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Monitoring of Selected Energy Parameters in the Supply System of a Model Vibratory Unit

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Abstract

The article presents the results of selected energy parameters calculations, carried out for the recorded values of instantaneous voltages and currents in the three-phase power supply of the model vibratory unit. The parameters were the values of active and apparent power taken from the drive consisting of two electric motors supplied by the inverter for selected frequency settings and directly from the power grid. In addition, calculations of tgφ power factor values were made to evaluate the compensation of reactive power consumption in the tested power systems. Measurements and calculations lead to the conclusion that if the frequency of the inverter output voltage rises, the active and apparent power consumed by the model vibratory drive unit increases. The active and apparent power for setting the output frequency of the inverter from 50 Hz was less than the active and apparent power taken by the model vibratory unit that was powered directly from the power grid. The power factor tgφ in the power supply system was approximately 6, except one case (f = 30 Hz).

Keywords: Model of vibratory unit, Selected energy parameters, Active and apparent power consumption

1. Introduction

Vibration devices are used, inter alia, in the processes of mechanical regeneration of used molding sands [1-5]. To test the effectiveness of such vibration device, the drive system consisting of two electrovibrators [6] was powered by a frequency inverter [7]. The power demand characteristics of the model vibration unit as a function of the frequency of the output voltage from the inverter were registered by the instantaneous voltage and current values recorder, which was described in detail, especially in the articles [8]. Figure 1 presents the measuring system diagram, while Figure 2 shows the test bench. The recorded instantaneous values of voltages and currents in the three-phase power supply system were used to calculate the active and apparent power values and the power factor tgφ [9-13].

The results of the research presented in this paper refer to the work of a model vibratory device with a nominal load of 21 kg of spent molding sand.

2. Results of selected energy parameters calculations

Figure 3 shows the recorder's software window, which includes graphs of changes in instantaneous voltages and currents in the given measurement time-boxed window for a frequency inverter set at a frequency of 30 Hz.

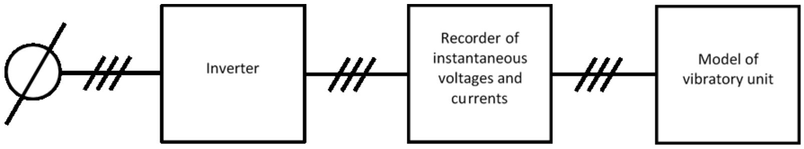

Fig. 1. The recording system of instantaneous voltages and currents values between inverter and model vibratory unit

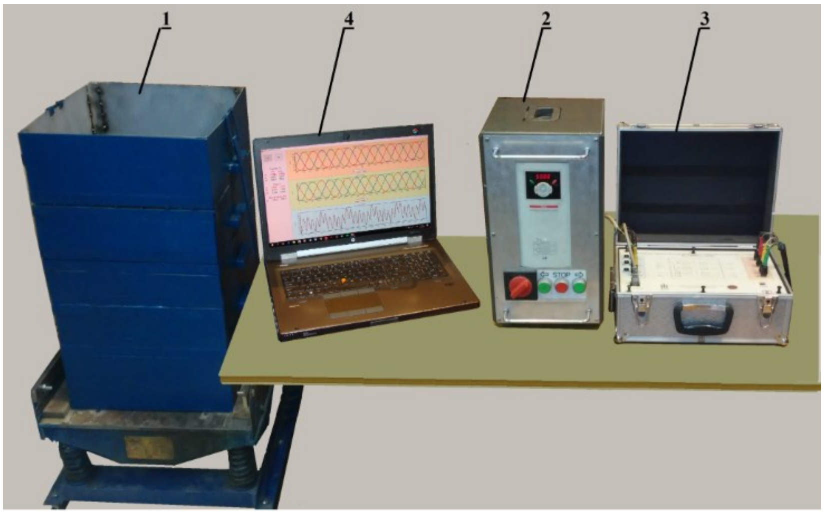

Fig. 2. The research system: 1 – model vibratory unit, 2 – inverter, 3 – instantaneous voltages and currents values recorder, 4 – computer with recorder's software

The calculation of active, passive and apparent power values was made for the inverter output frequency settings of 30 Hz, 40 Hz, 50 Hz and 60 Hz respectively (Figure 3-6). In addition, the course of changes in the value of the power factor tgφ was determined. In order to calculate the parameters' values, algorithms of digital conversion of signals were used, which included the set of values of instantaneous voltages and currents in each phase of feeding the motors of the examined system [14-15].

