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More about Negative Magneto resistance of Electric Current in Liquid

S.A. Gerasimov
Department of General Physics, Southern Federal University, Rostov-on-Don, 344090, Russian Federation

ABSTRACT : *The electric current in the electrolyte and the dark electric current in pure waterwith two asymmetric electrodes immersed in a liquid increases under the action of a magnetic field, even if the source of the magnetic field is a permanent magnet. The relative change in current with such a negative magnetoresistance depends on the resistance of the load through which the electric current flows.*

KEYWORDS : *Negative resistance, Water, Electrolyte, Aluminum, Magnetic field, Dark current.*

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I. INTRODUCTION

It is believed that the electric current in a liquid is not much different from the electric current in a gas [1]. This means that under the action of a magnetic field, the electric current must weaken. However, measurements have shown that the electric current in a cell with two aluminum electrodes immersed in water not only does not weaken under the action of an external magnetic field created by an electromagnet, but even increases [2]. The relative change in current strength, as it turned out, is proportional to the square of the magnetic field induction [3]. On the other hand, the temperature of the liquid is also proportional to the square of the current flowing in the electromagnet. This does not allow one to unambiguously relate the increase in current due to the action of a magnetic field with a change in the current strength due to heating of the liquid. This, apparently, is about negative magnetoresistance [4], which makes it possible to significantly increase the efficiency of liquid sources of electrical energy. The only way to eliminate the duality of this interpretation of the increase in current under the influence of a magnetic field is to use permanent magnets in measurements. While the effect is rather weak. Therefore, in order to eliminate methodological errors due to vibrations of the liquid cell, it is best to carry out the magnetic exposure very slowly. Simple manipulations, which are the movement of a cell with a liquid under study into a region with a strong magnetic field, do not give an unambiguous result. The mechanical effect of the magnetic field source on the liquid should be minimized.

The effect of negative magnetoresistance was obtained for the so-called dark current [5]. This is quite an unusual phenomenon. It is believed that the dark current arises as a result of quantum effects occurring on the surface of aluminum with its thin oxide film [6]. Therefore, the appearance of negative magnetoresistance for the electric current flowing in the electrolyte must be confirmed. Moreover, it turned out that the relative increase in electric current under the influence of a magnetic field weakly depends on the direction of magnetic field induction. Of course, in some cases this also happens when an electric current passes through a gas medium. In any case, suspicions of the inadequacy of the connection of the increase in current with the influence of the magnetic field should be eliminated.

II. MEASUREMENTS

All of the above can be achieved with a simple experimental setup shown in Fig.1, in which the magnetic exposure of cell *V* with two asymmetric aluminum electrodes *E* and *C* immersed in liquid *L* occurs with the rotation of two neodymium magnets *M* with a diameter of 30 mm and with an average magnetization 10^6 A/m, carried out clockwork *CV*. The magnetic field induction in the center of the disk electrode is 0.11 T . Electrode *E* is a thin aluminum disk with a radius of r=15 mm, located at a distance of h=5 mm from the top surface of the clockwork. Electrode *C* is a cylinder 20 mm high and 4 mm in diameter. The gap between electrode *E* and the lower base of electrode *C* is 5 mm. Depth of immersion of electrodes in liquid is l= 25 mm.

