



Statement of Verification

EU Environmental Technology Verification Pilot Programme

Technology Type:	Biostabilization and composting of organic waste	
Technology Name:	BIO-COM SYSTEM	
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1. Technology description

The Bio-Com system is technology used for aerobic composting of mixed municipal waste, thereby reducing the volume and biodegradability of waste before its disposal, which is required by the European Landfill Directive. The whole installation is modular and can easily adapt if the incoming waste stream changes.

The composting process is realized in low-cost foil reactors with the use of forced aeration. Feedstock containing mixed and fragmented organic material is loaded into the containment vessel by a special machine (bagging machine) that lies inside the reactor's three perforated pipes: two on the bottom for aeration and one at the top of the reactor for collecting and driving air out. The two lower aeration pipes are connected to an electric blower, while the upper one is connected to an outflow pipe leading process air to the bio-filter. Two or three wireless thermometers are installed immediately after filling the reactors and the values are automatically read during the whole process.

Blowers periodically blow fresh air, which passes dynamically through the feedstock, delivering oxygen necessary for the process. The rhythm and intensity of blowing is controlled by dedicated software, which can work in a fully automatic mode or can be switched to manual mode.

Innovative solutions that set the Bio-Com system apart from other alternative technologies with similar purposes are: an aeration system including automatically controlled static saturation of the feedstock; very effective filtering system of the process air; a bagging machine laying three pipes inside the reactor and advance software for controlling the process and archiving parameters.

2. Application

The Bio-Com system is used for the biological treatment of mixed and fragmented organic material from 0 to 80 mm in aerobic conditions with the aim of obtaining stable material suitable for storage (stabilizat – qualified as waste with code 19 05 99). The process allows emissions of unwanted odours and greenhouse gases to be reduced.

2.1. Matrix

Verification was conducted on mixed municipal waste – fraction from 0 to 80 mm, which is potentially biodegradable. Additional parameters for matrix are specified in chapter 2.3.

2.2. Purpose

The purpose of the Bio-Com system is to reduce the volume and biodegradability of waste and obtaining stable material suitable for disposal by using aerobic composting processes and with the maximal possible reduction in emissions of odours and process gasses into the environment.

2.3. Conditions of operation and use

Conditions for the operation and use are specified in relevant manuals: Bio-Com Manual, BioComSoft Manual, GreenBagger Manual.

Waste treated in Bio-Com system has to meet specified conditions like: size (fraction 0-80 mm), temperature (higher than 9°C), AT₄ (above 25 mg/g), humidity (above 35%), C/N ratio (between 20 and 35).

2.4. Verification parameters definition summary

Verification parameters are thoroughly described in Specific Verification Protocol no 1/JWTS/2015 and summarized in Table 1.

Table 1 Verification parameter definitions for the Bio-Com system

	Parameter	Claimed (or required) value	Comments
PERFORMANCE PARAMETERS	Quality of stabilizat:		
	– respiration index AT₄	< 10 mg O ₂ / g DM	
	– loss on ignition index of dry matter LOI	< 35% DM	
	– total organic carbon content of dry matter TOC	< 20% DM	
	Humidity	45-60%	during the process
	Electric energy consumption	-	
OPERATIONAL PARAMETERS	Morphology of waste	fraction 0-80 mm	under-sieve fraction – sieving effectiveness was not verified
	Initial mass of municipal waste	-	
	Properties of waste:		
	– respiration index AT₄	> 25 mg O ₂ / g DM	
	– loss on ignition index of dry matter LOI	-	
	– total content of organic carbon of dry matter TOC	-	
	– humidity	> 35%	
	– C/N ratio	20 - 35	
	Time of process	5 weeks	
Temperature inside the reactor	min. 60°C for at least 1 week	recommended, not required(see Verification Report for details)	
ENVIRONMENTAL PARAMETERS	Concentration of the odours in the air	< 500 – 6000 OU _E / m ³	concentration in the air sampled from chosen points around working installation
	Concentration of the ammonia (NH ₃)	< 20 mg NH ₃ / m ³	
	Concentration of the methane (CH ₄)	< 0.3%	concentration in the probes sampled from inside the reactors
	Concentration of carbon dioxide (CO ₂)		
ADDITIONAL PARAMETERS	Concentration of nitrogen oxide (N ₂ O)	-	
	Concentration of hydrogen sulphide (H ₂ S)	-	
	Concentration of oxygen (O ₂)	> 5%	concentration in the probes sampled from inside the reactors
	Initial temperature of waste	> 12°C	
	Concentration of odours inside the reactors	-	
	Concentration of gases (NH ₃ , N ₂ O, H ₂ S) inside the reactors	-	

3. Test and analysis design

3.1. Existing and new data

Existing data were used as a guidelines in designing tests for verification purposes.