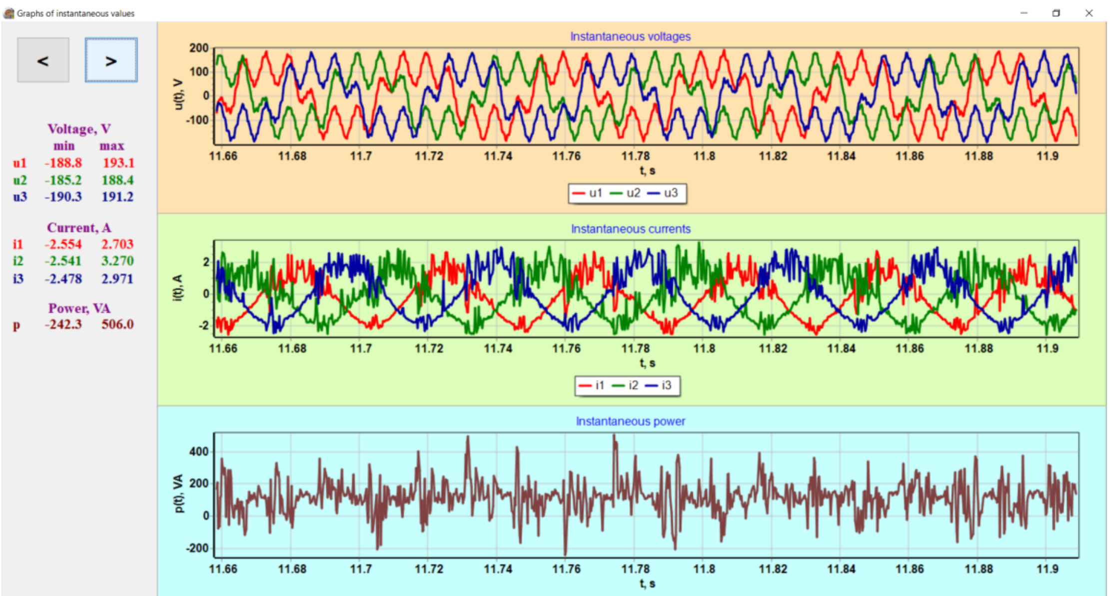

Fig. 3. The recorder's software window, which includes graphs of changes in instantaneous voltages and currents in the given measurement time-boxed window for a frequency inverter set at a frequency of 30 Hz

The duration of the measurement process of instantaneous voltages and currents included the moment of switching on the vibration device unit, its stable work and the deceleration of the drive motors, after the supply voltage was switched off. The frequency inverter was set only at the output voltage of whereas the other parameters were set as default. In addition to the graphs, the figure below shows the minimum and maximum values of the effective voltages and currents in each phase of the feed system.

Fig. 4. The diagram of active, passive and apparent power values and tgφ power factor in the supply system of a model vibratory unit for the inverter output frequency set at 30 Hz

