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I.P.Kuritnik[1], B.R.Nussupbekov[2], D.Zh.Karabekova[2], S.S.Zhargakova[2]

[1]*University of Bielsko-Biala, Poland;*
[2]*E.A.Buketov Karaganda State University*
(E-mail: karabekova71@mail.ru)

Thermal control method for the diagnosis of underground heating systems

Thermal methods of nondestructive testing are widely used for the analysis of the thermal insulation of underground pipelines. In heat methadone nondestructive testing, the thermal energy is distributed in the test object. Temperature field of the object's surface is a source of information on the characteristics of heat transfer. This article describes the modifications we have developed some of the heat flux sensors. A common element of these devices is the battery thermoelectric sensor special design, acting as a thermoelectric converter heat flow.

Key words: heat flux, heat flux sensors, thermal radiation detectors, heat sensor metric.

Now one of promising methods of nondestructive testing is the thermal method, in which malfunction data of a design carries the surface temperature of the controlled object. Values of temperature are defined by change of thermal and geometrical adjectives.

Nondestructive testing devices allow to carry out a state diagnostics or an operating control of various parameters of construction materials and designs, at that without breaking their integrity and appearance. Quality monitoring of construction materials and products is one of a set of fields where use of such devices is requires. The main controlled parameters: dthe strength of brick or concrete products, setting depth of seal of fittings in concrete, existence of emptiness in the monolithic concrete block, thickness and hardness of metal products, quality of a welding seam, a state of the pipeline and others. The analysis of results of experimental survey of sites the duct-free and channel grid, carried out in the conditions of various modes of exploitation and climatic influences showed that in all cases of nondestructive testing determined flux density of thermal radiation is more informative indicator of heat transfer, quantitatively characterizing any change of a temperature track on a ground surface, than temperature of this surface [1].

In this regard special actuality is the problem of improvement of this method by creation of specialized heatmetric devices and heat flux sensor, providing the necessary accuracy of nondestructive testing of thermal properties of underground heat pipeline of duct-free and channel laying and also fully conforming to all standardization and metrology requirements.

Development and creation of heatmetric devices will allow to solve two problems, firstly in-line localization of heat carrier leak point, which is carried out by determination of abnormal values of thermal radiation surface density or temperature over surveyed laying of heating systems. The second is reduced to determination of sites of heating systems with the damaged or humidified thermal isolation of heat pipeline, and also an unsatisfactory state of their protecting designs, which is carried out by comparison of the measured values of thermal radiation distribution from the ground surface over heat pipeline or its temperatures with calculated values. In this case measurement of controlled sizes is carried out as directly over a route axis and out of a zone of thermal influence. In such a way, this measurements method also includes information about a thermal state of the natural Earth's massif that is indicated in reliability of carried-out diagnostics. Solutions these problems will allow to increase the pipelines service life and reduce the loss of heat delivery to the consumer [2].

The device is developed for practical implementation allowing by heat loss changing and soil temperatures over surveyed heating systems quickly and with insignificant expenses to determine places of leak point of the heat carrier to environment and also timely to define sites of heat conductors with an unsatisfactory state of their heat-insulating and protecting designs.

The device consists of the heatmetric block and the electronic small-sized showing device with autonomous battery power supply. Basic element of the heatmetric block is the thermoelectric battery converter of a heat current.

The device works by the auxiliary wall method, the heatmetric block contains the thermal stream thermoelectric converter, at the basic of which is the battery thermoelectric sensor. The thermoelectric sensor is made in the form of the bounded cylinder, one basis represents a working surface, the second basis has thermal contact with a body which has external temperature. Built-in heaters allow to create a heat current via the thermoelectric sensor in the directions, perpendicular to its bases.

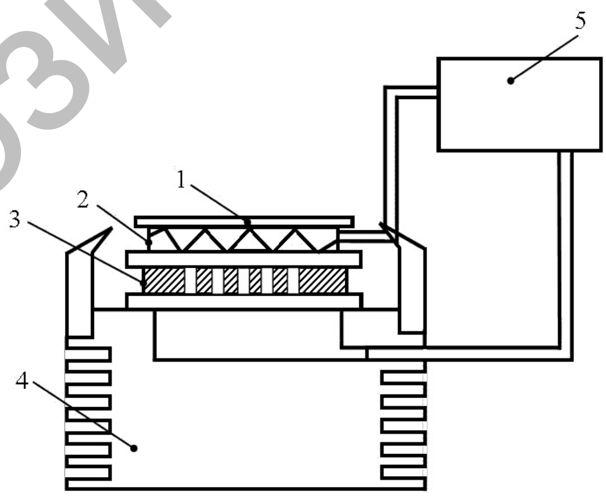
The device is given to an operation conditions for measurement of local heat current (via isolation of heating system, electric power installation, furnaces, technological devices), for this purpose heat interchange control is done out from a surface by standard heatlosses. The zero signal achieves by dint of the built-in heater at the device exit. The heat current created by the heater is fiducial, they are compared by heat current of studied objects. Areas with possible isolation defects lead to increase in a signal at the device exit.

