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MAGNETS AND THEIR USE

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Abstract. Danish physicist Hans Oersted noticed that when he brought a current-carrying conductor to a compass, the compass's magnetic needle deflected. This discovery by the scientist led to the emergence of a new branch of physics - electromagnetism. This gave impetus to the development of new hypotheses. At the same time, he united the teachings of electricity and magnetism, which were developing in parallel.

Nowadays, magnet properties are widely used in engineering, industry and medicine. This article provides the latest information on magnet properties, characteristics and applications.

Keywords: magnet, diamagnetic, paramagnetic, ferromagnetic, pole, substance, 3D technology, medicine, model.

Any material that attracts and repels objects is called a magnet. Most magnetic devices are horseshoe-shaped, as the air between their poles plays a major role in creating magnetic phenomena. The air between the horseshoe magnets enhances the magnetization of the magnet. For example, iron, nickel and some other metals have gravity. Magnets are widely used as independent sources of constant magnetic fields in radio electronics, radio engineering and automation [11,13].

A spiral solenoid or electromagnet made of a superconducting material is called a superconducting magnet. It is widely used in the study of electrical and optical phenomena, as well as in experiments to study the properties of plasma, atomic nuclei, elementary particles, etc. At the same time, the operation of some modern devices used in medical practice is based on constant and electromagnetic phenomena.

A magnet is an object that has its own magnetic field. The simplest and smallest magnet can be called an electron.

Currently, the properties of a magnet are diamagnetism, paramagnetism, and ferromagnetism. Diamagnetism of magnets is widespread and is used in many different technological applications. Materials that are weakly repelled by both poles of a magnet are called diamagnets [9,12].

Fig. 1., shows a schematic representation of diamagnetic molecules in the absence of a magnetic field (A) and in a magnetic field (B). They are considered substances that bend the lines of force in a magnetic field.

The magnetization vector of diamagnets is directed opposite to the magnetic induction, and its value increases with increasing induction:

$$\mu < 1.$$

Magnetic storage media encode audio and video data on a magnetic tape coating and are used in debit, credit, plastic cards, computer monitors, electric guitars, dynamic microphones, etc.

In industry, mechanical energy is converted into electrical energy by means of a magnetic field using a generator. Diamagnetic transformers, or autotransformers, are used to transfer electrical energy between two circuits through a magnetic field [10,12].

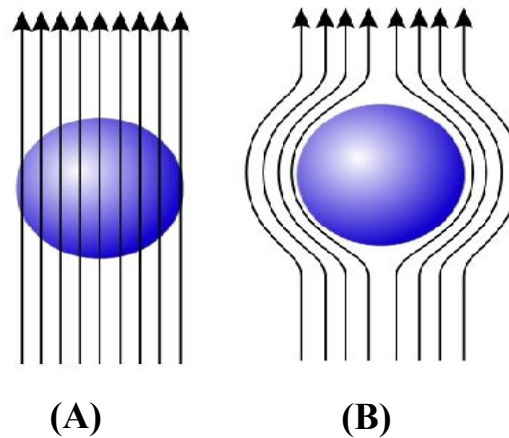


Fig. 1.

Paramagnets are magnetized substances that have a positive magnetic susceptibility in the direction of an external magnetic field. These include aluminum, oxygen, molybdenum, etc. Here is an example. Paramagnetic molecules have non-zero magnetic moments, and in the absence of a magnetic field, these moments are located randomly.

When a cylinder made of paramagnetic materials is placed in a magnetic field, the magnetic field in the cylinder groove increases relative to the external field while:

$$\mu > 1.$$

The study of paramagnetic properties of substances allows determining the magnetic moments of atoms and ions, investigating their charge states, obtaining information about the complex structure of molecules, the structure of complex molecules, solid solutions of paramagnetic ions, and measuring low temperatures. This demonstrates the achievements of magnets in medical practice. For example, elements from the rare earth group of metals are commonly used as contrast agents introduced into the bloodstream using modern analytical methods. Gadolinium (Gd), which has such paramagnetic properties, is administered intravenously to study the function of the inner surface of blood vessels, the reaction of blood vessels to blood flow or vice versa, blood composition and other parameters [10,12,13]. Modern magnetic and paramagnetic phenomena that contribute to the development of medicine are called “miracles” of diagnostics.

