ROTORS WITH VARIABLE PARAMETERS IN DYNAMICS FOR AIRCRAFT AND POWER INSTALLATIONS

Raul Turmanidze
Professor, Head of the Department of Mechanical Engineering,
Georgian Technical University, Tbilisi, Republic of Georgia
inform@gtu.ge
Akaki Peikrishvili
Dr. Dipl. Engineer, Senior Researcher Tsulukidze Mining Institute,
akaki.peikrishvili@stcu.int

The analysis of literary sources and other information materials proves that since the existence of rotors there has been an abrupt problem of creation of designs of rotors with the possibility of change of the basic geometry parameters in dynamics. It is conditioned with the fact that rotors with fixed pitch are not optimal for all stages of operation of units of various purposes. The solution to this problem is possible only by use of the variable geometry rotor (VGR) due to the possibility of simultaneous change of the rotor diameter and also setting angle and twist of blades in dynamics.

As a result of manufacture and tests of the rotor demonstration model with variable geometry parameters in dynamics we have proved that, for example, for aviation the use of VGR enables especially effective optimization of flight of planes with vertical takeoff and landing (VTOL) providing maximum diameter and minimum twist in the hover mode and contrary minimum diameter and maximum twist during cruise flight. Particularly, during varying of the rotor diameter from 4,1 to 5,6 m and blade twist within $8^0 \div 30^0$ it is possible to increase the aircraft payload 1,6 times or to increase the flight speed 1,4 times or accordingly to reduce the fuel consumption.

For wind energy installations especially with big powers the use of the VGR enables to widen the range of maximum values of efficiency of the setting during the change of the wind speed in big range from 3 to 20÷22 m/sec and also to provide the workability of the setting at those high speeds of the wind (22÷35 m/sec.), at which the existing settings are unable to work. This problem became especially topical after the accident in Fukushima, Japan. These events make the leaders of all the leading countries of the world search for possibilities in order to change maximum the part of nuclear energy with other types in the general energy balance. For

nowadays for this purpose, unfortunately, there is no more effective method than wind energy by economic and ecological criteria and also potentially mastered volume of energy.

The conducted preliminary aerodynamic and economic calculations prove that by means of the design developed by us it is possible to increase the annual volume of the worked out energy of each wind station maximum by 100%.

In the presented work will be analyzed various versions of developed designs of rotors indicating their advantages and on the basis of the conducted aerodynamic tests of existing models recommendations have been issued for effective use of each version in these or those concrete fields of engineering.

REFERENCES

1. V. Kharitonov. Autonomous Wind Power Installations. 2006. Moscow. State Scientific Department "All Russian Scientific Research Institute of Electrification of Agriculture". 2006. 20 pages.
2. R. Janson, Wind Installations. Moscow. The Bauman HSTU Publishing House. 2007. 20 pages.
3. T.Al. Shemmeri. Wind Turbines. Publisher: Book Boon 2010. ISBN–13: 9788776816926. – Number of pages: 88.
4. V. Animitsa, V. Golovin, M. Krainov, V. Novak, N. Tarasov, V. Shcheglova. Experiment-Calculated Investigations of Fields of Inductive Velocities Behind the Rotor on Aerodynamic Characteristics of the Antitorque Rotor at Small Flight Speeds at Lateral Wind. TSAGI. Moscow. The 4th Forum of the Russian Helicopter Society. February, 2004.
5. R. Turmanidze, L. Dadone, G. Sanadze. Increase of Flight and Technical Characteristics of Flying Vehicles By Means of Application of the Variable Geometry Rotor. Materials of the 5th Forum of the Russian Helicopter Society. Moscow, 2002. p. VI39-VI48.
6. R. Turmanidze, L. Dadone, J.J. Philippe, B. Demaret, Investigation, Development and Tests Results of the Variable Geometry Rotor. 33rd European Rotorcraft Forum. Kazan, 10–14 September 2007, Pages 11.
7. L. Dadone; J. Liu; C. Acree. Proprotor Design Issues for High Speed Tiltrotors. Boeing Defense & Space Group, Helicopter Division. NASA Ames Research Center. Presented at the 50 th Annual Forum of the American Helicopter Society, Washington, DC, May 1994. p.21.