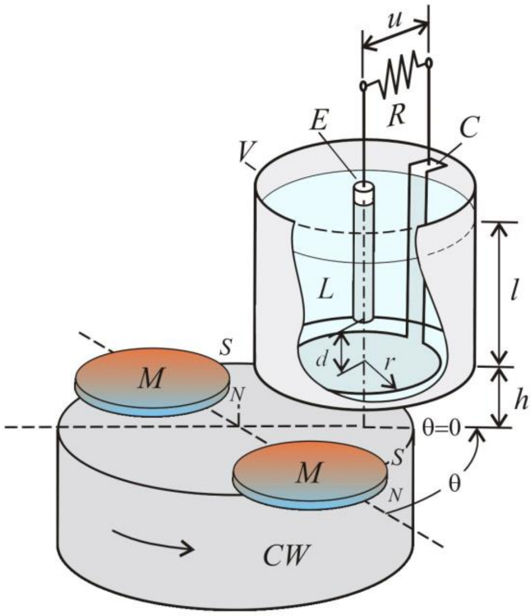

Fig. 1. Magnetic exposition of liquid with two metallic electrodes

During the time that one or another magnet is under the electrode, the voltage u across the load resistance R increases (Fig. 2). Even for distilled water in contact with two asymmetrical electrodes, the relative change in voltage proportional to the relative change in current is a few percent. Unfortunately, the process is not stationary. This does not allow one to describe the dependence of the relative change in the current on the position of the magnets in the form of two identical dependences shifted by an angle of π. A quantitative characteristic of the result of such a magnetic effect on the liquid is needed. This can be the average value δI of the relative current change $\Delta u/u$ over the angle $-\pi/2<\theta<3\pi/2$. In contrast to the magnetic exposure created by an electromagnet with heating of the electrodes and liquid [3], in such an experiment there is no interfering phenomenon that would create a significant methodological error.

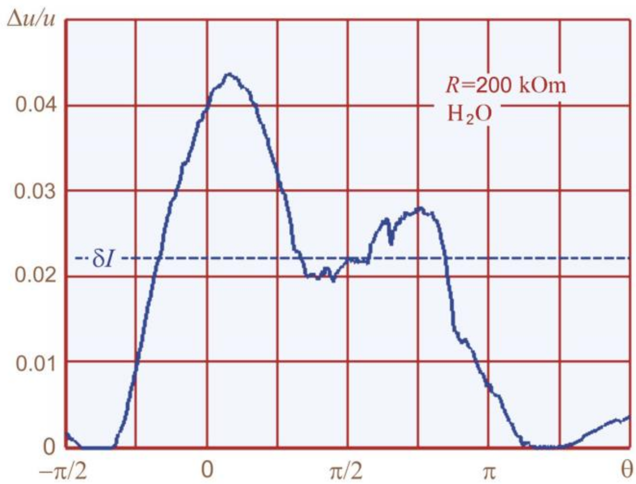

Fig. 1. Dependence of relative variation of dark electric current on position of magnets

At high values of load resistances R, the average change in current δI is practically unchanged (Fig. 3), however, at low R, it is small. It is possible that this is due to the high internal resistance of such a dark source of electrical energy. In any case, the external magnetic field increases the efficiency of the selection of electrical energy created by the dark current. Since the relative change in current is proportional to the square of the induction of the external magnetic field, this gain can be quite significant.

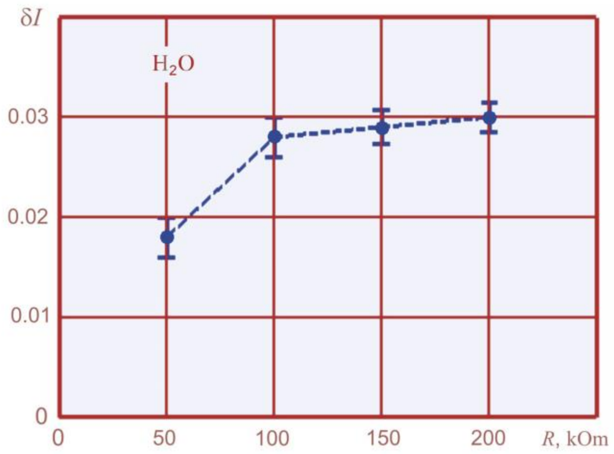

Fig. 3. Dependence of averaged relative change of dark current versus values of load resistance

Further, the same thing, but for a 3 percent solution of 1 electrolyte playing the role. In this case, the current strength in the circuit significantly exceeds the strength of the dark current. Therefore, the average value of the voltage drop across the load resistor is small, although the direction of the current remains the same. The maximum change in current occurs after the magnet is no longer under the electrodes. This is not the only feature of the increase in the current strength in the electrolyte under the action of a magnetic field. The increase in current occurs with a significant delay in time. Significant fluctuations and oscillations of the current flowing through the electrolyte should be noted. Therefore, the results shown in Fig. 4 are obtained as a result of smoothing the experimental dependences of voltage drops on the slow turn angle.