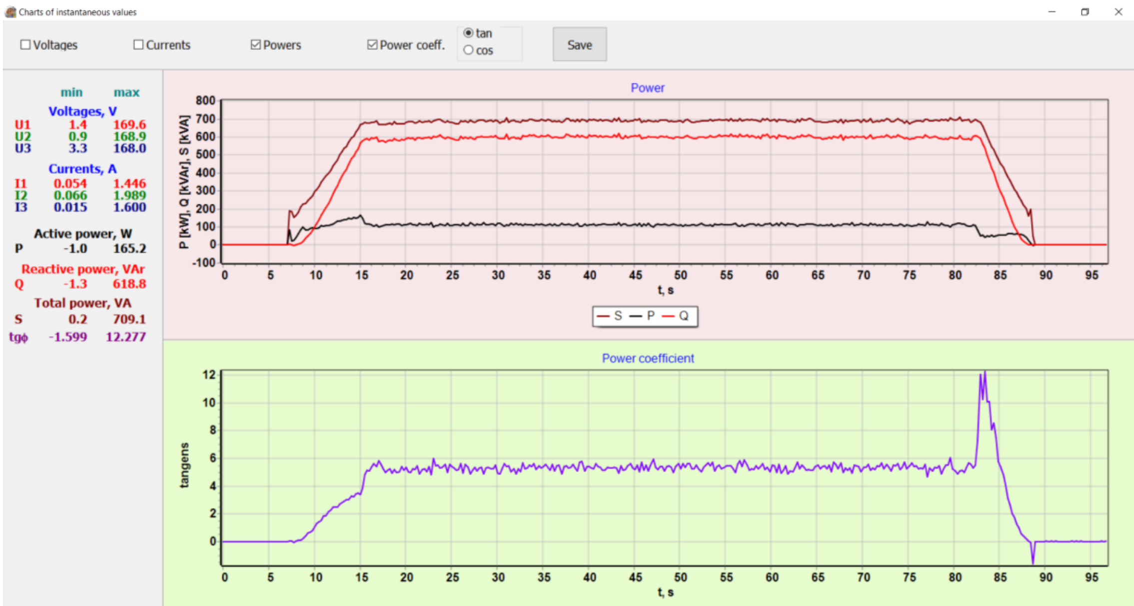

Fig. 5. The diagram of active, passive and apparent power values and tgφ power factor in the supply system of a model vibratory unit for the inverter output frequency set at 40 Hz

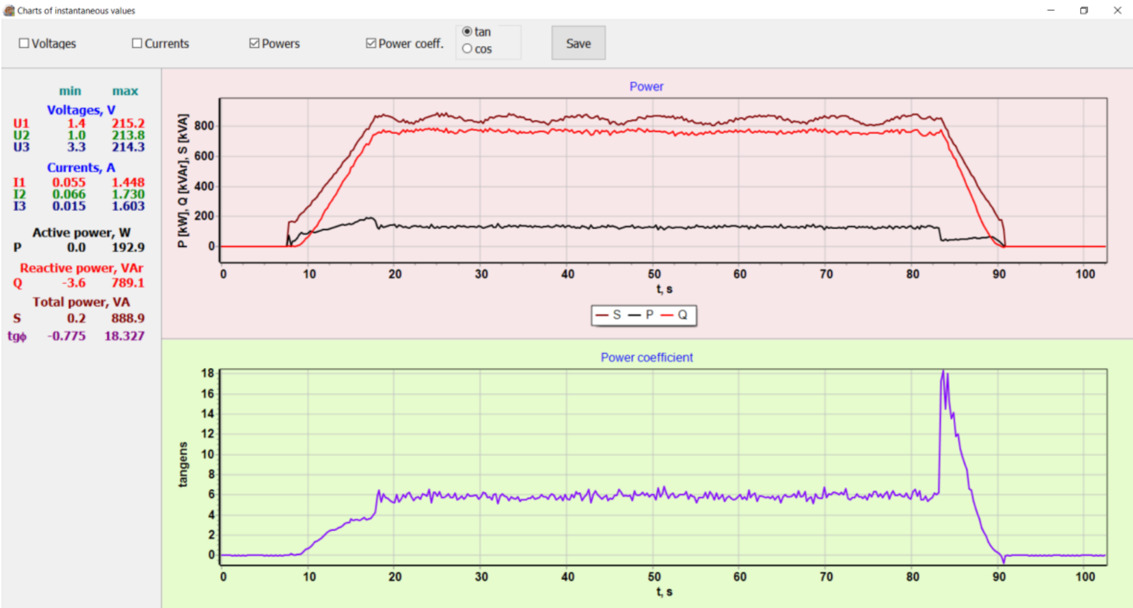

Fig. 6. The diagram of active, passive and apparent power values and tgφ power factor in the supply system of a model vibratory unit for the inverter output frequency set at 50 Hz

