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The Evaluation of the Functional Performances for Microhydroaggregates Endowed with Asynchronous Generators by Vibrations Measurements

By this study we aim to establish some methodologies for the estimation of performances for microhydroaggregates by limiting the power according to the vibrations level.

Keywords: *asynchronous generator, vibration, turbine, active power, reactive power.*

1. Introduction

The present paper aims at presenting a methodology of experimental determination of real operation performances for a microhydroelectric power station endowed with a Banki turbine and horizontal asynchronous generator. The experimental researches were achieved at the microhydroelectric power station Poiana 2.

The microhydroelectric power station Poiana 2 is endowed with a hydroaggregate with Banki turbine having the following nominal data:

- Nominal output 270kW;
- Voltage rating 400V;
- Power factor 0.85;
- Rated speed 1000 rpm.

2. Results of measurements

On the occasion of the first start-up, a series of preliminary tests were performed in which we checked both the microhydroaggregate technical conditions of operation and its mechanic and electric performances for different charges of active loads of the generator connected to the network.

The following experimental tests were performed:

2.1. Tests in idle-running regime at MHC Poiana 2

The generator being driven by rated speed, the vibrations were checked at the turbine and generator level recording a low value of these ones, the mycrohydroaggregate getting the score „Very well”.

The flow consumed by the turbine is very small, a fact which indicates a very small level of mechanic losses in the turbine and generator. The results of the measurements are given in fig. 1. The vibrations were recorded according to the radial directions V1rms, vertical direction V2rms and axial direction V3rms measured at the turbine level.

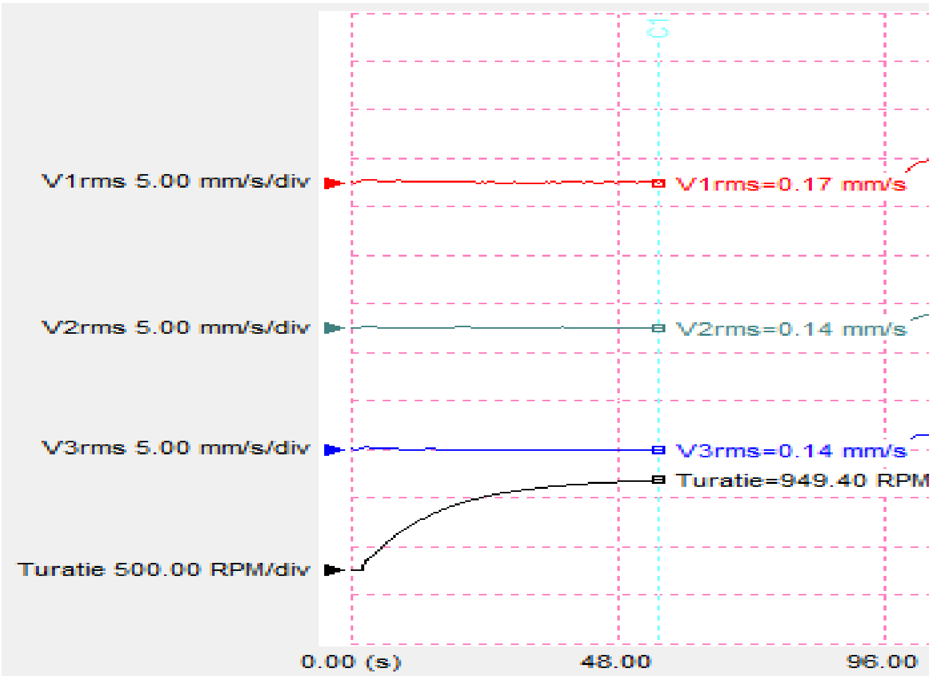

Figure 1. The variation of the parametres for the process of idle running without connecting the generator to a network in MHC Poiana 2

2.2. Tests in load running regime at MHC Poiana 2

In the conditions when the generator was driven at rated speed and then connected to the network, the generator was charged with active power by the opening of the valve of water input in the turbine.

For different values of the opening of the turbine valve, different values of the active flow were obtained in the network and of the reactive power input in the network.

We have recorded vibrations at the turbine level in three directions: horizontal, vertical and axial, in the process of starting up and loading for different values of the valve opening.