New data were obtained by two laboratories: Laboratorium Bezpieczeństwa Maszyn do Produkcji Zwierzęcej (LBMPZ, accreditation no AB 116) and Ośrodek Badań i Kontroli Środowiska (OBIKŚ, accreditation no AB 213).

See Verification Report no. 1/JWTS/2015 for details.

3.2. Laboratory or field conditions

A full-scale Bio-Com system installation was used for the tests during the verification process. The installation was located on the Sita Starol Sp. z o. o. site in Chorzów, at Kluczborska 29 street.

Four foil tunnels were filled on different dates, allowing the observed states of the ongoing process to be maximized and the number of test body visits on site to be minimized. The test phase lasted from 31.03.2015 to 22.05.2015. The dates of filling the tunnels and sampling are summarized in Table 2.

Table 2 Summarized information about filling and sampling foil tunnels in verification of Bio-Com system

	Tunnel A	Tunnel B	Tunnel C	Tunnel D
Date of filling	31.03.2015	07.04.2015	14.04.2015	07.05.2015
Initial ambient temperature [°C]	3°C	10.5°C	12.5°C	~21.5°C
Date of finishing the process	26.05.2015	not assessed	not assessed	not assessed
Duration of biostabilization process during test phase [number of weeks]	7	6	5	2
Dates of sampling [number of weeks from filling date]	0; 3; 6; 7	0; 2; 5	0; 1; 4	0

Sample collection and measurements were performed according to the relevant standards and/or procedures by test bodies mentioned in chapter 3.1.

3.3. Matrix compositions

The matrix for the Bio-Com system is mixed municipal waste meeting certain criteria which are summarized in Table 3.

Table 3 Matrix composition for the Bio-Com system

Parameter	Required value	Measured value
Respiration index AT₄ [mg O ₂ / g DM]	> 25	25 - 33
Loss on ignition index of dry matter LOI [% DM]	not defined	35.5 - 45.5
Content of organic carbon in dry matter TOC [% DM]	not defined	19 - 24
Humidity [%]	> 35	36.3 - 43.2
Relative proportion of the organic carbon to nitrogen (C/N)	20 - 35	19.6 - 34.8

3.4 Test and analysis parameters

Test methods are presented in Table 4.

Table 4 Summary of test and analysis methods used in the Bio-Com system verification

Parameter(s)	Standard/procedures	In scope?*
AT ₄	Procedure PB/BT/52/C:07.05.2013 and PB/FCH/82/B:07.01.2013	Y
LOI	PN-EN 12879, procedure PB/BT/52/C:07.05.2013	Y
TOC	PN-EN 13137, procedure PB/BT/52/C:07.05.2013	Y
humidity	PN-EN 14346:2011, procedure PB/BT/52/C:07.05.2013	Y
C/N		
temperature	direct instrumental method	N
odours concentration	PN-EN 13725:2007	Y
gases concentration	direct instrumental method, procedure I-ZPE/115 ed.11.07.2012	N
electric energy consumption	direct instrumental measurement of electric energy and total mass	N

3.5 Parameters measured

The parameters measured during verification are presented in Table 1. Those parameters allow the effective assessment of the technology working on a known matrix as well as the primary influence on the environment.

4. Verification results

The number of findings obtained during the verification process is substantial. Most of the results can be found in Verification Report no. 1/JWTS/2015 and the most important are presented below. For clarity reasons, results of crucial importance are presented graphically in Figure 1.

4.1. Performance parameters

The performance parameters verified are presented in Table 5.

