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ASSESSMENT OF ENERGY PRODUCTION AND ENERGY BALANCE FOR THE ADAPTATION OF WIND MICRO-AGGREGATES AT A COMPARATIVE ANALYSIS

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Abstract: *The work intends to make a synthetic presentation of an assessment method of the production of energy and energy balance in the conditions of adaptation of wind micro-aggregates at a comparative analysis, by determining certain energy parameters which are used in design calculations, obtaining the total production of energy kwh/year.*

Key words: *energy assessment, turbine, electric generator, energy balance, system*

1. INTRODUCTION

In the process of assessment of a turbine, the installation point represents a pair of values (P_{ai}, v_i) for which the system is dimensioned, where P_{ai} represents the largest power at which the system may work.

The turbine's energy balance refers to determining certain energy parameters, which are used in the design calculation, for the adaptation of wind aggregates to the requirements of a comparative analysis (Dubău, 2007; Bej, 2003).

2. MATERIAL AND METHOD

For assessments during the design were used three positions of powers (Gyulai, 2000, 2003), that is:
- valorized power by the turbine's blading (P_{pal});
- power at spindle (coupling between turbine and generator) (P_{arb});
- electric power at the generator's marker stones (P_{eb})

For the dynamic behaviour of the group of machines were identified the curves for the engine moment of the turbine and for the resistant moment of the electric generator.

For these analyzed were used experimental programs.

In the area of maximum powers the three levels of powers had the following orientative values:

$$P_{eb} \cong 2500\ W,\ P_{arb} \cong 2800\ W,\ P_{pal} \cong 3000\ W.$$

The power at markers stones at the nominal point has the value of 2000 W, and the nominal speed is of 250 rpm, and in an accepted functioning field we have for n = 40…500 rpm.

The power installed at the electric generator's marker stones was established at 2500W and this was based on the results of an economic efficiency study.

By correlating the performances of the three dimensions of turbines with the electric generator, where the level of limited power ws considered at the level of 3 kW (at the turbine's spindle), different limitation speeds are accepted. The management system shall select the speed in relation to the admitted electric power in the generator's winding.

The parameters which define the turbine's gauge are the diameter (*D*) and the height of the blading (*H*). In these conditions, the exposed area is calculated with the formula $A = D \cdot H$ and the relation of power at the spindle is

$$P_a = C_{Pa} \cdot \rho \cdot \frac{v^3}{2} \cdot D \cdot H\ , \qquad (1)$$

where ρ is the air's density which depends on the altitude of the sea level and the air's temperature; v – air speed depends on time and elevation of the place; C_{Pa} depends on the characteristic number

$$\lambda = \frac{peripheral.speed}{wind.speed} \qquad (2)$$

3. RESULTS AND DISSCUSIONS

The assessment of energy production and the energy balance for the three dimensions of the turbine have the following determined values such as:

3.1 The assessment of energy production and the energy balance in the case of Turbine T 32

We have the parameters: Turbine *T 32* ($\lambda_o = 3$), $S = 4,5\ m^2$ $D = 1,5\ m$; Location's offer: $v_m = 6\ m/s$, *Const.* $k = 0,73$; Air density: $\rho = 1,225\ kg/m^3$.

The assessment of energy production is shown in Table 1.

V [m/s]	F [hours/year]	C_P	P_T [W]	n [rpm]	η_G [%]	P_G [W]	Prod. of energy at marker stones [kWh/an]
2	934	0,45	10	76	6	0,6	0,6
3	1031	0,45	35	115	8	2,8	2,9
4	1035	0,45	79	153	20	15,8	16,4
5	969	0,45	156	191	32	49,9	48,4
6	858	0,45	267	229	56	149,5	128,3
7	723	0,45	425	267	76	323,0	233,5
8	583	0,45	636	306	81	515,2	300,4
9	452	0,45	905	344	86	778,3	351,8
10	338	0,45	1242	382	88	1093,0	369,4
11	244	0,45	1651	420	89	1469,4	358,5
12	170	0,45	2143	458	90	1928,7	327,9
13	115	0,45	2726	497	90	2453,4	282,1
14	75	0,397	3000	472	90	2700,0	202,5
15	48	0,322	3000	411	90	2700,0	129,6
16	29	0,266	3000	391	90	2700,0	78,3
17	18	0,222	3000	379	90	2700,0	48,6
18	10	0,187	3000	367	90	2700,0	27,0
19	6	0,159	3000	363	90	2700,0	16,2
20	3	0,136	3000	357	90	2700,0	8,1
Total energy [kWh/year] :							**2930,5**

Tab. 1. The assessment of energy production and the energy balance in the case of Turbine T 32

3.2 The assessment of energy production and energy balance in the case of Turbine T 33

We have the parameters: Turbine *T 33* ($\lambda_o = 3$), $S = 6\ m^2$ $D = 2\ m$; Location's offer: $v_m = 5\ m/s$, *Const.* $k = 0{,}73$; Air density: $\rho = 1{,}225\ kg/m^3$.

