Power and environmental disturbances of the production process for vegetal bio-stimulants

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Abstract. The paperwork aims to identify and find methods to reduce power pollution, by noise and dust released in atmosphere. According to operation diagram of the installation there are items (electrical equipment and mechanical systems), that during operation under normal mode cause power pollution like noise with parameters that may exceed the legal limits. Damage of quality indicators of the power can be avoided by continuous monitoring and actions taken in real time. Many organizations underestimate the impact of power quality damage, which speaking about time of unplanned non-operation, lost production, lost data and premature equipment damage, it can be significant. The problems also lead to big invoices for electricity and even penalties for “pollution” of power supply network. To check the framing within admitted limits, acoustically speaking, an experimental research was started on the level of acoustic pressure produced during operation of the installation. Considering the installation for bio-stimulant obtaining is using vegetal waste as raw material, during their chopping stage and transport to the bin intended for maceration there is the possibility of releasing a quantity of fine powders into internal atmosphere. Under these circumstances, this study is checking the framing within admitted limits, required by laws, of the concentration of powders released into atmosphere during operation of an installation that produces vegetal bio-stimulants from after-cropping agricultural waste and medicinal herbs.

1. Presentation of technological process for production of vegetal bio-stimulants
Vegetal waste is the most accessible and the cheapest source of organic matter, its chemical composition including all nutrients needed by plants for balanced raising and development. By chopping the vegetal waste and their inclusion in the soil, the physical-chemical indicators of soil fertility can be improved. The current agricultural technologies recommend use of these practices for vegetal waste chopping and inclusion in the soil, as well as using green fertilizers to improve soil fertility condition.
The paperwork is the result of research within the project PN-III-P2-2.1-PTE-2016-0073, as to production of vegetal bio-stimulants obtained by chopping and bio-degradation of agricultural organic waste.
The process flow designed for obtaining vegetal bio-stimulants from agricultural waste includes the following process steps [14]:
- Transport by a lift truck the agricultural waste which are stored on a concrete platform, located at 120 m distance from bio-degradation pilot station;
- Weighing the post-cropping agricultural waste bales and loading them on a conveying belt;
- Chopping the waste by means of the chopper grinder, that sends the load through the cyclone directly into stain less steel bin for bio-degradation;
- Addition of bioinoculant of lignocellulolytic micro-organisms and water, to initiate the aerobic fermentation;
- Homogenizing and monitoring of physical-chemical indicators (temperature, pH, humidity) of aerobic bio-degradation, for 7 days;
- Addition of hot water and medicinal herbs extract with anti-fungi and anti-bacterial effect, to stop the aerobic bio-degradation;
- Homogenizing and monitoring of indicators for another 7 days;
- Separation of liquid part from the solid one, by evacuating the mixture in the bin by means of bucket conveyor and compost pressing;
- Bagging of solid organic material, by weighing, sealing and labeling of bags;
- Bottling of liquid bio-stimulant and labeling the cans.

2. Equipment and drives

2.1. Process flow diagram
The process flow diagram and component parts of the bio-degradation platform are specified in figure 1 and table 1, together with their role within the process flow to obtain the bio-stimulants [1].

![Figure 1. Process flow diagram.](image-url)
Table 1. Component equipment within industrial micro-pilot station for bio-degradation of post-cropping agricultural waste and obtaining of vegetal bio-stimulants.

| Designation       | Role in the process flow                                                                 |
|-------------------|------------------------------------------------------------------------------------------|
| Industrial scale  | Weighing the bales with agricultural waste before chopping, as per the formula for obtaining the bio-stimulants. |
| Conveyor belt     | Conveyor belt’s role is to convey the bales with waste to the chopper grinder, with a constant preset speed. |
| Chopper grinder   | The chopper grinder takes over the agricultural waste from the belt and chops them to sizes among 0.5 and 1 cm. |
| De-dusting cyclone| The de-dusting cyclone takes over the vegetal chopped material from the grinder and leads it to the stainless steel bin wherein the bio-degradation process takes place. |
| Mixture basin     | Mixture basin is stainless and has the role of keeping the compost for entire period of bio-degradation. |
| Mixer             | The mixer homogenizes the compost during entire bio-degradation period.                   |
| Scraper           | The scraper pushes the compost to the outlet hole of the bio-degradation bin, that carry the semi-fluid material to the bucket elevator. |
Heatig plant
The heating plant maintains the desired temperature in the room and produces hot water for the second stage of compost bio-degradation.

Hot water Boiler
The hot water boiler has 1000 l volume and brings water to the temperature of 70°C, needed to prepare the medicinal herbs infusion and to stop fermentation.

pH Edge sensor
The pH Edge Sensor permanently measures the temperature, pH and electrical conductivity, data that are stored in device’s memory then taken over in the laptop, for continuous monitoring of these indicators.

