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Research of the Principal Model of the Electric Energy Generator of the Electric Car (Stage Combination of Mechanical and Electromechanical Parts)

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Abstract. **The article presents the interim results of the ongoing study (http://journals.ru.lv/index.php/SIE/article/view/6884/5683). At this stage, measurements are made with a model in which we combined the mechanical part with the electromechanical part. At the presentation stage, a model demonstrating the principle operation scheme of the patented device has already been constructed as an object of research. A rotating magnet was connected to the impeller (it was rotated by the impeller). The magnet was rotating around the stationary coils and was already inducing an electric current in the coils. In this way, the generated current and generated voltage values can be used as an indicator for evaluating the efficiency of the impeller. The experiments in question are performed with three impellers of different configurations, keeping other conditions analogous. All experiments were performed using only one rotating magnetic ring and one set of stationary coils. The results of experimental measurements show a wide spectrum and possibilities of increasing efficiency and demonstrate the principle of operation of the future device. When designing an impeller with turned wings, two cavities for magnets and coils are already provided, thus preparing for the next step in improving the design of the model under study and increasing efficiency.**

Keywords: robotic system, electricity generator, regeneration, electricity, wind.

I. INTRODUCTION

This invention [4], on the basis of which research is organized, is primarily intended for electric cars and hybrid cars with an electric drive and a battery (for energy storage), but it can be used much more widely. At the presentation stage, a model demonstrating the operation principle of the patented device has already been constructed as an object of research. The article presents the intermediate results of the ongoing study [5]. At this stage, measurements are made with a model in which we combined the mechanical part with the electromechanical part.

The use of air flow energy is researching in studies of the practical application of wind power plants and efforts are made to maximize the use of air flow the kinetic energy. It was decided to make a practical study of this aspect in the initial stages. The essential issue of these stages was the need to determine the best number of blades for efficiency of the selected wind turbine and to improve the configuration of the blades based on the research results. The conducted studies show that it is

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logically to stay with six-bladed propeller and for now, continue the research the combined mechanics and electromechanics parts.

II. The General Research Motives, Selected Research Phase

Wind is moving air. As its speed increases, so does the kinetic energy associated with movement. Wind farms are designed to intercept kinetic energy, slow it down and convert it into electricity. A barrier to kinetic energy is created when the wind encounters the turbine blades, which are designed to capture the maximum amount of energy and thus create the largest possible barrier [2].

Lithuania and other European Union states are encouraged to switch to renewable energy in the Green Deal, which enshrines the aspiration to become the first climate-neutral continent. It is argued that ecology and climate issues should be the priorities of the political agenda of this period, thus harmonizing measures promoting economic recovery with the long-term vision outlined in the Green Deal - to create a cleaner Europe.

In the researches maintains a general trend to use renewable energy sources as widely as possible.

This invention relates to the transformation of wind (airflow) energy into electrical energy. It is a natural, constantly renewing source of energy for the environment around us, which is environmentally friendly and protects it. The process itself does not bring any harmful substances into the environment. However, to achieve efficiency that provides practical benefits, a complex approach is required, because mechanics, electromechanics, electronics, and several other specific areas of practical physics come together here.

In the first stages, which have already been presented, the focus was on the research of the mechanical part. Based on the research data, the impeller configuration was selected. The performance of these impellers was assessed by measurements at constant initial conditions.

At this stage, which is presented, the electromechanical part has already been connected to the mechanical part. A rotating magnet was connected to the impeller (it was rotated by the impeller). The magnet was rotating around the stationary coils and the rotating magnet was already inducing an electric current in the coils. The generated current and generated voltage values can be used as an indicator for evaluating the efficiency of the impeller.

How the generator works for electric cars (which involves the transformation of wind energy into electricity): in a wind turbine, when the air flow pressure reaches a critical value, the rotor starts rotating around the stator. Since it is a complex of several areas, a necessary condition for efficiency is the compatibility of individual parts and a positive efficiency coefficient of each step or part. The first link of this complex is mechanical - the wind turbine, so we started research from its efficiency. The accumulated measurement data of this stage already allows choosing certain impeller configurations for the next stage of research. The main criterion defining the efficiency of this stage was the speed of rotation of the impeller measured with the help of a tachometer. The higher the rotational speed of impeller at the same airflow, the more efficient the impeller configuration.

