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POWER CURVE DETERMINATION FOR A SAVONIUS TYPE WIND TURBINE

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Abstract: The paper presents the power curve determination for a *Savonius* wind turbine. The test rig is equipped with an air blower, a small scaled *Savonius* wind turbine, voltage and current measuring devices, an anemometer. The generated power is represented by graph, depending on the value of the wind speed. The generated electrical power is compared with the electrical power generated by a horizontal axis wind turbine (same scaled).

1. Introduction

The rotation of the wind turbines rotors is depending on the wind velocity and on the wind direction; the blades, in the rotational motion, should be oriented normal to the wind direction. The horizontal axis wind turbines should orient their rotor normal to the wind direction by using the giroscopic effect (in the case of small wind turbines) or by using an external actuator (in the case of big wind turbines), which means an energy consumption.
The main advantage of a vertical type wind turbine is that the motion of the rotor is not depending on the wind direction, so no supplementary energy consumption is needed.
The vertical wind turbines are based, mainly, on two models: the *Darrieus* type wind turbine and the *Savonius* type wind turbine (figure 1) [1, 2, 3, 5, 7].

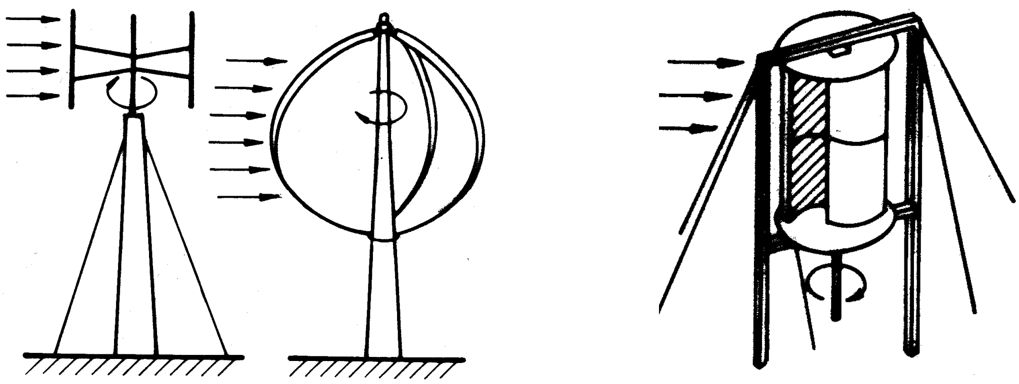

Figure 1: Darrieus type and Savonius type wind turbines

The functioning principle of a *Savonius* type wind turbine is presented in the figure 2 foor two cases: the rotor with and without air sluice [1, 2, 7].

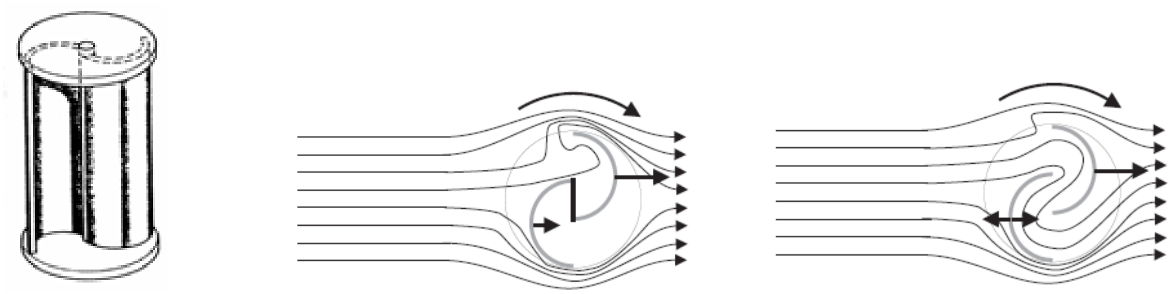

Figure 2: The functioning principle of a Savonius type wind turbine

The paper presents the power curve determination of a *Savonius* type wind turbine and its comparison with the power curve of a horizontal axis wind turbine.