Ferromagnets are solid bodies that self-magnetize at low temperatures and very quickly change their properties under the influence of an external magnetic field, due to deformation and when the temperature changes. Ferromagnets are substances in which the magnetic moments of the atoms or ions are ordered or the moments of the electrons are reversed below a certain temperature. Examples include steel, iron, nickel, cobalt and their alloys. Although ferromagnetic materials are not very common in nature, they are the main magnetic materials used in engineering [2,5,7].

Ferromagnets, like paramagnets, create magnetization oriented along the field. Ferromagnets enhance the magnetic field several times. Their relative magnetic resistance is as follows:

$$\mu \gg 1.$$

Some materials, such as chromium, are paramagnetic, meaning that when they are brought close to a magnet, their magnetization weakens. The magnetization disappears when the magnet is removed. Iron, nickel, and cobalt are ferromagnetic [2,6].

Although ferromagnetic materials are not very common in nature, they are the main magnetic materials used in technology. This is due to the presence of strong magnetism, residual magnetism and coercive force. Their magnetic permeability is several thousand times greater than that of a vacuum.

Therefore, all electrical devices that use magnetic fields to convert energy must have elements made of ferromagnetic material and designed to conduct magnetic flux. Such elements are called magnetic circuits. The magnetic properties of substances depend on the magnetic properties of the elementary carriers of magnetism moving inside atoms - electrons, as well as on the combined effect of their groups [1,5,7].

In medicine, ferromagnetic nanoparticle with constant or induced magnetic moment is used for diagnosis and treatment of various diseases. For example, mechanical forces acting on ferromagnetic objects and permanent magnets in a magnetic field are widely used in medicine, in straightening the chest of small children, in removing artificial substances flowing from the colon, in removing ferromagnetic dust and shavings from the eyes, etc [2,3,7].

Currently, the role of magnets in the diagnosis and treatment of oncological diseases is of great importance. At the same time, the diagnosis of complex pathological conditions is carried out in a short time and with high accuracy. In clinical settings, it is used for staged cancer treatment. It also plays an important role in monitoring disease recurrence [4,8].

For this purpose, magnetic resonance imaging technologies make it possible to obtain high-speed three-dimensional images of standard anatomical imaging methods [4,8].

Currently, 3D technologies are of great importance in medicine for recording data with a high degree of reliability in real time. Creates medical products that are maximally adapted to the individual characteristics of a person, using 3D modeling, 3D scanning and 3D printing [3,8].

These technologies allow visualization of organs and bones, as well as high-precision printing of prostheses, implants, surgical templates, orthopedic insoles and other products. This increases accuracy and reliability. At the same time, time is saved, production costs and the cost price of finished products are reduced [3,8]. This, most importantly, improves the patients' lives and increases their will to live. In short, it serves the futile purpose of solving medical problems.

3D scanners and 3D printers are now widely used in surgery and dentistry. New technologies make it possible to produce models of organs and bones, create 3D models, and also carry out high-precision 3D printing of prostheses, implants, surgical templates, orthopedic insoles, and other products. These innovations improve product reliability, save time, reduce production costs and the cost of finished products, and most importantly, improve and prolong the lives of patients, and are also of great economic importance [3,8].

Based on the above, we can conclude that magnets are unique. Its position in technology, industry, medicine and other areas is growing every year. For centuries, the properties of magnets have fascinated mankind. In modern medicine, the properties of magnets are invaluable in diagnostics, therapy, research and other areas.

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