The assessment of energy production is shown in Table 2.

V [m/s]	F [hours/ year]	C_P	P_T [W]	n [rpm]	η_G [%]	P_G [W]	Prod. of energy at marker stones [kWh/an]
2	1186	0,45	13	57	7	0,9	1,1
3	1194	0,45	46	86	35	16,1	19,2
4	1097	0,45	105	115	63	66,2	72,6
5	943	0,45	208	143	78	162,2	152,9
6	768	0,45	356	172	79	281,2	215,9
7	598	0,45	567	201	84	476,3	284,8
8	446	0,45	848	229	85	720,8	321,5
9	321	0,45	1207	258	86	1038,0	333,2
10	223	0,45	1655	286	88	1456,4	324,8
11	150	0,45	2200	315	90	1980,0	297,0
12	98	0,45	2857	344	90	2571,3	252,0
13	62	0,37	3000	292	88	2640,0	163,7
14	39	0,29	3000	274	88	2640,0	103,0
15	23	0,24	3000	261	87	2610,0	60,0
16	14	0,19	3000	252	88	2640,0	37,0
17	8	0,16	3000	244	87	2610,0	20,9
18	4	0,14	3000	241	86	2580,0	10,3
19	1	0,11	3000	233	86	2580,0	2,6
20	0	0	0	-	-	-	-
Total energy [kWh/year] :							**2672,5**

Tab. 2. The assessment of energy production and energy balance in the case of Turbine T 33

3.3 The assessment of energy production and energy balance in the case of Turbine T 34

We have the parameters: Turbine *T 34* ($\lambda_o = 3$), $S = 7{,}5\ m^2$ $D = 2{,}5\ m$; Location's offer: $v_m = 4\ m/s$, *Const.* $k = 0{,}73$; Air density: $\rho = 1{,}225\ kg/m^3$.

The assessment of energy production is shown in Table 3.

V [m/s]	F [hours/ year]	C_P	P_T [W]	n [rpm]	η_G [%]	P_G [W]	Prod. of energy at marker stones [kWh/an]
2	1450	0,45	17	46	6	1,0	1,5
3	1289	0,45	57	69	40	22,8	29,4
4	1057	0,45	132	92	70	92,4	97,7
5	818	0,45	260	115	80	208,0	170,1
6	604	0,45	445	138	82	364,9	220,4
7	428	0,45	709	160	86	609,7	261,0
8	294	0,45	1060	183	86	911,6	268,0
9	195	0,45	1509	206	87	1312,8	256,0
10	126	0,45	2069	229	87	1800,0	226,8
11	80	0,45	2751	252	87	2393,4	191,5
12	49	0,378	3000	215	85	2550,0	125,0
13	29	0,297	3000	204	83	2490,0	72,2
14	17	0,238	3000	193	83	2490,0	42,3
15	9	0,193	3000	183	82	2460,0	22,1
16	5	0,159	3000	177	81	2430,0	12,2
17	2	0,133	3000	182	82	2460,0	4,9
18	0	0	0	-	-	-	-
Total energy [kWh/year] :							**2001,1**

Tab. 3. The assessment of energy production and energy balance in the case of Turbine T 34

These tables emphasize assessments of production of energy and energy banalce for the three types of turbine, offering in this manner the possibility of adaptation of turbines to the specific requirements.

In the Figure 1 we can notice the correlation between the performances of the turbine with the generator performance.

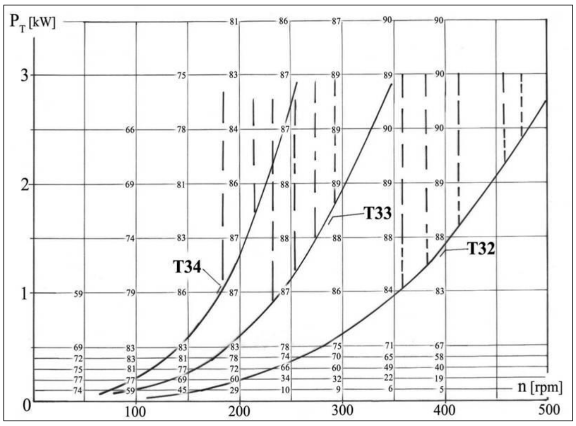

Fig.1. Performance of the turbine

4. CONCLUSIONS

By analyzing these results presented in relation to the energy reports regarding the adaptation of turbines to the specific requirements, the conclusions are as follows:

- it is necessary a better corellation of performances of the two machines (turbine and generator) with the objective of maximizing the product ($C_p * \eta_G$).

- the size of turbine's area exposed, with the condition of complying to the restrictions imposed.

- optimal management of the aggregate through controlling the speed (variable for C_{Pmax} and constant for limitation of power).

- verification of energy calculation for the favourable variability of the location's offer (const. $k = 0{,}73$).

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