2. The equipments

The wind is generated by using the fan from figure 3; *A* represents the inlet zone of the air; *B* – the outlet zone of the air; *C* – the connection socket of the electrical cable; *D* – selection switch of the wind speed. The calibration of the fan is achieved by identifying the correspondence between the position of the switch *D* and the air speed at the small scaled wind turbine rotor. The wind speed is measured by using the anemometer with cups (figure 4) [1, 2, 6, 7].

The anemometer with cups is equipped with: *A* – on/off switch; *B* – selection switch for the measuring unit; *C* – display of the measuring unit (KM/H – km/h, KTS – knots, M/S – m/s, MP/H – m/h); *D* – display of the instantaneous wind speed; *E* – display of the maximum value of the wind speed from the moment of turning on; *F* – display of the average value of the wind speed from the moment of turning on; *G* – MX (maximum value); *AV* (maximum value); *H* – display of the *Beaufort* scale; *I* – battery compartment; K – threaded hole for fixing on the base *A*.

Figure 3: The fan

Figure 4: The anemometer with cups

The hole *C* of the *Savonius* rotor (figure 5) is mounted in the *A* shaft of the electric generator (figure 6) and is fixed with the threaded pin *B*. The air sluice *D* is mounted in the gap *A*. The electric generator is connected to the measuring devices through the sockets *B* and is placed on the base plate in the hole *C*.

Figure 5: The Savonius Rotor

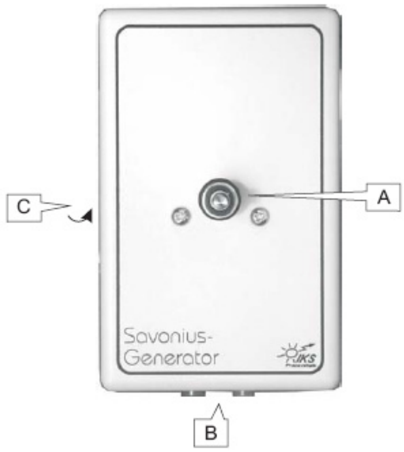

Figure 6: The electric generator

The multimeter from figure 7 is equipped with: the display of the measured parameters *A*; B – selector switch of the measured parameters (OFF – multimeter off; AVC – measuring the voltage of the alternative current by connection to the sockets *D* and *E*; DCA – measuring the continuous current by connection to the sockets *D* and *E*; 10A – measuring the continuous current by connection the sockets *C* and *E* – max. 10 A, connection without fusible fuse; OHM – measuring the electrical resistance by connection the sockets *D* and *E*; DCV – measuring the voltage of the continuous current by connection the sockets *D* and *E*; *C* – socket + used to connect a 10 A cable for continuous current; *D* – socket + used to connect a V / Ω / mA cable; *E* – cable connection socket [1].
The load (figure 8) is represented by a electrical resistance with the value of 100 Ω and the maximum power of 2 W with the components: *A* – the connection of the generator; *B* – the connection for the voltage measurement; *C* – the connection for the current measurement; *D* – rotational wheel used to increase the resistance value.
The base plate (figure 9) contains: the cavity *A* used to mount the fan; the pins *B* used to fix the wind turbine; the channels *C* used to mount the protection screen; the channel D

used to mount the obstructing screen; the *E* zone used for the mounting the experimental modules and the measuring devices; *F*, *G* – fixing elements [1, 7].

