4. Tolstix A.V. // Programmnaya realizatsiya imitatsionnoy modeli rasprostraneniya ugroz informatsionnoy bezopasnosti v kompyuternoy seti na osnove ispolzovaniya setey Petri // V sbornike: Informatsionnoe protivodeystvie ekstremizmu i terrorizmu Materiali I Vserossiyskoy nauchno-prakticheskoy konferensii. 2015. S. 124-127.
5. Kushnazarov F.I. Model organizatsii povtornix peredach v kanalax, podverjennix vozdeystviyu pomex // Sovremennaya nauka: aktualnie problemi teorii i praktiki. Seriya: Estestvennie i texnicheskie nauki. 2015. № 12. S. 62-67.
6. Kiryanov A.G. Razrabotka i modelirovanie metodov, primenyaemix v protokolax kanalnogo urovnya setey wi-fi dlya dostavki videopotokov realnogo vremeni // avtoreferat dis. kandidata texnicheskix nauk / In-t problem peredachi informatsii im. A.A. Xarkevicha RAN. Moskva, 2016.

IMPROVEMENT OF ELECTROMAGNETIC FLOW METERS FOR AGGRESSIVE LIQUIDS

A.O.Ataullaev[1] , N.O.Ataullaev[2]

[1,2]Department of Electric Power Engineering, Navoi State Mining Institute, Uzbekistan
Address: South-27[A], 210100, Navai city, Republic of Uzbekistan
[1]amin8181@list.ru

Abstract: *The model developed electromagnetic flow sensors with ring channels and alternating magnetic poles alternately in a three-dimensional approximation and the results of a study of their static characteristics. It was shown that due to the formation in the pipeline system with alternating magnetic poles is substantially increased channel length of the active zone of the sensor, thereby improving sensitivity of measurement. Found that the positive effect, i.e. fuller use of the cross-sectional area of the pipeline in the area of the electrodes is especially pronounced in the flow sensor with a diameter of 150 mm pipeline. It was found that the developed electromagnetic flow sensors allow to produce records of undistorted streams of water with an accuracy better than ± 0,5%.*
Keywords: *Electromagnetic flow sensor, mathematical model, static characteristic, the annular channel, the core, the weight function.*

Introduction

A comparative analysis of the design of electromagnetic flow meters (EMR) was performed by identifying generalized techniques for improving the characteristics of devices. The use of this method reveals the physical essence of the improvements.

1. Statement of a problem

The method of identifying generalized techniques is widely used and is being developed at the stage of the search design of electromagnetic devices with distributed parameters. It consists of a phased analysis of inventions within one subgroup of international classifications of inventions (MKI). To do this, make up the equations for the characteristic for the invention and its prototype, identify the distinctive features of the invention and, summarizing them, find a generalized technique. In the case of the analysis of the n-th number of pairs of inventions, the process of identification and implementation is carried out in a matrix form. At the same time, the designs of the analyzed inventions are located along the main diagonal of the matrix, and their prototypes are located in the first column of the matrix. All other cells of the matrix, empty as a result of the specific implementation of the identified generalized techniques. In this case, the prototypes of all ideas that are in each row are inventions that are located in the same row along the main diagonal of the matrix.

Filling empty matrix cells with possible ideas has two goals:

The first is the refinement or consolidation of the identified generalized techniques.

The second is the development of new EMR designs with improved characteristics, which will later be used at the design stage. The effectiveness of the filled matrix is determined by the effectiveness of the identified generalized techniques refined in the process of testing and the values of the characteristics of the new EMR designs.

However, the matrix filled in according to the above principles will be ineffective. This is explained by the fact that new technical solutions are created by improving the well-known construction of inventions by implementing one generalized technique, i.e. one-step improvement. Therefore, the following principle of filling the matrix is proposed and used in the article: in each row of the matrix each new technical solution serves as a prototype of the next one. In this case, the efficiency of the matrix increases with the number of pairs of inventions considered.

If you follow the development of the electromagnetic flowmeter technology, it is easy to replace that each new EMR design is created by improving known through the implementation of any generalized technique and at the same time the new design will have a better value and improved performance as a whole grows. For example, the design of magnetic magnetic resonance is obtained by improving the design of magnetic magnetic resonance by consistently implementing three generalized techniques. The valuesof the characteristics considered: accuracy, power consumption, mass and sensitivity were obtained by calculation formulas and refined by experimental studies.

2. The concept of the problem decision

Analyzing the values of the characteristics of the EMR, we can conclude that with an increase in the number of successively implemented generalized techniques for improving one design, its generalized characteristic grows as a whole.

