HYDROUSA

H2020-CIRC-2-2017

Water in the context of circular economy

Full project title:

Demonstration of water loops with innovative regenerative business models for the Mediterranean region

Deliverable: D20

Relative Number in D3.7

Composting reactor installed and running

Due date of deliverable: 30 June 2020

Submission date of revised deliverable: 12 March 2024

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643

DOCUMENT INFORMATION

Deliverable	**Number**	3.7	**Title:**	Composting reactor installed and running
Work Package	**Number**	3	**Title:**	Wastewater management and resource recovery

Due date of deliverable	**Contractual**	M24	**Actual**	M36	
Version number	1.5				
Format	MS Office Word document				
Creation date	24/05/2021				
Version date	12/03/2024				
Type	☐R	☒DEM	☐ DEC	☐ OTHER	☐ ETHICS
Dissemination Level	☒PU Public		☐ CO Confidential		
Rights	Copyright "HYDROUSA Consortium". During the drafting process, access is generally limited to the HYDROUSA Partners.				

Responsible authors	**Name:**	Eleni Nyktari Simos Malamis Costas Noutsopoulos Daniel Mamais Anna Biebl Johannes Kisser Athanasios Stasinakis Fabio Masi Anacletto Rizzo Ricardo Bresciani Ilias Skaltsas Vasilis Lamprinidis	**E-mail:**	eleni_niktari@hotmail.com malamis.simos@gmail.com cnoutso@central.ntua.gr mamais@central.ntua.gr biebl@alchemia-nova.net jk@alchemia-nova.net astas@aegean.gr fmasi@iridra.com rizzo@iridra.com bresciani@iridra.com iskaltas@gmail.com vlamprinidis@gmail.com
	Partner:	NTUA UOA ALCN IRIDRA MINAVRA	**Phone:**	(+30) 210 7722797

Brief Description	D3.7 describes the development, installation and testing of the integrated composting process treating the excess sludge from the UASB system and the green biomass from HYDRO2. The composting system is installed at the demo site in Lesbos. The

	integrated system includes a Sludge Drying Reed Bed (SDRB) unit, a composter and nature-based odour removal biofilters, where odorous gases from compost and SDRB process will be filtered through compost and plants. This deliverable provides the description of all systems, drawings and photos of the construction, installation and final testing of the integrated system.
Keywords	Anaerobic sludge, biofilter, composting system, sludge drying reed beds

Version log			
Rev. No.	**Issue Date**	**Modified by**	**Comments**
1.1	24/5/2021	Eleni Nyktari, Simos Malamis, Costas Noutsopoulos, Athanasios Stasinakis	Internal review
1.2	19/6/2021	Anna Biebl, Johannes Kisser	Internal review
1.3	30/6/2021	Eleni Nyktari, Simos Malamis, Costas Noutsopoulos	Final version for submission
1.4	13/03/2022	Eleni Nyktari, Simos Malamis, Costas Noutsopoulos,	Revised according to periodic review comments
1.5	12/03/2024	Simos Malamis	Revised according to final review comments

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643

TABLE OF CONTENTS

This project has received funding from
the European Union's Horizon 2020
Research and Innovation Programme
under Grant Agreement No 776643

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

CW	Constructed wetland
HMI	Human Manual Interface
PLC	Programmable Logic Controller
SDRB	Sludge Drying Reed Bed
TSS	Total Suspended Solids
UASB	Upflow anaerobic sludge blanket
UF	Ultrafiltration
UV	Ultraviolet
VOCs	Volatile Organic Compounds
VSS	Volatile Suspended Solids
VF	Vertical Flow
WWTP	Wastewater treatment plant

This project has received funding from
the European Union's Horizon 2020
Research and Innovation Programme
under Grant Agreement No 776643

EXECUTIVE SUMMARY

The present report comprises the technical information of the treatment of the sludge produced in HYDRO1 demonstrator of HYDROUSA. The aim of the Lesbos site (HYDRO1) is to demonstrate the potential to treat wastewater from a touristic site (high fluctuation in sewage production due to seasonality of touristic activities) and produce a treated effluent suitable for reuse in irrigation or fertigation under the strict Greek water quality standards. The treatment chain of the Lesbos demonstrator includes anaerobic reactors, constructed wetlands (CW), ultrafiltration (UF) and ultraviolet (UV) radiation. The anaerobic wastewater treatment takes place in a system of two parallel upflow anaerobic sludge blanket (UASB) reactors, triggering the production of biogas and a low amount of sludge that can be subsequently valorised.

The excess sludge produced, is dewatered to 10% solids in the Sludge Drying Reed Bed (SDRB) unit, and after being mixed with green biomass harvested from HYDRO2, it is co-composted in an innovative composting system, while the odorous gases produced at both the SDRB system and the composting unit are being treated for odours removal at two biofilters. This integrated scheme is the so-called compost cultivator.

The construction of the SDRB and the installation of the composting unit and the two biofilters were finalized in May 2021. The final technical testing was conducted in June 2021.

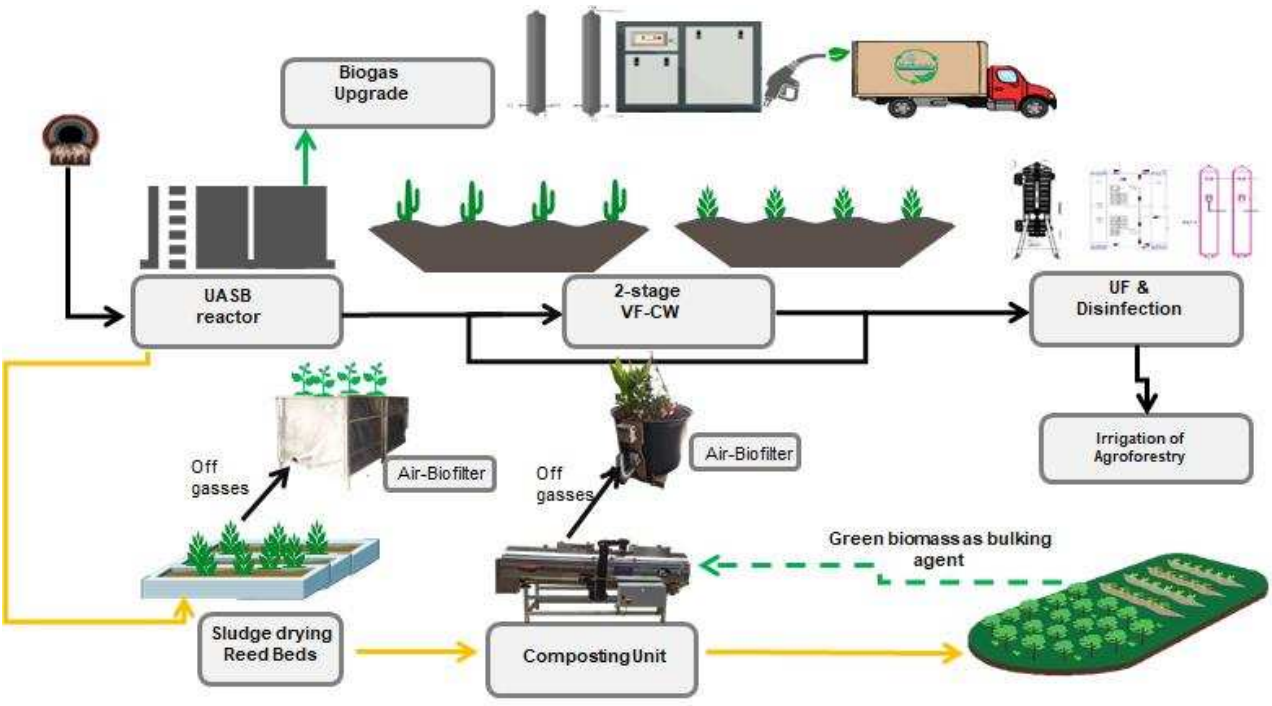


Figure 0.1 Overview of HYDRO1 processes

In this deliverable, a complete technical description of the excess sludge treatment of HYDRO1 is presented (SDRB, composting unit, biofilter). Additionally, the operating manuals of each element are included in the Annex.

It provides a detailed technical description of the full-scale system, including electro-mechanical equipment. The report is structured as follow:

Chapter 1 introduces the goal and the structure of the deliverable. The system's description is provided in Chapter 2, while the construction works, and all the final testing activities are detailed in Chapter 3. The technical manuals of all the electromechanical equipment installed are provided in the Annex.

HYDROUSA has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643.

1. INTRODUCTION

The excess sludge in a wastewater treatment plant (WWTP) is considered a waste and its disposal is becoming a significant problem, however, it is also an alternative source of organic matter and nutrients that can be used as soil amendment. The use of sludge requires a previous step of stabilisation in order to be safe and manageable. Composting treatment is a suitable biological process for sludge recycling that uses naturally occurring aerobic microorganisms to convert biodegradable organic matter into a humus-like product. The composting process stabilizes the sludge, destroys pathogens, converts nitrogen from unstable ammonia to stable, organic forms of nitrogen, and reduces the volume of waste. This process is controlled by process parameters (temperature, moisture content, pH, and aeration) and substrate properties (C/N ratio, particle size, and nutrient content), (Ucaroglu and Alkan, 2016).

Due to high moisture and low carbon content, anaerobic sludge must be mixed with dry materials for composting. The materials used as co-substrate or bulking agents include the organic fractions of municipal solid waste, sawdust, wood chips, and many other agricultural wastes. Wastes containing lignin, such as plant residues from agricultural production systems, that are difficult in disposal managing, are considered good bulking agents to balance the moisture contents of the sludge and the C/N ratio, providing additional carbon and increase its porosity to permit airflow. These substrates can also provide optimum free air space (FAS) and void dispersion in composting, which permit adequate water and gas exchange between gas and solid phases, and prevent excessive compaction of the composting materials (Kulcu and Yaldiz, 2007).

As part of HYDRO 1 circular wastewater treatment system, the compost system is applied in order to treat the excess anaerobic sludge that is discarded from the upflow anaerobic sludge blanket units (UASB) and turned it into a useful product suitable for agricultural use as a soil conditioner and a fertilizer (i.e. compost).

First, the sludge extracted from UASB is transferred to a Sludge Drying Reed Bed (SDRB) system for partial stabilization and dehydration. The dried sludge (10% solids) is mixed with shredded greens from the agroforestry system (i.e. HYDRO2) as co-substrate and the mixture is fed into the designed compost system, where the composting process is fully monitored in order to have the required humidity, temperature and C/N properties for the compost production. The produced compost, in return, will be used in the agroforestry or in any agricultural system as natural fertiliser.

In addition, two innovative biofilters were designed and installed in HYDRO1 in order to treat the odours from the SDRB and the compost process. The air streams from these processes are relatively low-polluted with gaseous by- and end-products from microbial degradation of organic material containing carbon-based compounds, sulphur and nitrogen-based compounds. Particularly odorous are volatile organic compounds (VOCs), hydrogen sulphide and ammonia. The degradation of such air streams with biofiltration is used in many enclosed compost systems to reduce odours (Kehres, 2010).

Biofiltration cleans polluted air by leading the air stream through biofilm-covered packing media, where pollutants transfer directly into the biofilm and then degraded to CO_2 and by-products such as VOCs. The degradation rate depends on the complexity of the molecule and the water solubility, but does not change much over a range of 10-40 °C due to the counterbalance of increased enzymatic degradation and decreased solubility of gases at increasing temperatures (Nelson and Bohn, 2011).

The packing media or filter material needs specific traits to guarantee effective sustenance of the biofilm and thus degradation of the pollutants. To facilitate a homogenously distributed gas flow and avoid drying of the media (moisture must be between 40 and 60 %) and high porosity and water retention capacity are desirable

traits. A high specific surface area over 300 m^2/m^3 guarantees a high gas-to-biofilm mass transfer. Soil, compost and wood chips, widely used packing materials, satisfy these requirements and are cost effective (Vikrant et al., 2017).

The two biofilter systems were designed based on the off-gases composition and quantities and the characterisation of elimination capacities of the filter material (wood chips and compost).

2. SYSTEM DESCRIPTION

As previously described, the excess sludge from the UASB reactors will be fed to the SDRB system to achieve the dewatering of the sludge up to 10% solids. Green biomass from HYDRO2 will be harvested and chopped using the shredder and then will be mixed with the aforementioned dewatered sludge using a homogenizer unit. The quantity of green biomass needs to be regulated so that sludge-green biomass mixture fed to the composter meets the specified C/N ratio (30-35) and humidity (60-67%); these conditions are required for the best operation of the composting process.

So, in this report the realization of the integrated closed vessel composting system is described for the treatment of the sludge quantities which have been specified in deliverable D3.1. Based on these calculations, a sludge production of about 2.5 kg TSS/d has been defined for summer conditions and 0.25 kg TSS/d for the winter operation. By considering a solids concentration value of 30 kg TSS/m^3 for anaerobic sludge that exits the UASB, a sludge flow rate of 83.3 L/d and 8.3 L/d can be calculated for summer and winter conditions respectively. The green biomass (harvested from HYDRO2) needed as bulking agent for the compost process was calculated to be 9 kg TS/d and 47.6 L/d (with a specific weight of 210 kg/m^3) so that the compost mixture fed to the composter has a moisture content of 65% and C/N = 32-33. Figure 2.1 presents the mass balance of the integrated scheme.