Heatmetric indicator of heating lines diagnostics are known, which consists of two identical heatmetric blocks, radiators and the electronic block of transformation, and signal measurement [3].

The disadvantage of the above devices is the low accuracy of measurements caused by differently external parameters influence of environment to signals of heatmetric blocks, working at some removal from each other (up to five meters). As well as the device is operated by two operators owing to simultaneous use of two blocks at some distance from each other.

The device contains the thermoelectric cooler, «hot» junction of the thermoelectric cooler are combined in a radiator, and «cold» junctions of the thermoelectric cooler are combined in thermoelectric battery inverter heat current [4, 5].

Using of a acceptance plate, the thermoelectric battery, the thermoelectric battery converter of a heat current and the thermoelectric cooler allows to combine functions of two heatmetric blocks in one. The reference heat current is taken away from a acceptance plate by means of the thermoelectric cooler, the thermal current is created by electric current so that temperature of a acceptance plate remained to equal ambient temperature. Corresponding to normal working conditions heat currents are compared to a heat currents in that areas where defects are assumed. Temperature pulldown of a acceptance plate up to the ambient temperature allows to exclude influence of a wind on radiometer indications working in natural conditions. At that it is possible to estimate the size of a heat current on an output signal of the heat current battery converter. Use of the thermoelectric cooler in combination with the acceptance plate, thermobatteries and the battery converter of a heat current allows: 1) to combine two heatmetric blocks functions in one; 2) to reduce influence of random vibrations of environmental variables; 3) to keep enormity an output signal of the heat current battery converter, it is new and distinctive signs in the offered device.



1 — acceptance plate; *2* — thermoelectric battery converter of a heat current; *3* — thermoelectric cooler; *4* — radiator; *5* — electronic block of signal transformation and measurement

Figure 1. Schematic image of the heatmetric device

The acceptance plate *1* is given to thermal contact with «active» junction of the thermoelectric battery converter *3*, «passive» junctions of the thermoelectric battery converter are operated in thermal contact by the «active» hot junctions of the thermoelectric cooler *4*. «Passive» junctions of the thermoelectric cooler are operated in thermal contact by the radiator *5*, at that «active» junctions built in between the acceptance plate and the thermoelectric battery converter *3*, and thermobattery «passive» junction is operated in thermal contact by the device case which has external temperature. The output signal from thermobatteries *2*, the thermoelectric battery converter of a heat current *3*, a acceptance plate *1* and the thermoelectric cooler *4* moves on the electronic block of transformation and signal measurement (fig. 1).

The heatmetric device works as follows, through the acceptance plate electric current is passed such size that developed power was more than a possible heat current from studied object. At the thermobattery exit there is a signal, via the thermoelectric refrigerator electric current is passed such size that the signal at the thermobattery exit became equal to zero. At that the signal at the thermoelectric battery converter exit will be proportional to a thermal stream, and acceptance plate temperature is close to ambient temperature. The heatmetric device is in an operating mode.

The heatmetric device is brought to studied object in area where there are no defects. The signal appears at the thermobattery exit. Acceptance platr current decreases up to such size that the signal at the thermobattery exit became equal to zero again. At that signals are restored at the thermoelectric battery converter exit. We bring the device to studied object in the area of defect existence. We discuss defect existence by signal change at the thermoelectric battery converter exit [6].

The device works in the range from 50 to 1000Вт/м^2 that corresponds to standard heatlosses, which eqals to ~ 300 W/m^2. Measurement time is about 1 minute with the secondary equipment. The measurement uncertainty is 3% of the measured value.

The temperature field of a wooden board sizes of 1500x2000x20 mm was investigated for the purpose of method operability check in laboratory conditions, the wooden board heats up from the opposite side by the blind roaster radiation (t = 4000 C) located from the board at distance 2m, 3m (fig. 2). The grid was put on the board with a step of 200 mm, measurements were carried out in grid knots. Numbers of points are noted from the left to right on a horizontal axis. Figures 2 on curves correspond to numbers of horizontal lines from bottom edge of a board to the top. Dependence of a relative signal of the heatmetric sensor (relation of the current signal to the maximum signal $\Delta\varepsilon$) on coordinates of a grid are given on drawing (fig. 3)

