AB) voltage of 7...24 V, and from the standard NA voltage of 12 ± 5 V. The PS provides power to all electronic schemes of EU and PEC with the help of three stabilized SC voltage ± 5 V and 12 V. At the same time, the power consumed by the TQV is no more than 2.7...3.0 W.

The software for the TQV provides the organization of the database, its visualization during the work on the PC display and the ability to process data for use in a format suitable for participation in international data collection programs.

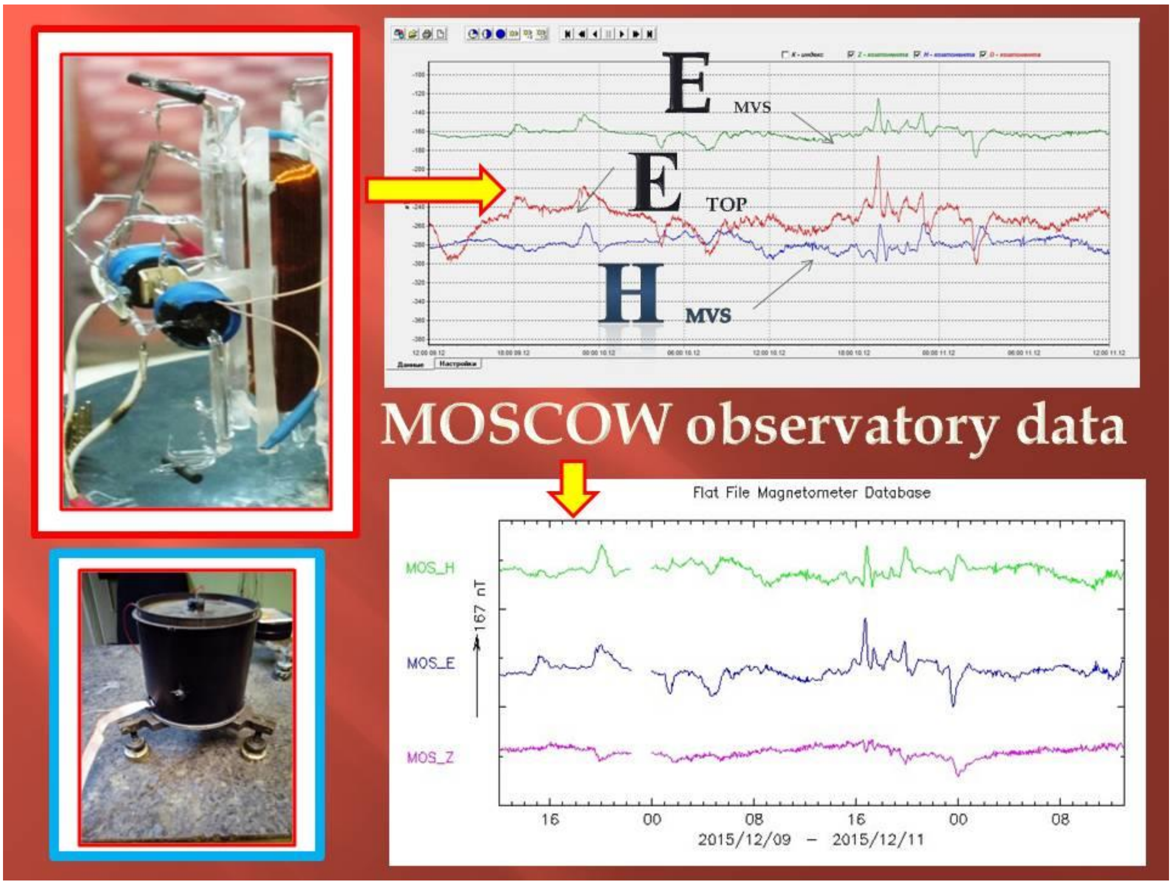

Figure 3. Results of the TQV tests. Fragment of a two-day simultaneous recording of the Earth magnetic field variations measuring channels of TQV and MVS in the MOSCOW observatory.

