

The correlation of parameters and characteristics of the axial two-input electric machine-generator

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Abstract. The article considers axial two-input contactless electric machine-generator designed for simultaneous conversion of solar energy (using a photoelectric converter) and wind into electrical energy that meets consumer properties. The work is performed within the framework of the research at federal state budgetary educational institution of higher education “Kuban State Technological University” on the theme of renewable energy sources under the supervision of the Honored worker of science and technology of the Russian Federation Professor B. Kh. Gaytov. The aim of this paper is to study the relationship between parameters and characteristics of axial two-input contactless electric machine-generator. The results of this study show characteristics taking into account the relationship of output parameters of the axial two-input contactless electric machine-generator with parameters of winding of the machine’s main components.

1. Introduction

The development of alternative energy determines necessity of using electrical machines of special designs.

Scientific papers related to alternative energy, are mainly aimed at improving the use of electromechanical energy converters when converting one form of energy into another one [1-11].

At Kuban State Technological University, a scientific school under the guidance of Doctor of Technical Sciences Prof. B. Kh. Gaytov has been studying electric machines for alternative energy for a long time. One of the projects of the authors is an axial two-input electric machine-generator (ATEM) [12-14]. A characteristic property of ATEM is the simultaneous conversion of mechanical energy coming from the wind turbine, and the electrical energy coming from photoelectric converters (PEC). Thus, the system consisting of wind turbine, ATEM, and solar cells is capable of efficient conversion of kinetic wind energy and solar radiation energy. When designing the ATEM, as well as any generator, the parameters of the machine's components are taken into account, in particular, the resistance and inductance of the windings. It seems appropriate to consider the dependency of the output parameters of the wind-solar generator (WSG) on the parameters of the components of ATEM for further optimization of the WSG.

When selecting the optimal values of these parameters, the generator will operate at rated speed without overheats and loss, with the greatest efficiency.

ATEM (its electric diagram is shown in Fig.1) is a complex electromechanical device which combines in one housing two nine-phase synchronous alternating current generators, two nine-phase



rectifiers and a three-phase synchronous alternating current generator (nine-phase synchronous generators are necessary to reduce the pulsation coefficient).

ATEM [12] comprises (Fig. 1): permanent multipole magnet 1 of pilot exciter inductor, magnetic circuit with winding 2 of pilot exciter armature, single-phase winding 4 of exciter feeding, and additional winding 6 of exciter feeding, multi-phase winding 7 of exciter armature, single-phase winding 9 of main generator feeding, three-phase winding 10 of main generator armature.

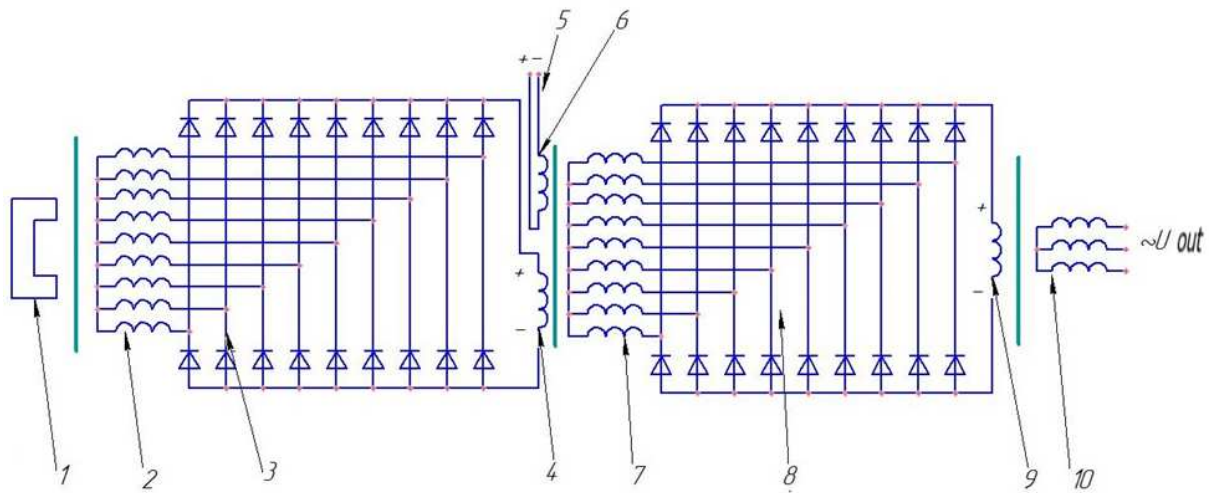


Figure 1. Electric diagram of axial two-input contactless electric machine-generator