2.3. The starting under load with an opening of the valve of 90% at MHC Poiana 2

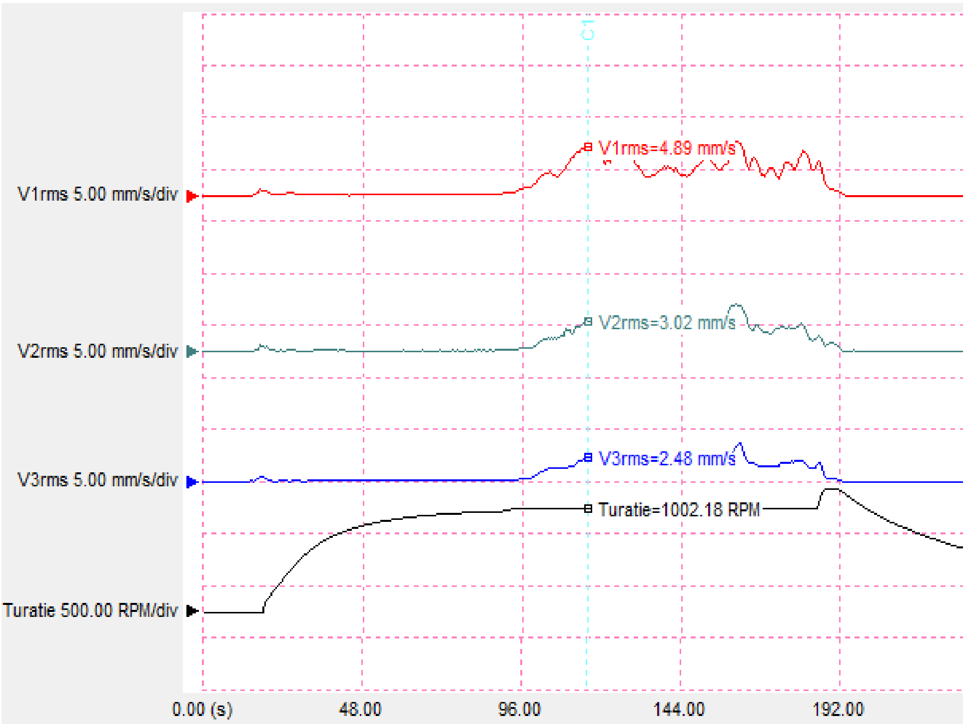

Figure 2. The variation of the vibrations in transitory regime of starting-up and stabilized regime with the valve of 90% at MHC Poiana 2

For the operation under load, from the point of view of vibrations the power is limited at 90%, when the vibrations reach maximal values admitted for these generators.

The results of the tests under load of the microhydroaggregate for different openings of the valve for water supply of the turbine are given in table 1.

Table 1.

Crt. no.	U [V]	I [A]	P [kW]	Q [kVAR]	H [m]	cosφ	The opening of the valve [%]
1	406	163	6	115	667	0.052	3
2	407	165	10	116	656	0.085	4
3	406	167	17	117	649	0.144	6
4	407	171	28	118	653	0.232	11
5	406	186	52	120	652	0.397	20
6	408	212	84	125	655	0.560	30
7	407	287	149	138	640	0.736	50
8	408	355	200	150	625	0.797	75
9	409	395	233	203	673	0.832	90

Based on the values of the table we represent graphically:

- the variation of the power I according to the active power P discharged in the network Figure 3.
- the variation of the reactive power Q consumed according to the active power P discharged in the network Figure 4.
- the variation of the active power P and the reactive power Q according to the opening of the blade Figure 5.

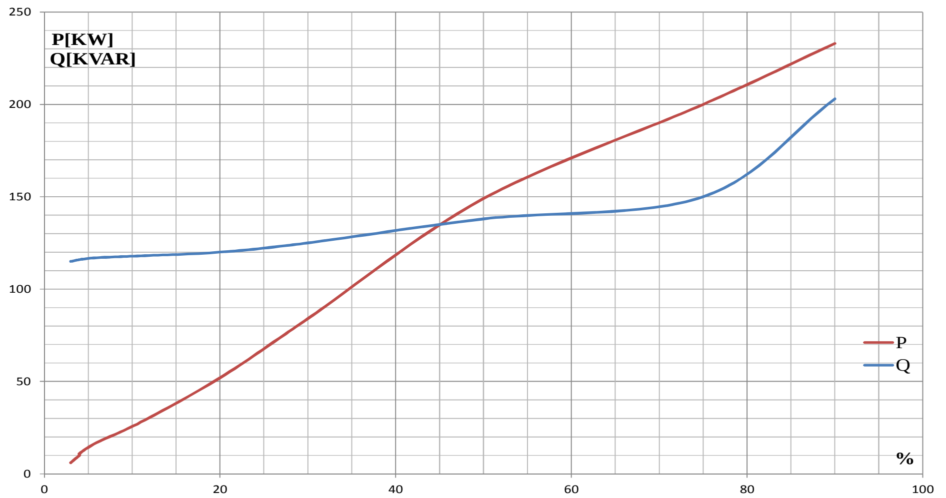

Figure 3. The active and reactive power according to the opening of the valve at MHC Poiana 2