At the current stage, after connecting the electromechanical part, the efficiency criterion is already changing. As it was already mentioned, the values of the current generated in the stationary coils and the generated voltage can be used as an indicator for evaluating the efficiency of the impeller. It opens opportunities to vary structural elements and use the same criteria for measurements. It is possible to further collect measurement data while improving the mechanical design of the vane itself (vane configuration). At the same time, it is already possible to collect measurement data of the efficiency of the electromechanical part (coil configurations). In this way, we already combine two rather important elements of the complex and two closely related areas, i.e., the impeller and the magnet rotating around the stationary coils, or the mechanical and electromechanical parts.

III. Experimental Part And Description Of Research

In the already presented stage, when the air flow pressure in the wind turbine reaches a critical value, the air flow pressure is concentrated on the rotor blades, thus achieving a more efficient use of energy, because according to the selected design, all pressure is concentrated at the edge of the blade. Measurements of critical points were performed with impellers of different configurations (by changing the number of blades). Measurements were also made in real conditions (mockup on the roof of the car) and for comparison in laboratory conditions. The results of these studies have been discussed in previous publications.

Based on the measurement data collected at this stage, the air flow conditions created in laboratory conditions correspond to the parameters of the passing air flow of a car traveling at a speed of 50 km/h. Under these constant conditions, further measurements and comparative analysis of various designs are carried out.

During this stage, measurements are made by changing the air flow adjustment in the incoming mock-up opening (Fig. 1).

Fig. 1. Model.

It was also possible to perform measurements by changing the air flow at the outlet (Fig. 2). This design of the model makes it possible to study the influence of the air pocket on the work of the turbine itself, but we are not yet ready for this kind of research. So, it remains for perspective stages.

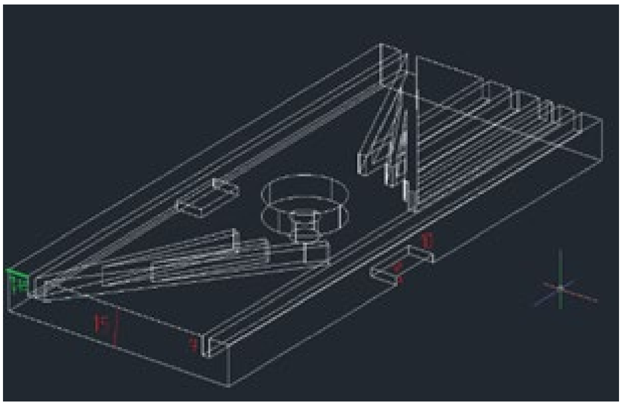

Fig. 2. Skeleton of the model.

Experiments are performed with three impellers of different configurations keeping other conditions analogous.

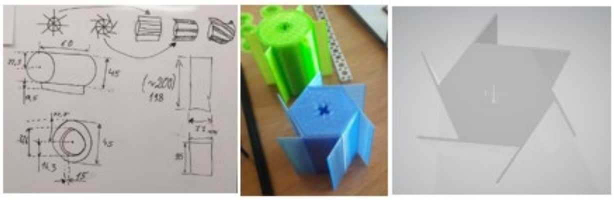

Fig. 3. Impeller (Airfoil) configurations.

As an indicator when evaluating the efficiency of impellers, we use the values of the current generated in the stationary coils and the generated voltage (tables and graphs).

All experiments were performed using only one rotating magnetic ring and one set of stationary coils. However, when designing an impeller with turned wings (Fig. 4), two cavities are already provided for magnets and coils, but this is for the next stage of experiments.

Fig. 4. Impeller with turned wings.

The most elementary active load impedance scheme was used to evaluate the efficiency of the impellers (Fig. 5).

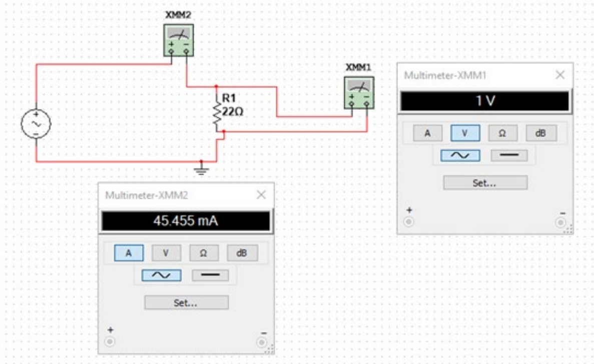

Fig. 5. Scheme of measurements.

Multimeter XMM1 (voltmeter) measured the voltage on the load resistance, and multimeter XMM2 (ammeter) measured the current flowing in the circuit.