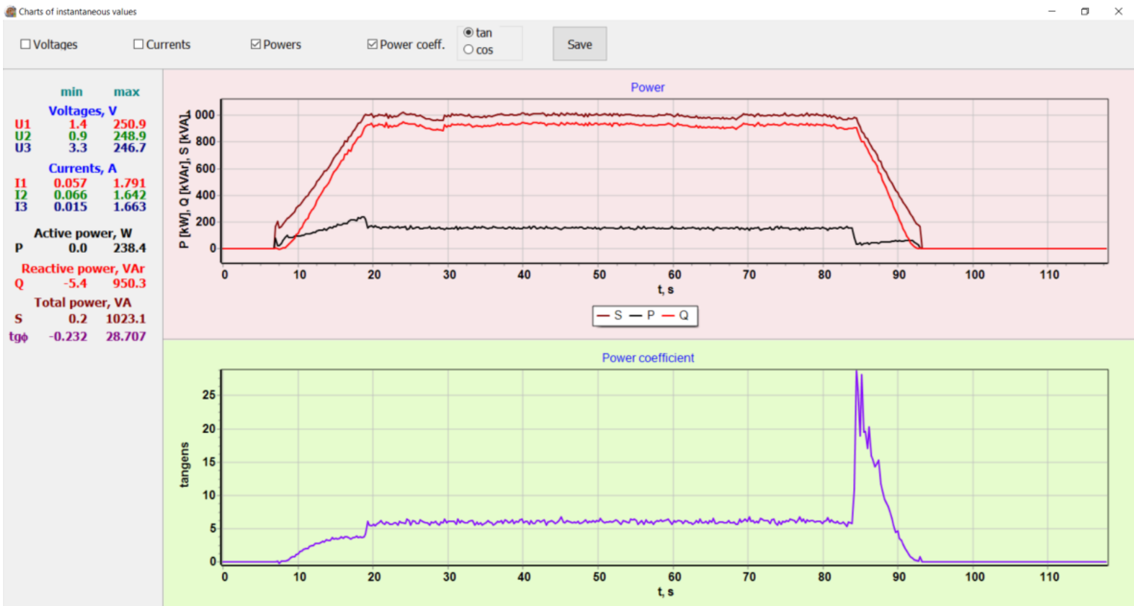

Fig. 7. The diagram of active, passive and apparent power values and tgφ power factor in the supply system of a model vibratory unit for the inverter output frequency set at 60 Hz

As shown in Figures 4 ÷ 7, the increase in the frequency of the supply voltage causes the increase in the value of the active and apparent power. The value of the power factor tgφ for the frequency of 30 Hz is around 4.1 (cosφ≈0,24), for 40 Hz tgφ≈5,2 (cosφ≈0,19) and for frequencies 50 and 60 Hz the value tgφ≈6,0 (cosφ≈0,16). This means that in the feed system of the motors in the vibration device units, the compensation of reactive power consumption is incorrect. The nominal value of the power factor cosφ for each motor according to the manufacturer is 0.88, which may mean that the motors are underloaded.

In order to compare the value of active and apparent power consumption in supply system of a model vibratory unit supplied by the inverter and directly from the power grid (50 Hz), the test was performed in the unit without the inverter (Figure 8)