As the nodes of the graph are the values of the characteristics of the EMR, and the magnitude of the transfer-values of the coefficients for individual or generalized characteristics. If we take into account that the values of the reception coefficients of the approved and refined methods in the process of a specific implementation change slightly, then using these graphs we can approximately estimate the values of the characteristics of the developed EMR structures.

With the help of this technique, EMR, possessing high manufacturability, reliability, accuracy, sensitivity and having minimum energy and mass-dimensional parameters, are analyzed.

The above principle of implementing generalized techniques was tested not only for the study of magnetic magnetic field, but also for electromagnetic devices with ferromagnetic and electrically conductive liquids, as a result of which new designs were obtained.

In addition, the morphological method of engineering creativity was used in the development of EMR. The essence of this method lies in the fact that in the improved design of the EMR several characteristic features are distinguished for it, for each of which a bank is made up of various specific options are placed in a morphological matrix that allows us to better imagine the search field. Looking through all sorts of combinations of options for EMR.

As morphological signs of electromagnetic magnetic resonance, the following structural features were chosen: a pipeline, a source of a magnetic field, pole pieces, and electrodes.

The article also compiled a morphological matrix of physical and technical effects that are part of the structural scheme of electromagnetic resonance, in particular the magnetohydrodynamic effect.

In the morphological matrix, it is possible to concentrate all knowledge on the existing and possible implementations of each physical and technical effect. The creation of morphological matrices of physicotechnical effects makes it possible to increase the number of synthesized EMR construction options by several orders of magnitude and, therefore, ultimately select the EMR that meets the set requirements.

Improving any indicator or characteristic, it is important to know from which structural element most of all this characteristic depends. The analysis of the identified generalized techniques and the compiled morphological matrix shows that when improving the electromagnetic field, the methods most often used are those that involve changing and improving the magnetic magnetic resonance system [5,6].

3. Realization of the concept

EMR, shown in Figure 1. developed using a generalized technique and consists of an insulating pipe 1 placed inside it and coaxially with it a cylindrical insulating insert 2, a magnetic system containing an inner 3 and outer 4 pole pieces, made in the form of open ferro magnetic hollow cylinders and interconnected by a source of magnetomotive force 5 at opposite ends. The electrodes 6 are made in the form of conductive plates and fixed on the side surfaces of the source of MDS 5. In the article, a circular channel between the ferromagnetic cylinders 3 and 4 under the influence of the source of MDS 5 produces a magnetic field of low frequency with constant induction. Magnetic induction is constant in the annular channel due to the constancy of the magnetic resistance along any path of the magnetic flux. In this case, the condition

$$\frac{h_H}{r_H} = \frac{h_b}{r_b} \quad (1)$$

Where h_b, r_b, h_H, r_H – is the thickness and radius of the inner and outer ferromagnetic cylinders 3 and 4, respectively.

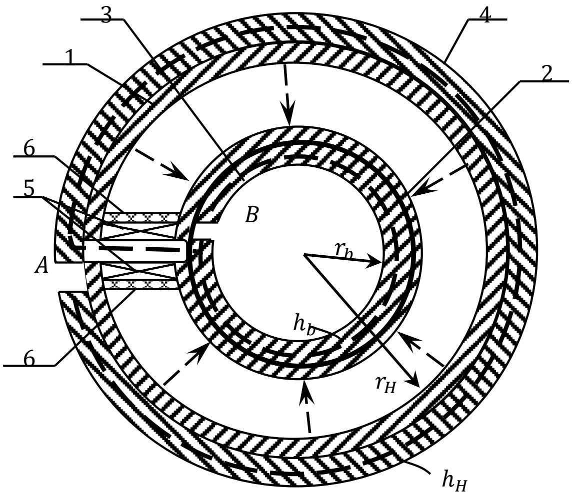

Figure 1. ***Flow transducer EMR.***

EMR works as follows. When an electrically conductive fluid, in particular water, flows, an annular electromotive force (EMF) arises between the ferromagnetic hollow cylindrical tips of the magnetic system through its annular channel in the layers of the magnetic system, which are summed and averaged on flat electrodes. Due to the constancy of the magnetic induction in the annular working channel and the averaging of the electric field in the liquid by flat electrodes, the change in the distribution profile of the flow rates of water in the pipeline does not affect the value of the emf proportional to the flow rate.

