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PRELIMINARY STUDY OF A SAVONIUS ROTOR AND ITS ADAPTATION TO A PUMPING SYSTEM USING WIND ENERGY

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Abstract

The Wind energy is an uncertain and discontinuous energy in the time, asking for no primary extraction, it is free and its capture is without serious influence on the climate and doesn't produce none poisonous residues for the atmosphere. The capture of the Wind energy is assured by the wind rotors, and among a big number of variants rotors, those with vertical axis present the advantage of construction simplicity, because they don't require any system of orientation and a simple pylon can serve like support. In this setting, our work consists in a experimental study of a rotor with vertical axis called SAVONIUS and its adaptation to a pumping system using the Wind energy.

The experimental study has been achieved in subsonic wind tunnel, after realisation of a model of the SAVONIUS rotor and a special installation of transmission of the energy. The adaptation of the experimental results to a pumping system in the real case, permitted us the determination of the variation of (□Cp) and (□□) according to the speed of wind and the establishment of a range of debits of the pump according to a range of wind speeds chosen by the meteorological evaluations of Batna region .

Key words: *Wind energy, SAVONIUS rotor, pumping system , coefficient of strength, transmission of energy;*

1. INTRODUCTION.

Of the fact of the rotundity of the earth, the solar radiance is absorbed by different way to poles and the equator, these variations of temperature causes differences of air masses densities, dragging their displacements from a latitude to an another one, for this reason we considers the Wind energy as one under solar energy product.

The Wind energy is an uncertain and discontinuous energy in the time, asking for no primary extraction, it is free and its capture is without serious influence on the climate and doesn't produce none poisonous residues for the atmosphere. Knowing it's own features, it's agrees to examine possibilities of exploitation, because, although it is unequally abundant, it's total quantity is considerable and has been encoded about 2.5 .1015 KWh per year for all the globe [1].

The capture of the Wind energy is assured by the wind rotors, and among a big number of variants, rotors with vertical axis present the advantage of construction simplicity, because they don't require any system of orientation and a simple pylon can serve like support. In this setting, our work consists in a experimental study of a rotor with vertical axis called SAVONIUS and it's adaptation to a pumping system using the Wind energy.

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2. EXPERIMENTAL STUDY

2.1. Description of the model achieved.

The model of the SAVONIUS rotor is constituted of two half-cylindrical dawns 2 gotten from a P.V.C tube with diameter 80 mm, length 180 mm and thickness 3 mm. These dawns are kept by the flabby 1, on which is achieved of grooves 3 by milling permitting the variation of the e gap between dawns.

The essential role of the flabby is to eliminate the vertical component of the speed in order to assure a two-dimensional out-flow.The whole is fixed on a vertical axis guided in rotation in a support (no represented).

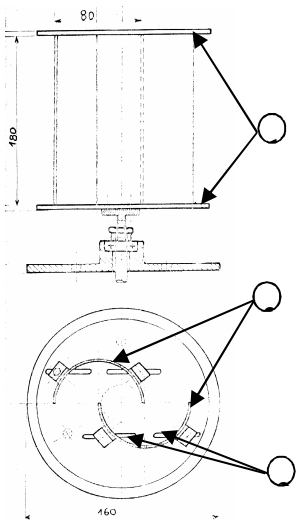

Figure 1. reduced model of a SAVONIUS rotor realised for tests in subsonic wind tunnel.

2.2. Description of a subsonic wind tunnel.

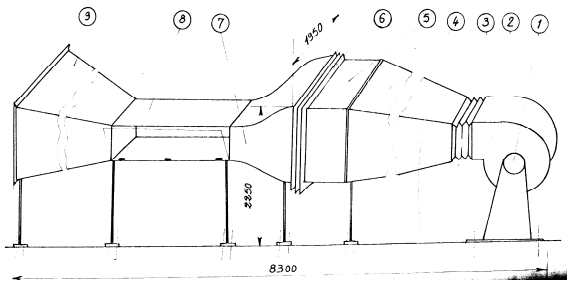

Figure 2.Representation of wind tunnel dimensions.

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The wind tunnel represented on figure 2, is blowing type with an open circuit which present excellent aerodynamic qualities with it's big vein of tries allowing numerous applied studies.