Single-phase winding 4 of exciter feeding is connected to the multi-phase winding 2 of pilot exciter armature using multi-phase rectifier 3. Single-phase winding 9 of main generator feeding is connected to multi-phase winding 7 of exciter armature using multiphase rectifier 8. From three-phase winding 10 of main generator armature a three-phase EMF can be supplied to the network.

ATEM works as follows: when rotating the shaft by the external mechanism (e.g. a wind turbine) permanent multipole magnet 1 of pilot exciter inductor and the magnetic circuit with windings 7, 9 and rectifier 8 are rotated together with the shaft. Generated by permanent multipole magnet 1 the magnetic flux interacts with multi-phase winding 2 of pilot exciter armature which is placed in the grooves of the magnet circuit on the side of permanent multipole magnet 1, and induces in it a multi-phase EMF system, which is rectified by nine-phase rectifier 3 and supplied to single-phase winding 4 of exciter feeding which is placed in the grooves of the inner axial magnetic circuit. At the same time in single-phase winding 4 of exciter feeding the magnetic flux is generated.

Magnetic flux [13, 14] generated by single-phase winding 4 of exciter feeding is combined with directed accordingly magnetic flux generated by the additional winding 6 (the flow of the current through the winding 6 is provided with the supply of the DC voltage, e.g. from the solar panels to this winding through contacts 5). According to the principle of superposition of magnetic fields magnetic fluxes generated by windings 4 and 6 are summarized. In the rotating winding 7 of exciter armature which is placed in the grooves of the axial magnetic circuit the resulting magnetic flux induces multi-phase system EMF, which is rectified by multi-phase (Fig. 1 – by nine-phase) rectifier 8 and is supplied to single-phase winding 9 of the main generator feeding, which are placed in the grooves of the axial magnetic circuit. At the same time single-phase winding 9 of main generator feeding induces

a magnetic flux, which induces three phase EMF in winding 10 of main generator armature for submission to the network.

To determine the dependencies of the voltages on the output terminals of ATEM on winding parameters the authors carried out a mathematical experiment of designing a mathematical model in MathCAD and MATLAB environments [15].

Figures 2-6 present dependencies of the output voltage of ATEM on the resistance of its windings of specific parts of the unit.