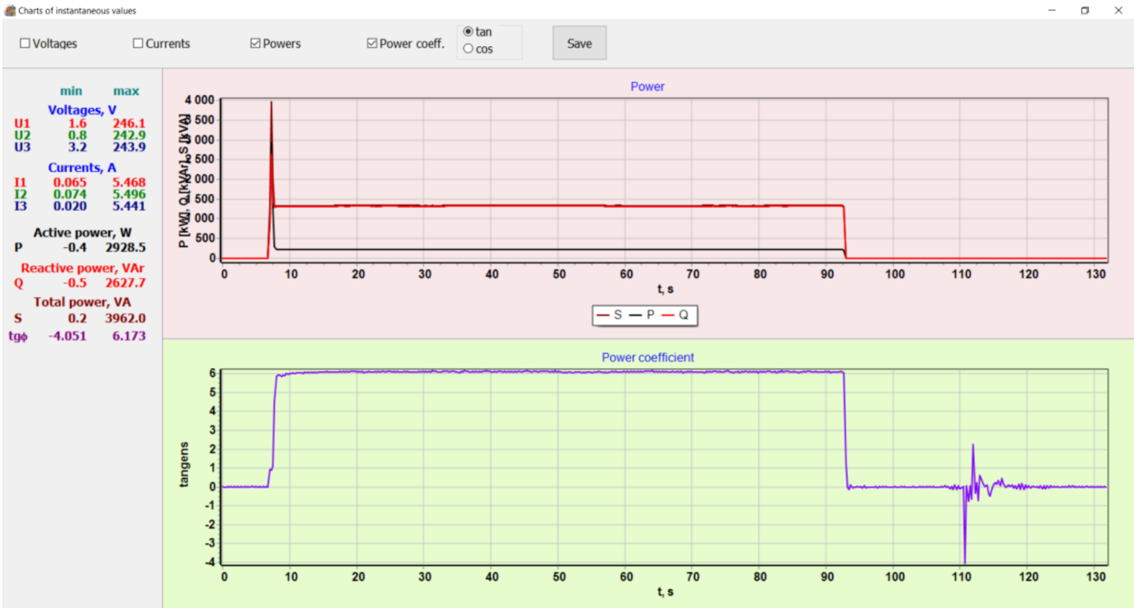

Fig. 8. The diagram of changes in active, passive, apparent power consumption and tgφ power factor in supply system of a model vibratory unit without the inverter at the frequency of 50 Hz

Figure 9 presents the overall diagram of changes in active and apparent power consumption of supply system of model vibratory unit with and without the inverter. The analysis of this graph reveals that for standard inverter settings, as well as for 50 Hz, the active and apparent power values are lower than the values of the test system supplied directly from the power grid. The value of the power factor tgφ in case of the unit supplied directly from the power grid is around 6.0, comparable to the value of this factor in case of the unit supplied by the inverter set at 50 Hz and 60 Hz.

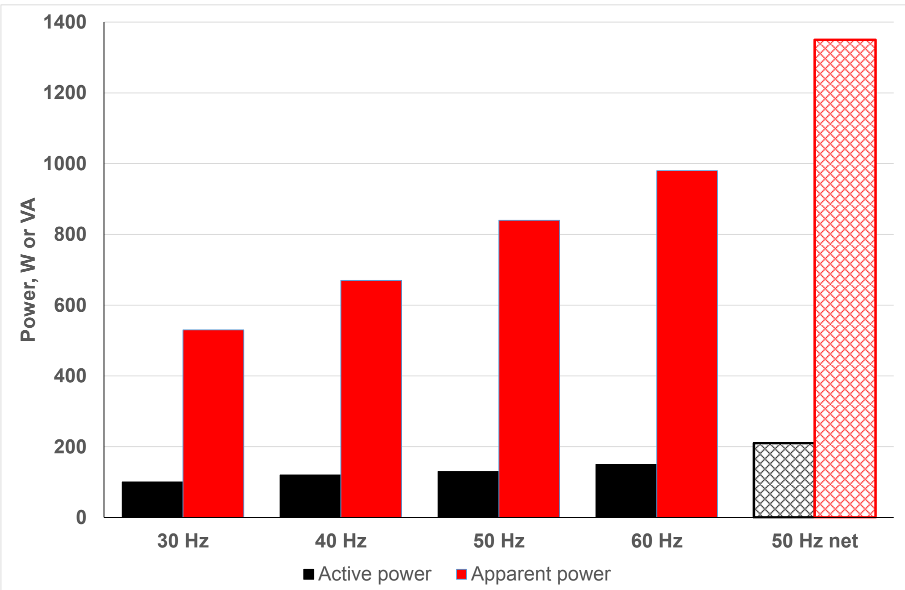

Fig. 9. Diagram of changes in active and apparent power consumption of supply system of model vibratory unit with and without the inverter

3. Summary

Taking into consideration of the results of measurements and calculations of given energy parameters (active passive and apparent power consumption and the power factor tgφ), it can be concluded that for the standard settings of the inverter parameters of the drive motors in the model vibration unit, the value of power consumed by this drive depends on the voltage output from the inverter and is lower than the value of the power consumed by the system fed directly from the power grid. The measured values of instantaneous voltages and currents were used to calculate the values of active, passive and apparent power values consumed by the drive motors in the model vibration unit. The obtained results of the calculations broaden the knowledge of the vibration units and, together with the results of research on regeneration of used molding sand, can be a set of operating parameters in the research of mechanical regenerators.

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