Table 5 Measured performance parameters for the Bio-Com system

	Parameter	Obtained value**	Comment
STABILIZAT QUALITY	AT ₄ [mg/g DM]	6.7 - 11.3	after 6 weeks
	LOI [% DM]	19.9 - 24.3	
	TOC [% DM]	7.7 - 14.3	
	humidity [%]	49.4 - 60.4	the highest value
	average energy consumption [kWh/Mg]	5.86	reproducibility not verified

* Y - in scope of accreditation; N - not in scope of accreditation

** 95% confidence interval, $k \approx 2$

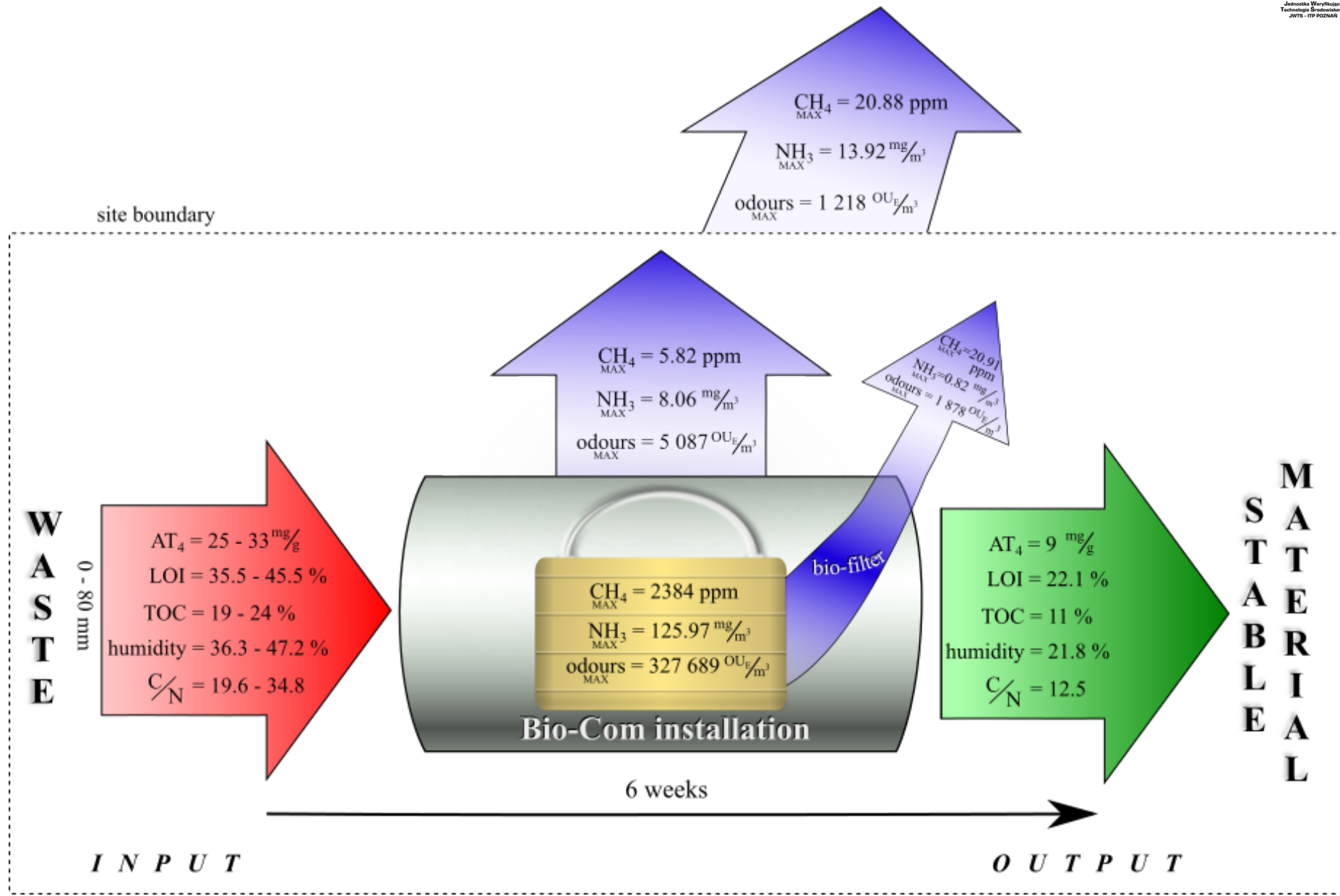


Figure 1 Summary of crucial results of verification for the Bio-Com system

4.2. Operational parameters

Operational parameters are:

- morphology of waste (fraction 0-80 mm, obtained by mechanical sieving, effectiveness of sieving was not verified),
- initial mass of treated waste (between 185.0 and 201.5 Mg),
- properties of waste (presented in Table 3),
- time of process,
- temperature inside the reactor.