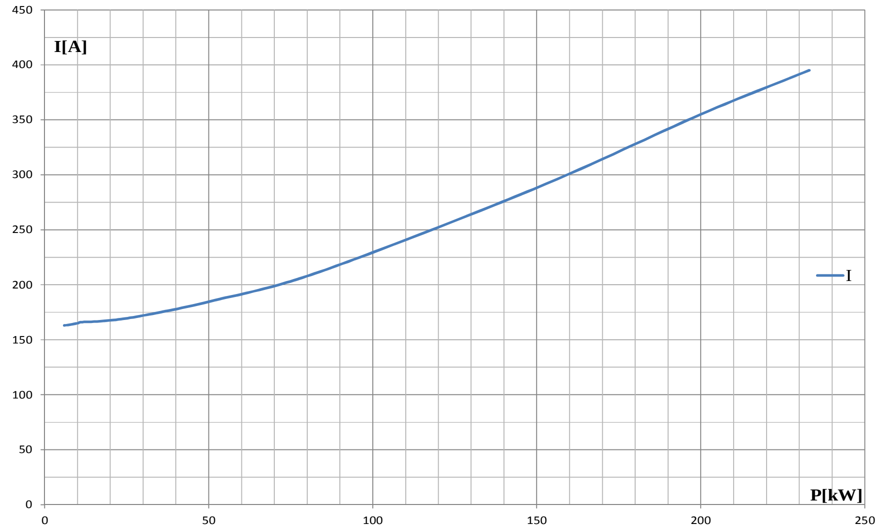

Figure 4. The variation of the stator power according to the active power at MHC Poiana 2

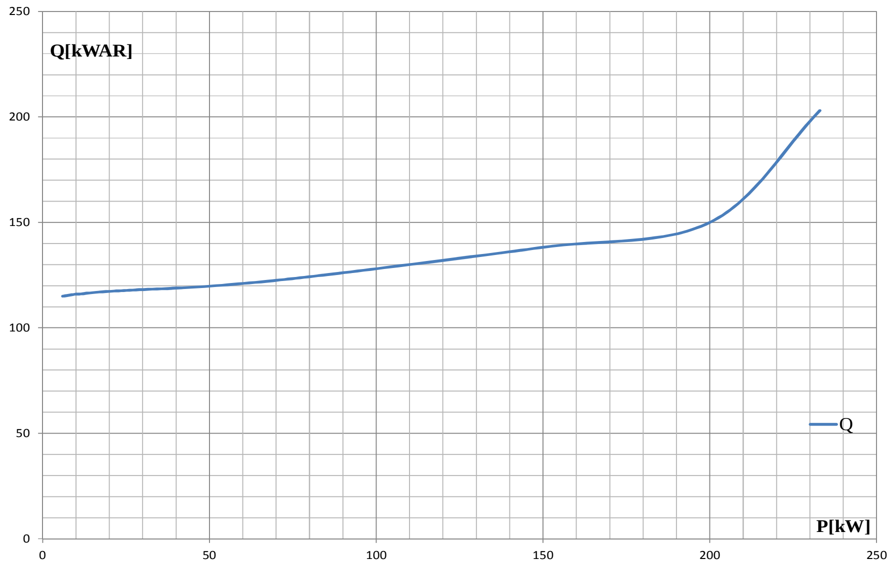

Figure 5. The variation of reactive power according to the active power at MHC Poiana 2

2.4. Checking the performances of operation in the transitory regime of putting off load at MHC Poiana 2

In the conditions in which the generator is linked to a network and loaded at a certain active power, we switched on the switch connecting to the network recording the following values which characterise the transitory regime of putting off load.

- The speed/revolution of the rotor n;
- the vibrations of the axial radial bearing on the horizontal direction+x V1rms;
- the vibrations of the axial radial bearing on the radial direction+y V2rms;
- the vibrations of the radial bearing on the direction-x V3rms;

The tests for putting off load were achieved for an opening of the valve of 25%.

The generator being connected to a network and the valve opened at 25% was put off load with the recording of all parametres which characterise this process.

The measured values are presented in Table 2.

Table 2.