Theoretical and experimental studies of magnetic systems of such magnetic magnetic fields show that the uniformity of the magnetic field in the annular channel is achieved when condition (1) is fulfilled, as well as when using a magnetic core made of steel with exactly the same values of specific magnetic resistances. Otherwise, the non-uniformity of the magnetic field increases dramatically.

In figure 2 shows the EMR, the development of which was used a generalized technique. In this flow meter open hollow ferromagnetic jumper 5 with the excitation winding 6 at the ends of the same name. The outer ferromagnetic cylinder is provided with a magnetizing winding 7 distributed over the coordinate 7. Moreover, the linear magnetizing force of the winding 7 along the change coordinate is determined by the formula:

$$f_r(a) = \frac{\gamma U_{Mb}}{ch(\gamma a_M)} * sh(a * \beta) \quad (2)$$

whereU_{Mb} –MDS excitation winding 6, γ – the propagation coefficient of the magnetic field waves in the magnetic core, a,a_M – the angular coordinate of the channel and its maximum value, deg.

In the annular channel between hollow ferromagnetic cylinders under the influence of the source of MDS, a field with a higher degree of uniformity is formed. The magnetic field is uniformly along the coordinateα due to the compensation of the losses of magnetic induction in the NA$f_r(a)$ ferromagnetic cylinders of the distributed winding.[1,7]

The linear value of the loss of magnetic induction in ferromagnetic cylinders along the coordinate αvaries in proportion to the magnetic flux$\Phi(a)$. Therefore, the linear value of the NA$f_r(a)$ also varies in proportion to the magnetic flux by the formula (2). Since the specific $NAf_r(a)$ is calculated for the sum of the magnetic resistances of ferromagnetic cylinders, the inequalities of the materials of the cylinders $\rho_m$do not affect the uniformity of the magnetic field in the annular channel.

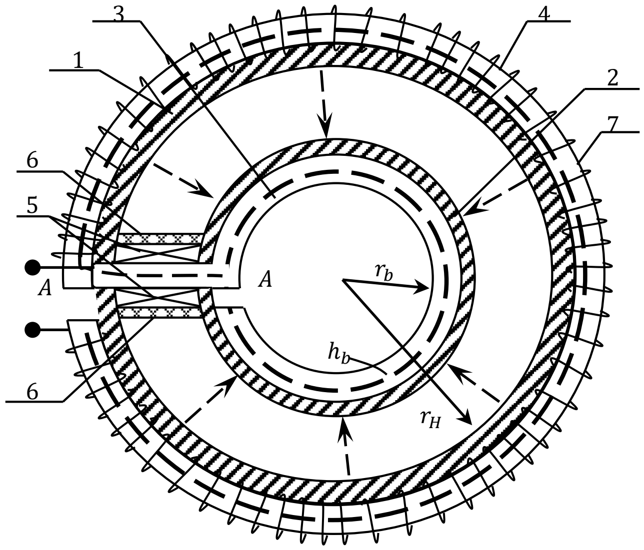

Figure 2. ***Flow converter.***

Analysis of the magnetic systems of the examined magnetic resonance showed that near the sections of ferromagnetic hollow cylinders - in the electrode zone, the magnetic field is largely uneven and, if we take into account that this zone will make the greatest contribution to the output signal, then the measurement of water flow with non-axisymmetric flow is sharp is increasing.

Therefore, in order to reduce the influence of this non-uniform field region on the output channel, it is necessary to reduce the distance between the electrodes, which leads to a decrease in the sensitivity of the conversion. The source of MDS is in the working annular channel, which, firstly, with poor insulation leads to contact with controlled water, and secondly, a parasitic electric field occurs between the winding with the current and the electrodes, causing interference to the conversion circuit. In addition, the magnetic system has a relatively large power consumption, which is explained by the large value of the length of the middle turn of the excitation winding.

To preserve the longitudinal dimension of the EMR under one end of the lintel 3, the inner cylinder 1 has a notch filled with non-magnetic material. Since the end area of the notch is small, then this scattering flux and its influence on the overall picture of the magnetic field in the annular channel can be neglected in the first approximation. On the side surfaces of the insulating bridge 5 connecting hollow cylinders 1 and 2 to each other along the entire length of the magnetic system, conductive flat plates 6 are reinforced. The outer cylinder 2 simultaneously acts as a conduit.[1,2,3,4]

In the developed electromagnetic field along the entire annular channel along the coordinates and z, including the electrode zone, a magnetic field is created with a high degree of uniformity. There is no winding with current in the channel, which leads to reduction of interference between the signal power circuits and contributes to improving the reliability of magnetic magnetic resonance by eliminating the possibility of winding contact with controlled water

The main reduction in energy costs is provided by the location of the excitation coils on the basis of the jumper, having a small cross-sectional area and, therefore, a significantly smaller average length of the coil.