Lysimeters set
By means of lysimeters, liquid samples are taken from the bio-degradation platform, for lab analysis.

Bucket conveyor
The bucket conveyor takes over the liquid and solid material resulted from the fermentation basin and takes it to the press.

Worm press
The worm press takes over the material from bucket conveyor and squeeze it, the result being liquid part (bio-stimulant – BIOSTIM) separation from solid (organic substrate – BRAISOL) part.

Liquid product pump
The pump takes the liquid from the press to the storage basin.
3. Assessment of acoustic pollution level and the concentration of powders released in the atmosphere during operation of the installation for obtaining the bio-stimulant

3.1. Assessment of acoustic pollution level
According to operation diagram of the installation, there are items (mechanical systems) that during operation under normal mode generate noise whose parameters may exceed the legal limit values. To check framing within admitted limits, acoustically speaking, it was proceeded to experimental research on sound pressure level produced during operation of the installation [2].

For experimental assessment of sound level generated by the installation intended for obtaining vegetal bio-stimulants, the following steps were followed:
- identification of noise sources with pollution potential,
- identification of workstations exposed to noise,
- assessment of noise sources,
- measurement of noise level.

After investigating the technological parameters of the noise producing systems, the conclusion was reached that the chopper is the item with the greatest risk of acoustic pollution [3,4]. As the noise produced by chopper can have impact on entire personnel in the room where it is located, two sets of sound measurements have been done as follows [5]:
- the first set of measurements was done around the chopper and conveyor belt feeding it, as per figure 2.a.;
- the second set of measurements was done on entire room wherein the targeted object is located, as per figure 2.b.
Experimental determination of the sound pressure level was performed by using the sound-level meter Testo 815, class 2, which allows reading only instant values.

3.1.1. The obtained results
Sound pressure level values for the first set of sound measurements are shown in table 2.

| No. | Measurement point | Sound pressure level, $L_p$ [dB(A)] |
|-----|-------------------|------------------------------------|
| 1   | 1                 | 94.1                               |
| 2   | 2                 | 94.3                               |
| 3   | 3                 | 97.7                               |
| 4   | 4                 | 98.1                               |
| 5   | 5                 | 93.4                               |
| 6   | 6                 | 93.0                               |
| 7   | 7                 | 92.8                               |
| 8   | 8                 | 98.2                               |
| 9   | 9                 | 95.1                               |

On the basis of acoustic pressure level values obtained further to the second set of acoustic measurements, a sound map was done in order to identify the areas inside the industrial room where the maximum admitted limit value of the acoustic pressure level is exceeded, figure 3 and 4 [7].

Figure 2. Points where the level of sound pressure was determined.

a. around the chopper
b. inside entire room
It was possible to draw up this map as the operation mode of the installation is not variable as to the produced noise. It has to be mentioned that the sound pressure level of the background noise had the value of 46.5 dB(A) which is not requiring corrections to the experimentally determined values.

3.2. Assessment of the dust concentration level released in the atmosphere

Considering the installation for obtaining the bio-stimulant use vegetal waste as raw materials, in their chopping stage and transportation to the bin intended for maceration there is the possibility of releasing a small quantity of fine dust into the inner atmosphere [6].

In this context, the main objective of this study was to verify framing within admitted limits, legally required, of the concentration of dust released in atmosphere during operation of an installation for obtaining the vegetal bio-stimulants from post-cropping agricultural waste and medicinal herbs.

Concentration of dust in atmosphere was determined in the points specified in figure 2.b and around the mixing basin, by using portable device of the type Haz - Dust HD 1100.

This precision device was designed for monitoring the quality of breathed air the size of counted particles being among: 0.1 - 50 µm.

3.2.1. Obtained results

Concentration values were determined for two distinct situations, meaning: before starting the process of chopping the vegetal waste and during the said process. The values determined according to points established in figure 2.b were mathematically interpolated and represented as a map in bi-dimensional and tri-dimensional forms. Figure 5 and 6 show the maps for particles concentration in the atmosphere before starting the chopping process, in tri-dimensional respectively bi-dimensional forms [7].
Figure 7 and 8 show the maps for particles concentration in the atmosphere during the chopping process, in tri-dimensional respectively bi-dimensional forms.

