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THE RESEARCH OF AERODYNAMICS OF CIRCULATING CONES IN SURVEY

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The work shows the regularities of changes in the forces of drag and aerodynamic lift force acting on a rotating cone under the influence of wind currents. During the research also it was examined the effect roughness on the surface of the cone. The results are presented in graphs and physically examined. When observation revealed that the age-velocity increases lift and drag relatively precise numerical values of influence roughness surface.

Keywords: aerodynamic lift force, wind currents, circulating cones, age-velocity, *roughness surface*.

The survey class both experimental, and theoretical works is devoted research of a flow by a stream of air of bodies of various geometry. The interest shown to the given question, speaks their great value for the most various branches of techniques. Studying of a flow of [1] bodies by a stream represents the whole physical interest in the field of the decision of problems of occurrence of turbulence, construction of the analytical description of a turbulent current.

Till present time aerodynamics of bodies of various geometry basically was studied only for a flow of cylinders and spheres by a stream of air both theoretically, and experimentally. Numerous data which are presented in work are thus obtained. In this work results of researches on distribution of speed of a stream in a circulating zone behind a body, and also the short description of length of a circulating zone of frequency of failure of whirlwinds over a wide range of change of number of Reynolds Re (from 0,5 to $2 \cdot 10^4$), influences of blocking up of a stream on aerodynamics of bodies of the cylindrical form are resulted. Basically in experiment used cylinders with flat, and hemispherical end faces. Aerodynamics of a cylindrical body in a stream of the infinite size is theoretically described. Influence of regional effects on aerodynamic resistance, cross-section streamline short cylinders and influence of finiteness of length and forms of end faces of the cylinder, on laws of vortex formation and turbulent structure of a current, and also distribution of pressure and speed on a body surface was investigated.

The bodies having the form of truncated [2,3] cones, are used in various heat exchanging devices as elements and knots of working parts. However, aerodynamic characteristics of the truncated cone are studied insufficiently. Basically researches were spent with the longitudinal streamline cone. In works on studying of a longitudinal flow of a cone, the cone with the sharp and rounded (dulled) end was used. The interval of used speeds of a stream of air at studying of a longitudinal flow of a cone varied from small subsonic [4,5] till hypersound speeds (speed of a stream of air to 5M).

In this work results of an experimental research of aerodynamic characteristics of cross-section streamline cone are given, which were spent in the laboratory «Hydrodynamics and heat exchange» of the Karaganda State University named after E.A.Buketov. Wind tunnel T-1-M of the closed type, small subsonic speeds with an open working part 1 (fig. 1) was used.

If on rotating cone runs air stream in a direction, perpendicular to a cone axis round it there is a circulation. The reason of occurrence of this circulation is the friction. Circulation round a cone creates the force operating on a cone in a direction, perpendicular to a stream direction. And consequently this force name cross-section. On unit of length of an axis of a cone this force is equal $\rho \Gamma V$, *where* ρ *is air-density, G is circulation.* Also force arises and at running stream on the trihedral or tetrahedral prism rotating round a longitudinal axis, on rotating sphere. Cross-section force always to that party of a rotating body on which the direction of rotation and a stream direction coincide is directed. Occurrence under the specified conditions of cross-section force is called as effect of Magnus, in the honour, for the first time opened (in 1852) this phenomenon.

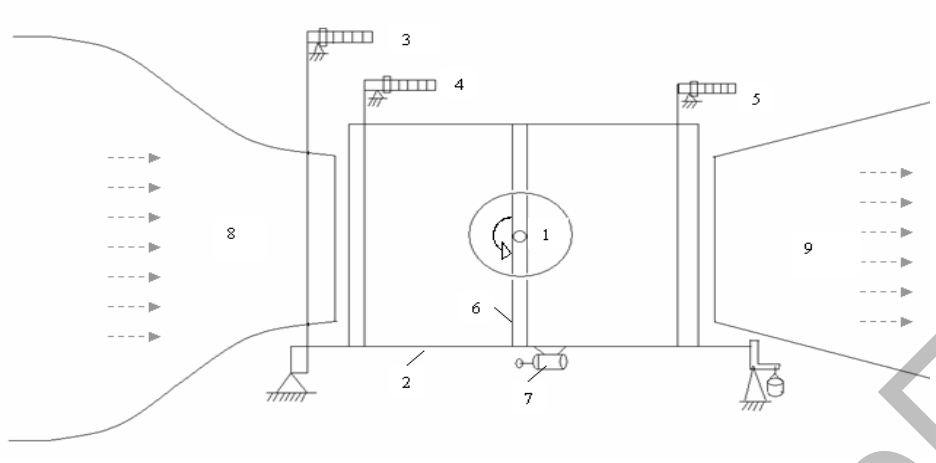

Fig. 1. The experimental stand for research of aerodynamic characteristics of a rotating cone.

1- investigated cone; 2 - a framework of aerodynamic scales; 3 - scales for definition of force of front resistance; 4,5 -scales for definition of elevating force; 6 - cone fastenings; 7 - the motor for cone rotation, 8,9 - saplo and diffuser of wind tunnel.

Research of aerodynamic characteristics of model of a body in the form of the truncated cone was spent at the laboratory stand of a cone which length of 30 cm, diameters of end faces of 3,2 cm. and 15,3 cm. has been established on an axis in the centre of a working part of a wind tunnel on the pendant frame connected to aerodynamic scales. Scales are established for the purpose of definition of size of front resistance and elevating force of a streamline body that is a problem of the given experimental researches further. For elimination of failure of a stream and vortex formation at end faces of the truncated cone limiting plates in diameter 20 cm. are established. On figure 2 it is shown a working part of a wind tunnel, with a rotating cone having a sand roughness.

