MICRO WIND POWER TURBINE WITH EXTENSION OF THE MAXIMUM ADMISIBLE WIND SPEED

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Abstract:

Technical aspects of mechanic resistance of wind turbine blades, specially due to centrifugal and aerodynamically forces at high speed, as well as in correlation with power of electric generator, are usually determinant in limitation of wind speed at level of 10 -13 m/s. This paper presents an unconventional concept and some theoretical aspects of a micro wind power turbine with modular electric generator and sequential coupling of this module.

Conclusion: this solutions, materialized through an experimental model, permit to revaluate the performances at higher wind speed, without pass dangerous peripheral speed of the wind rotor turbine

Keywords: Mycro wind turbines, Unconventional electric generator

1. Introduction

In accordance with the UE last politics (where Romania is a member with full rights and obligations), referring to "clean" electricity production, for our country was determined a portion of 8, 3 % from the electricity production for the year 2012 (not taking into consideration the portion delivered by the main power hydro plants–over 10 MW).

From the year 2006, due to favorable legislation developed for promoting renewable resources electricity, in Romania start being imported wind installations of main and medium power (over 100 kW), and small wind turbines (with power of the kW's order).

However, we consider that the innovational and research Romanian units can successfully be involved in complete products and technology development, using own innovative solutions, concerning energetic low power micro installations, for specific applications, installations that don't require a lot of financial resources. Scientifically and technical objectives, which we will deal, referring the proposed theme on the work paper abstract (**Micro wind power**

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turbine with extension of the maximum admissible wind speed) , will be performed during the new research project with title „***Innovative micro electric power plants, based on renewable resources (wind and hydraulics), with the extension of the working fluids speed range, beyond the usual limits***", funded by the Second National Research & Development Plan (2007-2013) – Energy research direction.

This research project will be performed by a joint research teams from: National Research and Development Institute for Electrical Engineering Bucharest (INCDIE ICPE-CA)– the leader of the project, ICPE –Electrical Motors, ICPE-Actel, University POLITEHNICA from Bucharest, AISTEDA, Romanian Technical Sciences Academy and last but not list Hidroserv Cluj, who will integrate the new prototype of this innovative micro wind turbine.

The main objective of this project is to increase the speed limit utilization of the micro wind turbines, up to 15-18 m/s (taking to account news optimizations that would be obtained by sequential regulation of electric, mechanic and aerodynamic parameters). In present, is well know that almost all micro wind turbines from this range of power, is cut-off (at superior speed limit) beyond 12-13 m/s. Thereby, an innovative wind turbine (working in 5-10KW – power range), will be ideal for residential, living on high wind potential sites.

2. State-of-art of small wind turbines worldwide

Areas with existing energy renewable resources, especially those who are situated at a significant distance towards local and national electric alimentation networks have a maximum interest for electricity conversion from wind power trough micro installations for covering the energetic necessities of houses, huts and other tourist objectives. On the other side, due to fiscal facilities for acquiring renewable resources energy production installations resulted by introducing in the alimentation network this kind of "clean" energy (profitable energy sealing prices, green certificates, preferential tariffs for a particular part of a day etc.), in developed countries it has increased the demands for such installations in a power range of 0,5-10 kW (e.g. 16 million wind micro units soled in 2006 in USA). We have to accentuate, the micro plants offers of Southwest Windpower (USA), Bergey Windpower Co. (USA), Skystream(USA).

Wind micro turbines from this power range, mentioned above, for being more efficient financially (fabrication prices about 2000 Euro/kW) have a relative simple constructive concept: wind rotor propeller turbine without the possibility of modifying the attack angle of the rotor blades (aerodynamic parameters can't be optimized this way) and multi poles permanent magnets electric generators.

This type of syncronous electric generator has the excitation performed by permanent high energy magnets.

The variable voltage, took from the output of electric generator is redressed and stabilized to a convenient level, for supplying a accumulator battery (continuous current), as a tampon and for energy storage role. For utilities that need alternative voltage at national network parameters, a force electronic module is being used (static frequency converter- which assures 220 V/ 50 HZ). For this alternative, electric energy can delivered in local or national electric network.