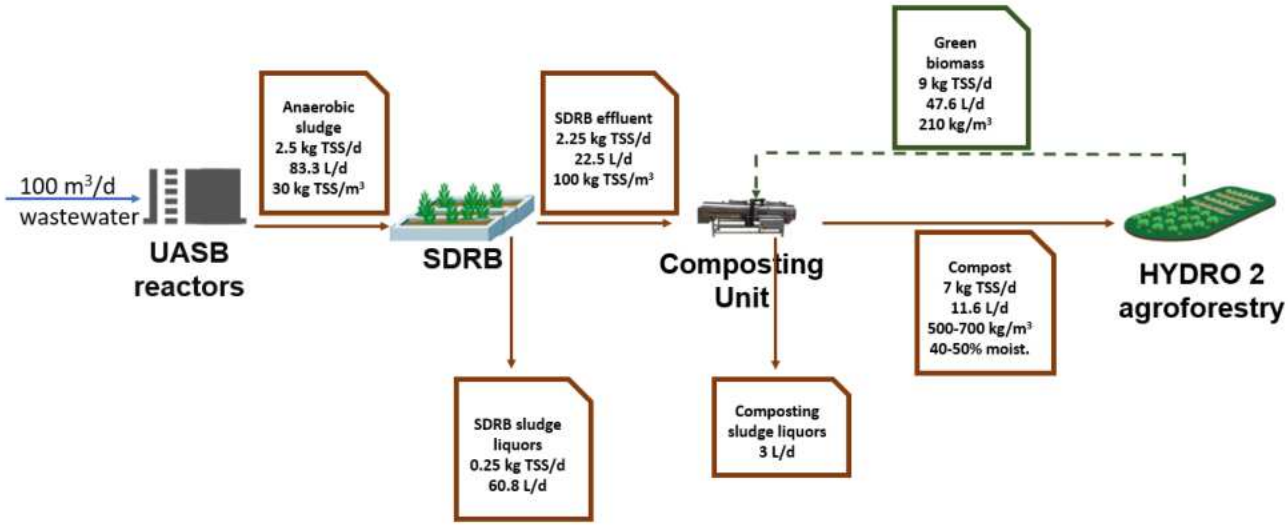


Figure 2.1 Mass balance of the integrated system

The sludge treatment system that has been implemented enables some improvements and changes compared to the original design (D3.6) in order to optimize the system's performance. More specifically, extended experiments have been performed in order to assess and validate the performance of the initially designed system to filter and compost effectively the anaerobic sludge with the addition of shredded green biomass.

Several pilot scale prototypes were developed, based on the design described in Deliverable 3.6, to test the feasibility of the integrated concept design. This first concept was based on an existing system, which integrates composting and plant growth in the upper part, in one system. The compost cultivator would do this plus use a biomass layer for solid-liquid separation and further composting and treating the air directly above in the plant layer. The compost should be mixed to ensure aeration of the whole biomass with the sludge. However, during the development of the system, the idea of the mixing blade was discarded, as when applied in the prototype was deemed unfit for mixing consistently the wet compost. A static barrel composter

with a mesh support for the biomass was found to be the most suitable option. A 150 L pilot prototype was used for further filtration and composting tests. The first tests using digestate filtered by shredded biomass in the static barrel composters showed insufficient results due to high water content, low retention of solids and no thermophilic composting phase.

Focusing further on filtration to retain a sufficient amount of solids and to lower the moisture content, various filtration methods and materials such as filter paper, compost, shredded biomass, activated charcoal and biochar have been investigated in various configurations and assessed in pilot scale. A master thesis "Optimization of filtration and composting of excess sludge from biogas digestion" has been supervised by ALCN in cooperation with the University of Applied Sciences, Vienna. No appropriate filter design for the digestate was found. The focus in the following tests was thus laid on the nutrient recycling without filtration with the use of biochar as a thickener – degradation of the material and a decrease of smell was observed, but no thermophilic phase, needed for definite sanitation, was achieved.

The comprehensive filtration and composting tests, performed partly in cooperation with the University of Applied Science, Vienna, did not show sufficiently promising results to allow the proper installation of bigger prototypes of the compost cultivator for final integration at demo - scale.

In view of the above it was decided to separate the all-in-one-system system into three different systems:

1) A SDRB unit for the dewatering of the anaerobic excess sludge in order to decrease the water content of the sludge prior to composting,
2) An innovative continuous composting system enhanced with sensors to compost the sludge from the SDRB
3) Two novel air biofiltration systems for the treatment of the odorous air generated from the sludge wetland and the composting system.

By this integration, the desirable performance of the sludge treatment unit can be achieved while maintaining the basic initial concept, as the integrated systems is a closed vessel system which promotes efficient composting and odour treatment through biofiltration.

2.1 **Sludge Drying Reed Beds (SDRB)**

The Sludge Drying Reed Bed consists of one bed divided in three sectors for alternate loading, with a net surface area of 20 m^2. A regulation manhole is also designed from where the leachate of the bed is directed back to the influent pit of HYDRO 1.

The 3 sectors of SDRB will be loaded intermittently, thus providing a resting period to facilitate dewatering. Approximately, every 7 days each sector will be loaded with excess sludge resulting in a resting period of 21 days. Flush volume will depend on sludge production and the scheduling of the loading will be defined based on the characteristics of the sludge.

During operation the sludge valve from UASB will be opened until the manhole is filled with the desired flow; then the valve corresponding to the selected sector will also be opened; by gravity, the sludge is fed to the sector and the valves are closed when the sector is filled. In order to avoid any odour problems the SDRB will be enclosed in a greenhouse. The greenhouse will be ventilated by an air blower that will renew the air 5 times/hour and will pump off-gases from the greenhouse to the biofilter.

SDRB drawings are presented in Figures 2.2-2.3.

The system consists of one bed divided into 3 sectors with the following characteristics (Table 2.1):

Table 2.1 Required characteristics of the SDRB

Flow	m^3/d	**To be defined on the basis of sludge characteristics**
Bottom surface area	m^2	**20**
L external dimension	m	**5.3**
W external dimension	m	**4.9**
Bottom surface area per sector	m^2	**6.75 (1.5 x 4.5)**
No. of units	-	**1**
Size and depth of filter media (starting from bottom) – **30 – 60 mm round, washed gravel** – **12 mm round, washed gravel** – **Washed sand 0.4-5 mm (D60 = 1 mm)**	m	 – **0.20** – **0.30** – **0.05**
Free board	m	**0.5**
Total Depth	m	**1.05**
Type of plants	-	**Phragmites Australis**
Material of construction	**-**	**Excavated in the soil, soil embankments, waterproofed with 1.5 mm EPDM liner or similar**

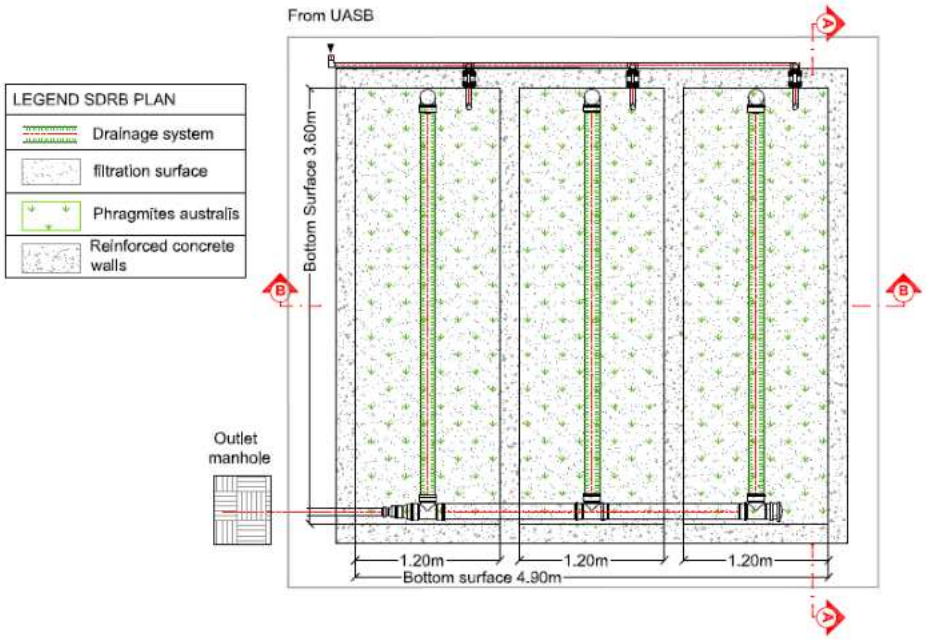
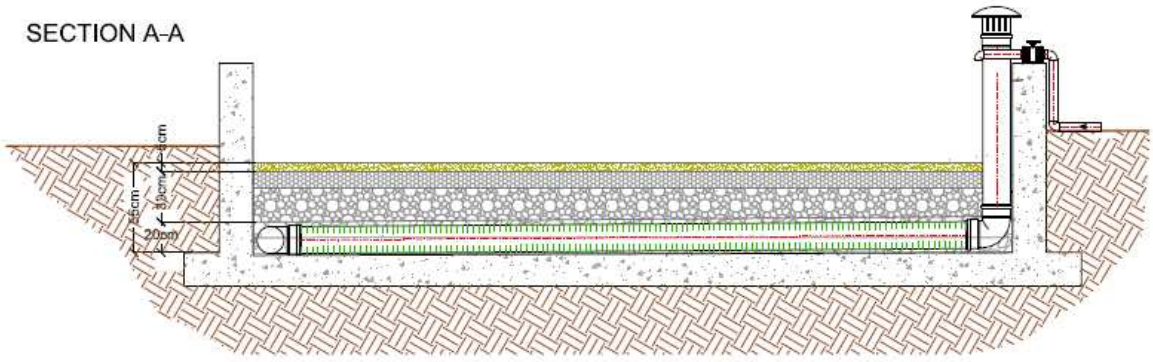


Figure 2.2 Sludge Drying Reed Bed (SDRB) - plan



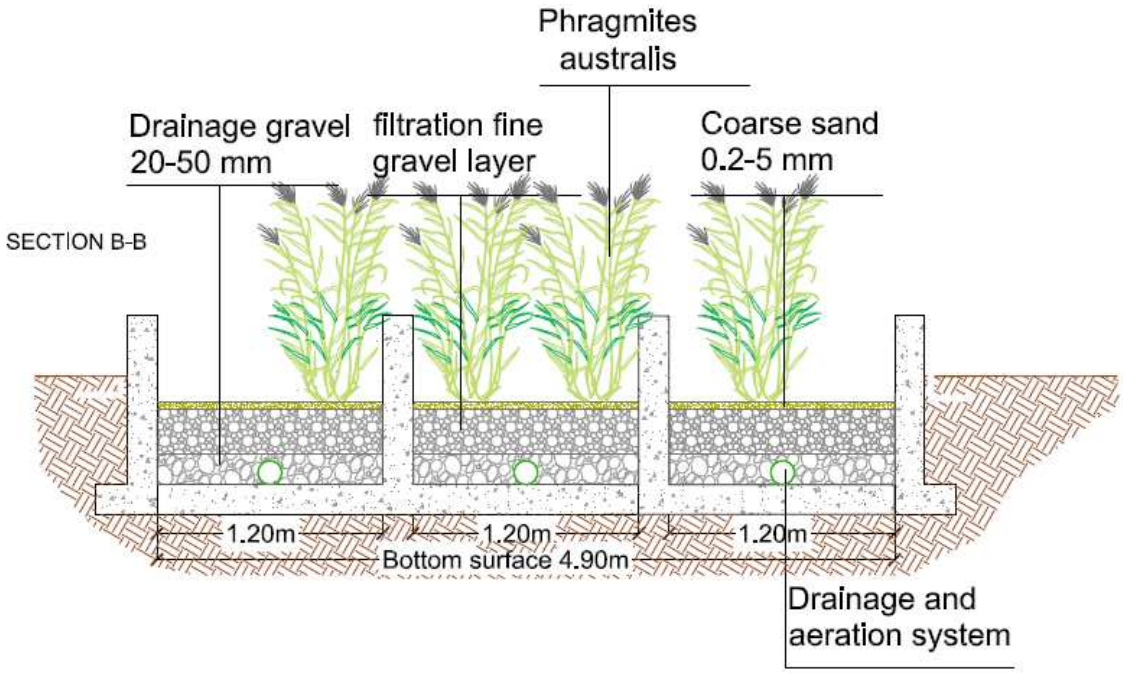


Figure 2.3 Sections of SDRB unit

2.2 **Composting unit**

The innovative composting unit was designed by UOA in collaboration with NTUA to treat the dewatered sludge coming from the SDRB mixed with the green biomass from HYDRO2. The main design parameters for the dimensioning of the compost reactor were the pre-dewatered excess sludge volume in the summer period (high flow rate season- 100 m^3 wastewater/d) and the amount of green biomass required and the composting process retention time. The dewatered excess sludge was estimated to 0.158 m^3/week, based on the amount of excess sludge calculated in the design deliverable of UASB for summer conditions (Deliverable 3.1). The quantity of green biomass was calculated to approximately 0.33 m^3/week in order to retain the C/N ratio at 32-33 and the humidity around 65% for the best practice of compost process.

