STUDY OF FARADEY'S LAW OF ELECTROMAGNETIC INDUCTION IN PHYSICAL EXPERIENCE

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ABSTRACT

According to the law of electromagnetic induction, if the magnetic flux is increasing (DF>0), a negative induction EYuK (εind<0) appears in the circuit, and vice versa, if the magnetic flux is decreasing (DF<0) a positive induction EYuK (εind>0) appears in the circuit. If the magnetic flux changes uniformly, then the value of the induction EMF formed by the wire frame is constant. That is, an alternating magnetic field excites an rotating electric field in the space around it, which in turn causes an inductive current inside the coil and an electromotive force in the coil.

KEYWORDS: *Faraday's law, energy sources, coil, magnetic flux, electromotive force, induction current.*

INTRODUCTION

Today, mankind's need for energy resources is growing. The main reason for this is, firstly, the growing population of the planet, and secondly, the declining energy resources of the Earth. The solution to this problem is assessed as finding opportunities for efficient use of alternative energy sources in all areas. Of course, these types of energy are currently more expensive than existing types of energy, but they are environmentally friendly, energy efficient and do not require complex technological equipment and tools. So, the first major challenge is to reduce the cost of recognizing alternative energy sources, and the second is to develop their improved technologies. This requires, first of all, modern professional staff with knowledge and skills on the fundamental and practical foundations and design of alternative energy sources. In the training of such modern specialists, it is necessary to ensure an integral link between science, education and industry. **[1]**

Materials and methods

There are a lot of innovations and discoveries in science today. These innovations have limited opportunities to apply the findings directly to the educational process. After that, students will be able to develop knowledge, skills and competencies. In particular, let's take a look at the general educational process of providing information to students about alternative energy sources. It is known that alternative energy sources include solar photovoltaic, wind energy, geothermal energy, bioenergy and others. We know that energy does not disappear from existence, and vice versa, it simply passes from one form to another. A device that converts mechanical energy into electrical energy is a generator. Its operation is based on Faraday's law of electromagnetic induction. That is, when a closed-circuit circuit is crossed by a time-varying magnetic flux, an inductive EYuK is generated in the circuit, and this phenomenon is called electromagnetic induction. **[2]**

Michael Faraday, who in 1822 set himself the task of generating an electric current in a conductor using a magnetic field, as a result of nine years of consistent research, in 1831 the closed-loop circuit determined that an electric voltage is generated from each change in the alternating magnetic field current. The magnetic field flux is found by integrating the cross-sectional surface of the magnetic field induction norm B:

$$\boldsymbol{\Phi} = \int_{S} \boldsymbol{B} \cdot \boldsymbol{dS}$$

In particular, this induction showed that the generated voltage is proportional to the formation of the magnetic field flux Φ Integral of electromotive force (EYuK) over time:

$$\int_{1}^{2} \boldsymbol{\varepsilon} \cdot \boldsymbol{dt} = \boldsymbol{\Phi}_{2} - \boldsymbol{\Phi}_{1} = \Delta\boldsymbol{\Phi}$$