CONCLUSION

As a result of the research and experimental work carried out, a new design of the TQV has been created. This technical solution of the MMC has the following distinctive features from all previously created similar devices:

1) High stability of work in time (which is important for long-term research in MO conditions) and good stability, work at changes in ambient temperature in broad ranges (which is important in field and expeditionary work).

2) Low level of own noises of the measuring channel, the amplitude of which is no more than 3...5 pT.

3) Low energy consumption, which allows efficient use of MMC in the construction of autonomous stations powered by AB or solar batteries.

The prototype of the TQV has been successfully tested in the MOSCOW observatory (IZMIRAN). A fragment of a two-day recording of one of the measuring channels of the TQV constituents of the Earth magnetic field together and in sync with the recordings of a nearby quartz MVS and records of the MOSCOW observatory variometers is presented on ***Figure 3***.

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INVESTIGATION OF COAL DUST FORMATION UNDER CYCLIC CRYOGENIC INFLUENCES

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Abstract. Analysis of the need to consider the fractional composition of coal dust in the calculation of the dust load is carried out. The impact of cycles of freezing and thawing on the fractional composition of the dust generated during mechanical destruction of coal marks D are found. To achieve this goal, in vitro experiments were carried out with coal mark D of the Tugnuisky deposit. The collected sample was split into smaller samples and, with the help of mechanical crushing followed by classifying, the following fractions were obtained: 1 mm, 1 + 0.63 mm, 0.4 mm -0.63, -0.4 +0 25 mm, -0.25 mm + 0.2, 0.2 + 0.14 mm, -0.14 mm. For determining the fractional composition of the coal, depending on the degree of hydration was used Camsizer XT installation, which allows obtaining a density distribution of particles in a sample. Altogether were conducted 80 trials, of which 40 - in the natural moisture and 40 - with artificial moisture (full saturation).

The experimental results showed that there is a relationship between the fractional composition of the sample, its moisture content and the number of cycles of freezing and thawing. It is shown that the level of dust, depending on the number of cycles at increasing humidity is substantially reduced: by the degree of destruction of 7-fold effect of the dry coal is 1-fold to humidified coal.

Also was found the effect size fractions on the degree of destruction. In particular, the processing of the experimental data showed that the initial fraction of less than 0.14 mm output of fine dust does not change, and further research may be excluded from the analysis. The maximum degree of destruction observed dust sample fractions 1 + 0.63 mm, which should be used in determining the impact of man-made laws of moisture on the fractional composition of the dust in the cyclic cryogenic effects. The established regularities will continue to develop the best plan of experimental work to achieve this goal for different marks of coal.

Keywords: dust concentration, fractional composition, coal, pneumoconiosis, cycles of freezing and thawing, dusting, respirable fraction.

Introduction. Currently, there is no unified system for measuring the dust content in the working area. Each country adheres to its own way of normalizing the dust content in the air of the working area and, accordingly, its dust suppression measures. The only thing that is similar in all countries is the rationing of coal dust depending on the content of silicon dioxide in it, because this compound has a negative impact on the early appearance of pneumoconiosis in workers. Table 1 shows the maximum permissible concentrations of coal dust in different countries. The table shows that Russia is the most" loyal " to dust: the content of silicon dioxide can reach up to 70%, which is unacceptable in most developed countries [1, 19].

Table 1

Indicative data on the measurement and assessment of dust concentration in the coal industry in Germany, France, the UK, the USA and Russia.

Indicator	Germany	France	The UK	The USA	Russia
Maximum permissible dust concentration, mg/m^3	10	13,5	7	2	10
Assessment of quartz content	q>5% with a coefficient K=1; 0,7 и 0,3	Fixed q>7%	At the testing stage	Fixed q>7%	q>10%, 2 mg/m^3, q<10% - 10 mg/m^3

Over the past 10 years, it has been revealed that the incidence of workers is affected not only by the content of free silicon dioxide, but also by the fractional composition of dust (the most dangerous is the dust fraction from 2 to 5 microns, since it is retained in the alveoli of the lungs and remains there in 50-90% of