3. State-of-art of wind micro turbines in Romania, especially on PMG (permanent magnet generators). Main characteristics and

In Romania there are no small wind turbine producers, only experimental models and subassembly prototypes was developed in some research institutes. Also, research units from our consortium have some significant results. On the photos below, we present two achievements of research units from our research consortium.

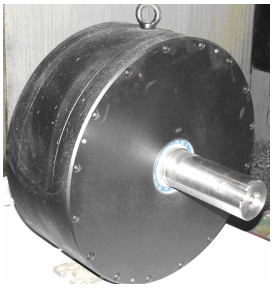
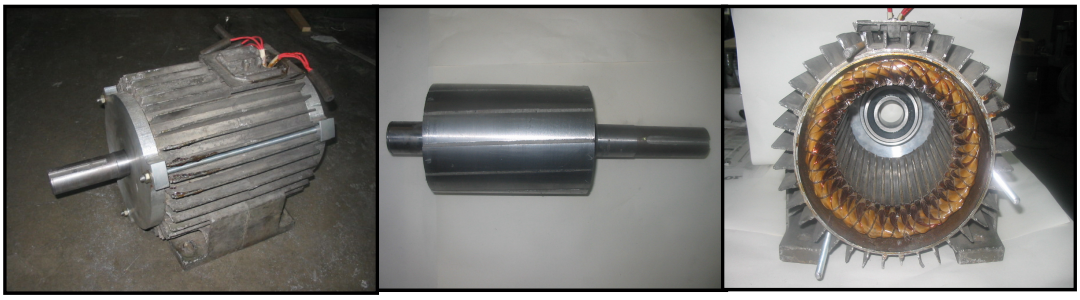


Fig.1. 5 KW (at 250 rot/min) permanent magnets synchronous electric generator made by ICPE -ME



a) **b)** **c)**

Fig. 2. 1,5 KW (at 400 rot/min) permanent magnets syncronous electric generator made by INCDIE ICPE –CA.

In **fig**. **2.a)** is presented an classic permanent magnet generator, who might be direct drove by an classical wind axial rotor.

For minimize the costs, this synchronous electric generator was transformed from induction (asynchronous) electric motor with three phases.

It is a classical construction for electric generators, functioning in atmospherically condition, with induced stator circuit – **fig**. **2.c** (electrical steel pocket and induced stator coils) took from an asynchronous electric motor. The inductor rotor circuit (with multiple poles) has inclined magnetic poles, equipped with high power permanent magnets (N-Fe-B). This magnetic pole are settled and joined with a massive steel cylindrical yoke, strengthened with two lateral flanges. (**fig**. **2.b**. and **fig.3.a**).

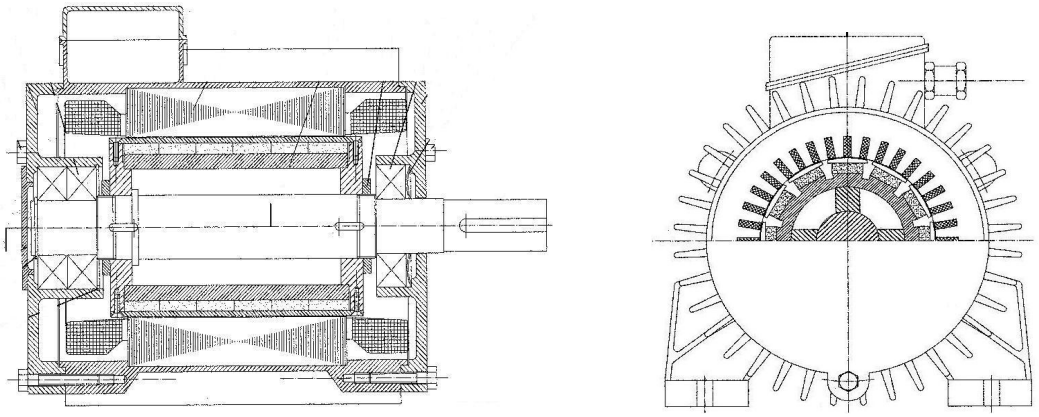


Fig.3. Classical design of synchronous permanent magnets electric generator

The radial thickness of the magnetic yoke is defined by magnetic field saturation. On the cylindrical area of yoke there are drilled axial channels to positioning parallelepipedic permanent magnet poles.