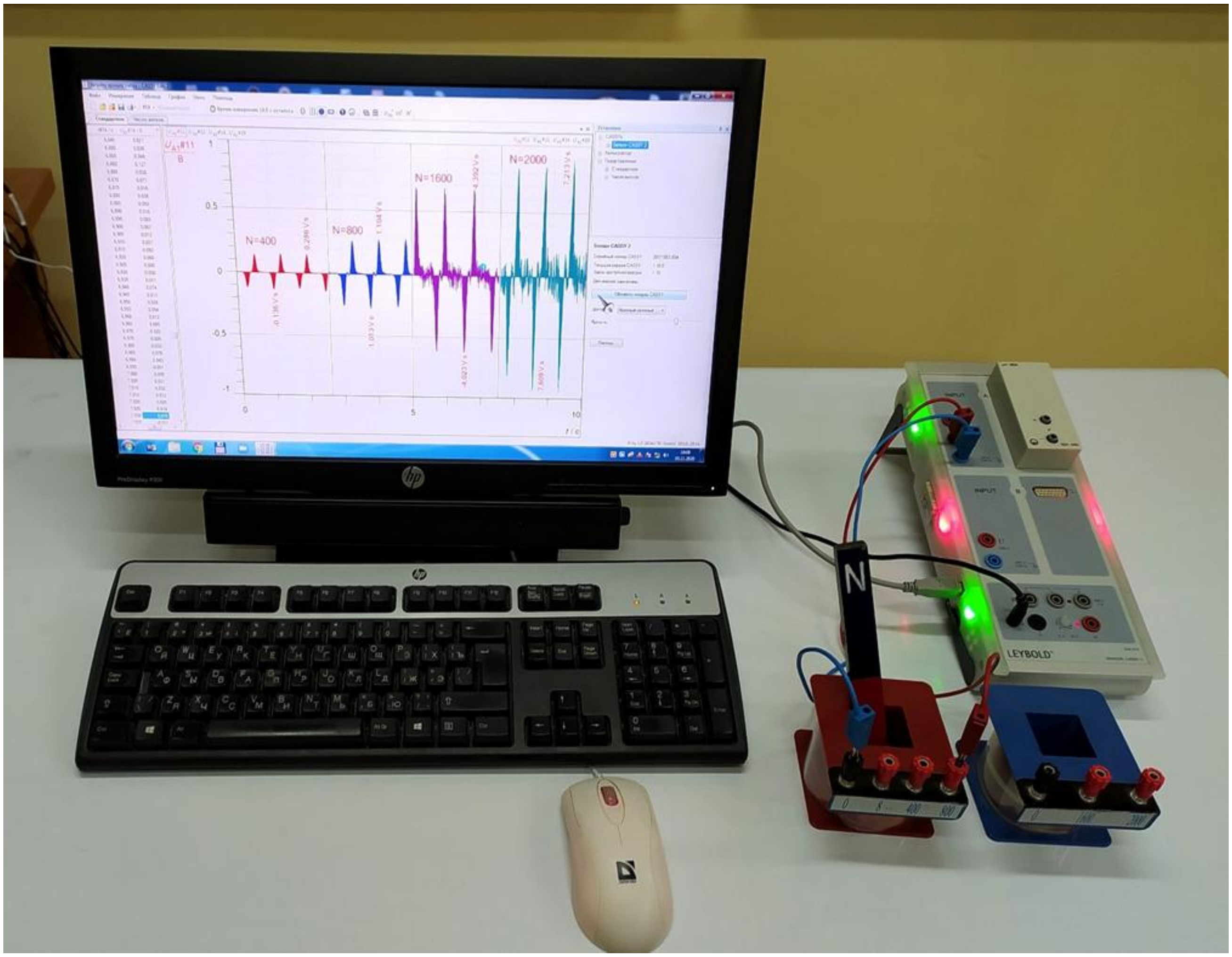
Depends only on the change of magnetic flux. Thus Faraday's law of electromagnetic induction was discovered.

$$\varepsilon = -\frac{d\Phi}{dt}$$

This experiment proved that when the magnetic field lines crossing a conductor change over time, it produces an electromotive force (EYuK). The faster the magnetic field lines change over time, the greater the electromotive force in the conductor.

The electric current generated in the conductor by the magnetic field is inextricably linked with the current of the magnetic field, as well as the number of turns of the coil that make up the conductor. The following laboratory experiments can be used to study the dependence of the electric current generated on a conductor on the number of windings.