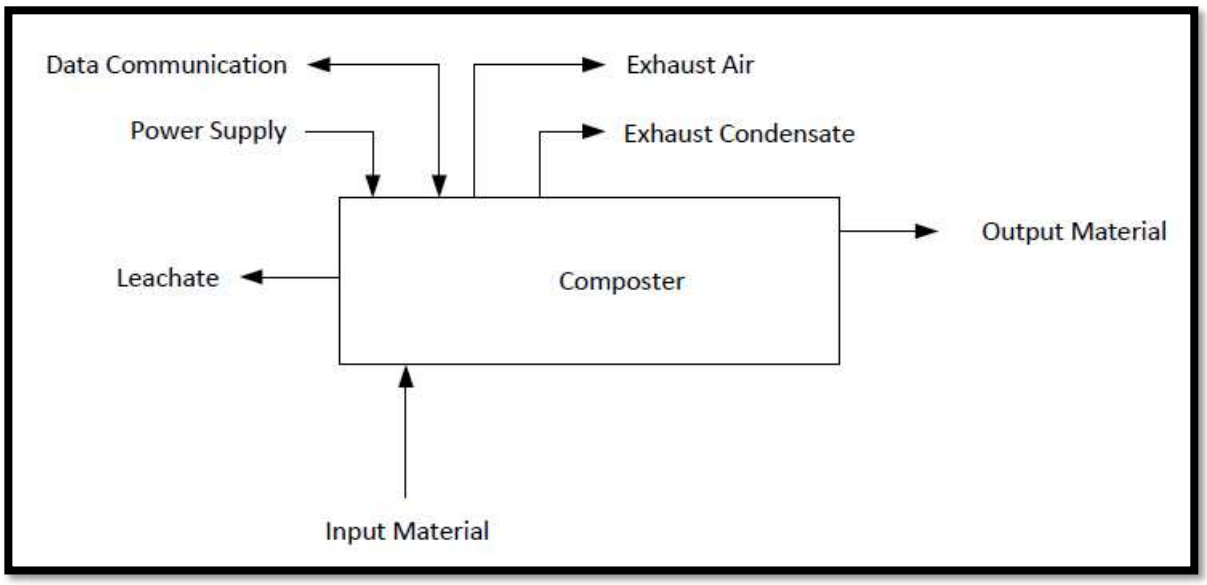


Figure 2.4 Flow chart of compost unit

In Figure 2.5, an overview of the composting reactor is presented. The technical characteristics of the unit are included in the following Table:

Table 2.2 Technical Characteristics of HYDROUSA compost unit

Length (m)	3.00
Width (m)	0.90
Height (m)	1.60
Capacity	Up to 700 L/week
Engine	0.75 kW
Heating	2 X 0.80 kW
Power supply	Single phase 240V 50 Hz
Power consumption	29 kWh/d
Temperature monitoring	4 recorders along the chamber as well as in the air intake and air exhaust
Ventilation system	included
Spatial Requirements	At least 5.0 meters X 3.0 meters X 3.0 meters

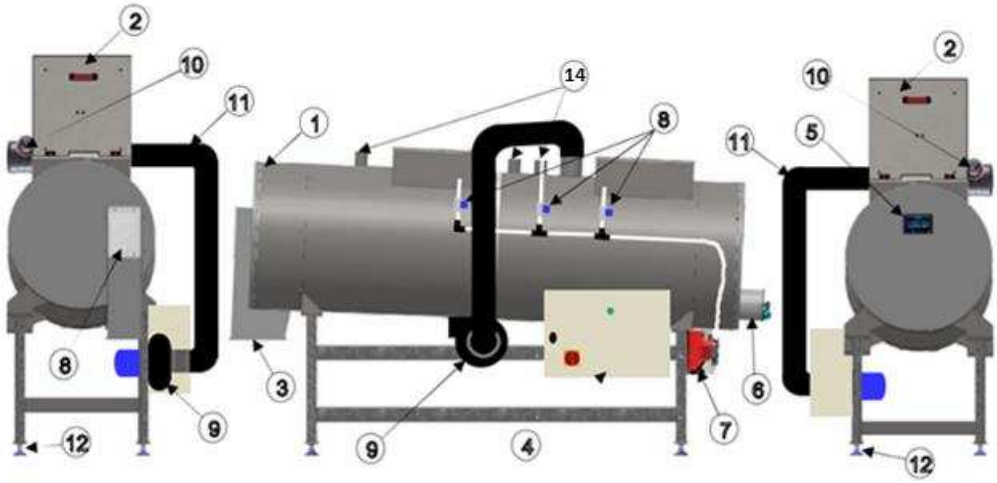
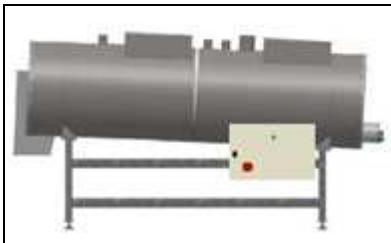


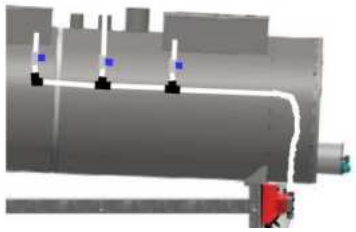
Figure 2.5 Overview of the composting unit

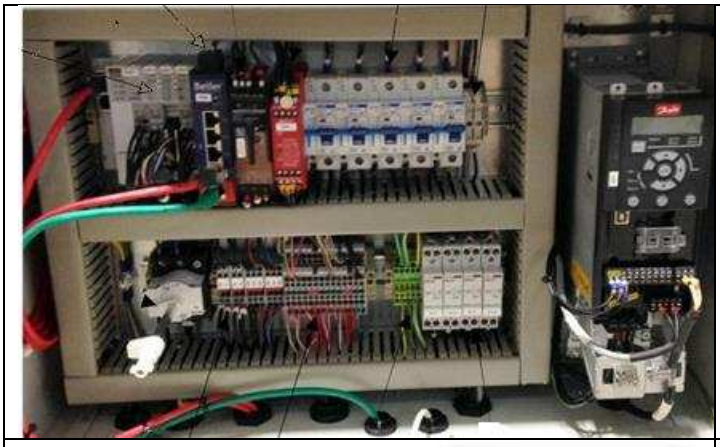
The unit is separated into the following items:

1. Composter Vessel
2. Access Hatch with Lid (2)
3. Discharge Chute
4. Electrical Control panel
5. Human Manual Interface (HMI)
6. Sludge Box
7. Water Dosing Pump
8. Water Dosing Valves (3)
9. Air Extraction Fan
10. Air Extraction Damper Valve
11. Air Extraction Manifold
12. Adjustable Levelling Feet
13. 20L leachate collection container (not shown)
14. Instrumentation ports

Description of Components

 	***Composter Vessel:*** The vessel has a rotary shaft with blades that agitate the material and slowly move the material to the output conveyors. There are 2 Hopper Lid Assemblies (access hatches) both protected with a Dual Coded Magnetic Safety Switch, 3 of 2“ BSP probe entry ports and 1 off discharge chute.

  	**Water Dosing Pump** The dosing pump will pull water from an open water source, i.e. a bucket filled with water, and pump it up to the 3 off dosing nozzles, via the 3 off selection valves **Water Dosing Valves** The 3 off two-way dosing valves allow 1 of the 3 off dosing nozzles to be selected. Only 1 valve can be selected at a time. **Water Dosing Nozzles** The 3 off dozing nozzles have a 1mm orifice and a sintered filter, and spray water at an 80° angle
	***Air Extraction System:*** **Air Extraction Fan** The fan extracts water vapour, created by the composting process, out the extraction point, via the Ø110mm pvc manifold. **Damper Butterly Valve** To balance the quantity of extracted air, a butterfly valve (damper) is fitted to the air intake. When the valve is fully open (0°) the minimum amount of air will be extracted from the vessel. When the valve is fully closed (90°) the maximum amount of air will be extracted from the vessel
 	**Leachate Drain System:** **Sludge Box** At the bottom of the composting vessel, there is a sludge box, which allows liquid (called Leachate) to drain from the vessel. This contains a perforated filter, that requires cleaning weekly. **Leachate Collection Container** This 20 Litres container collects the leachate via a Ø22 mm pipe, allowing it to be disposed in a suitable dirty drain.

	**Electrical Panel** The electrical components are housed in an IP66 enclosure, mounted on the side of the machine.
	**Human Manual Interface (HMI)** The entire operation of the machine is controlled by a programmable logic controller (PLC) via an electronic HMI display with touch screen.

The online monitoring equipment consists of 6 temperature probes (Figure 2.6), located as follows:

Probe	Description	Location
VP1-4	Material	Inside Vessel
VP5	Ambient Air	Behind Electrical Panel
VP6	Exhaust Air	Inside Exhaust Pipe

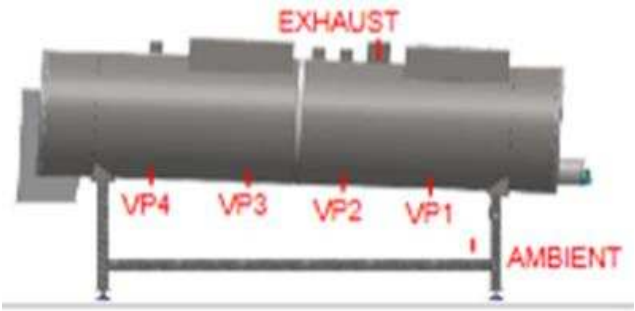


Figure 2.6 Points of temperature probes in the compost reactor.

2.2.1 SPECIAL EQUIPMENT

Wood Chipper / Shredder

Figure 2.7 Chipper for greens

The BIO Wood Chipper (Figure 2.7) is used to shred the greens harvested from the agroforestry (HYDRO2). It has an emergency stop button for safety reasons. Its metal construction guarantees durability. It is equipped with a large hopper, wide at the cutting point so that it grinds even especially leafy material. The output of the material is at a height of 150 cm which helps to directly load the finished product into a transport carriage or large bins. Each knife has 2 cutting edges, so when one side is worn, you just turn it over.

Table 2.3 Technical specifications of BIO Wood chipper/shredder

Engine	Loncin 13hp 420cc
Cubic Capacity	420cc and over
Start	Hand Starter
Knives	2 Sharpened with 2 cutting edges
Wheels	3
Net Weight	200 Kg
Dimensions	Height 155cm
	Width = 75cm
	Length 170cm

Homogenizer

The homogenizer Bormann BMX 1400 (Figure 2.8) is used for the homogenization of the feedstock used for composting. It is of 140 L capacity and has a power consumption of 550 Wh.

Figure 2.8 Homogenizer unit

2.3 **Biofilter**

The purpose of the air biofilter is to reduce odorous off gases generated during the SDRB and the composting treatment. These air streams are relatively low-polluted with gaseous by- and end-products from microbial degradation of organic material such as ammonia, hydrogen sulphide and volatile organic compounds (VOCs). The degradation of such air streams with biofiltration is applied successfully for enclosed compost systems to reduce odours (Kehres, 2010). The dimensioning is conducted using empirical data from literature and the calculations provided in Deliverables 3.1 and 3.6. The concentrations and air flow rates will be measured on site and used for optimisation of biofilters' operation.

2.3.1 OFF-GAS FROM SDRB

The assumed main source of odour from SDRB unit is expected to be H_2S with an emission rate of 1-10 mg/(m^3 sludge × h). NH_3 has a magnitude higher odour threshold than H_2S and a 10-50-fold lower emission rate. A wide array of VOCs is expected to be found with ~10 ppmv overall. Each individual VOC would have less than 0.5 ppmv. According to the calculation on Deliverable 3.1, the UASB reactor produces 0.083 m^3 sludge per day at the maximum flow rate operation (100 m^3/d). Removal of built-up sludge with a TSS of 10% TS is assumed to happen every 21 days. The amount of H_2S, NH_3 and VOCs will therefore increase with the amount of sludge added to a maximum amount of 1.73 m^3. The total emission rate of$_2S$ is therefore 17.26 mg H_2S/h and 1.72mg NH_3/h. The 10 ppmv VOCs equal 32.5mg VOCs/m^3. With assumed air flow of 1.5 m^3/h, the exhaust air from the sludge wetland will have an input concentration of 11.5 mg/m^3 H_2S, 1.14 mg NH_3/m^3 and 21.7 mg VOCs/m^3. The humidity of the sludge wetland will be higher than the ambient air humidity due to the evaporation from the sludge and the wetland. The amount will be determined on site and is assumed to be 70-80%.

2.3.2 OFF-GAS FROM SLUDGE COMPOSTING

The purpose of the composter is the treatment of the excess sludge from the UASB. The maximum volume of dewatered sludge entering the composter would be 0.158 m^3/week. The off gases from the composting unit were calculated using empirical data from literature. Maulini-Duran reported measurements of VOCs and NH_3 from composting of anaerobically digested sludge with a 3:1 (volume) addition of wood chips as a bulking agent (Maulini-Duran et al., 2013). They reported a peak of 0.0016 kg NH_3 and 0.01 kg VOCs per wet tonne composting mix. Thus, the maximum inlet concentrations of 506 mg NH_3/m^3 air and 3160 mg VOCs/m^3 air are assumed.