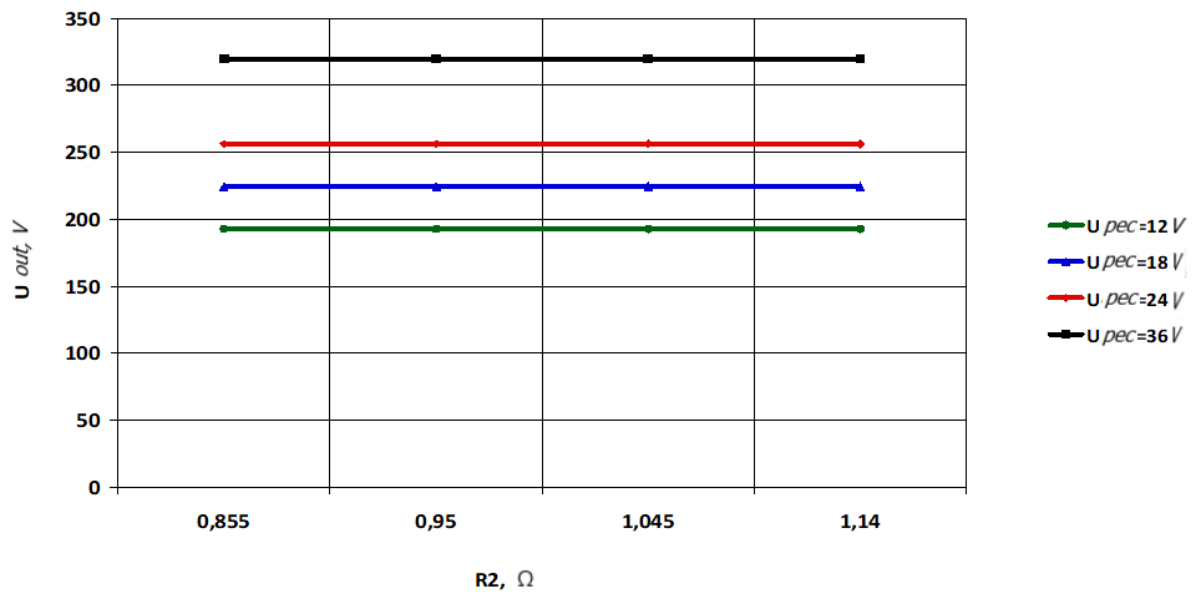


Figure 2. Dependency of the output voltage on the resistance of winding of pilot exciter armature when changing the voltage of solar panels

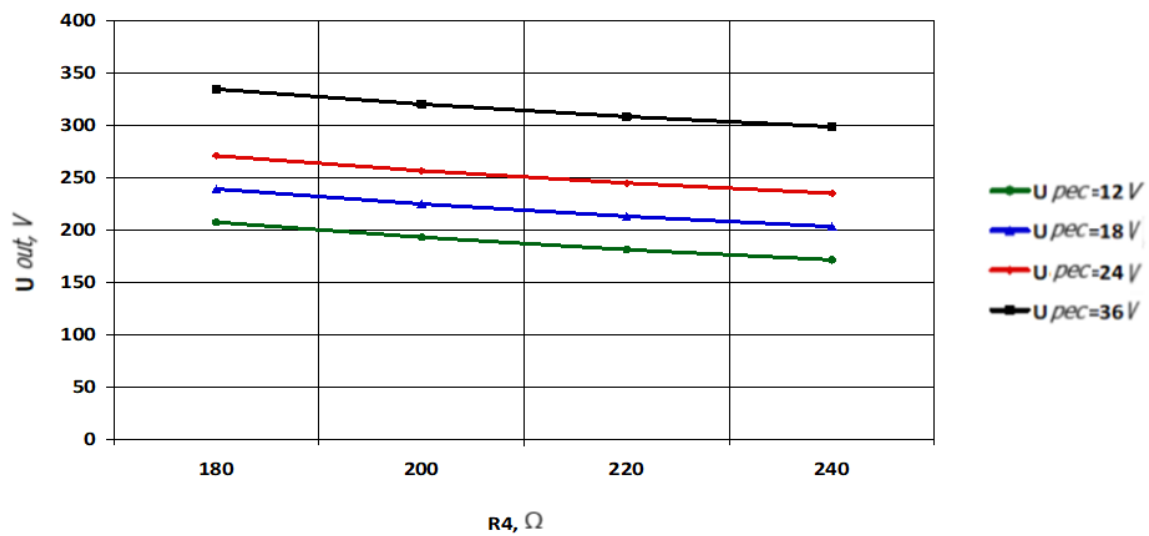


Figure 3. Dependency of the output voltage on the resistance of winding of exciter feeding when changing the voltage of solar panels