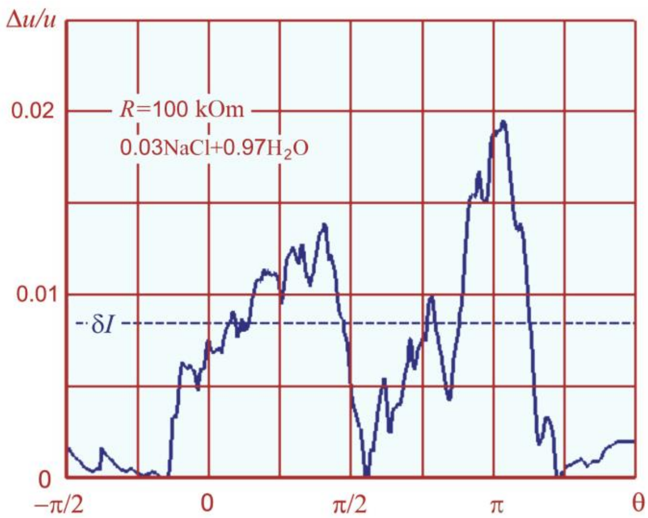

Fig. 4. Angular dependence of the relative change of current in electrolyte under action of magnetic field.

The dependence of the average relative change in the current strength on the load resistance does not saturate at large values of *R* (Fig. 5). Everything seems to be that the dark electric current and the electric current in the electrolyte are significantly different. In this case, the effect of negative magnetoresistance also occurs in the electrolyte. In order to enhance the effect of negative magnetoresistance, the shape and dimensions of the electrodes and the magnetic field source are changed. Therefore, it is not yet possible to compare the results of this work with other results [3,5]. The main difficulty is created by the shapes of the magnetic field sources, although the cell shown in Fig. 1 can participate in measurements with an annular electromagnet surrounding the cell. Such a variant of the experiment is beyond the scope of this work. The aim of this work was to elucidate the role of temperature on negative magnetoresistance.

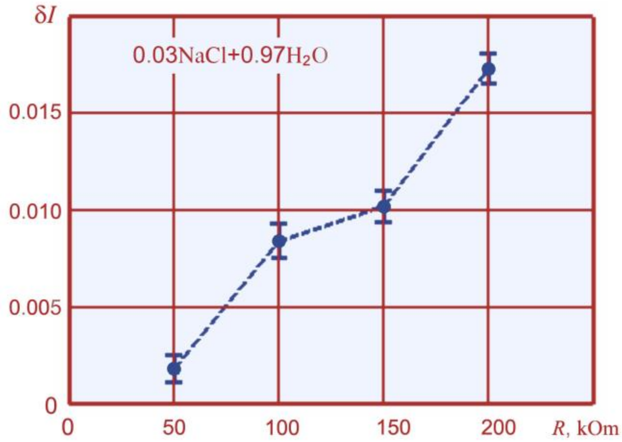

Fig. 5. Average relative change of electric current in electrolyte as a function of load resistance

III. CONCLUSION

Heating of the liquid and electrodes in contact with the liquid does not significantly affect the electrical resistance to the current flowing in the liquid. This is the main result of the present work. So far, there are not enough arguments to distinguish negative magnetoresistance from the effects that accompany the magnetization of substances [7], including aluminum and distilled water, although it is not yet known how the electrical resistance changes with the magnetization of a substance. In any case, an external magnetic field increases the strength of the current flowing in a pure liquid and in an electrolyte. This increase is interpreted as a negative magnetoresistance effect.

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