The main components of the wind tunnel are:

1. a driven centrifugal fan by electric motor that develops 12 Kw to 2000 tr/mins, the regulating of the speed is by electronic drive.

2. a convergent, of a report of contraction of 25 to the entrance of the vein of tries.

3. a vein of tries of length section 300x300 mm2 1500 mms.

4. a wagon brought up on rails and a divergent to the downstream of the vein of tries.

5. speed inside of the vein (of 0 to 60 m/sec).

1. electric motor. 2. fan. 3. filter to pockets 4. calming Distributor. 5. room of tranquillisation. 6. three metal gratings 7. convergent Distributor for the acceleration of the out-flow. 8. Vein of tries. 9. divergent Distributor.

2.3. Experimental installation.

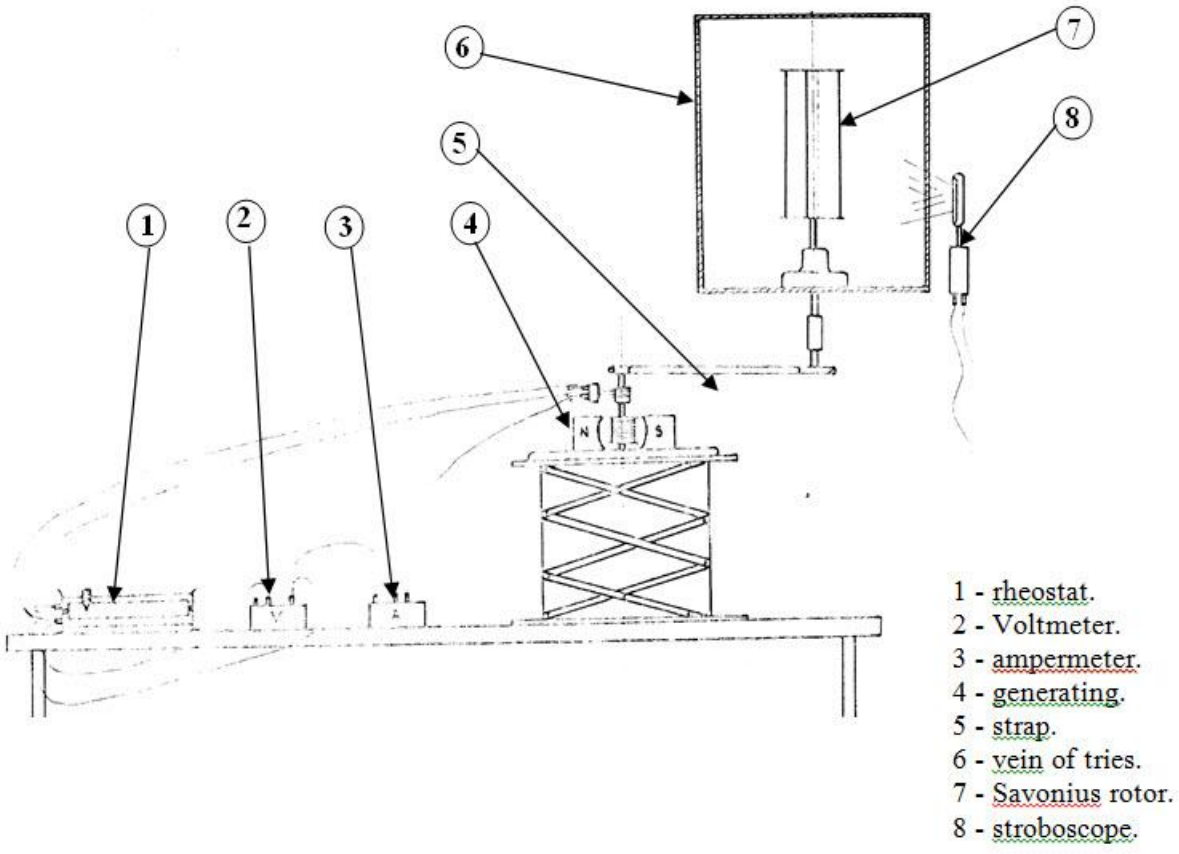

Figure 3. Experimental installation showing the circuit of transmission of the energy