![Figure 7](image1.png)  ![Figure 8](image2.png)

**Figure 7.** Dust concentration in suspension during chopping the vegetal waste (3D representation).

**Figure 8.** Dust concentration in suspension during chopping the vegetal waste (2D representation).

The concentrations determ ined in the four corners of the mixing basin, before and during chopping-transport process, are shown in table 3 [8,9].

| Measurement moment | Measurement point | Dust concentration [mg/m³] | Measurement moment | Measurement point | Dust concentration [mg/m³] |
|-------------------|-------------------|----------------------------|-------------------|-------------------|---------------------------|
| Before chopping process | 1 | 0.59 | During chopping process | 1 | 10.42 |
| | 2 | 0.63 | | 2 | 10.21 |
| | 3 | 0.61 | | 3 | 4.79 |
| | 4 | 0.59 | | 4 | 10.79 |

3.3. **Power pollution**

For assessment and monitoring of power pollution inserted by electrical drive of the installation for production of bio-stimulant, the requirement coefficient method was used [10,11,12].

Further to using the above-mentioned method the electric drive structure resulted according to the data in table 4 [13,14].

| Technological process | Drive | Operation time |
|-----------------------|-------|----------------|
| Biomass transportation | Heat engine | - |
| Biomass elevation | Heat engine | 0.2 hours |
| Biomass transportation on conveyor belt | Asynchronous motor P=2.2 kW | 1 hour |
| Chopping the biomass | Asynchronous motor P=15 kW | 1 hour |
| Particle separation | Asynchronous motor (chopper) | 1 hour |
| Technological water heating | P=55kW | 2 hours |
Water pumping: Asynchronous motor P=1.1 kW 2 ore (1 hour/day)
Compost mixing: Asynchronous motor P=1.1 kW 14 hours
Compost evicting: Asynchronous motor P=0.44 kW 14 hours
Compost elevating: Asynchronous motor P=1.1 kW 1 hour
Compost pressing: Asynchronous motor P=3.6 kW 1 hour
Biostimulator evacuation: Asynchronous motor P=1.2 kW 0.5 hour
Biostimulator bottling: Asynchronous motor P=1.2 kW 2 hours
Solid part packing: Manual

This way, both the power consumption per each and every consumer and total power consumption of the experimental installation are determined (table 5)[15,16,17,23].

Table 5. Total consumed power per days, per one process cycle for production of vegetal bio-stimulant.

| Day no. | Consumer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Power [kWh] |
|---------|----------|---|---|---|---|---|---|---|---|---|----|----|----|----|---|---------|
| Lift truck | 5.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 5.1 |
| Conveyor belt | 2.18 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.18 |
| Chopper | 6.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | 6.2 |
| Blower (Cyclone) | 8.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | 8.5 |
| Heating plant | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 98 |
| CT pump | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Mixer | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 14.84 |
| Scrapper | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.42 |
| Bucket elevator | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.05 |
| Worm press | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3.55 |
| Outlet basin pump | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.6 |
| Bottling station | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.37 |
| **Power [kWh]** | 23.04 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 101.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | **144.81** |

Further to monitoring process for the total power consumption per one complete process cycle for production of vegetal bio-stimulant instant values of characteristic sizes were recorded, incrementing period chosen was 2 seconds, and the resulted graphs have the shapes in figure 9[18,19,20].
Figure 9. Analysis of power consumption and power.
The power measured in kWh is the sum of power measurements taken at 2 seconds time periods. The summing values of measured power consumption are found in table 5 [21,23], for all power consumers belonging to balance contour of the experimental installation for production of vegetal bio-stimulants [22,23].

Figure 10. Analysis of system’s disturbances.

4. Conclusions

Analysing the obtained results when monitoring the noise level and taking into account the applicable normatives (art. 594 in NGPM/2002) the maximum limit value of sound pressure level admitted at job sites for daily exposure to noise is 87 dB(A). In relation to this limit value, for both sets of experimental determinations of the sound pressure level exceedings are noticed.

Considering the noticed exceedings, it is required to apply a solution intended to diminish the sound pressure level transmitted to hearing system of the serving personnel. In this respect, a viable solution is wearing specific safety equipment, such as plugs that are inserted into hearing channel, these being able to achieve a 30 dB decrement.
As to analysis and monitoring of the released dust concentration level, comparison is made between the data measured in the installation and those required by safety norms, that establish the admitted limit value of the grains dust existing in the inhaled air is 4mg/m$^3$. In relation to this admitted value, exceedings are noticed nearby the mixture bin during chopping and transport activities. Remedy of this situation is done by wearing dust protection masks by the serving personnel, only during the process stages wherein exceedings were highlighted.

In balance condition identified in this power study, the value and quality of electric power are measured by means of a portable system for acquiring data and with adequate soft for processing these data on PC. This is a „Chauvin Arnoux C.A 8336 Power Analyser” purchased from project’s funds. Analysing the graphs in figure 10 it is noticed that during one process cycle, the disturbances inserted by electrical consumers of the installation itself have no influence on the quality of the power in the network.

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