The declared value of the process duration was 5 weeks – after that time, the feedstock met 2 out of 3 criteria for stabilizat and 3rd parameter was on the borderline. After 6 weeks of processing, the feedstock met all criteria to be defined as stabilizat.

Temperature inside reactor exceeded level of 60°C for more than one week in 3 out of 4 cases.

4.3. Environmental parameters

The environmental parameters aimed to check what the working Bio-Com system installation emits into the air and whether the process inside is actually aerobic. The results are presented in Table 6.

Table 6 Declared environmental parameters and actual verified values for the Bio-Com system

Parameter	Declared value	Actual value confidence interval for the highest level *	Legal requirements
Concentration of odours [OU _E /m ³]	< 500 - 6 000	4 694.1 - 5 512.4	< 500 - 6 000
Concentration of NH ₃ [mg/m ³]	< 20	13.42 - 14.22	< 1 -20
Concentration of CH ₄ (inside reactor) [%]	< 0.3%	0.23 - 0.25	
Concentration of CO ₂ (inside reactor) [g/m ³]		157.6 - 169.1	

4.4. Additional parameters

Additional parameters – N₂O, H₂S outside and odours and gases (NH₃, N₂O, O₂, H₂S) inside the reactors – did not have declared values (except O₂) and were measured mainly for the purposes of broadening knowledge. A brief assessment of the concentration of gases implies that the installation worked in a standard range of parameters for aerobic biological processes. The oxygen concentration is above the claimed limit value (5%) for 6 out of 7 samples collected from inside the tunnels. For the 7th one, the concentration is just below the claims (4.5 ± 0.2%).

Last of the additional parameters – ambient temperature – was changing during the process (highest recorded value was over 40°C, lowest 0°C). No significant impact of temperature on the ongoing process was observed.

* 95% confidence interval, k≈2. The measurements were performed at least 10 times.

4.5. Conclusions

Based on the results obtained, the following conclusions can be drawn:

1. The Bio-Com system allows biological treatment of a fraction separated from mixed municipal waste, whose temperature is higher than 9°C with properties specified as follows:
 - fraction: from 0 to 80 mm,
 - humidity: above 35%,
 - respiration index AT_4 : above 25 mg/g DM,
 - C/N ratio: from 25 to 35.
2. The duration of the process – 6 weeks – this allowed a stabilizat to be obtained, which meets the legal requirement for waste with code 19 05 99.
3. In a process with such a duration as declared by the proposer – 5 weeks – the stabilizat met the legal requirements for two of the three parameters. These are: $TOC < 20\%$ and $LOI < 35\%$, while the respiration index AT_4 reaches the limit value of 10 mg/g DM. After six weeks of the process, all the parameters met the legal requirements.
4. The method for biological treatment of a separated fraction of mixed municipal waste in the Bio-Com system limited level of odours and ammonia are emitted into the air, which arises as a result of biodegradation of the waste. The highest level of odour emission within the installation borders was 5 512.4 OU_E/m^3 (the upper limit of the confidence interval) and does not exceed the regulated level of 6 000 OU_E/m^3 . The highest average result of ammonia concentration in the air in the installation's surroundings was 13.92 mg NH_3/m^3 and was lower than the declared value – 20 mg NH_3/m^3 .
5. The Bio-Com system works in a range of parameters specified for aerobic biological process. It is concluded that the level of CH_4 concentration obtained inside the reactor (maximum 0.24%) meets the declared value (0.30%).
6. The Bio-Com system creates friendly conditions for the hygienization of waste, even though it is not required. These conditions are access to oxygen and temperature. The correlation between oxygen and temperature has been not measured.
7. Energy consumption during one technological process performed in the conditions described in verification report no. 1/JWTS/2015 was 5.86 kWh calculated per one tonne of mixed municipal waste used in the biological treatment of waste.

5. Additional information

Detailed information about the verification process, conducted procedures and compatibility of verified parameters with legal requirements are presented in Verification Report no. 1/JWTS/2015.

6. Quality assurance and deviation

The test and verification activities were planned and performed in order to meet the requirements on quality assurance described in General Verification Protocol. The test bodies engaged in the process were both accredited and the personnel of the Verification Body conduct audits to assure the quality of results. Full information about quality assurance is summarized in Verification Report no. 1/JWTS/2015.