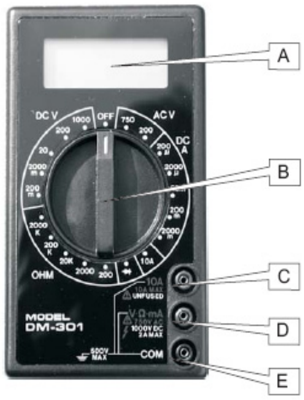

Figure 7: The multimeter

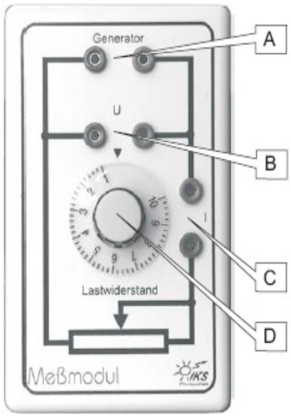

Figure 8: The load

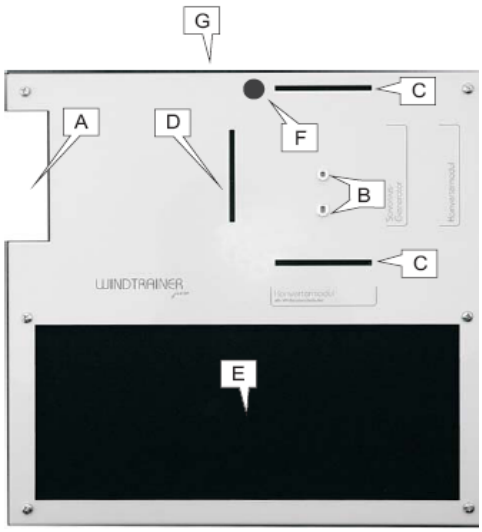

Figure 9: The base plate

The wind turbine with horizontal axis (figure 10) is equipped with: the hub *A* where 2, 3 or 4 blades can be mounted; *C* – connection sockets to the electrical generator and to the tacho-generator; *D* – threaded pins used to fix the blades; *E*, *F*, *G* – positioning holes of the wind turbine on the plate base.

The protection screen (figure 11) contains a scale *A* with graduation which is used to adjust the pitch angle of the blades and the magnets *B* used to fix the screen on the base plate.

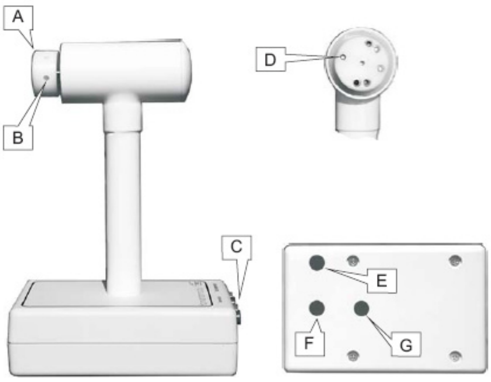

Figure 10: The small scaled wind turbine

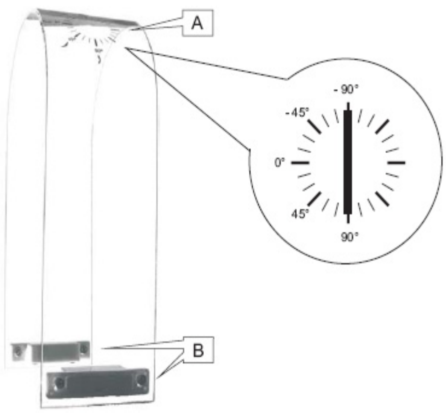

Figure 11: The protection screen

3. The tests

The tests are achieved by using the test rig presented in figure 12 by considering some specific aspects [1, 2, 6]:

- the voltage measurement for the current generated by the small scaled wind turbine is achieved by using a multimeter as a voltmeter by fixing the switch on the position DCV 20 V;
- the current intensity measurement is achieved by using a multimeter as an ampermeter by fixing the switch on the position DCA 200 mA;
- the wind speed is adjusted by using the switch *D* of the fan, between the positions 0 and 10;