For minimization of the electric generator „cogging torque" (at zero rotor speed) , between magnetically rotor and induced stator circuit (with slot), the magnetic poles was inclined with the dimension of one step of slot stator [1], [2].

Main characteristics of this PMG :

- Effective voltage (without charge)/ phase : $\mathbf{U_0}$ = 55 V at 300 rpm
- Effective current /nominal phase**:** $\mathbf{I_{fN}}$ = 11 A

- Number of chops / pole and phases : **q** = 1.

The experimental measurements had shown a good behavior of our PMG on function (with and without electric charges).

On present two main characteristics of this synchronous generator fig. **4** and fig.**5**.

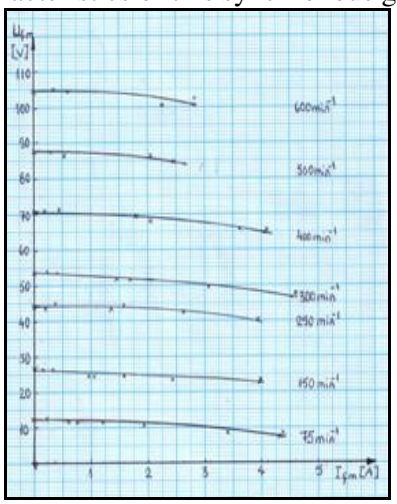


Fig. 4 External characteristics of output voltage depends on current out put of charge, for fixed speed

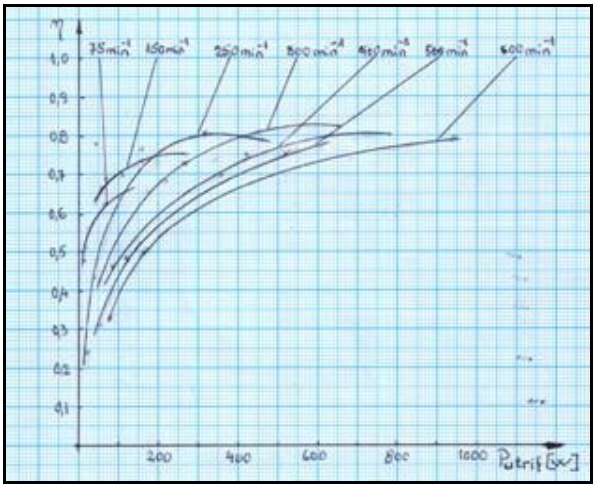


Fig.5. Power efficiency function of useful power put out of charge, for fixed speed .

4. Inovative and perspective elements on small wind turbines

Based on previous experience, we propose to develop an syncron electric generator, with two active subassemblies and the possibility of sequential activation, dependent on the primary wind speed available and in correlation with

the command of the parameters of the electrical energy injected or consumed in/from electric network.

It is considered the fact that sequential activation should be realized in 8-15 m/s interval, offering the possibility to the electric generator to discharge power up to wind speeds of 15-20 m/s, atypical values known for wind micro turbines.

Also modern solutions are considered as:

- The possibility of modifying the rotor blades incidence angle in two steps: at big incidence at low wind speeds (3,5 m/s) for a starting facility and optimum calculated incidence angle, corresponding to the speed of nominal power, for medium and high speed interval : 5-18 m/s)
- The functional adaptation of the force electronic converter to the extended domain of the innovative electric generator parameters.
- Solutions of higher resistance for aerodynamic structures materials (rotary blade – special carbonic materials fiber armed polyesters), necessary for application at wind speeds of 15-20 m/s.

All the above facts go to the possibility of adjusting the functioning parameters (electric and aerodynamic) in terms of increasing the global efficiency, also for small wind turbines.

5. Conclusion

The installation is destined for establishments were exists an annual medium wind speed about 6-10 m/s and also exists a representative time domain in 10-16 m/s speeds interval (example: The Black Sea littoral and especially on the cliffs situated in open fields, dams, high mountains areas al across the Carpathian Mountains, high table land Moldavian areas, adjacent to Meridional Carpathians a.o.).

REFERENCES

[1]. *H. Gavrila, H. Chiriac, P. Ciureanu, V. Ionita, A. Yelon;* Magnetism tehnic si aplicat, Editura Academiei Romane, Bucuresti, 2000.

[2]. *C. Bala,* Masini electrice. Editura Didactica si Pedagogica Bucuresti, 1979.