IV. Measurement Results And Summary

In this case, the recording and comparison of the averaged values was decided to appoint as enough. The table of characteristic data measurements looks like this (Fig. 6). One multimeter XMM1 (voltmeter) measured the averaged (in AC mode) voltage on the load resistance, while the other multimeter XMM2 (ammeter) measured the averaged current flowing in the circuit (in AC mode). When working in the environment of critical conditions, such measurement accuracy is sufficient.

sparnuotė		I, mA	V, mV	out v, km/h
	anga in1	4,8	104,2	11,7
	anga in2	3,08	68,1	11,2
	anga in3	0,4	0,1	11
	anga in1	4,5	98,3	12
	anga in2	3,93	84,3	10,5
	anga in3	0,8	13,01	10
	anga in1	1,55	35,02	11
	anga in2	0,12	2,8	11
	anga in3	0	0	12,9

Fig. 6. Table of measurement results.

The table immediately shows that in one position the impeller does not rotate at all, although the passing air flow at the outlet is even faster than in other cases. This shows that we are working in an environment of critical conditions. The line between action and non-action is very close. This provides excellent opportunities research for improving the efficiency and this is immediately noticeable in the measurement table. When the impeller is not rotating, it can be assumed that the air flow does not lose some of its kinetic energy and therefore the speed of the outgoing air flow is higher. Another rather obvious assumption based on these measurement results is that the most efficient air flow concentration is in the gap of one wing height. When evaluating prospects, it should be taken into account that both the theory and practice of wind energy show that the energy of the air flow is proportional to the cube of its speed [1].

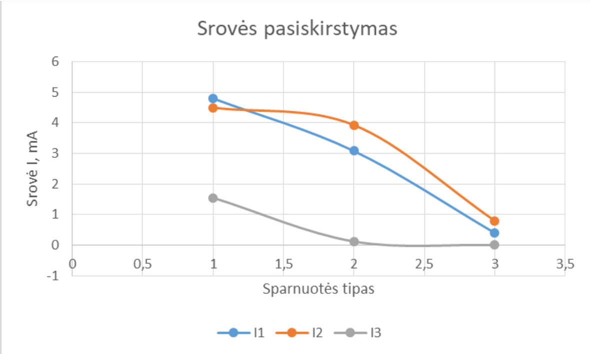

Fig. 7. Current distribution graph.

Analyzing the graphic representation of the measurement domains (Fig. 7), we drew the curves of the dependence of the current on the height of the inlet air flow for different vane configurations. Although wind energy studies emphasize that the amount of air flow energy almost directly depends on the mass of the air flow passing the vane1, from the graphs we can assume a slightly different variable dependence characteristic of this design. Increasing the height of the inlet opening also increases the mass [1] of the air flow past the vane, but the energy changes slightly, and after reaching a certain value, it even starts to decrease and probably quite suddenly. This observation encourages a more careful study of structural features and the search for a combination that can ensure the highest possible efficiency. You should also pay attention to the fact that the speed of the exit air flow starts to decrease when the height of the entrance channel is increased (emphasis in the measurement table). Only in the case when the impeller is no longer rotating, the speed of the outgoing air flow has increased slightly.

The graph of current dependence was selected for analysis. The voltage and power graphs are very similar to the current dependence curves, so we will not analyze them in detail. One of these dependencies is sufficient for the examination of characteristic features at this stage.

When combining mechanical and electromechanical parts, quite a number of interesting nuances emerge, which should be studied in more detail, so the field of research can and should probably be expanded. Well, to achieve practical progress, it would be logical to choose the direction of the most promising efficiency coefficient based on the available measurement data and not to delve into possible parallel studies and solutions. This dilemma disturbs many researchers, and the decision is not easy, but necessary, as both available resources and physical capabilities must be considered. By connecting the electrical and electronic parts to the available mechanical and electromechanical parts, the nuances that are worth investigating in more detail will probably appear even more, so the possibilities for improvement remain wide and tempting.

This research project and the scientific research areas revealed in it are relevant not only in a scientific or applied practical sense, but also their pedagogical aspect remains very important in developing the curiosity of our students and promoting cognition.

V. Conclusions And Suggestions

The results of experimental measurements show that the amount of electricity generated using one rotating magnet and one set of stationary coils is small for practical use, but such a mock-up already demonstrates the principle of operation of the future device. The positive efficiency factor of the mechanical part (impeller configuration) achieved at this stage already allows us to move on to the studies of the efficiency factor of the electromechanical part (coils and magnets) and the mutual coordination of these two parts. For further research, two sets of rotating magnets about stationary coils can already be used. Configuration will allow more energy to be extracted and observed, but with increased resistivity, so measures may need to be taken to maintain the boundary conditions.

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