Electrets: A new Method for Achieving and Measuring

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Abstract—Green energy research have increased in recent decades and interest in unconventional energy production systems is becoming more pronounced. Such unconventional energy generation systems are also based on electret generators. The electret, underlying generator, is a dielectric material that has a quasi-permanent electric charge. This paper provides a brief history of the electret, describes the process of electret making and measuring and presents the research results.

Keywords—Dielectric, Electret, Electret generator, Green energy.

I. INTRODUCTION

The term was first introduced in 1839 by Faraday to define substance along or across which electric forces act. After further investigation it was found that between polarization and magnetization of the substances there is an analogy: magnetic substances behave in a magnetic field as dielectric substances in an electric field. As in iron can be created a remanent magnetization by placing it in a magnetic field, a remanent polarization can be created on dielectric bodies by keeping them in a strong electric field. After removing the external field the polarization is maintained for a long time. These findings are underlying the creation of the electret [1].

First electret was created by Mototaro Eguchi, 35 years later after Heaviside described the procedure to achieve an electret. Eguchi followed exactly the procedure with one difference: the material was heated to melting point and then allowed to solidify under the action of the electric field. This way the molecules oriented after the electric field's orientation and the polarization of the material in solid state becomes permanent. This electret made under the simultaneous action of an electric field and heat is called thermoelectret [1].

Since the first research on the electret effect to the present, various methods and materials were used to build the electret but one of the easiest ways to achieve an electret remains that of an electret made of different types of wax. Over time were conducted thorough research over the electret made of various dielectrics such as ceramics, polymers, crystals, etc. [1].

II. ELECTRET MANUFACTURING

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Electrets were originally used for producing electret microphones and phones. Later, they were used in other applications such as electret transducers, electret electrometer, electret galvanometers, high voltage generators.

In order to achieve an electret under laboratory conditions there has been used an installation consisting of a thermostatic oven, a high voltage source, an electret matrix and two electrodes as shown in Figure 2. Figure 1 is a schematic diagram of the manufacturing installation to achieve an electret.

The electret is placed between metal electrodes B and C, C electrode being provided with a guard ring K. As a voltage source a battery or a stabilized high voltage reducer has been used. To measure the current is used the current amplifier A, thermostat T is shown dashed, in which are placed the electrodes and the sample. Sample diameter is slightly larger than the diameter of the electrodes because during dielectric polarization a breakdown of the air between the electrodes on the side of the disc is possible. Polarization field’s strength can be increased by reducing the diameter of the electrodes. Guard ring role is twofold: firstly it reduces those deviations from uniformity distribution of the electric field that are observed at the edges of the disc and second it channels the surface currents to ground, which allows us to gauge the spatial volume electrical conductivity of the substance [1], [4].

The material used to build the electret consists of 45% Carnauba wax, 45% rosin and 10% natural wax.

In previous research [3], [4], [5], paraffin and ferrite electrets were made by heating the sample up to a temperature of 40ºC and 150ºC for polyethylene electrets, applying an electric field with an intensity of 1.66 kV, and maintaining a constant polarization temperature. The sample was held in the electric field and heat for eight hours, after which the temperature is slowly lowered to room temperature while maintaining the applied electric field.
The process of electret making in this paper is given below. The sample is introduced into the mold which is held between the two electrodes connected to the power supply as shown in Figure 2. After this step, the thermostatic oven was set at a temperature of 80 °C for a period of 90 minutes. Subjected to thermal action the material passes in liquid state. Electrode voltage is then applied through the power supply which is set to a value of 3kV for 3 hours. This time is called polarization time in which the temperature and applied voltage are constant. After this period, for about 1 hour, the temperature inside the oven is gradually decreased to ambient temperature while the electric field is being maintained stable. Figure 3 shows the plot of the electret polarization regime.

This way the polarization becomes permanent.

III. ELECTRET MEASUREMENT

Are presented below two electret load measuring devices designed based on the magnetostriction phenomenon. The electret measuring device has in its structure a magnetostrictive vibrator consisting of a Terfenol-D bar located in the alternative magnetic field produced by an electromagnet powered from an AC source. The Terfenol-D bar is embedded at one end and at the other end is provided with a circular metal electrode mounted through an electroinsulating component. The electrode moves together with the rod in the electric field produced by the investigated electret, placed in close proximity. In the first variant, namely Figure 4, is a longitudinal section through the device for measuring electret load version I, electret load measuring device primarily consists of a terfenol bar, recessed at one end to a fixed support. The free end of the Terfenol-D bar is provided with a disc-shaped metal electrode mounted via an electroinsulating fitting and a mounting part. The Terfenol-D bar is under the action of magnetic field produced by an electromagnet consisting of an electroinsulated housing to which is placed a coil that is powered from an AC source.

The magnetic field created by the electromagnet is located in a magnetic circuit constituted, besides the Terfenol-D bar and a ferromagnetic cylindrical part and two ferromagnetic plate armature that also has a supportive role. The mobile electrode is located within the electric field produced by an electret located in the immediate vicinity. The electret is in contact with another electrode mounted via electrical fittings, into a support piece placed on a support surface. Into the device must also be included an electrostatic voltmeter connected to the two electrodes.

In the second variant, shown in Figure 5, which is a longitudinal section through the device for measuring electret's load achieved in the II variant, the device is equipped with two workstations which enable simultaneous verification of two electrets. As can be seen from the figure, the Terfenol-D bar is fixed in the center of the electroinsulated housing, into which is made the coil itself. For the same purpose at both ends of the rod are placed two mobile electrodes, mounted via two electroinsulating parts. Mobile electrodes are placed in electric fields produced by investigated electrets that are each in contact with electrodes, each placed through the insulating mount by an adjustable support, both placed on a support surface.
For this electret measuring device in both versions, has been established the regular national filing to obtain the patent.
IV. EXPERIMENTAL RESULTS
The electret experimental measurement stand, as shown in Figure 7, consists of a digital oscilloscope, a power source and the device for measuring electrets itself.

Oscillogram obtained using this system are shown in Figure 8.

V. CONCLUSION
In this paper has been presented a method for achieving Carnauba wax electrets and measurement those using a new type of device [2].

Its electric field, sufficiently strong to a distance of 10 mm and its stability, recommends using Carnauba wax electrets in various applications of electret transducers to electret generators. In comparison with other dielectric materials, Carnauba wax electrets have a higher lifetime if kept in appropriate conditions. Results obtained using the device for measuring electrets lead us to achieve much stronger electret types.

Although it is more than a century from their discovery, only the last two decades have brought new insights into the methods and materials used in making the electrets. Current research is focused on diversifying applications and increasing electret efficiency, smaller, more powerful.

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