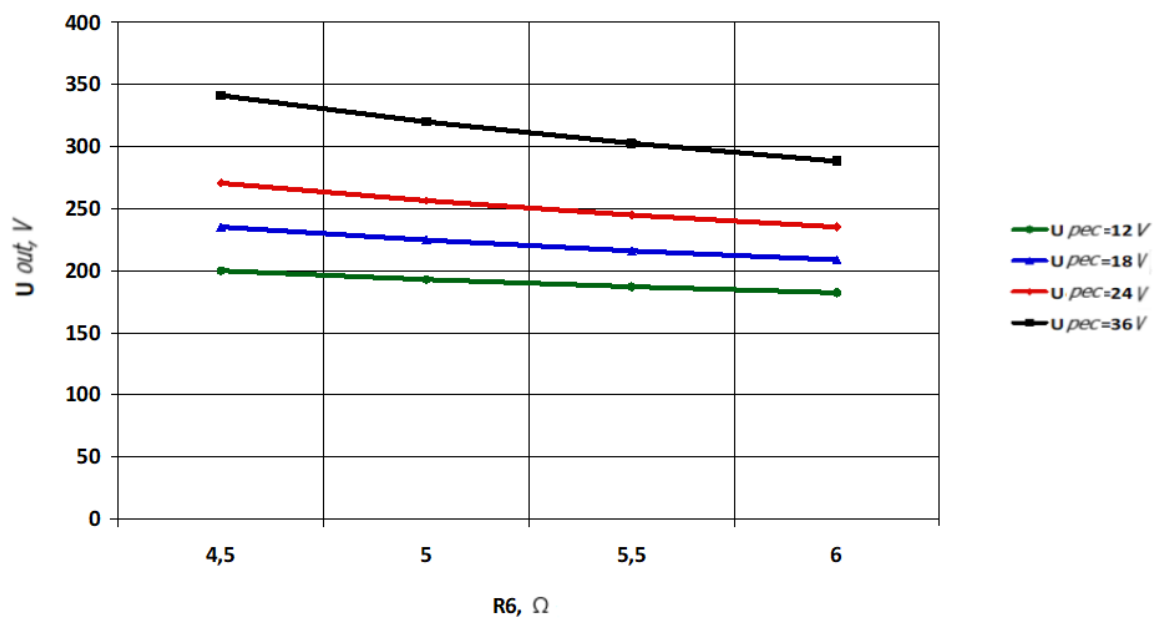


Figure 4. Dependency of the output voltage on the resistance of additional winding of exciter feeding when changing the voltage of solar panels

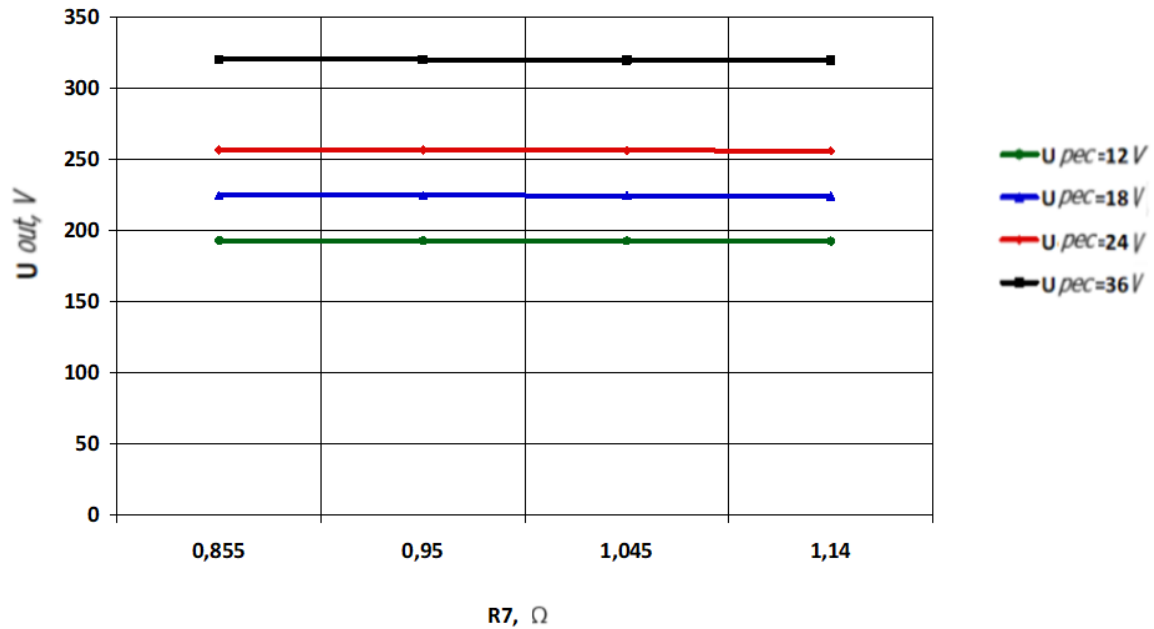


Figure 5. Dependency of the output voltage on the resistance of winding of exciter armature when changing the voltage of solar panels