However, the amount of exhaust air as well as humidity and pollutant concentration vary with the phases and the temperature of the composting process. Odour can reach peaks of over 30000 VOCs/m^3 exhaust air. This variation of pollutant concentration could have an impact on the efficacy of the biofilter microbes and might therefore have an impact on filter efficiency (Kehres, 2010). If the loading rate is sometimes higher than microbial capacity, these can be to some extent mitigated by using higher empty bed residence time (minimum 60 s) (Omri et al., 2013). These parameters will be determined on site.

2.3.3. LIMITS ON EMISSIONS

Limits of emissions from composting and digesting systems are stated in the TA Luft (Bundesumweltministerium (BMU, 2002) (Table 2.4). The biofilter was designed to reach those limits.

Table 2.4 Emission requirements for exhaust air from compost and digestion plants according to "TA Luft"

Emission	Mass flow rate	Concentration
Dust	-	10 mg/m³
Odorous compounds	-	500 oue/m³
Total Carbon	0.50 kg/h	50 mg/m³
Ammonia	0.15 kg/h	30 mg/m³
Hydrogen sulphide	0.015 kg/h	2.5g/m³

2.3.4. DESCRIPTION OF AIR BIOFILTER

Two biofilters have been installed in HYDRO1. The one is reducing the odours generated from the sludge drying bed and the second one from the compost unit.

The dimensioning of the filters was based on the amount of exhaust gas as well as its composition. Extensive literature review was conducted, on the removal efficiency (RE) and elimination capacity (EC) of the materials used that depend on pH, inlet concentration and bed moisture. These data along with the recommendations of standard VDI 3477 were used for the designing of the filters and will be elucidated in the HYDROUSA project.

Based on design calculations, one air biofilter is enough to filter the occurring off-gases. However, it was decided to develop two biofilters in order distinguish the off gases from the compost process and the sludge drying process. The operation and the efficiency of each filter will be validated in running operation. The P&Id of the designed biofilter and the prototype developed are presented in Figures 2.9 and 2.10.

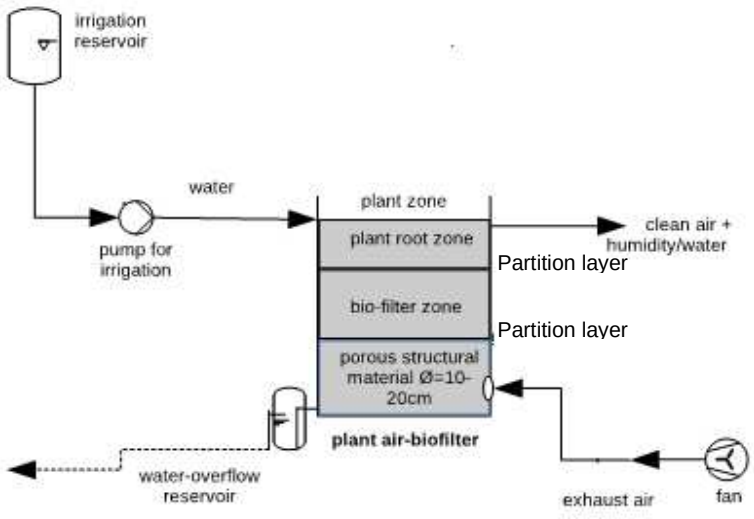


Figure 2.9 P&ID of air biofilter

Figure 2.10 Biofilter prototype

The biofilter for the SDRB gases is made of stainless steel (Figure 2.11). The external dimensions of the system are 2.40 m (length) x 1.20 m (width) x 1.40 m (height) and 4 mm wall thickness. The effective volume of this biofilter is 2.6 m^3. It consists of the following parts (from bottom to top):

- Inlet of the effluent gases. It consists of a perforated pipe Ø110 located at the bottom of the biofilter. A ventilator is used to blow the gases into the inlet pipe. A perforated metal sheet made of stainless steel is placed above the inlet pipe to avoid penetration of particles from the above parts of the biofilter that may lead to clogging of the inlet pipe.
- Layer of gravel with 5cm thickness and participle size of 1 – 2 cm. The gravel layer is placed on the above- mentioned perforated metal sheet.
- Compost type filter with 70 cm thickness and 2.88 m^2 effective surface area. Geotextile is placed at the lower and upper part of the compost to separate the layers.
- Layer of soil organic material with 15 cm thickness.
- At the upper part, an irrigation system is installed consisted of water sprinkler nozzles.

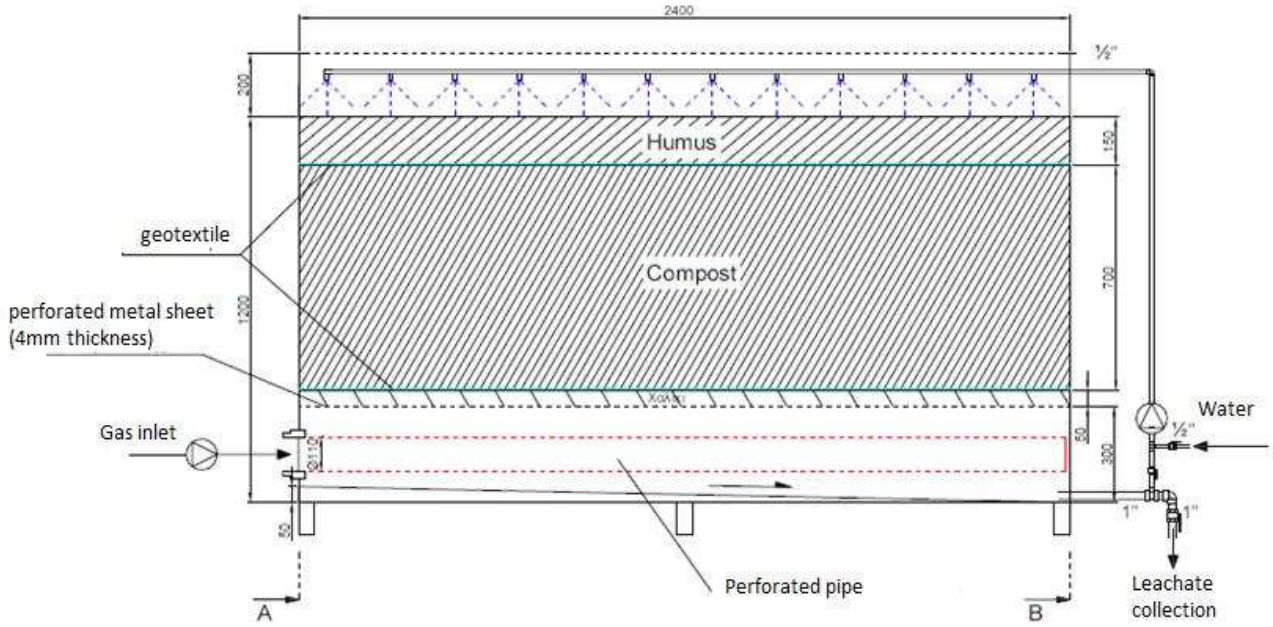


Figure 2.11 Section of the biofilter for SDRB off gases

The second biofilter, used to treat the gases from the compost unit, is a modular system with a fixed space of 1 m^3, containing 0.75 m^3 of active filter material in two layers of 0.5 m biomaterial and 0.25 m root zone with a surface of 1 m^2 per unit (Figure 2.12). The packing media of the lowest layer was 10-20cm gravel and will allow equal distribution of air inside the filter. The lower biomaterial layer, with a thickness of 50 cm, consists of wood chips (i.e. shred pruning material from the agroforestry site). The packing media of the upper root zone layer consists of a mixture of soil, compost and expanded clay.

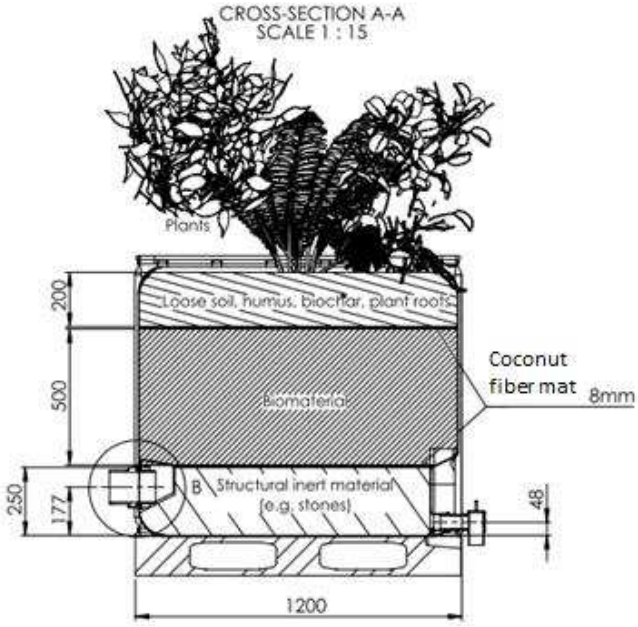


Figure 2.12 Biofilter for compost off gases

3. CONSTRUCTION AND START-UP

3.1 Construction and hydraulic tests of SDRB

Construction activities for SDRB:

First the clearing and grubbing of the designated area was carried out by removing all vegetative growth, deadwood, debris, rubbish until the natural ground level. Excavations and shoring were kept as close as possible to the structure foundation. Banks or backslopes cut at a safe angle of repose or sufficiently shored to protect any work within the excavated area. Next, all loose material, debris rock seams beneath foundation were removed from excavations for foundations and the surface was filled with concrete mortar or grout. On that surface the enforcement was constructed. Finally, the formwork for the sidewalls as well as the enforcement meshes were installed (Figure 3.1).

Figure 3.1 Excavations, formworks and enforcement meshes works at the SDRB area

Upon the completion of the aforementioned activities, concreting took place creating a final bed divided into 3 sectors (Figure 3.2). The constructed basin was tested for water-tightness by filling each sector with water. The water left to stand for 3 days and meanwhile the liquid level was recorded every 24 hrs. Drop level due to small leaks were detected (at the joint between concrete wall and base) and repaired.

Figure 3.2 Completion of the concreting activities for the SDRB unit

Then, the drainage pipe system was installed which tested after it was jointed, and before backfilling commenced (Figure 3.3).

Figure 3.3 Installation of drainpipe network and backfilling with 3 gravel layers

Next stage was the backfilling of the basin accordance with the designer's instructions. The bed filled with selected medium gravel layers, and lastly a layer of sand in the way the final filling surface to be horizontal (Figure 3.4). After the backfilling was completed, further tests were carried out. Finally, the reeds (Phragmites Australis*)* were planted with a density of 6 plants/m^2.

Figure 3.4 Backfilling with coarse sand

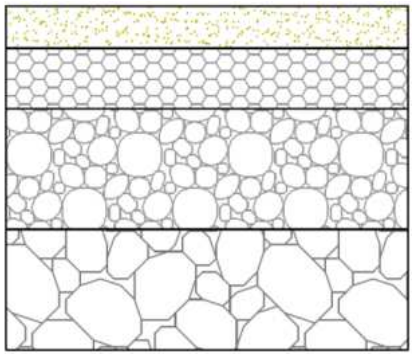
The bed media filter consists in combinations of various size material. MINAVRA installed the filter by using specialized personnel and with the suitable equipment. The activity was strictly in accordance with the following technical specifications:

- the upper surface of each gravel (previously washed) and sand layers was perfectly horizontal and uniform.
- The depth of different gravel and sand layers was according to the technical drawings as shown at Figure 3.5.
- The filling material is obtained from approved borrow areas after testing it, confirming the suitability of the material, containing maximum calcium carbonate until 20% and acid solubility lower than 2% 1:1 HCI Solution.
- The gravel and sand used had the following specifications (Table 3.1):

Table 3.1 Specification of bed media filter materials

Material	Position	Particle size (mm)	Parameters (Effective size and Uniformity coefficient)	Thickness
Coarse sand	Upper layer	0.2-5	d10 > 0.3 mm d60 < 1.5 mm 3.5 < d60/d10 < 5 portion of cohesive particles <2% Permeability: kf > 1x10-3m/sec	5 cm
Fine gravel	Median layer	2-6	D10>1.5 mm D60<4 mm d < 80 µm = < 2%	10 cm

		10-20	d10 > 10 mm d60/d10 < 2	20 cm
Gravel	Bottom layer	20-50	d10 > 20 mm d60/d10 < 2	20 cm



Coarse sand 0.2-5 mm, 5 cm

Fine gravel 2-6 mm, 10 cm

Fine gravel 10-20 mm, 20 cm

Gravel 20-50 mm, 20 cm

Figure 3.5 Bed media layering cross section

3.1.1 PIPELINES

The pipeline inlet network consists of PVC material and all valves operating manually. The selected material is capable of withstanding corrosion in the ambient conditions. As the pipe installation was completed, leak tests were conducted. At Figure 3.6, the pipeline inlet network is presented.