Fig.2. A working part of a wind tunnel with a rotating cone with a sand roughness

Speed of a running stream - 5÷15 m/s, diameter of the open worker of a part wind tunel-500 mm. The geometrical sizes of cones: diameter d = 3,2 ÷15,3 cm, length l = 30 cm

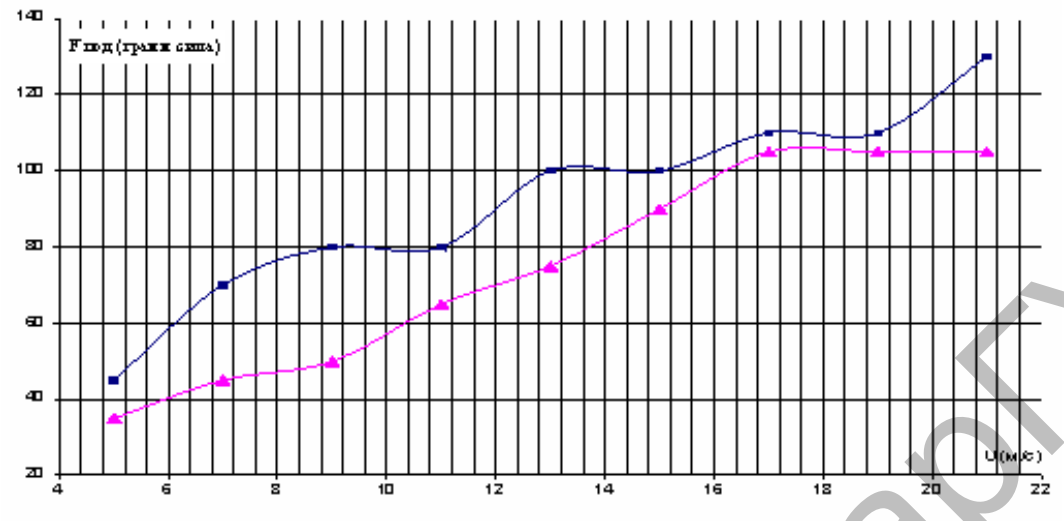

Fig. 3. Dependence of elevating force of a rotating cone on speed of a running stream: ■ - rough surface ▲- smooth surface

Experimental dependences of elevating force for cones with rough and smooth surface it is resulted on fig 3. Speed of a stream U=5m/s÷ U =15m/s. It is visible, that with increase in speed of rotation of a cone elevating force increases. The data received in different directions of rotation of cones, practically qualitatively repeat each other, there are only some differences in numerical datas - with growth of speed of a stream the maximum value of elevating force increases. The similar picture is observed at a flow of a rotating rough cone. With increase in speed of rotation elevating force increases also this growth the more strongly, than the speed of a stream is hihger. Comparison of numerical values of a maximum of speed for rough and smooth cones have shown, that the rough cone with other things being equal possesses a big elevating force.

Thus, elevating force increases as growth of speed of a stream and speed of rotation of a cone, and depending on a roughness of a surface of a cone.

On figure 4 the dependence of forces of front resistance of a rotating cone on speed of a running stream is shown. Force of a head-on collision has appeared more, elevating force and it grows with increase in speed of a stream.

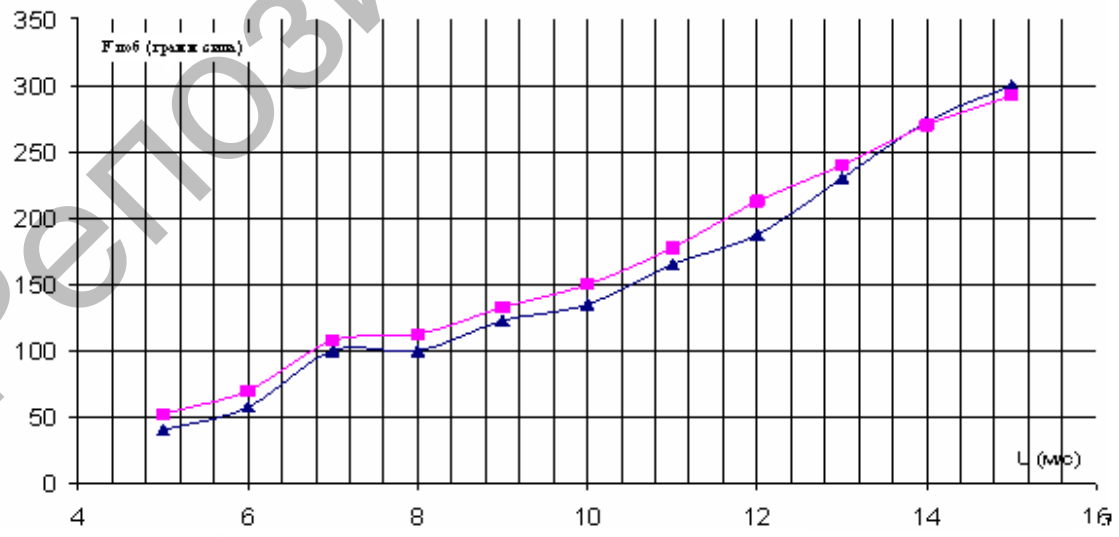

Fig. 4. Dependence of forces of front resistance of a rotating cone on speed of a running stream. ■ - cone without rotation; ▲ - cone with rotation

It has been establishe by us that with the growth of speed of a stream maximum value of elevating force increases, and also front resistance at increase in speed of a stream increase to the maximum value. The received experimental data can be useful to a wind turbine during the process of wind turbine with the using of Magnus effect.

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