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In the fig.3 above, is represented the experimental installation permitting the determination of the strength coefficient according to the reduced peripheral speed of the tip of pale for different speeds of wind. The principle of the manipulation is based on the measure of the well stocked electric strength by a generating 4 driven in rotation by two hardback pulleys directly to the axis of the rotor 7 and a strap 5. the intensity produced by the generating under a certain tension, are measured by an Amper-meter 3 and a voltmeter 2.The variation of the speed of rotation of the generating is assured by rheostat 1, whereas the stroboscope 8 measures the speed of rotation of the model in the vein.

3. RESULTS OF THE EXPERIENCE.

After the adequate measure set, one represents in the face 4 the variation of the coefficient of Cp strength according to the peripheral speed coefficient, these two last being given by:

$$\lambda = \frac{R.\omega}{V_\infty} \quad \text{et} \quad C_p = \frac{P}{\frac{1}{2}.\rho.S.V_\infty.L_b}$$

R: Radius of dawn span.

□ : Angular speed to the periphery.

V_∞: Speed of wind to the infinite.

P: Recoverable strength by the rotor.

□ : air density .

S: Surface of the master couples

L_b: Betz limit

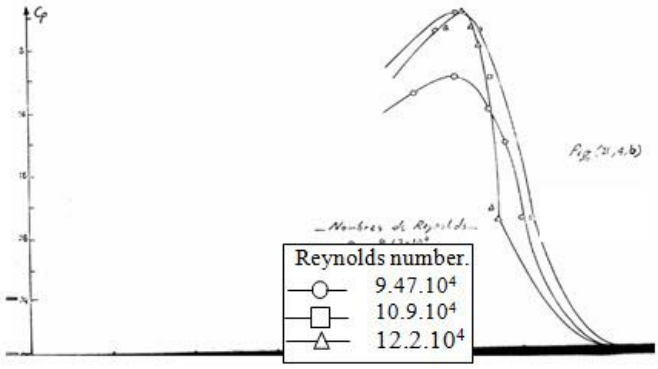

Figure 4. Variation of strength coefficient Cp in fact of □ for different values of Reynolds number.

3.1. Interpretation.

Curves of the fig. (4) show that the Cp admits a maximal value for the curve to number of Reynolds 12.2.104 and that for the 3 speeds of wind chosen, the optimal value of the Cp is located in a reduced interval of the peripheral speed. It makes that the variation of Cp according to the speed of wind is not important. Values of Cp for weak speeds of wind can't be gotten because of rubbing in the transmission chain that slows down the generating. In this case the intensity produced becomes impossible to capture by the plain measure instruments.

We can conclude that the complete performances of the Savonius rotor are not completely determined with good precision because of shortcomings of manufacture and the no uniformity of the out-flow and other factors. We intend to simulate a pumping installation using this type of rotor because this one doesn't ask for big values of the strength.

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4. THE PUMPING INSTALLATION

The installation of pumping that we intend to study is constituted of a rotor Savonius **1** with 2.5 m of height, brought up on a pylon **2** of 10 m of top, these measurements being chosen more of way to be able to develop a strength of 1.024 KW in correspondence with a middle speed of wind in the region of Batna of 60 Km/hs during blowing periods.

The rotation of the rotor is transmitted, by the mean of a homocinetic axis **3** to a multiplier of speed **4** mated to a radial centrifugal pump **5** of low debit and middle pressure running in 760 tr/mins, which could defeat 18 m of height.

The study permitted to clear a complete range of debits of the pump according to the middle speed of wind indeed, and to represent them on the fig. 5.