Figure 3.6 Pipeline inlet network from UASB to SDRB system

After the completion of the pipe network system and the backfilling of SDRB, a metal frame was constructed to support the plastic film (poly ethylene) cover of the SDRB system (Figure 3.7).

Figure 3.7 SDRB greenhouse cover structure

3.2 Construction of biofilters and installation of composter unit

Prior to the installation of the biofilters and the compost unit a canopied concrete base was constructed by MINAVRA (Figure 3.8) for the weather protection of these systems (Figure 3.8).

Figure 3.8 Construction of the canopied base for the composter and biofilter units

Then, the 1 m^3 biofilter for the treatment of compost system's off gases was installed (Figure 3.9), following the design described in chapter 2.3. Gravel of 10-20 cm was used as structural inert material for the bottom layer, pine bark for the biomaterial layer and a mix of soil, compost, and expanded clay for the upper root zone. Coconut fibre mat was placed between the layers for the efficient separation of the materials. Finally, different species were planted on the top and the irrigation system was installed.

Figure 3.9 Biofilter system for the compost off gases

The 2.6 m^3 biofilter with stainless steel base was installed and connected to the SDRB system in order to reduce the produced off gases of the treatment (Figure 3.10). Following the construction details presented in chapter 2.3, a gravel layer was placed above the perforated stainless steel separator sheet (Figure 3.11). Geotextile was used to separate this layer with the compost layer above (70 cm thickness). Finally, a 15 cm layer was placed as the upper layer of the biofilter separated again with geotextile. At the upper part, an irrigation system was installed consisted of water sprinkler nozzles.

Figure 3.10 Biofilter unit for the SDRB off gases

Figure 3.11 Biofilter detail: perforated stainless steel separator sheet

The composter unit was also installed (Figure 3.12) and the air extract pipe was connected to the 1m^3 biofilter (Figure 3.13). Finally, the electrical and network connection was established (Figure 3.14).

Figure 3.12 Compost reactor installed

Figure 3.13 Composter's gas pipe connection to the biofilter unit

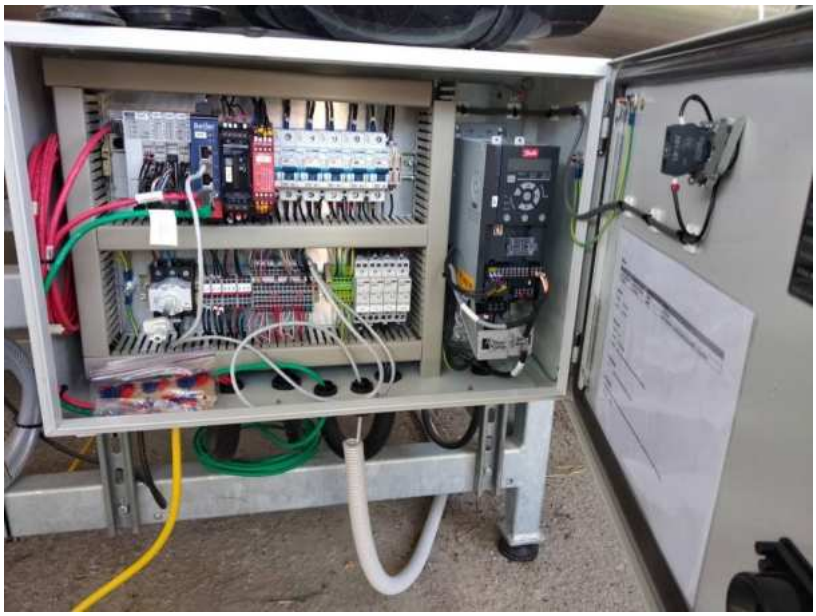


Figure 3.14 Electrical panel of the compost unit

3.3 Final Testing & Start-up

A series of tests have been performed in order finalize the process and have the integrated sludge treatment system ready to use. An indicative list of the tests performed follows:

- Test of water tightness in each sector of the SDRB
- Hydraulic testing of SDRB feeding line
- Hydraulic testing of SDRB drainage pipe
- Hydraulic testing of the SDRB beds
- Testing of the automatic control of the composting unit

- Testing of the electrical connections of the systems.
- Testing of the PLC of the composting unit
- Testing of the air tightness of the biofilters feed air pipes.

The integrated sludge treatment process is aligned with the UASB reactors' operation as it receives the excess sludge from this treatment. The UASB unit is operating since March 2021, but as this is an anaerobic process extra time is needed to reach steady state conditions that is estimated to be achieved by July-August 2021. However, for the needs of the start-up of the composting unit, a small quantity of the dewatered in the SDRB unit sludge (approximately 45 L) with an almost 10% solids content was extracted and after being mixed with shredded greens (approximately 100 L) from the agroforestry system (i.e. HYDRO2) as co-substrate (in order to achieve a moisture of 65% and C/N around 32-33), the mixture was fed into the composting unit.

More specifically prior to the start-up, dried sludge was removed from the SDRB (Figure 3.15) and some parameters, such as humidity, total solids, etc., were measured. In addition, green biomass collected from the agroforestry was produced using a shredder (Figure 3.16) in order to control the moisture of the compostable substrate and increase its C/N ratio. Dried sludge and green biomass were added in the mixer drum (2.25:9 weight ratio) to produce a homogenized mixture (Figure 3.17) with appropriate humidity level (65%) and C/N ratio (32-33), which was, then fed into the composter. Initially, the unit was fed with almost 150 L of the compostable mixture to enable the microorganism growth and the process start-up. The unit includes auger blades to slowly mix the organic matter every couple of hours, heating mats, that regulate the process temperature, which was, initially, set to 40° C, and water nozzles to increase humidity, if necessary. The system is currently under operation ((Figure 3.18).


Figure 3.15 SDRB beds in operation and sludge dewatered sludge extraction

Figure 3.16 Production of woodchip from green biomass of HYDRO2

Figure 3.17 Dewatered sludge and woodchip before entering the mixer

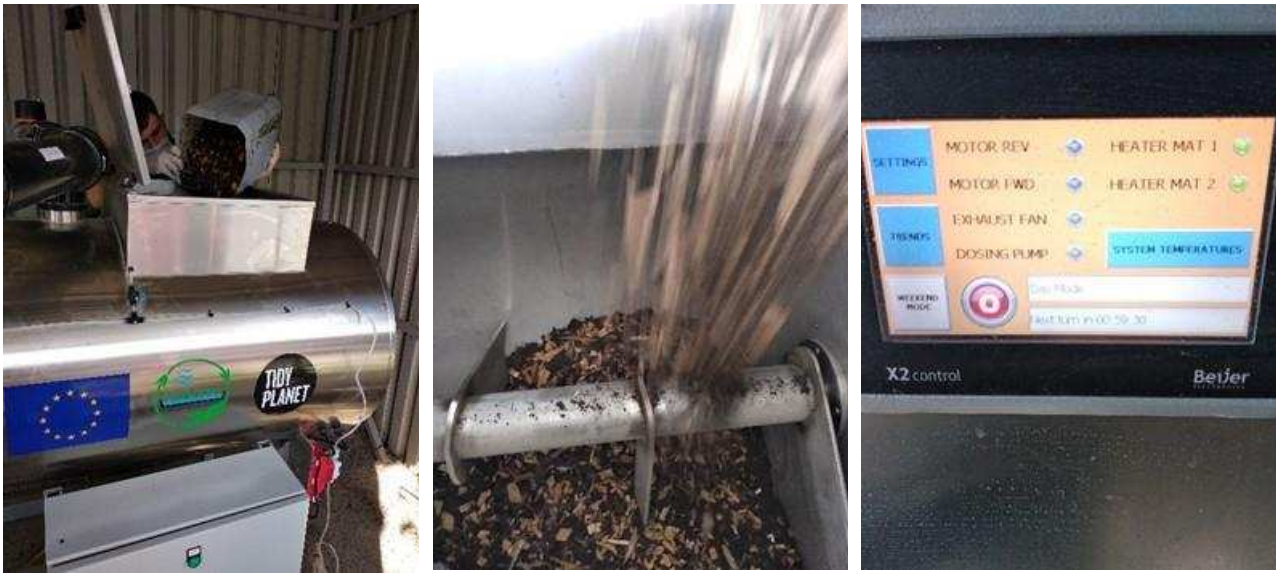


Figure 3.18 Composting unit start-up operation

3.4 Operation manual and safety instructions

The operation manuals and safety instructions are included in Annex chapter.

4. REFERENCES

Kehres, Bertram. 2010. 'Betrieb von Kompostierungsanlagen Mit Geringen Emissionen Klimarelevanter Gase'. Bundesgütegemeinschaft Kompost e.V.

Kulcu, R., and O. Yaldiz. 2007. Composting of goat manure and wheat straw using pine cones as a bulking agent.Bioresour.Technol. 98:2700–2704.

Nelson, Mark, and Hinrich L. Bohn. 2011. 'Soil-Based Biofiltration for Air Purification: Potentials for Environmental and Space LifeSupport Application'. *Journal of Environmental Protection* 02 (08): 1084–94. https://doi.org/10.4236/jep.2011.28125.

S. Uçaroğlu and U. Alkan, "Journal of the Air & Waste Management Association Composting of wastewater treatment sludge with different bulking agents Composting of wastewater treatment sludge with different bulking agents," *J. Air Waste Manage. Assoc.*, vol. 66, no. 3, pp. 288–295, 2016.

Vikrant, Kumar, Ki-Hyun Kim, Jan E Szulejko, Sudhir Kumar Pandey, R S Singh, B S Giri, and Richard J C Brown. 2017. 'Bio-Filters for the Treatment of VOCs and Odors - A Review', 15.

5. ANNEX

Hydrousa A700 Rocket Composter

Safety

This section gives an overview of all important safety aspects to ensure optimal protection of staff and safe, fault-free operation.

This manual only refers to risks that were determined in a risk assessment procedure. It does not refer to risks resulting from working conditions, the site of operation, or interfaces with foreign components.

Unauthorised Persons

WARNING!
Unauthorised Access is Dangerous!
Unauthorised persons who do not fulfil the requirements specified in this manual and are not familiar with the hazards of the work area.
To avoid safety risks, please follow the instructions below:

- Keep unauthorised persons away from the work area.
- If in doubt, address the person directly and ask them to leave the work area.
- Interrupt operations while unauthorised persons remain in the work area.

Intended use also includes compliance with all requirements specified in this manual.

All use exceeding or differing from the intended use is considered misuse and is expressly prohibited.

WARNING!
Misuse May Cause Hazards!
Misuse of this machine may lead to dangerous situations.
In particular, make sure to avoid the following forms of misuse:

- Shredding of metal parts, stones, viscous material, material contaminated with glue, explosive or flammable material.
- Shredding of material not approved by the manufacturer.
- Shredding of paper and use of a perforated screen without star-shaped inserts.
- Shredding of food products suitable for consumption.
- Shredding of long items that protrude from the edge of the hopper.
- Shredding with insufficient removal of material.
- Feeding the hopper with large amounts of dust as well as the material to be shredded.
- Starting up the machine without ensuring compliance with all safety requirements and relevant directives.

Personal Protective Equipment (PPE)

During operation of this machine, personal protective equipment must be worn in accordance with Health and Safety regulations in order to minimise health hazards.

The protective equipment required for each task must be worn at all times during operation.
Signs referring to personal protective equipment that are posted in the work area must be complied with.
The following items are fundamental requirements for all tasks:

Protective Clothing
refers to tight-fitting work clothes with high tensile strength, tight sleeves and no parts that stick out. It prevents clothing being caught up in moveable machine parts. Rings, necklaces and other jewellery must not be worn.

Safety Shoes
protect wearers from heavy falling parts and from slipping on wet surfaces.

Safety Gloves
protect hands from friction, abrasions, punctures or deeper wounds as well as from hot surfaces.

Protective Helmet
protects wearers from falling and flying parts and from material to be shredded.

Ear Protection
protects wearers from hearing damage.

Protective Goggles
protects eyes from flying debris and splashes of liquid.

Light Breathing Protection
to prevent health-damaging dust.

Safety Harness
to prevent wearers falling from heights.

Useful Hints and Recommendations

Chemical-Resistant Protective Gloves
to protect hands from aggressive substances. Check for leak tightness prior to use. Clean gloves before taking them off, then store in a well-aired location.

Special Risks

The following section defines remaining risk elements that were defined in a risk assessment procedure:

It is important that you pay attention to the safety instructions and warnings contained in the next chapters of this manual to reduce health hazards and dangerous situations.

Electrical power

DANGER!

Danger of Death - Risk of Electrocution!

Contact with live parts may result in immediate death. Damaged insulation or individual components may be lethal.

To avoid safety risks, please follow the instructions below:

- Make sure that all work on the electrical system are carried out by qualified electricians.

Switch off the power prior to maintenance, cleaning or repair work and provide a safeguard against unintentional restart

Check electrical equipment regularly.

- Exchange damaged components, cords or cables immediately.
- Keep the control cabinet closed at all times. Make sure that access is granted only to qualified electricians!
- Never clean electrical equipment with water!
- Follow all the instructions contained in the manual "Electrical Control Unit".

Safeguard Against Restart

DANGER!

Unauthorised Restart May Result in Death!