Using the device shown in the figure, we can see that Faraday's law of electromagnetic induction is inextricably linked to the number of turns of the coil. **[3]**



During the experiment, when inserting and pulling a magnet into an electromagnetic coil, EYUK clearly shows that it has the same absolute value, but has opposite signs, ie,

$$\downarrow \int \varepsilon \cdot dt = -\uparrow \int \varepsilon \cdot dt$$

When two magnets are used, there is an additional correlation between voltage pulses and their number.

$$\int_1^2 \varepsilon \cdot dt = \Phi_2 - \Phi_1 = \Delta\Phi$$

Using differentiation, we can test Faraday's law of electromagnetic induction. The magnetic flux depends on the number of windings, as each individual coil winding produces a current difference $\Delta\Phi 0$ and the total current is calculated as $\mathbf{\Delta\Phi = N \cdot \Delta\Phi_0}$.

TABLE: ACCORDING TO FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION, THE RELATIONSHIP BETWEEN THE VOLTAGE AND THE NUMBER OF TURNS OF THE COIL N FOR A GIVEN TIME.

The number of rolls of the reel							
N=400		N=800		N=1600		N=2000	
U(V)	*t (s)*	*U(V)*	*t (s)*	*U(V)*	*t (s)*	*U(V)*	*t (s)*
0.001	0.1	0.013	2.6	0.443	5.1	-0.047	7.6
-0.013	0.2	0.002	2.7	0.138	5.2	0.008	7.7
-0.103	0.3	0.003	2.8	-0.019	5.3	-0.533	7.8
0.002	0.4	-0.011	2.9	0.059	5.4	0.035	7.9
0.133	0.5	-0.174	3.0	-0.003	5.5	0.829	8.0
0.011	0.6	-0.039	3.1	0.044	5.6	0.046	8.1
0.003	0.7	-0.006	3.2	-0.619	5.7	-0.081	8.2
0.002	0.8	0.263	3.3	0.046	5.8	0.122	8.3
-0.002	0.9	0.019	3.4	0.337	5.9	0.019	8.4
-0.100	1.0	0.002	3.5	0.116	6.0	-0.595	8.5
-0.013	1.1	0.004	3.6	-0.023	6.1	0.097	8.6
0.037	1.2	-0.016	3.7	0.057	6.2	0.020	8.7
0.056	1.3	-0.275	3.8	0.007	6.3	0.377	8.8
0.008	1.4	-0.020	3.9	-0.022	6.4	0.050	8.9
-0.003	1.5	0.049	4.0	-0.550	6.5	-0.002	9.0
-0.001	1.6	0.153	4.1	0.043	6.6	-0.085	9.1
-0.022	1.7	0.008	4.2	0.065	6.7	0.070	9.2
-0.087	1.8	0.004	4.3	0.287	6.8	-0.871	9.3
0.003	1.9	-0.001	4.4	0.067	6.9	0.110	9.4
0.149	2.0	-0.018	4.5	0.099	7.0	0.220	9.5
0.009	2.1	-0.247	4.6	-0.029	7.1	0.101	9.6
0.002	2.2	0.005	4.7	-0.070	7.2	-0.050	9.7
0.003	2.3	0.212	4.8	-0.577	7.3	0.181	9.8
-0.004	2.4	0.031	4.9	0.041	7.4	0.178	9.9
-0.137	2.5	0.006	5.0	-0.030	7.5	-0.019	10

The induction current generated in a closed loop is directed in such a way that the magnetic field generated by the induction current prevents any change in the external magnetic flux.

This means that the induction current is such that its magnetic field tends not to increase as the number of magnetic induction lines crossing the contour increases (so as not to push the magnetic rod closer), and the magnetic induction tends not to decrease as the number of lines decreases (by pulling the magnetic rod). Thus, the secondary field generated by the induction current tends not to change the relative position of the contour and the magnetic rod. This is because the magnetic flux through the circuit does not change unless its relative position changes. **[4]**

From the results obtained and the table, we can see that as the number of turns of the coil increases, so does the electromotive force (EYuK) on the coil over time. In addition, the direction of the induction current is such that the magnetic field it generates tends to compensate for changes in the external magnetic field.

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