DESIGN OF HIGH SPEED INTERIOR PERMANENT MAGNET TYPE MOTOR FOR TURBO-MACHINERY

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Abstract. High speed Interior Permanent Magnet (IPM) motor is proposed. It is intended to apply to the turbo-machinery which is supported by magnetic bearings. Such a system usually requests a big UPS to support the rotor when the power supply stops suddenly. Just after the power supply stope, the motor generates electric power from the rotational energy. The regenerated energy is used to operate the magnetic bearing until the rotor speed slows down. The rotor is touch down to the emergency bearing (ball bearing). This paper is considering two pole IPM motor as a generator for such a sudden power stop. The rotating energy is regenerate the electric power to support the magnetic bearing until the rotor speed slow down.

Keywords: High speed motor, Magnetic bearing, Turbo machinery, Regenerative generation.

1. Developing tested motor

A laboratory model of two pole type IPM motor is developed which is expected to run up to 20,000 rpm. The analytical model is shown in Fig. 1. The motor yoke is made by thin non-oriented electrical steel sheet (15HX1000) with outer diameter of φ100. The detailed rotor is shown in Fig. 2. Inside the rotor six PMs (N32EX) are inserted in two lines to give N-S polarities. The detailed dimensions are determined using the commercial Finite Element Method (FEM) MagNet, as shown in Figs. 1 and 2.

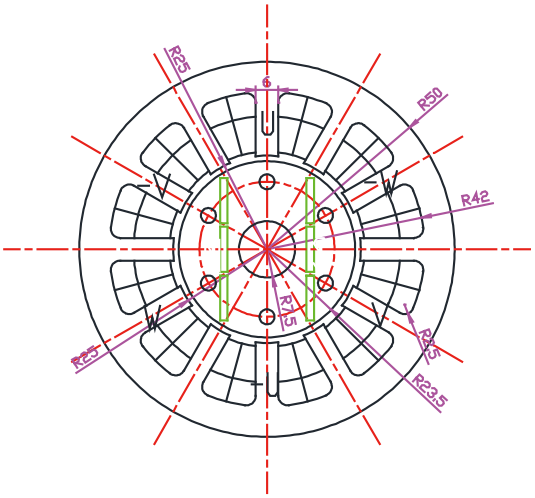

Fig.1. The analytical model of the IPM high speed motor.

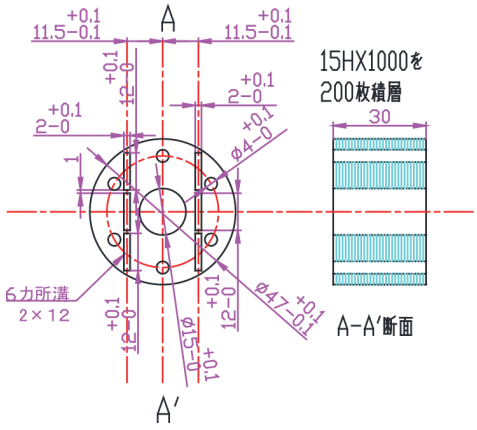

Fig.2. The construction of rotor

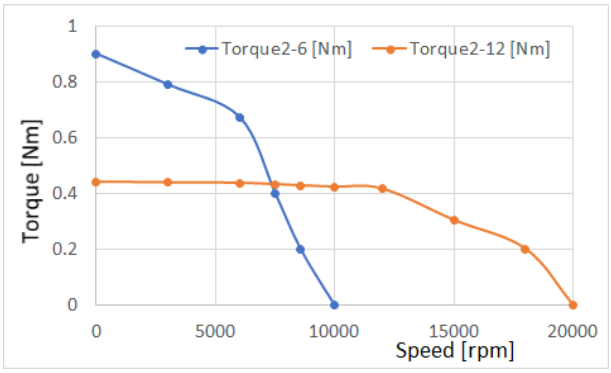

Fig.3. Torque versus speed curves (72 V)

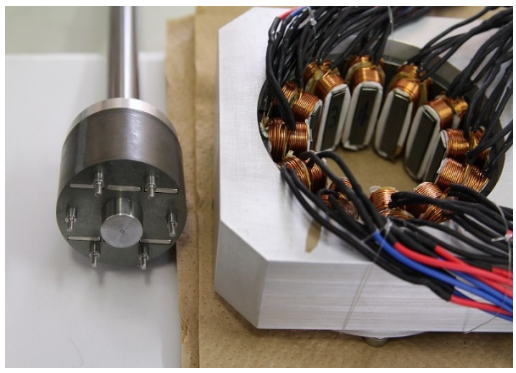

Fig.4. The manufactured rotor and stator

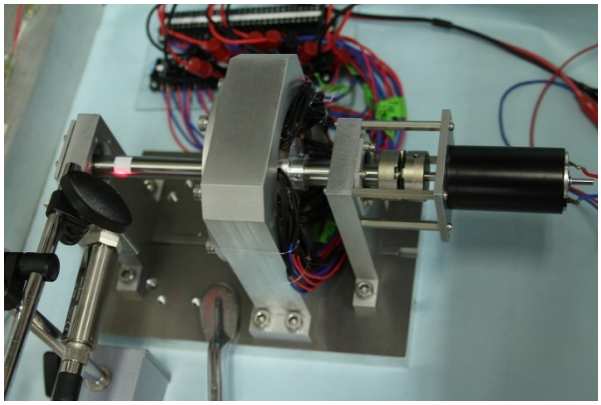

Fig.5. Photo of BEM voltage test

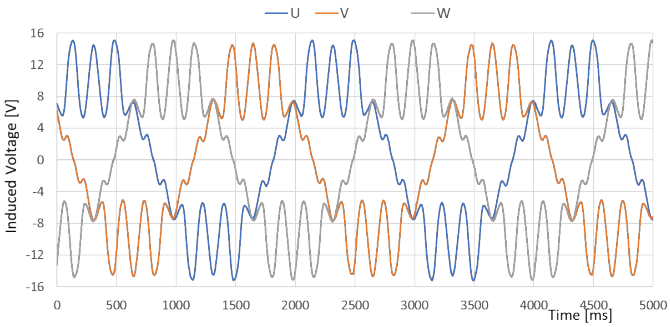

Fig.6. BEM test results of the motor

2. Fabricated motor and back-electro-motive (BEM) voltage test

From the analysis we get the torque and velocity properties shown in Fig. 3. There are two curves with six slot type and 12 slot type ones. The 12 slot type has higher speed property, we developed a 12 slot motor as shown in Fig. 4. The motor is driven by a DC motor and BEM voltage test is carried out as shown in Fig. 5. The three phase BEM voltage is measured at the rotating speed at 3000 rpm, as shown in Fig. 6. There are high frequency ripple, but we can recognize the fundamental frequency component. Further research work is continuing to get high speed rotation.

3. Concluding remarks

The research is just started to develop two pole high speed IPM motor. BEM voltage test is carried out. After we can succeed to get high speed, Active magnetic bearing is installed and the regenerative power is used to support the magnetic bearing until the speed is slow down.

Acknowledgement

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References

[1] Okada Y., Kitayama F., and Kondo R. Proposal of High Speed IPM Motor for Turbo Machinery, Proceeding of the 27th MAGDA Conference in Katsushika, pp. 74-77, Oct. 20-21, 2018 (in Japanese)