STUDY OF PHYSICAL PARAMETERS OF SOFT MAGNETIC POWDER COMPOSITE MATERIALS WITH ADDED CERAMIC FIBRES

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Abstract
The aim of the research is to attempt at improving the performance of mechanical composites manufactured in powder technology, with particular reference to applications in electrical machines. The paper presents results of mechanical and magnetic tests of samples made of soft magnetic composites of iron powder, which contain admixtures of glass fibers and crystalline alumina fibers.

1. Introduction
Soft magnetic composite (SMC) materials, also called dielectromagnetics, are applied in various electric devices, in particular a new generation of electric motors. This type of technology has numerous advantages: the possibility of tailoring physical properties of parts, the possibility of preparing parts with intricate shapes, low level of eddy currents in room temperature, 3D flux distribution, environmental friendliness and recyclability of technology. A large advantage of powder metallurgy is the possibility of making the stator or rotor within one technology process. Production of an electric motor made of SMC, is based on compressing of powders in the die. For simple and small structures it is possible to produce the stator or rotor in a single process, using a die and stamps in the shape and dimensions of the finished part of the motor[1,4]. One disadvantage of powder materials is much lower mechanical strength in comparison to elements of electrical steel sheet. It reduces the stator teeth’s resistance to breaking during a heavy start. There are several methods for improving the mechanical properties of composite materials. The most popular item is placed inside a wire made of permaloy or Armco steel. Wires are placed during pouring of the powder into the die. This solution is technologically complex; wires placed inside the motor affect the eddy current loss.

Another method is to cover elements of SMC with ceramic coatings in order to improve their endurance and resistance to corrosion.

A new way to increase endurance of the SMC is adding to the iron powder synthetic or ceramic fibers. The author’s efforts are aimed at finding effective, inexpensive and easy methods of improving the mechanical endurance of large bonded elements made of iron.

2. Method of research
The studies concern the mechanical and magnetic parameters of composite materials with various admixtures. Strength was tested by transverse rupture strength testing. Transverse rupture strength (TRS), also called bending strength, is measured on samples with dimensions of 30 x 12 x 6 mm. Measurements were taken according to ISO 3325 [2]. Mechanical properties were measured on a computer-controlled universal testing machine - Instron 1115. The samples selected for research of magnetic properties are ring-shaped, with size of $\Phi 55$ mm x $\Phi 45$ mm x 5 mm. Magnetic properties were determined according to IEC 60404-6 [3] on the ring samples. To determine the parameters of iron composite, the multifunction device AMH-20K-HS's Laboratorio Elettrofisico Walker LDJ Scientific was used. Three sets of samples were made, each consisting of several samples for measuring mechanical and magnetic properties. The type of iron powder in set No. 1 is Somaloy 500 + 0.6% LB1. Another two sets were made of the same powder with an additional 1% weight of synthetic fibers. The study used strips of glass fiber with length of 6mm and fibers of a crystalline alumina $\text{Al}_2\text{O}_3$. The samples were formed under pressure of 800MP, and then cured at 200°C for 2 hours. Figure 1 shows a sample for testing magnetic properties, and the sample for testing transverse rupture strength.
3. Results and Summary

The results of the mechanical tests shown in Fig 2: fiberglass has not improved the bending strength of the element. Tests of items containing Al₂O₃ fibers yielded better results. On average, strength of components increased by 6%.

Adding non-magnetic fibers such as ceramic fibers to iron powder affects the magnetic parameters. The figure 3 shows the magnetization characteristics of samples tested.

Based on the characteristics of magnetization determined the maximum permeability of the composites tested. In both cases there was more than 15% of decrease in permeability of the samples. Magnetic permeability of tested material show on figure 4.

The attempt to improve the strength of magnetic composites with ceramic fiber brought about little improvement of mechanical properties in samples with alumina fibers. Further tests are already being carried out in order to come up with materials which will improve the mechanical properties of components made of SMC. Researchers plan to use synthetic fibers and carbon nanotubes.

Bibliography

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