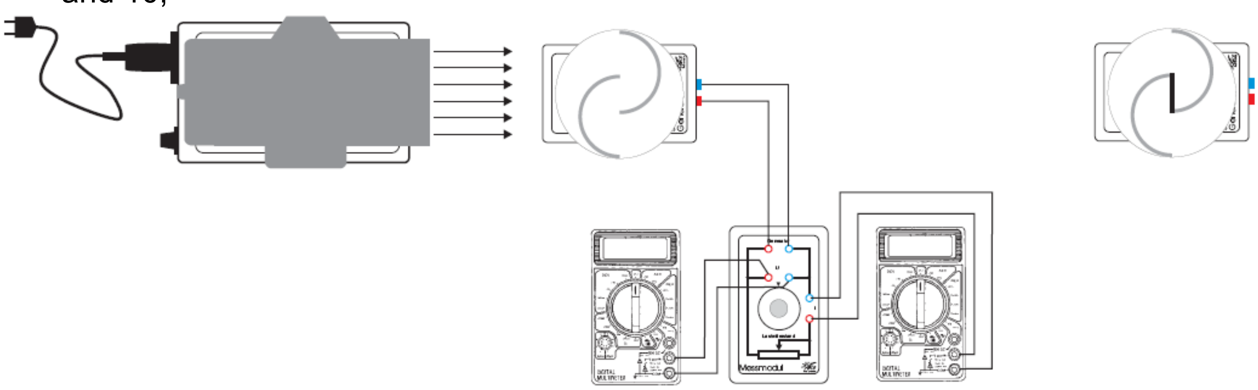

Figure 12: The test rig

- the measurement of the wind speed, for each position, is achieved by using the anemometer with cups, mounted on the base plate instead of the small scaled wind turbine (figure 13);

Figure 13: The wind speed measurement

- by mounting the wind turbine and by connecting the measurement devices the measurement of the voltage and of the current intensity is achieved, for each position of the fan's switch (figure 14);

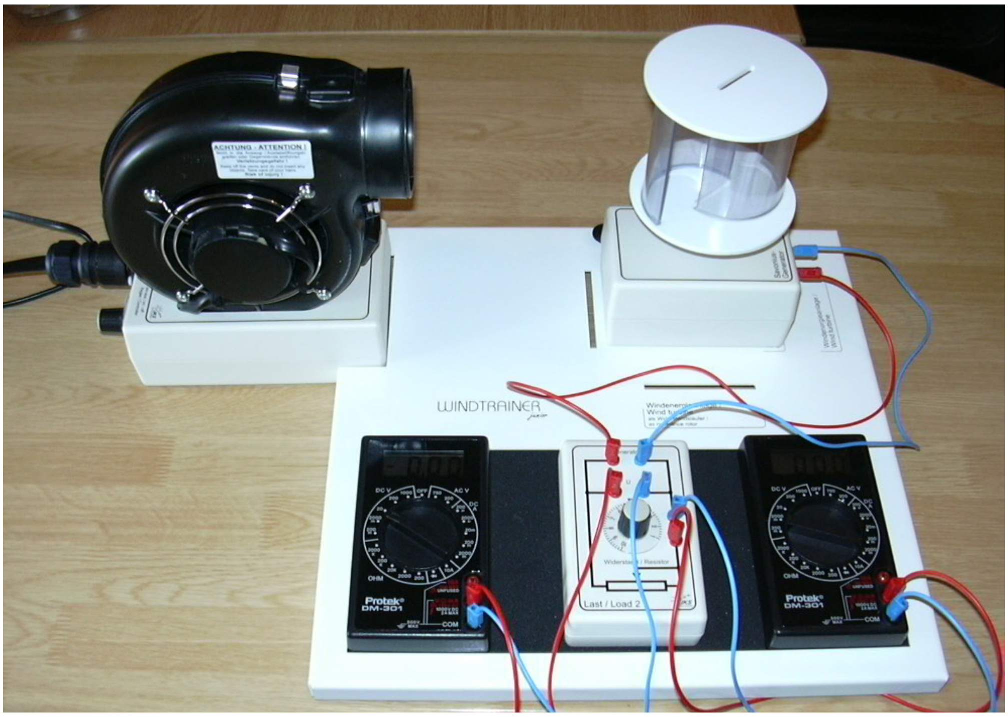

Figure 14: The Savonius test rig

- the tests are made for three cases: the *Savonius* rotor with and without air sluice and for the horizontal axis wind turbine with 3 blades (figure 15).

