Developing a boss for hybrid electric motors

F F Bagdanurov1, L N Shafigullin1 and F M Akhmetov1

1Naberezhnye Chelny Institute (branch), Kazan Federal University
Sjujumbike street 10а, Naberezhnye Chelny, 423800 Tatarstan, Russia
misharin_82@mail.ru

Abstract. The existing types of electric motors were analyzed. The paper describes the concept of a hybrid electric motor. The paper describes the process of developing a boss for hybrid electric motor. The paper describes the technology of making particulate filler from electrical steel.

1. Introduction Today, electric motors are widely used in various industries: machinery, processing industry, etc. Conventional asynchronous motors are used in many industries, their advantage is high reliability. The disadvantage of these motors is low efficiency. These machines were invented over one hundred years ago. There are more advanced stepper motors which require expensive controllers, with typical slew range. The advantage of motors is a high torque, chopper control to adjust a number of revolutions per minute precisely.

2. Body text The hybrid electric motor under development (see Figure 1) is based on the operating principles of stepper and asynchronous motors and uses the advantages of both of them. The hybrid electric motor consists of various types of composite materials (85% of its content). The key motor structure components are as follows: shaft, housing cover, housing, rotor disc, coil with winding, stator ring, rotor disc.

Figure 1. Section of hybrid electric motor: 1. shaft, steel 35, GOST 10702-78; 2. cover “1”, fiberglass, GOST 8865-93; 3. housing, fiberglass, GOST 8865-93; 4. rotor disc “1”, section; 5. permanent magnet, GOST 21559-76; 6. coil with winding; 6. stator ring; 7. rotor disc “2”; 8. cover “2”, fiberglass, GOST 8865-93
The paper studies the process of developing a boss with its main function being transfer of electromagnetic fields from a winding to a rotor (Figure 2).

![Figure 2. Boss, general view](image)

Due to a complex part geometry, a new material needs to be developed in order to get a complex product geometry and maintain electromagnetic values.

The analysis of the literature showed the absence of particulate-filled composite materials with the required electromagnetic values. In view of this, it was required to make a new composition which would consist of a polymer matrix and particulate filler. The exploratory research was carried out. The most suitable binder was Norsodyne H 44173 polyester resin [1]. It has the required physical mechanical and processing properties [2]. It was suggested to use a powder made of electrical steel as a filler, which has the necessary parameters of “hysteresis line”. Today, the Russian industry does not produce powders with required characteristics. So, the process was developed to produce a powder from electrical steel. A grinding machine was developed to get required powder fraction and characteristics, elongated shape (Figure 3).

![Figure 3. Particles of filler made from electrical steel powder (x 200)](image)

Resulting particles have a length of 0.1 mm, thickness of about 0.02 mm. The advantage of resulting powder shape is improved transfer of magnetic field. As magnetic fields tend to form parallel lines the elongated particle shapes are most suitable for this implementation. When exposed to a magnetic field, magnetic fields are concentrated at the ends of filler particles. A unique forming process was developed to prevent filler particles from sublimation and damage when added to matrix material. It involves the use of a special instrument with specified shape and size, which has optimized conditions for mixing composite systems.

A mixing process demanded the development of requirements for process of manufacturing composite materials [3]:
- a mixing tool should have a cylindrical shape with the rounded end;
- powder agglomerates should not contact the tool [4];
- tool speed should be within 20-30 mm/s.

These requirements make it possible to provide a uniform particle distribution in the binder and prevent their damage.

Plastic molds and permanent magnets are used to ensure unidirectionality of particles inside a mold and their contact with each other during molding [5-6]. The direction of permanent magnet fields
coincides with the axis of a product, which makes it possible to guide filler particles along the axis of a part. And every particle becomes magnetized and starts gravitating towards other particles. Polymer compound is made by vacuum forming to ensure minimum number of defects in materials. The resulting boss has unique electromagnetic properties due to different directions of magnetic fields inside a composite material.

3. Conclusions
An innovative design of a boss for electrical motor ensures high heat transfer, concentration of magnetic fields in some restricted space, prevents sticking effect for permanent magnet over the coil.

References
[1] Karikh F G and Shafigullin L N Automation of process of manufacturing products from a mixture of fluids fast polymerized in air using the jet centrifugal method IOP Conf. Series: Materials Science and Engineering 570 (2019) 012038 IOP Publishing doi: 10.1088/1757-899X/570/1/012038
[2] Zharin D E, Butorin I V and Shafigullin L N 2008 Optimized compositions of matrix particulate-filled and fiber polymer composite materials with high processing properties Collection of papers and abstracts of VII Congress of production engineers in the automotive industry pp. 94 - 5
[3] Galimov E R, Fedyaev V L and Morenko I V 2014 About the basic laws of non-isothermal cross-flow past of a circular cylinder with beads mix Journal of Physics: Conference Series vol 567 number 012012
[4] Galimov E R, Bobryshev A N, Lakhno A V, Voronov P V, Galimova N Ya and Sharafutdinov R F 2015 New approaches for evaluating rheological models in composites IOP Conf. Series: Materials Science and Engineering vol 86 number 012001
[5] Kashapov N F, Nafikov M M, Gazetdinov M X, Nafikova M M and Nigmatzyanov A R 2016 Innovative production technology ethanol from sweet sorghum IOP Conference Series: Materials Science and Engineering vol 134 issue 1 8 number 012012
[6] Sokolova Yu A, Zharin D E and Shafigullin L N 2009 Developing compositions of special polymer composite materials Academia. Architecture and Construction vol 2 pp. 104-7