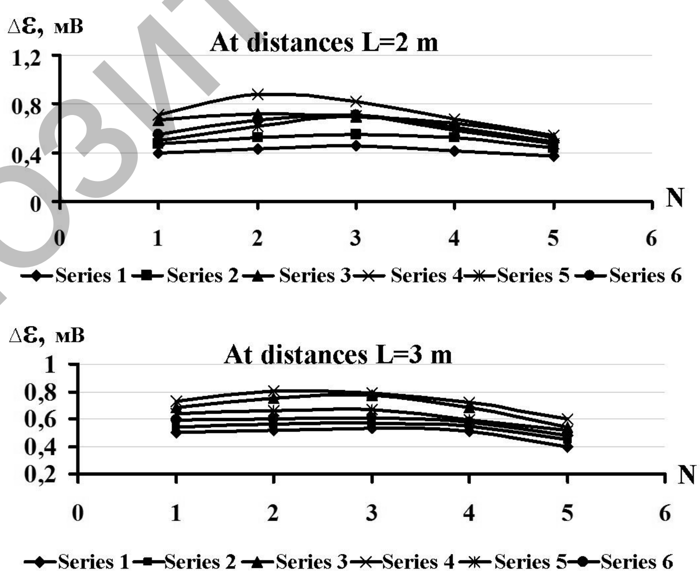


Figure 2. Dependence of the relative signal on grid coordinates

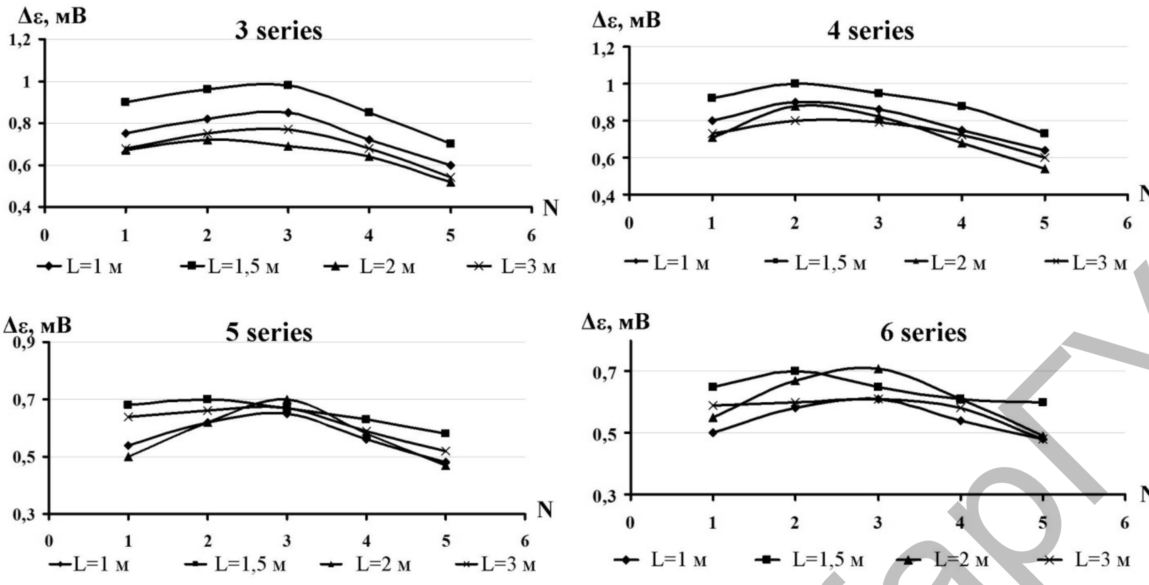


Figure 3. The comparative analysis of graphs on ranks is carried out according to the obtained data

The developed devices will allow by the nature of thermal losses change and ground temperature over surveyed heating systems quickly and with insignificant expenses to determine places of leak points of the heat transfer to environment, and also in due time to determine heat conductors areas with an unsatisfactory condition of their heat-insulating and protecting designs.

The offered device can work both on single-channel, and according to the two-channel scheme. At that founding abnormally high values of power losses indicate to pipeline areas with in whole or in part destroyed thermal isolation or mechanical damages of the pipeline material.

The presented device can be helpful for municipal engineering, for the oil and gas industry, for building industry, etc. for definition of leak points of warmth on heating lines.

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И.П.Куритник, Б.Р.Нүсіпбеков, Д.Ж.Қарабекова, С.С.Жарғақова

Жерасты жылу құбырларын бақылайтын жылулық әдіс

Бақылаудың жылулық әдістемесі жерасты құбыр өткізгіштерінің жылулық оқшаулығышы кезіндегі талдаулары үшін кең қолданыс табуда. Бақылаудың жылулық әдістемесінде бақылау нысанасында таралатын жылулық энергиясы қолданылды. Объект бетінің температуралық өрісі жылу берілу процесінің ерекшеліктері туралы ақпарат көзі болып табылады. Мақалада біз жасаған жылулық ағын құрылғыларының бірнеше модификациялары сипатталған. Бұл аспаптардың ортақ элементі жылулық ағынның жылуэлектрлік түрлендіргіш рөлін орындайтын арнайы конструкциялы батареялы жылуэлектрлі құрылғы болып есептелді.

И.П.Куритник, Б.Р.Нусупбеков, Д.Ж.Карабекова, С.С.Жаргакова

Тепловой метод контроля для диагностики подземных теплотрасс

Тепловые методы неразрушающего контроля получили широкое распространение для анализа состояния тепловой изоляции подземных трубопроводов. В тепловых методах неразрушающего контроля используется тепловая энергия, распространяющаяся в объекте контроля. Температурное поле поверхности объекта является источником информации об особенностях процесса теплопередачи. В статье описаны разработанные нами несколько модификаций датчиков теплового потока. Общим элементом этих приборов является батарейный термоэлектрический датчик специальной конструкции, выполняющий роль термоэлектрического преобразователя теплового потока.

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