During the installation process, there is a risk that the power supply is unintentionally switched back on. This puts persons in the hazard area at risk of death. To avoid safety risks, please follow the instructions below:

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

Noise

WARNING!
Risk of Hearing Damage Resulting from Noise!
The noise level in the work area may cause severe hearing damage. To avoid safety risks, please follow the instructions below:

- Wear ear protection at all times during operation.
- Remain in the hazard area only for as long as necessary.

Insufficient Lighting

WARNING!
Risk of Injury Due to Hazards Resulting from Insufficient Lighting!
Insufficient lighting in the work area increases the risk of tasks not being completed properly due to lack of visibility. This may cause hazards that pose a risk of injury. To avoid safety risks, please follow the instructions below:

- Make sure that all work areas are lit properly.
- Make sure that defect lighting equipment is exchanged immediately.

Dirt and Stray Objects

CAUTION!
Danger of Tripping Due to Dirt and Stray Objects!
Dirt and stray objects are stumbling/slipping hazards and may cause considerable injuries.
To avoid safety risks, please follow the instructions below:

- Keep the work area clean at all times.
- Remove objects that are no longer needed.
- Mark tripping hazards with a yellow-black marker band.

Climbing on the Machine

DANGER!
Climbing on the Machine May Result in Death!
Falling off this machine may result in death.
To avoid safety risks, please follow the instructions below:

- Make sure that nobody climbs on the machine, in particular on the drive section and the protective covers.
- Make sure that only approved ladders, scaffolding or pedestals are used during maintenance work.

Pedestals and Ladders

WARNING!

Falling Off Pedestals or Ladders May Cause Serious Injuries! Pedestals or ladders that are used to reach high machine components are fall hazards and may cause extremely serious injuries if used improperly. To avoid safety risks, please follow the instructions below:

- Ensure that ladders and pedestals are stable.
- Ensure that the necessary safety distances to sources of danger are complied with.
- Ensure that only ladders and pedestals with non-slip surfaces are used.
- Ensure that safety shoes are worn.
- Ensure that sufficiently dimensioned guardrails are provided.
- Ensure that all maintenance tools are removed once the maintenance work is completed.

Overhead Loads

WARNING!

Overhead Loads May Cause Death!

Falling loads may cause severe injuries or even death.

To avoid safety risks, please follow the instructions below:

- Never stand below overhead loads.
- Ensure that loads are only moved under supervision.
- Ensure that the load is put down when the work area is left unattended.
- Ensure that only appropriate, authorised and certified hoisting devices and lifting accessories with sufficient carrying capacity are used. Always take into account the weight of the machine components to be lifted.
- Never use ripped or worn ropes and belts.
- Always take into account the provided information on suspension points.
- Do not attach ropes to protruding machine components or to hooks of fitted components.
  Ensure that the fitting accessories are attached properly.
- Ensure that ropes and belts do not rub against sharp edges and corners and are not twisted or knotted.

Tilted Loads

WARNING!

Tilted Loads May Cause Injuries!

Tilted loads may cause serious injuries.

To avoid safety risks, please follow the instructions below:

- Always safeguard components against overturning.
- Ensure that only appropriate, authorised and certified hoisting devices and lifting accessories with sufficient carrying capacity are used. Always take into account the weight of the machine components to be lifted.
- Ensure that loads are only moved under supervision.

Off-Centre Loads



WARNING!
Fall Hazard Due to Off-Centre Loads!
Handling units may have off-centre balance points. Incorrect positioning may cause the handling unit to fall and cause injuries or death.
For this reason:

- Always follow the instructions on the handling unit.
- Position the crane hook in such a way that it is located above the balance point.
- Lift the load carefully and observe whether the load tilts. Change position if necessary.
- Position the forks of the forklift under the indicated contact points of the machine. Ensure that the machine or the machine components cannot tilt. Secure the load if necessary.

Explosive Dust


WARNING!
Explosion Hazard Resulting from Dust!
If a considerable amount of dust develops from the shredded wood, there is a danger of explosion. Explosions may cause extremely severe injuries as well as massive material damage. To avoid safety risks, please follow the instructions below:

- A strict ban on smoking, open light sources, fire and/or ignition sources of all kinds must be in place in the facility and in the machine hall.
- Clean the hazard area regularly to keep it free of dust.
- Operate the machine only in conjunction with a sufficiently dimensioned extraction and/or ventilation system when dust develops.

Harmful Dust
WARNING!
Dust May be Harmful to Your Health!
In the long term, the dust you breathe in may damage your lungs or cause other damage to your health. To avoid safety risks, please follow the instructions below

- Wear a light breathing mask while working in the hazard area.
- Operate the machine only in conjunction with a sufficiently dimensioned extraction and/or ventilation system when harmful dust develops.

Highly Flammable Material
WARNING!
Highly Flammable Material is a Fire Hazard!
Highly flammable material, liquids or gases may catch fire and cause severe injuries or death. To avoid safety risks, please follow the instructions below:

- Pay attention to the safety data sheets of the material to be shredded and the machinery materials.
- Pay attention to spark formations.
- Obtain information on appropriate extinguishing agents and methods.

- Keep an appropriate fire extinguisher ready. Make sure that operating and maintenance staff are familiar with handling fire extinguishing equipment.
- Comply with local fire prevention regulations.
- Ban smoking within and around the hazard area. Do not handle open fires or ignition sources.
- In case of fire, stop all work immediately and disconnect the machine from the mains before fire-fighting measures are initiated.
- Act in accordance with the internal emergency plan in case of fire.

Hot Operating Materials and Machine Components

WARNING!
Danger of Burns Resulting from Hot Operating Materials and Machine Components!
Operating supplies and machine components can get very hot during operation and cause burns upon contact.

To avoid safety risks, please follow the instructions below:

- Check the temperature of all operating supplies and machine components prior to handling them. Let them cool down if necessary.

Machine Start-up

WARNING!
Danger of Injuries Resulting from Machine Start-Up
Persons entering the machine's hazard area are at risk of extremely serious injuries.

To prevent situations of this sort:

- Ensure that no other persons remain in the hazard area to avoid accidents during machine start-up.

Moving Components

WARNING!
Danger of Injuries Resulting from Moving Components!
Rotating and/or linear moving components may cause serious injuries.
To avoid safety risks, please follow the instructions below:

- Do not touch or handle moving parts during operation.
- Do not remove covers during operation.
- Apply caution during run-down time.
  Ensure that all components have stopped moving before removing covers.
- Wear tight-fitting protective clothing in the hazard area.

Sharp Edges and Corners

CAUTION!
Danger of Injuries Resulting from Sharp Edges and Corners!
Sharp edges and corners may graze and cut the skin.
To avoid safety risks, please follow the instructions below:

- Be very careful when working near sharp edges and corners and when handling sharp- edged components.
- If in doubt, wear protective gloves.

Sharp-Edged Material

WARNING!
Danger of Injuries Resulting from Sharp-Edged Material, such as Shredded Wood or Granulated Plastic!
Shredded or granulated material with sharp edges and pointy corners may graze or cut the skin. To avoid safety risks, please follow the instructions below:

- Never touch the discharged material during operation.
- Never touch the granulated material.
- Always wear protective gloves.

Control Cabinet

CAUTION!
Water, Dirt, Dust and Other Environmental Factors may cause Material Damage!
If the door of the control cabinet is open, there is a danger of water, dirt, dust and other environmental factors causing damage to the machine.
To prevent situations of this sort, please follow the instructions below:

- Keep the doors of the control cabinet closed at all times.
- Access should be granted to qualified staff only.
- Make sure that no water, dirt or dust gets into the control cabinet.

Safety Guards

WARNING!
Malfunctioning or Missing Safety Guards may cause Death!
Safety is only warranted when all safety guards are installed correctly and function properly.
To prevent safety risks, please follow the instructions below:

- Check that all safety guards work properly and have been installed correctly before starting work.
- Never disable safety guards.
- Only remove safety guards when the power supply has been switched off and a safeguard against unintentional restart has been set up. The machine must have come to a standstill.
- Do not climb on safety guards.

Safeguard Against Restart

DANGER!
Unauthorised Restart may Result in Death!

During the installation process, there is a risk that the power supply is unintentionally switched back on. This puts persons in the hazard area at risk of death. To avoid safety risks, please follow the instructions below:

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

Preventing Accidental or Unauthorised Restarts

DANGER!
Unauthorised Restart may Result in Death!
When work is carried out in the hazard area, there is a risk of the power supply being switched back on without authorisation. This puts persons in the hazard area at risk of death. To prevent safety risks, please follow the instructions below:

- Follow the instructions on how to prevent unauthorised or accidental restart contained in this manual.
- Always observe the following section on how to prevent unauthorised or accidental restarts.

-
- **Isolate Power Supply**
- Turn main isolator to the "OFF" position to disconnect the power supply.
-
- **Padlock main isolator**
- Protect main isolator against unauthorised restarts with a padlock.
-
- **Safely store the key**
- The key for the padlock on the main switch must be stored by the person carrying out work on the machine.

What to do in Hazardous Situations and in Case of Accidents

Preventive Measures:

First-aid equipment (first-aid kit, blankets etc.) and appropriate fire extinguishers in sufficient quantities must be kept within easy reach.

Ensure that staff are familiar with the internal emergency plan and know how to handle the fire extinguishers.
Remember that the transmission and hydraulic oils in the tank and in the lines are highly flammable.

Act in accordance with local fire protection regulations.

1. Turn main isolator to "OFF" position to disconnect the power supply.

2. Protect main isolator against unauthorised restarts with a padlock.

If personnel are injured

3. Initiate first-aid measures according to the internal emergency plan.

If the Machine is Faulty or Damaged

4. Immediately inform the person in charge that there is a fault and/or damage with the machine.

5. Only authorised, trained engineers, that have completely read and understood the instruction manual, must be used to find and rectify the fault.

Environmental Protection

CAUTION!

Improper Handling may Pose a Danger to the Environment!

Improper handling of substances that are harmful to the environment, in particular improper disposal, may cause considerable damage to the environment. To prevent safety risks, please follow the instructions below:

! - Always act in accordance with the principles for environmental protection specified in this manual.
- If harmful substances are accidentally released into the environment, appropriate action must be taken immediately. If in doubt, inform the local authorities of the damage.
- Substances harmful to the environment must always be collected, stored and transported in appropriate containers.

Lubricants

Lubricants such as grease and oil contain toxic substances and must not be released into the environment. They must be disposed of by a specialist waste disposal firm in accordance with local regulations.

Gear Oil¶
Gear oil contains toxic substances and must not be released into the environment. Please refer to the appropriate safety data sheet. Gear oil must be disposed of by a specialist waste disposal firm in accordance with local regulations.¶

Leachate¶
Compressed food waste releases leachate and must not be released into the environment. Leachate must be disposed of by a specialist waste disposal firm in accordance with local regulations.¶

Machine Components¶
Machine components that are exchanged may be contaminated by oil or grease and may thus contain toxic substances. For this reason, they must not be released into the environment. They must be disposed of by a specialist waste disposal firm in accordance with local regulations.¶

General Specifications

Specification	Value	Unit
Serial number(s)	A700	-
Machine type	Rocket Composter	-
Year of manufacture	2020	-

Capacity	700	L / Week
Service	Sludge and wood chip	-
Decibel Rating at 3m	60	dB

Weight

Specification	Value	Unit
A700 (Empty)	400	kg

Electrical Specifications

Specification	Value	Unit
Supply	230V 1ph + N + E	-
Frequency	50	Hz
Power Consumption	~2.4	kW

Operating Conditions

Specification	Value	Unit
Temperature range of the machine	0–40	°C
Temperature range of the control cabinet	5–40	°C

Relative humidity (@ max temp of 40°C)	< 70	%
Site of operation	Covered area, protected from direct humidity	

Operating Materials

WARNING!
Operating Materials and Supplies may be Harmful to your Health!
Long-term exposure to gases may cause lung damage. Long-term skin contact with the process materials may be harmful to your health.
To avoid safety risks, please follow the instructions below:

- Always consult the safety data sheets for operating materials and supplies. If necessary, request the appropriate safety data sheets from the manufacturer.
- Always follow local directives and regulations for handling the process materials.
- If in doubt, wear a light breathing mask.
- If in doubt, wear protective gloves.

Gear Oil

CAUTION!
The gearbox is maintenance-free, sealed and oiled for life!
Any unauthorised maintenance will cause damage, malfunction and total machine failure.
To avoid damage, please contact Tidy Planet for any of the following reasons:

- The gearbox starts to make grinding noises
- The gearbox starts to leak oil

Bearing Lubricant Grease

CAUTION!
The bearing is maintenance-free and does not require any grease!
Any unauthorised maintenance may cause damage, malfunction and total machine failure.

HAZARD AREAS

NOTE!
Personal Protective Equipment (i.e. safety footware, hard hat, gloves and safety glasses) must be worn when the machine is running.