Time	Speed	V1rms	V2rms	V3rms
[s]	[RPM]	[mm/s]	[mm/s]	[mm/s]
1	1001.85	1001.85	2.47	2.41
2	1001.9	1001.9	2.49	2.43
3	1029.86	1029.86	2.56	3.16
4	1286.53	1286.53	5.23	4.2
5	1468.3	1468.3	5.47	3.97
6	1523.05	1523.05	4.27	2.71
7	1535.82	1535.82	3.32	1.5
8	1514.89	1514.89	1.91	1.03
9	1475.96	1475.96	1.64	0.91
10	1444.92	1444.92	1.43	0.81
11	1417.56	1417.56	0.77	0.41
12	1388.86	1388.86	0.27	0.15
13	1358.28	1358.28	0.14	0.12
14	1326.44	1326.44	0.13	0.12
15	1296.96	1296.96	0.14	0.1
Val.max	1535.82	5.47	4.2	3.97

The graphic representation of the form of variation in time of the recorded values is given in figure 6.

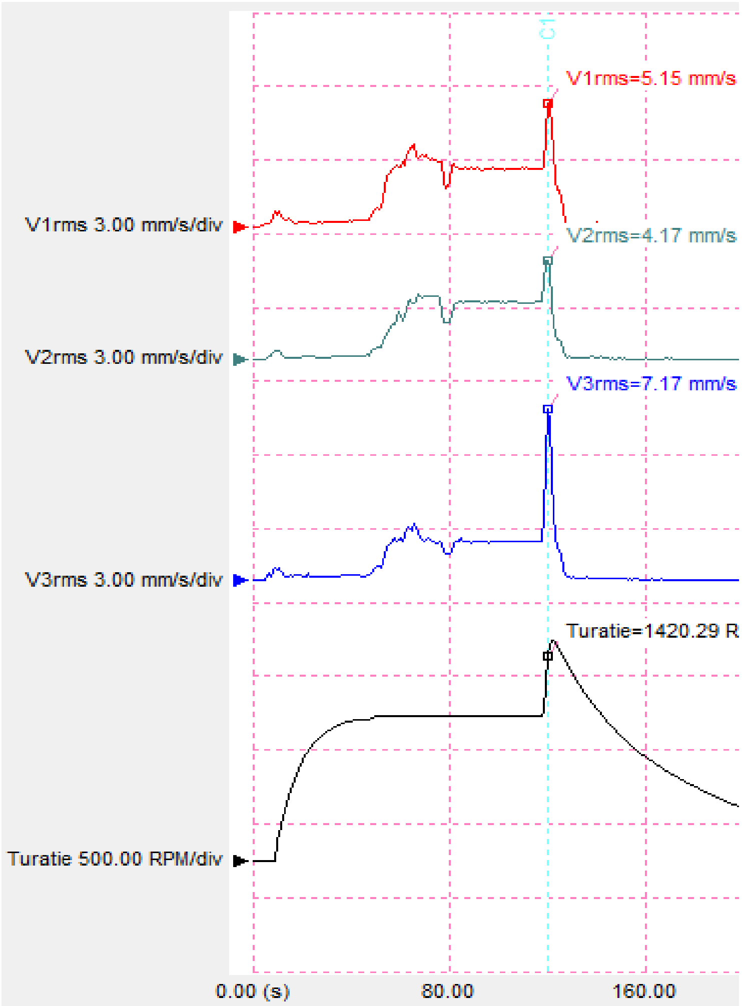

Figure 6. Putting off load with the valve opened at 25% at MHC Poiana 2

From the graphic representation, the following maximal values result and they characterise the transitory regime of putting off load:

Maximal speed n_{max}= 1535.82 which represents 153,5% from the rated speed

The maximal vibrations are:

- V1= 5.47 at the bearing opposed to the turbine;
- V2= 4.2 at the bearing to the turbine;
- V3= 9.97 at the turbine bearing.

3. Conclusions

The microhydroaggregate in CHE Poiana 2 with asynchronous generator ensures the power foreseen in the documentation but in a lower working capacity than the estimated one.

The asynchronous generator functions with vibrations which depend on the level of the valve opening, thus, on the charge of the generator a fact which constitutes an important drawback especially for the transitory regimes of putting off load when the vibrations can reach dangerous values.

The experimental tests presented in this paper represent an important database which constitutes a bulk of useful information for researches connected to the determination of real operation performances of microhydroaggregates.

The methodology proposed for the determination of performances from the analysis of the spectra of the bearing vibrations was an efficient method to determine the real performances without being necessary other detailed tests, tests which are very often impossible to be achieved.

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