Studies have shown that electromagnetic flow metering with one annular channel has the best properties in pipelines from 50 to 200 mm. With smaller diameters (less than 50 mm) of the pipeline, the magnitude of the leakage flux will increase significantly, which reduces the efficiency of the used magnetic system. In large pipelines (over 200 mm), due to the increase in the width of the annular channel, the sensitivity and accuracy of the conversion are reduced. This is due to a decrease in the length of the active coil, an increase in the non-magnetic gap and an increase in the non-uniformity of the weight function in the radial direction.

Therefore, for measuring the flow in large pipelines, EMR with alternating magnetic poles have been developed. It consists of an insulating pipeline, polar tips located inside it, made in the form of turns of an Archimedean spiral, and the spirals are displaced relative to each other so that the gap between them is constant, electrodes made in the form of current from conducting plates adjacent to the tips. The magnetic system also contains an excitation winding. At the end of the tips, an additional electrode is installed, the length of which is equal to the pitch of the helix, and the section of the pipeline cavity that is not involved in the creation of the EMF is filled with insulating material.

Spiral coils of tips form a magnetic system with alternating poles. The direction of the EMF arising from the movement of water in a magnetic field and the direction of flow of water. The EMF is summed and averaged on the electrodes due to the presence of an additional electrode. Considered EMR allows to increase the sensitivity of the conversion of water flow in the output signal compared to EMR with the annular channel.

An increase in sensitivity in such an EMR occurs as follows. With an increase in the length of the coil of the Archimedean spiral, the area of the gap between the pole tips increases, as a result of which the magnetic field induction in the gap will be as many times as many times as the area of the gap. But an increase in the length of the active coill_a is accompanied by a simultaneous decrease (for the purpose of preserving the living section in the water flow path) of the gap between $\rho_{н-}\rho_{в}$ the lugs by as many times as the length of the liquid coil increases. Induction will not occur. Therefore, the sensitivity of EMR at the same and will be greater due to the increase in the length of the active coil, which is achieved by performing the tips in the form of an Archimedean spiral. In order to improve the manufacturability of the magnetic system, another EMR design with alternating magnetic poles was developed. Placing in the magnetic system of concentric open hollow cylinders leads to an increase in the length of the active coil. Since EMR is a magnetic system with alternating poles, the increase in the length of the magnetic poles leads to a double increase in the length of the active coil. The direction of the excitation currents in these sources is chosen so that a magnetic system with alternating poles forms in the pipeline. The electrodes are fixed on the side surfaces of the sources of MDS. With a large length of the magnetic system along the flow of water in order to reduce power consumption, sources of MDS are set locally at regular intervals.

Conclusion

The developed EMR designs have small weight and size parameters and allow to increase the accuracy and sensitivity of the transformation. The creation of a magnetic system with alternating poles in the pipeline allows for the same valuesof magnetic induction and water flow rate to increase the sensitivity of the flow conversion.

References

1. Welt I.D., MikhailovaYu.V. Measurement of flow and level of electrically conductive liquids: Monograph. LAP LAMBERT Academic Publishing. Germany, 2018. - 155 p.
2. Electromagnetic flowmeter Magnetoflow® Primo Installation and Maintenance Manual VERSION 1.1/01-04 Czech. 2006. - 41 p.
3. Specifications Integrated two-wire electromagnetic flowmeter. AHR Japan series. 2008. - 60 c.
4. Loginov N.I. Electromagnetic transducers consumption of liquid metals. - Moscow: Energoizdat, 1981. - 104 p.
5. Theoretical foundations of electrical engineering: In 3 volumes. Textbook for universities. Volume 2. - 4th ed./K.S. Demirchyan, L.R. Neyman, N.V. Korovkin, V.L. Chechurin. - St. Petersburg: Peter, 2006. - 576 p.
6. Patent RUz. №04960. Electromagnetic flow transducer / Amirov S.F., Ataullaev A.O., Turdybekov K.X., Juraeva K.K., Ataullaev N.O.// Herald. - 2014. - №4.
7. Amirov S. F., Ataullaev N.O., Ataullaev A.O. Approximation of the main magnetization curve of sensor magnetic circuits// International Jornal of Advanced Research in Science, Engineering and Technology. India. ISSN (Online): 2350 – 0328. Vol. 5, Issue 4, April 2018. – P. 5515 – 5518.