Area	Hazard
Inside the Machine	The entire inside area of the machine constitutes a hazard area! During servicing and maintenance work, there is a risk of being crushed, if the service hatches are removed. Ensure mains isolator is padlocked in off position and the engineer has key!
Access Hatches	When the screw augers are running, there is a risk of limbs being amputated if the covers are removed. Therefore both hatches are protected with safety switches that will isolate the drive motor when a hatch is opened.
Discharge Chute	When the screw augers are running, there is a risk of limbs being amputated if a person puts an arm up the discharge chute.
Material to be Composted	The material to be composted may contain fine granules and sharp edges. There is a risk of cuts and infection when reaching into the material to be composted with bare hands. Harmful dusts may develop during the wood chipping process. There is a risk of inhalation or swallowing.
Electrical installation and control cabinet	When unauthorised work is carried out on the electrical installation system or the system is not installed properly, there is a danger of death by electrocution.

Control Elements

WARNING!
Inaccessible or Malfunctioning Control Elements may cause Death!
Safety can only be warranted if all control elements are easily accessible and functioning properly.
To avoid safety risks, please follow the instructions below:

- Ensure that all control elements are functioning properly.
- Ensure that all control elements are clearly recognisable and easily accessible.

Control Panel

Human Manual Interface (HMI)
The entire operation of the machine is controlled by a programmable logic controller (PLC) via an electronic HMI display with touch screen.

Main switch

DANGER!
Risk of Death and Material Damage Resulting from Accidental or Unauthorised Reactivation!
Even if the main switch is protected with a padlock, people may still be present in the hazard area. If the switch is reactivated, these persons may be at risk of death.
To avoid safety risks, please follow the instructions below:

- Never remove the padlock without authorisation.
- The key for the padlock on the main switch must be stored by the person carrying out work on the machine.
- Before removing the padlock, make sure that no other persons remain in the hazard area.

The main switch is situated on the control cabinet.
The main switch activates and deactivates the power supply.
ON → Power supply is switched on and lamp illuminated green
OFF → Power supply is switched off and lamp diminished

Securing the main switch
Use a padlock to protect the main switch from accidental reactivation and to secure it in the "OFF" position.

Safely store the key
The key for the padlock on the main switch must be kept in the possession of the person carrying out work on the machine.

Start-Up

Checks

The following checks must be carried out prior to start-up:

1. Ensure that all safety features are functional.
2. Ensure that there is no externally visible damage on the machine.
3. Ensure that the electrical connectors are not damaged.
4. Ensure that there is no foreign material in the hopper or the cutters.
5. Ensure that the machine is stocked with all required operating materials.
6. Ensure that no other persons remain in the hazard area.

Check probes are functioning
On SYSTEM TEMPERATURES page, if any of the probe texts are RED, i.e. V.TEMP1: 0°C, then there is a fault with the corresponding probe.

If all the texts are black, then check all probes are reading ambient temperature.

NOTE!
If any of the probes are red or not reading ambient, then check the cable(s) in accordance with the Schematic Wiring Diagram. If no obvious faults are found, then replace the probe(s) and/or cables and recheck all probes are reading ambient. All electrical work must be carried out by a qualified electrician.

Check the Heater Mats and Sensors are Functioning

Heater Mats and Sensors
On the machine, there are two heater mats, each with two temperature sensors

Navigate to the System Temperature Page
On HMI Homepage, touch the 'SYSTEM TEMPERATURES' button to navigate the temperatures page.

Check probes are functioning

On SYSTEM TEMPERATURES page, if any of the probe texts are RED, i.e. V.MAT1: 0°C, then there is a fault with the corresponding probe.

If all the texts are black, then check all probe temperatures are rising, as the heater mats heat up.

Check the Exhaust Fan is Functioning

NOTE!
On the HMI, remain logged into the 'MANUAL MODE'

Power the Exhaust Fan

On the HMI, touch the 'EXHAUST FAN' button for more than 2 seconds and the fan will start, indicated by:

- The button will change to a 'STOP' button
- The power indicator will turn green

Check the Fan is Turning

Check the fan blades, on the end of the motor, are turning in a clockwise direction.

Check the Water Dosing Pump is Functioning

NOTE!
On the HMI, remain logged into the 'MANUAL MODE'

Set Up the Water Dosing Pump

1. Fill a bucket with water
2. Put the inlet tube end into the bucket
3. Open one of the three toggle valves

Power the Exhaust Fan Motor
On the HMI, touch the 'DOSING PUMP' button for more than 2 seconds and the pump will start, indicated by:

Check Water is Being Pumped
After 10 seconds check water is being pumped out of the corresponding water jet.

Operating the Machine

NOTE!
The machine must only be operated by qualified staff.

Improper operation

WARNING!
Danger of Injuries Resulting from Improper Operation!
Improper operation may cause serious bodily or material damage. To avoid safety risks, please follow the instructions below:

- Perform all operational steps according to the instructions of this manual.
- Ensure all covers and safety features are installed and functioning properly before starting work on this machine.
- Never disable safety features during operation.
- Never remove safety features during operation.
- Check the machine for visible damage before commencing work.
- Keep the work area clean and tidy. Loosely stacked or scattered components and tools are accident hazards.

In case of defects, damage, unusually strong vibration or noise, switch off machine and put a safeguard against accidental reactivation in place.

Reaching and Looking into Hazard Areas

WARNING!
Reaching and looking into hazard areas may cause injuries!
Attempting to reach or look into hazard areas, for instance through the outlet conveyor discharge duct from below or into the inlet hopper from above, may cause extremely serious injuries to the head and the limbs.
To avoid safety risks, please follow the instructions below:

- Never attempt to reach or look into the hopper from above during operation.
- Never attempt to reach or look into the discharge area during operation.

Never remove protective covers during operation.

Steps to be Taken Prior to Operation

Always complete the following steps before putting the machine into operation

1. Ensure that all safety features are functional.
2. Ensure that all required protective covers are mounted properly.
3. Ensure that there is no visible damage to the machine.
4. Ensure that the electrical cables are not damaged.
5. Ensure that there is no foreign material in the composter vessel.
6. Ensure that the machine is stocked with all required operating materials.
7. Ensure that no other persons remain in the hazard area.
8. Ensure that all transport bins for feeding and discharging material are operating correctly and ready to use.

Switching on the Machine

Switching off the Machine

NOTE!
If the machine is to be turned off for a long period of time, all material must be removed from the vessel. Otherwise, the material will solidify, damaging the rotor blades and shafts.

Turn off Power Supply
Turn main isolator to the 'OFF' position, to disconnect the power supply.

Protect Against Unauthorised Restarts
Use a padlock to protect the main switch from accidental reactivation and to secure it in the "OFF" position. The engineer must keep the key in their possession.

Composter

WARNING!
Reaching and Looking into Hazard Areas may cause Injuries!
Attempting to reach or look into hazard areas, for instance through the outlet conveyor discharge duct from below or into the inlet hopper from above, may cause extremely serious injuries to the head and the limbs.
To avoid safety risks, please follow the instructions below:

- Never attempt to reach or look into the hopper from above during operation.
- Never attempt to reach or look into the discharge area during operation.

Never remove protective covers during operation.

To control the length of time the material takes to compost, the following settings can be amended on the HMI display:

NOTE!
The duration and agitation of the material directly affects the quality of the compost. Operators must fully read 'HOW TO COMPOST', see chapter A.

Navigate to Settings Page
On the HMI, touch the 'SETTINGS' button.

Login as Engineer
Touch the 'LOGIN' button, select 'SITE_ENGINEER' from the pulldown menu and enter the password.

Navigate to Process Settings Page
On the HMI, touch the 'PROCESS DAY' and 'PROCESS NIGHT' buttons.

Day/Night Mode
The duration between the vessel operating can be different during the day and night.

Start/End Time (Hours and Minutes)
Enter when your working day starts and finishes.
The hours can be set between 0 (midnight) and 23 (11 pm).
The minutes can be set between 0 and 59 minutes.
Note: These times can only be changed on 'DAY MODE' screen and the 'NIGHT MODE' screen is just for information.

Turn Every
Enter the duration before the next vessel operation.
Can be set between 5 minutes and 300 minutes (5 hours).

Normal Operation

During operation, the mixing auger will run in reverse, then pause and then run forward.

The duration controls how long the material remains inside the machine and how much the material is mixed.

Reverse Duration

Can be set between 0 and 300 seconds (5 minutes).

Pause Duration

Can be set between 0 and 300 seconds (5 minutes).

Forward Duration

Can be set between 0 and 600 seconds (10 minutes).

The HMI will display the composter in operation as follows:

HMI Home Page

To indicate the motor is operating the HMI will display:

Main Reverse (REV) and Forward (FWD)

The power indicator, either REV / FWD, will turn green.

Vessel Information Box

The vessel information box will state 'PROCESSING'.

Navigate to Settings Page

On the HMI Homepage, touch the 'SETTINGS' button.

Login as Engineer

Touch the 'LOGIN' button, select 'SITE_ENGINEER' from the pulldown menu and enter the password.

Navigate to Process Settings Page

On the HMI, touch the 'DRIVE MOTOR' button.

Motor Speed

'FREQUENCY' sets the main drive motor speed> Can be set between 30Hz (Slow) and 50Hz (Fast).

Stall Set Point

'STALL SP' sets the amperage when the main drive motor will stop, to protect the motor from damage when stalled.

Stall Delay Buffer

'STALL DB' sets the time the main drive motor can be in a stall situation before stopping.

Vessel Temperature Probes

To display the temperature probes page:

Display System Temperature Page
On the HMI Homepage, touch the 'SYSTEM TEMPERATURES' button, to display the temperatures for the vessel.

Check Probes are Functioning
On HMI Homepage, if any of the probes are faulty, the text will display red. The exhaust probes are displayed next to the exhaust fans.

Check Probes are Functioning
On the SYSTEM TEMPERATURES page, if any of the probes are faulty, the text will display **red**.

Heater Mats and Sensors

NOTE!
The two heater mats ensure that the vessel is maintained at the optimum temperature for the composting process to happen. A cold vessel will adversely affect the quality of the compost.

Heater Mat Location
The two heater mats (HM1 and HM2) are wrapped around the underneath of the vessel, under 50mm of insulation and covered in cladding.

There is temperature sensor fitted to each heater mat (HS1 and HS2).

Heat Mat Indication
On the HMI Homepage, when the mats are heating the power indicators will turn green.

Display System Temperatures Page
On the HMI Homepage, touch the 'SYSTEM TEMPERATURES' button, to display the temperatures for the vessel.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643

Heater Mat Temperatures

The heater mat temperatures are displayed two ways:

H.MAT 1:	Reading from HS1 only
H.MAT 2:	Reading from HS2 only
H.ZONE 1:	Compilation from HS1+VP1+VP2
H.ZONE 2:	Compilation from HS2+VP2+VP3

Faulty Probes

If any of the probes are faulty, the text will display **red**.

Heater Mat Settings

Navigate to Settings Page

On the HMI, touch the 'SETTINGS' button.

Login as Engineer

Touch the 'LOGIN' button, select 'SITE_ENGINEER' from the pulldown menu and enter the password.

Navigate to Heater Settings Page

On the HMI, touch the 'HEATER MATS' button

Turning Heater Mats On/Off

Touch the 'POWER' button for more than 2 seconds, the heater mat will turn off and the button will change to a red .

Set Point and Hysteresis

The SET POINT temperature is where the heater mats turn off and HYSTERESIS is the temperature drop where the heater mats turn back on (i.e. 55°C - 5°C = 50°C).

Setting Compilations H.ZONE 1 and 2

The mats can be controlled by an average of the heater mat and/or material temperatures by selecting the buttons in the boxes. When selected the buttons will turn **green**.

Electrical Cabinet

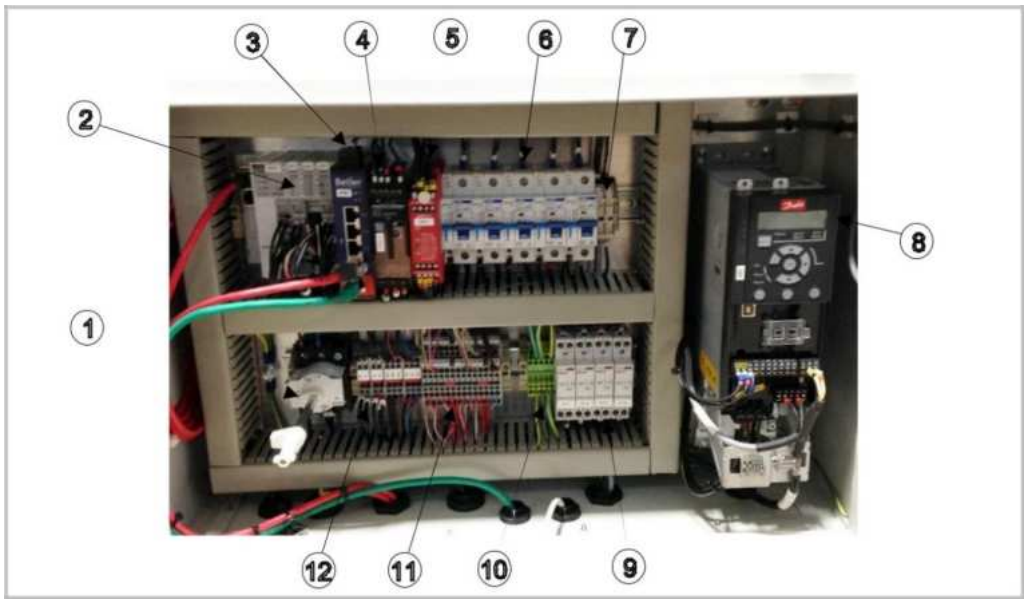
DANGER!

