Development of Axial Flux Permanent Motors with Amorphous Cores

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In electrical machines, the use of rare-earth magnets enables smaller motors to perform with higher power and efficiency. Over the past 30 years, electrical machines equipped with rare earth magnets have been used in a wide variety of industries such as automotives, home appliances, electronics, and power plants. With increasing demand for green energy products, rare earth magnets have become virtually indispensable in the industrial market. However, the limited supply of rare earth elements such as neodymium and dysprosium has made the development of alternative technologies for high efficiency motors a top priority. This research aims at increasing motor efficiency without relying on rare earth metals by using a novel motor design to decrease losses within the motor.

Non-rare earth magnets, such as ferrite or ceramic permanent magnets are typically 50% to 70% weaker than rare earth magnets. Increasing the output of a motor using these weaker magnets is extremely difficult with conventional radial-flux permanent-magnet (RFPM) motor. In this research, the axial-flux permanent-magnet (AFPM) motor with double-rotor and single-stator is proposed to obtain larger output torque. Fig.1 shows the structure of a RFPM motor and Fig. 2 shows the structure of an AFPM motor with double-rotor and single-stator. Furthermore, amorphous magnetic materials (AMMs) have features of extremely low iron losses, and high magnetic permeability, which can improve motor performance when combined with low energy magnets [1] and [2]. However, commercial amorphous metal is typically processed as 0.025mm thick tape. Amorphous tape is very hard and brittle, which makes stamping or pressing difficult.

This paper presents the development of amorphous cores for electrical motor’s application. A new method to process low iron loss amorphous cores is introduced. The concepts of designing AFPM motors are introduced. The design, manufacturing and test results of 11kW industrial motor are presented. This motor delivered 93% efficiency at full load, which places the motor in the IE4 level in the efficiency standard IEC60034-30, as published by the International Electrotechnical Commission (IEC).

Reference

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2) Z. Wang, Y. Enomoto, M. Ito, R. Masaki, S. Morinaga, H. Itabashi, and S. Tanigawa, "Development of an Axial Gap Motor with Amorphous Metal Cores," IEEE Trans. Industry Applications, vol.47, no.3, pp.1293-1299, May/June2011.

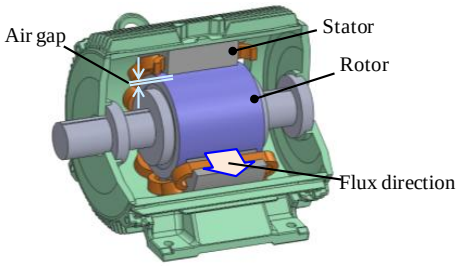

Fig.1 Radial-flux permanent-magnet motor.

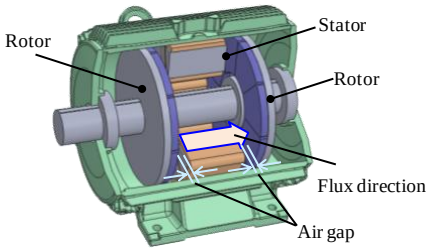

Fig.2 Axial-flux permanent-magnet motor.

Some of these developments are granted by the New Energy and Industrial Technology Development Organization(NEDO) through the “Funding program for development of realization technology for replacement and reduction of rare-earth metal".