Study of the aerodynamic parameters of the installation, generating wind flow in open space

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Abstract. The article is devoted to the study of the aerodynamic parameters of the installation, causing wind flow in open space. In the open space, a model of an aerodynamic installation which creates an uneven wind flow rate is presented. To determine the speed at each distance using an aerodynamic model, creating a jet wind, an experiment was conducted. The results of experimental studies to determine the speed when changing the flow rate and rotation number at a distance from 10 cm to 130 cm from the propeller model are given. Experimentally found to reduce the speed in the stream, distributed from the propeller, when \( y = +10 \) cm, \( y = -10 \) cm, with increasing distance, and the axial velocity in the stream, distributed from the propeller.

1. Introduction

Currently, many countries produce electricity in various ways. The transition to an ecological and sustainable development economy is associated with the use of natural resources. Due to the fact that at present the lack of electricity and the improvement of the environmental situation, recently the problem of obtaining energy from renewable energy sources is relevant [1, 2]. To save fuel and energy resources, protect the environment from harmful effects and provide regions with electricity, renewable energy sources are needed. The growth of energy consumption while using renewable energy sources does not disturb the general thermal equilibrium on the earth and does not lead to the global heating. The amount of energy entering the earth and departing from the earth does not change.

In the world, wind energy is a developing type of renewable energy [3-6]. The exhibition EXPO-2017 will be defined as the main symbol of the formation of technical progress, the achievement of the globalization process, the creation of an innovative economy [7]. This is a great opportunity for our country to get new energy and "green" technologies. The “green” economy is primarily aimed at the economical use of resources prone to depletion and the efficient use of inexhaustible resources [8-11]. In the Republic of Kazakhstan at the present time there are several systems that do not have a sufficient number of wind turbines, which can function effectively with a
2. Experiment

Objective - study of the aerodynamic parameters of the aerodynamic installation, causing wind flow in open space.

Compiled models of the aerodynamic installation, creating an uneven wind speed in open space. The installation is designed to study the aerodynamic characteristics of a wind turbine. A diagram of the aerodynamic installation, creating an uneven wind speed, is shown in Figure 1.

1-propeller, 2-engine type DKM-1UHL4, 3-props, 4-connecting wire, 5–support.

Figure 1. Diagram of the model of the aerodynamic installation, causing wind flow.

To determine the speed at each distance using the model of the aerodynamic installation, creating a vortex jet of wind, an experiment was conducted. To determine the speed in the stream, the Skywatch Xplorer1 anemometer was used. Blade propeller forms an ellipse, which rotates in a circle. Figure 2 shows the current scheme for changing the speed depending on the distance between the screw and the turn in the current spread from the propeller, \( y = 0, y = -10 \text{ cm} \).

Figure 2. Diagram of the velocity change from a screw in a stream spread from a propeller, with \( y = +10 \text{ cm}, y = 0, y = -10 \text{ cm} \).
The model of the aerodynamic installation, which causes a whirlwind of wind, caused an air flow from a speed of 1 m/s to a speed of 7.6 m/s. In practice, the velocities were determined at a distance of 10 to 130 cm. In Figure 2, it can be seen that the velocities in the stream spread from the propeller \( y = +10 \text{ cm} \), \( y = -10 \text{ cm} \) decreased as the distance lengthened, and the axial velocity spread from propeller, with the first 10 cm is zero. Then, when the distance from the screw was extended to 50 cm, the axial velocity in the flow became 4.9 m/s. After the maximum axial velocity in the flow reaches 4.9 m/s, the velocity decreases as the distance increases.

3. Results

To determine the flow velocity at a distance of 10 cm to 130 cm from the model of the propeller, causing a jet of vortex wind, an experiment was conducted. To determine the speed in the stream, an anemometer Skywatch Xplorer1 was used. Depending on the distance from the screw at given points during the experiment, the indicators of the change in velocity in the stream spread from the propeller, with \( y = 0 \), \( y = -10 \text{ cm} \), are shown in Table 1.

| x (cm) | In a stream spread from a propeller |
|--------|-----------------------------------|
|        | speed when \( y = +10 \text{ cm} \) | axial \((y=0)\) speed | speed when \( y = -10 \text{ cm} \) |
| 10     | 7.6                               | 0                      | 7.6                          |
| 30     | 6.5                               | 3.1                    | 6.5                          |
| 50     | 5.4                               | 4.9                    | 5.4                          |
| 70     | 4.3                               | 4.4                    | 4.2                          |
| 90     | 3.2                               | 3.4                    | 3.2                          |
| 110    | 2.1                               | 2.3                    | 2.1                          |
| 130    | 1                                 | 1.2                    | 1                            |

To determine the flow velocity at a distance of 10 cm to 130 cm from the model of the propeller, causing a wind flow in open space, an experiment was conducted.