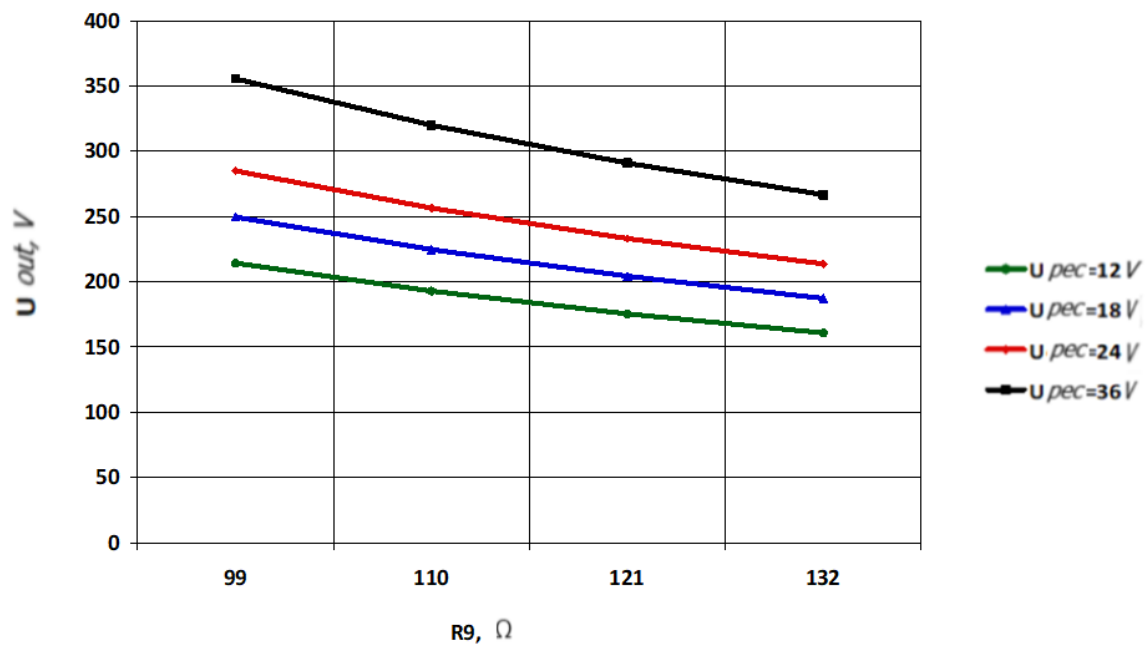


Figure 6. Dependency of the output voltage on the resistance of winding of main generator feeding when changing the voltage of solar panels

2. Conclusion

The analysis of the dependencies represented above allows us to draw the following conclusions. The output voltage of ATEM does not depend on the resistance values of the winding of pilot exciter armature as well as multi-phase winding of exciter armature and depends on the resistance of the winding of exciter feeding, additional winding of exciter feeding, the winding of main generator feeding. These results are explained by the fact that the change in the resistance of the winding of pilot exciter armature and multi-phase winding of exciter armature to a lesser extent influence the values of the MMF generated by the respective currents in the main single-phase winding of exciter feeding and single-phase winding of main generator feeding. MMF values generated by currents I_4 and I_9 depend on (including) resistance of contours formed by the main single-phase winding of exciter feeding – rectifier 3, and single-phase winding of main generator feeding – rectifier 8. The resistance of the winding of pilot exciter armature and multi-phase winding of exciter armature is much smaller than resistance of rectifiers 3 and 8, respectively.

3. Acknowledgments

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