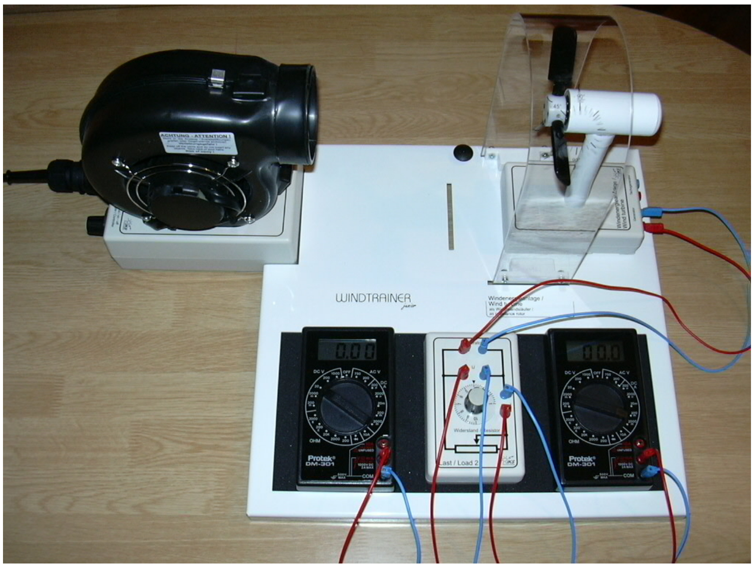

Figure 15: The horizontal axis wind turbine test rig

4. The results

The variation of the power curve is presented in the figure 16 for the three cases: the *Savonius* rotor with and without air sluice and for the horizontal axis wind turbine with 3 blades.

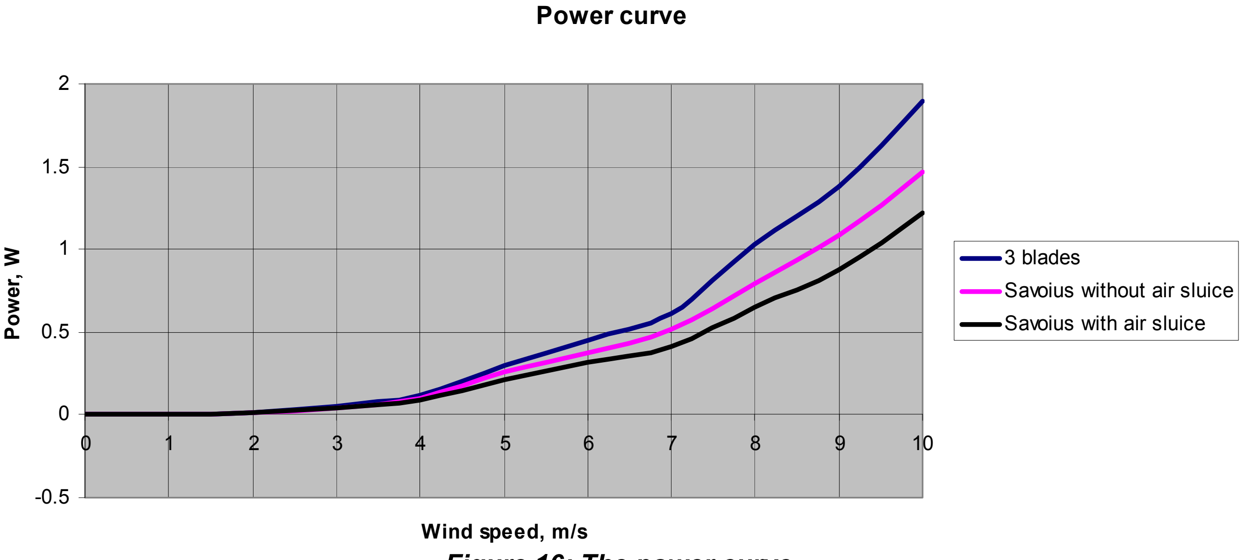

Figure 16: The power curve

The best behavior has the horizontal axis wind turbine and the *Savonius* rotor without air slice.

5. Conclusions

According to the tests the following conclusions can be expressed:

- the tests of the *Savonius* type wind turbine are useful to understand the functioning of the system;
- the test principles can be applied to any wind turbine;
- the best behavior has the horizontal axis wind turbine and the *Savonius* rotor without air slice;
- the cut-in wind speed for the tested turbines is the same - 1 m/s.

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