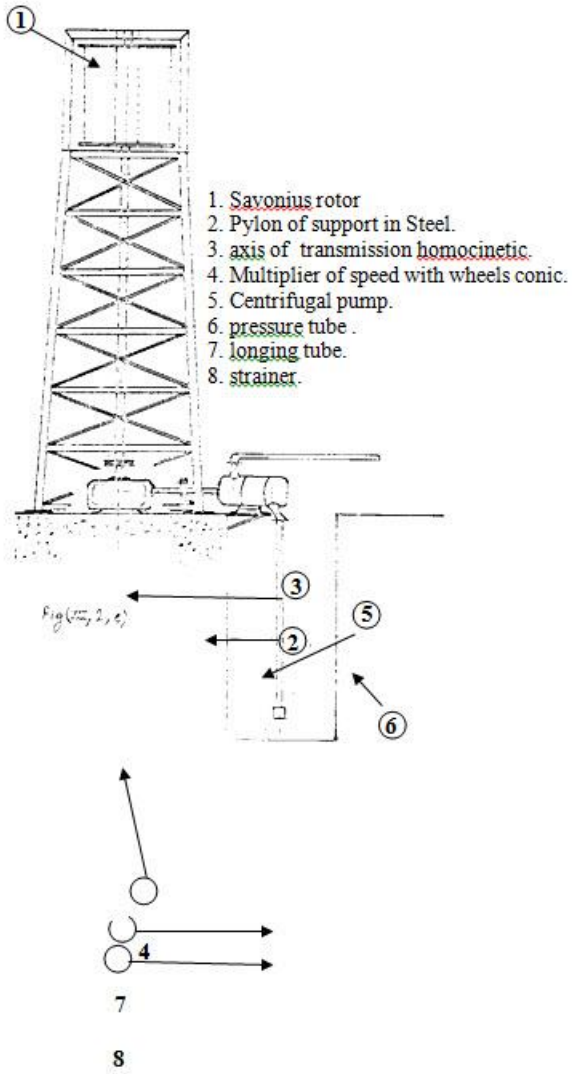

Figure 5. schematic representation of pumping installation .

5 . RANGES OF DEBITS.

V_∞ (m/s)	Cp_{max}	□	P (w)	N (tr/min)	Q (l/min)
22	23 %	0.68	2693.9	1136.96	232.8
20	22 %	0.67	1936	1018.4	208.6
18	21 %	0.66	1347.19	902.88	184.93
16	20 %	0.65	901.12	790.4	161
14	19 %	0.64	573.4	681	139
12	18 %	0.632	342.14	576.4	118.05
10	15 %	0.624	165	474.2	97.12
08	12 %	0.616	67.58	374.5	76.29
06	9 %	0.608	26.136	277.2	56.32

Table 1. experimental Parameters calculate and debits values in fact of wind speed V_∞.

Using the values of □Cp and □□□we can get values of Cp_{max} and □□corresponding, as well as

the strength, the speed of rotation of the rotor and of the pump, for different speeds of wind.

All these values are regrouped in the table I.

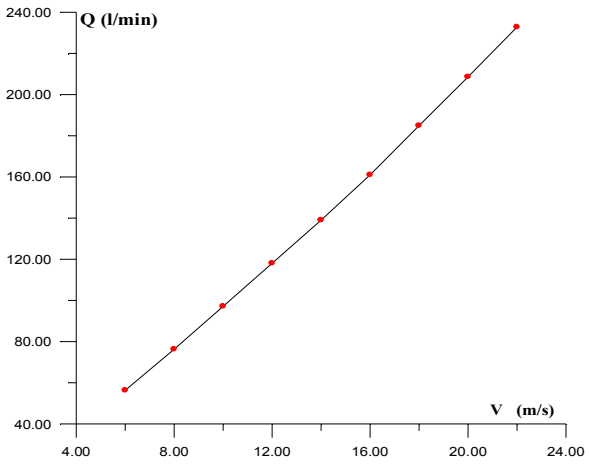

Figure 6. Curves showing the variation of pump debit in fact of wind speed.

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6. CONCLUSION

The interest of pumping installations using wind energy is obvious and becomes more and more actual. The uses of a rotor with vertical axis not requiring system of orientation as SAVONIUS, shows, after the experimentation done it's efficiency, in spite of it's low output the model present the advantage to starting with very low speeds of wind, and can give an important energy production and a satisfying number of hours of works, contrarily to other known models.

The applied results to a concrete case showed, that for the fairly blown regions, the studied system can be very profitable and can be competitive with the electric, thermal pumping systems and particularly the wind groups to lively multiblades of piston pumps.

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