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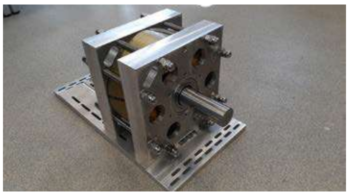
# Hybrid excited claw pole machine with skewed stator core

***Abstract***. *The paper presents chosen research results of hybrid excited claw pole machine with laminated rotor and skewed stator core. During the research the influence of the current in additional excitation circuit and current in the excitation coil on the back-emf and cogging torque in the claw pole machine with hybrid excitation and laminated rotor structure have been analyzed.*

**Keywords:** hybrid excitation, claw pole machine, permanent magnet, back-emf, cogging torque.

## Introduction

Hybrid excited permanent magnet machines have many advantages compared to machines with permanent magnets: permanent magnet synchronous machine and brushless direct current machine, i.e. they allow for easier change of excitation flux in the machine. These machines are able to generate higher torque at low speeds and also allow to increase the maximum speed without the use of commonly known methods of flux weakening. In earlier authors' works [1] the results of research of hybrid excited machines with claw poles were described. The concept of claw pole electric machine with hybrid excitation and laminated rotor was presented by this author in [2]. Claw pole machines are most commonly used as alternators to charge batteries in cars. However, more and more often cars are equipped with start-stop systems, which require machines with the power of several kilowatts, which work both in the generator and motor regime. This type of machine can be also used as a generator in small wind plant. The proposed topology seems to fit these types of application.



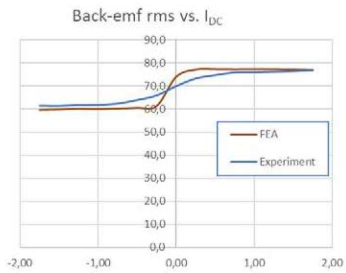



Fig.1. Suggested structure of the machine.

## Design of the machine and experimental validation

The machine's length equal to 100 mm and the machine air gap length is 1 mm. Machine's structure has 36 slots and 12 poles. The outer diameter of rotor is 162 mm, the stator stack is skewed and its' height is 326 mm and the inner diameter equal to 164 mm. Fig. 1a presents back-emf values comparison of experimental versus simulation results. Figure 1b shows built experimental prototype of hybrid excited claw pole machine with skewed stator core.

## Conclusion

This paper describes a concept of a claw pole machine with hybrid excitation and laminated rotor core and skewed rotor core. This design allows to PMs placement inside the rotor. Moreover, it is possible to project and make complex shapes of the rotor parts. This paper has also analyzed the influence of the current value in the excitation control coil on the back-emf and also cogging torque in this machine with laminated rotor.

## References

1. Marcin Wardach, *Hybrid excited claw pole generator with skewed and non-skewed permanent magnets*, Open Physics 2017, vol. 15 (1), pp. 902-906, DOI: 10.1515/phys-2017-0108.
2. Marcin Wardach, *Design of hybrid excited claw pole machine with laminated rotor structure*, Innovative Materials and Technologies in Electrical Engineering (i-MITEL 2018), Sulęcin, Poland, 18-20 April 2018, DOI: 10.1109/IMITEL.2018.8370488.

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