The model of the aerodynamic installation, which causes a whirlwind of wind, caused an air flow from a speed of 1 m/s to a speed of 7.6 m/s. In practice, speeds were determined at a distance of 10 to 130 cm. As can be seen from the graph in Figure 3, which shows the dependence \( U=f(x) \), the velocity in the flow spread from the propeller, \( y = -10 \text{ cm} \), decreases as the distance is interrupted, and the axial velocity in the flow spread from the propeller, is equal to zero at the first 10 cm. Then, when the distance from the screw was extended to 50 cm, the axial velocity in the stream was 4.9 m/s. After the maximum axial velocity in the flow reaches 4.9 m/s, as the distance lengthens, the velocity decreases.
Figure 3. Schedule of changes in speed depending on the distance from the screw in the stream, distributed from the propeller, with \( y = +10 \text{ cm}, y = 0, y = -10 \text{ cm} \).

Figure 4 shows a graph of the speed change in the range from the screw, \( U = f(x) \rightarrow y = +10 \text{ cm}, U = f(x) \rightarrow y = 0, U = f(x) \rightarrow y = -10 \text{ cm} \) was determined.

Figure 4. Communication speeds in the stream, spread from the propeller, \( y = +10 \text{ cm}, y = 0, y = -10 \text{ cm} \).

An experiment was conducted with a change in the rotation number in the model of an aerodynamic installation. During the experiment, a control panel was used, which regulates the amount of rotation to change the rotation number of the propeller model. At different distances from 10 cm to 130 cm, by changing the rotation number from the control panel, the velocity \( U = f(x) \rightarrow y = +10 \text{ cm}, U = f(x) \rightarrow y = 0, U = f(x) \rightarrow y = -10 \text{ cm} \) was determined.
In the stream, +10 cm in the width of the stream spread from the propeller when the propeller rotates at 120 rp/m, 710 rp/m, 1200 rp/m.

In Figure 5, it can be seen that the flow rate distributed from the propeller model decreases with separation from the propeller. In addition, as the number of propeller rotations increases, the speeds spread from the propeller in the flow are increased.

Figure 5. The graph of the change in speed as a function of the distance from the screw in
\[ U = f(x) \Rightarrow y = +10 \text{ cm} \] in the flow spread from the propeller when the number of rotations of the propeller sample is 120 rp/m, 710 rp/m, 1200 rp/m.

Figure 6 shows a graph of the axial velocity change in the flow spread from the propeller when the propeller rotates at 120 rp/m, 710 rp/m, and 1200 rp/m, depending on the distance from the screw.

Figure 6. Schedule of axial velocity change in the flow from the propeller versus the distance between the propeller and the propeller of the air propeller when the rotor sample rotates 120 rp/m, 710 rp/m, 1200 rp/m.

Paying attention to the 5th figure, the speed is equal to zero at a distance of 10 cm from the axial
speed of the screw in the flow spread from the propeller when the propeller rotates at 120 rpm, 710 rpm, 1200 rpm. After lengthening the distance, the axis speed increases to 4.9 m/s. The maximum speed of the axis reaches 4.9 m/s.

4. Conclusion
To study the aerodynamics of the aerodynamics of an aerodynamic installation that causes a wind flow in open space, one can draw the following conclusions from the experiment:

1) The experiment was performed to determine the speed at a distance of 10 cm to 130 cm from the model of the propeller, causing a jet of vortex wind. The velocity in the flow spread from the propeller when y = +10 cm, y = -10 cm decreases when the distance is broken, and the axial speed in the flow spread from the propeller is zero in the first 10 cm. After that, when the distance from the screw extended to 50 cm, the axial velocity in the stream is 4.9 m/s. After the maximum axial velocity in the flow reaches 4.9 m/s, as the distance increases the speed decreases. The model of the aerodynamic installation, which causes a whirlwind of wind, caused an air flow from a speed of 1 m/s to a speed of 7.6 m/s.

2) About the propeller screw with the rotation number of the propeller 120 rpm, 710 rpm, 1200 rpm there is a graph showing the speed change in the corner U = f ( x ) → y = +10 cm depending on the distance between the screw. From the propeller velocity in the stream, extended from the propeller with increasing distance, we see a decrease in speed. In addition, as the number of propeller rotates increases, speeds increases on carts spread from the propeller.

3) The graph of the axial velocity change in the flow spread from the propeller is established when the propeller rotation number is 120 rpm, 710 rpm, 1200 rpm depending on the distance from the screw. It is established that the speed is zero at a distance of 10 cm from the screw axial speed in the stream, spread from the propeller, with the number of propeller rotation 120 rpm, 710 rpm, 1200 rpm. After lengthening the distance, the axis speed increases to 4.9 m/s. The maximum speed of the axis reaches 4.9 m/s.

Consideration of efficient sources of energy with the use of renewable types of energy requires a lot of work, a great search. A better development of this type of energy makes a great contribution to the development of the country's economy.

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