Danger of Death - Risk of Electrocution!

Contact with live components may cause death. Live electrical components may perform sudden jerky movements and cause extremely serious injuries. To avoid safety risks, please follow the instruction below:

Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

The electrical panel major components are located as follows:



Item	Description	QTY	Model	Manufacturer
1	Main Isolator, 3 Pole, 25A	1	P1-25/M4/SVB	EATON
2	Programmable Logic Controller	1	FnIO Series	CREVIS
3	Cloud VPN Gateway Ethernet	1	600-0001	BEIJER
4	Power Supply, 24Vdc	1	S8VK-G06024	OMRON
5	Safety Relay, Dual Channel	1	PN0ZS4	PILZ
6	MCB, 1 Pole + N	5	B10C Series	IMO
7	Terminal, Fused, 6.3A, 5x20	2	WSI 6	WEIDMULLER
8	Motor Inverter Drive, 0.75kW	1	FC280	DANFOSS
9	Contactor, 1 Pole + N	4	CN2020220	LOVATO
10	Terminal, Earth, 4mm^2	5	PTV4-PE	PHEONIX
11	Terminal, Double, 2.5mm^2	14	STTB2.5	PHEONIX
12	Terminal, 2.5mm^2	10	ST2.5	PHEONIX
End	Human Manual Interface	1	X2 Control 4	BEIJER
Front	Pilot Light, Green, 24Vdc	1	XB4BVB3	SCHNEIDER

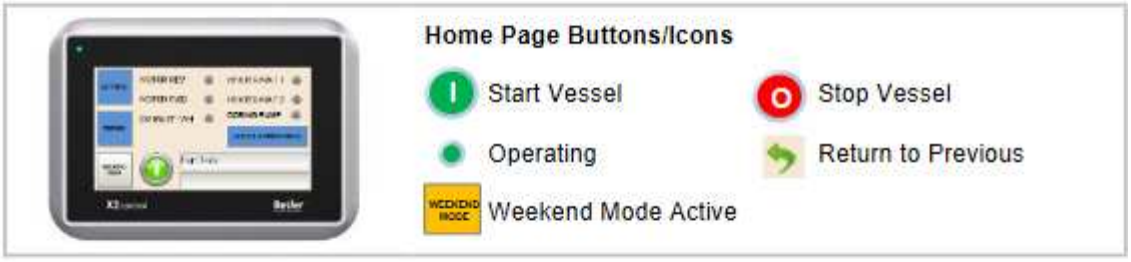
Human Manual Interface

The Human Manual Interface (HMI) allows the operator to control the Programmable Logic Controller (PLC), via accessing pages and pushbuttons, to operate the composter.

NOTE!

Modifying settings on the HMI, without fully understanding how the machine operates or what effects the changes will have, may adversely affect the quality of the compost.

Standard Icons and Information



Composter Vessel Status Texts

Waiting for start	Vessel is in standby and awaiting start.
Next turn in...	Count down to next turn of vessel mixing auger.
Reversing...	Vessel mixing auger is turning in reverse.
Pausing...	Vessel mixing auger is pausing.
Processing...	Vessel mixing auger is turning forward.

Standard Menus

The operator can access menu pages as follows:

Other Menus

On the HMI Homepage, there is one other menus:

System Temperatures Displays the system temperatures.

Access to Settings Pages

On the HMI, touch the 'SETTINGS' button and select the settings you require:

Process Day Day processing settings **Process Night** Night Processing settings **Heater Mats** Heater Mats settings **Drive Motor** Main Drive Motor settings **Exhaust Fan** Exhaust Fan settings **Dosing Pump** Dosing Pump Settings

7.7.4 Passwords and Access Levels

NOTE!

Password access should only be given to limited staff because modifying settings on the HMI, without fully understanding how the machine operates or what effects the changes will have, may adversely affect the quality of the compost.

Navigate to Login Pop-Up

On the HMI, touch the 'LOGIN' button.

Select access level required from the pulldown menu and enter the password.

Users and Passwords

There are three access levels on the HMI:

Username	Password	Level of access
USER	None	Basic access
SITE_ENGINEER	SE_001	Change some settings
SITE_MANAGER	SM_001	Total access

NOTE!

To ensure there is no unauthorised access, the HMI automatically returns to 'USER' level after 5 minutes of inactivity.

Alarm Notification Log

NOTE!
Alarm flags only appear when live alarms are present.
To enable fault finding, refer to 'MACHINE FAULT TABLE'

Navigate to Alarm Log Page
When an alarm is live, touch the 'ALARM' flag . If no live alarms are present, access via the 'SETTINGS' button and 'ALARM LOG' button.

Alarm Colour Code

RED	Live alarm and machine will not operate.
YELLOW	Auto-Cleared alarm and machine will operate.
GREEN	Cleared alarm, machine will operate.
WHITE	Historical alarm that has been cleared.

Dealing with Alarms
Alarms can be cleared and exported by using the buttons on the left of the alarm log page.

Alarm Buttons

Clears alarm, once fault has been rectified.

Exports undeleted alarms to a flash drive plugged into the USB port on the back of HMI panel.

Manual Mode

DANGER!
Restart may Result in Death!
Before switching to 'MANUAL MODE', ensure no persons are in hazard area!

To allow parts of the machine to be tested, the engineer can log in and manually power components:

Navigate to Settings Page
On the HMI, touch the 'SETTINGS' button.

Login as Engineer
Touch the 'LOGIN' button, select 'SITE_ENGINEER' from the pulldown menu and enter the password.

Navigate to Manual Mode Page
On the HMI, touch the 'MANUAL MODE' button.

Manually Power Components
On the HMI, touch one of the power button for more than 2 seconds and the motor will start, indicated by:

- The button will change to a 'STOP' button
- The power indicator will turn green

Note: The machine must be in standby to use Manual Mode

Trend Graphs

NOTE!
All historic data for motor current, heater temperatures, and vessel temperatures are stored within the HMI and can be displayed in the form of a line graph.

Navigate to Trends Menu Page
On the HMI, touch the 'TRENDS' button.

Navigate to Relevant Trends Page
For Vessel Temps, touch the 'VESSEL TEMPS' button.
For Heater Temps, touch the 'HEATER TEMPS' button.
For Motor Amps, touch the 'MOTOR CURRENT' button.

Export Trends Data
On the HMI, touch the 'EXPORT DATA' button and export data to a flash drive plugged into the USB port Located on the back of the HMI panel.

Historic Data
Graphs can be scrolled by using the buttons on the left:

 Access historic data time settings.

 Returns graph to current date.

Graph Legend
Double-Click on the graph displays the legend for the graph.

HMI and PLC Software Versions

Navigate to Settings Page
On the HMI, touch the 'SETTINGS' button.

Login as Engineer
Touch the 'LOGIN' button, select 'SITE_MANAGER' from the pulldown menu and enter the password.

Navigate to PLC/HMI Settings Page
On the HMI, touch the 'PLC HMI' button.

The current version of the software is displayed in the software text boxes:

PLC Version No. PLC201218_1

HMI Version No. A700_Hydrousa_201218_1

Saving Modifications with Recipes
NOTE!
When modifications are made to settings, they will remain in place, until the PLC loses power and the settings will revert back to the last loaded recipe. To make modifications permanent, a new recipe must be created and then loaded.

Navigate to Settings Page
On the HMI, touch the 'SETTING' button.

Login as Engineer
Touch the 'LOGIN' button, select 'SITE_MANAGER' from the pulldown menu and enter the password.

Navigate to Recipes Page
On the HMI, touch the 'RECIPES' button.

Save a New Recipe
1. On the HMI, touch the 'SAVE' button.
2. Enter new recipe name in text box (i.e. RECIPE_230420).
3. Touch the 'SAVE' button Save and the 'SAVE RECIPE' box will disappear.

Load an Existing Recipe
1. On the HMI, touch the 'LOAD' button.
2. The touch and highlight the required recipe name in the top text box (i.e. RECIPE_230420).
3. Touch the 'LOAD' button Load and the 'LOAD RECIPE' box will disappear.

Delete an Existing Recipe
1. On the HMI, touch the 'DELETE' button.
2. The touch and highlight the required recipe name in the top text box (i.e. RECIPE_230420).
3. Touch the 'DELETE' button D and the 'DELETE RECIPE' box will disappear.

Import/Export a Recipe
1.Plug a flash drive into the USB port on the back of the HMI panel.

2.On the HMI, touch either the 'IMPORT' or 'EXPORT' button.

3.The recipe will either import or export automatically

HMI and PLC Settings

NOTE!

Modifications to the HMI and PLC settings can adversely affect the machine operation. Therefore, these modifications are limited to Manager access level only.

Alarm Server Address Book

Navigate to Settings Page
On the HMI, touch the 'SETTINGS' button.

Login as Engineer
Touch the 'LOGIN' button, select 'SITE_MANAGER' from the pulldown menu and enter the password.

Navigate to PLC/HMI Settings Page
On the HMI, touch the 'PLC HMI' button.

Available Settings

The available settings are:

IP Address	Set IP address for network.
Date and Time	Set current data and time.
Backlight	Set back light brightness and time.

IP Configuration Settings

IP Configuration is available when the PLC is connected to a network via WiFi or an ethernet cable.

Obtain IP address as follows:

1. Touch 'VIEW/EDIT' button next to IP Configuration.
2. Ensure 'OBTAIN AN IP ADDRESS VIA DHCP' is selected and touch the 'OK' button.
3. The five boxes will automatically populate with values.
4. Touch the 'APPLY' button.

Date and Time Settings

Set the current Date and Time:

1. Touch 'VIEW/EDIT' button next to Date & Time Settings
2. Touch 'ARROW' buttons to scroll Day, Month, Year or Hour, Minute, Second
3. Use 'PLUS' and 'MINUS' buttons to change the values.
4. Touch 'OK' button to exit.

Back Light Settings

Set when and for how long the back light on the HMI is illuminated:

1. Touch 'VIEW/EDIT' button next to Back Light Settings
2. The slider controls the brightness level
3. Once set, touch 'OK' button to close.

Remote Access

DANGER!

Restart may Result in Death!

Before switching to 'MANUAL MODE', ensure no persons are in the hazard area!

NOTE!

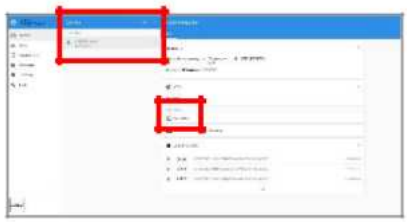
When modifications are made to settings, they will remain in place, until the PLC loses power and the settings will revert back to the last loaded recipe. To make modifications permanent, a new recipe must be created and then loaded.

Remote VNC Access

Remote access via VNC the user to operate the composter as if they are in front of the HMI.

Attaining Remote Access

1. Send an e-mail to hello@tidyplanet.co.uk requesting a remote login link.
2. When you receive the email, click on the link.
3. You will be asked to create login details using your email address and a password.
4. Once created log in.



Connecting Via VNC

1. Select your required device 'A700 Composter'
2. Click on VNC SERVER

Controlling the Composter

The user now has complete control of the HMI display, as stated in section 7.

Note: Any changes will need to be saved as a recipe.

NOTE!

Alarm Notify License (One off Purchase)

This provides the user with Email Notifications of Activated Alarms, along with them being listed within their Web Portal Login. Alarms can be configured to monitor a Change (BOOL) or say if something goes Above/Below a Set Value. Contact Tidy Planet for details.

NOTE!

Cloud Logging (Annual License)

This provides the user with Cloud Logged Data, both Current and Historic, in either Standard or Graphical Formats. Live Data can allow monitoring of Temperatures & Currents Etc, along with BOOL Tag (ie Alarms, System Status), which allows a more Simpler and Clearer way to monitor the system without having to VNC, making it safer, as VNC can be removed from user access as required. Contact Tidy Planet for details.

Default Settings

NOTE!
Modifications to the HMI and PLC settings can adversely affect the machine operation. Therefore, these modifications are limited to Engineer and Manager access.

Composter Operation

Component	Settings	Units	Low	High	Default
Day Mode	Start	hr:min	00:00	23:59	06:00
	End	hr:min	00:00	23:59	18:00
	Turn Every	min	5	300	60
Night Mode	Turn Every	min	5	300	90
Main Drive Motor	Reverse Duration	sec	0	300	30
	Pause Duration	sec	0	300	5
	Forward Duration	sec	0	600	90
	Frequency (Speed)	Hz	30	50	50
	Stall SP (Set Point)	A	3	1	12
	Stall DB (Delay Buffer)	sec	2	0	10

Heater Mats

Component	Settings	Units	Low	High	Default
Heater Mats	Set Point	°C	55	0	75
	Hysteresis	°C	5	5	20

Dosing Pump

Component	Settings	Units	Low	High	Default
Dosing Pump	Status	-	Not Fitted	Fitted	Fitted
	Run Time	sec	30	0	60

Exhaust Fan

Component	Settings	Units	Low	High	Default
Exhaust Fan	Fan Mode	Hz	Intermittent	Continuous	Intermittent
	Run Time (only intermittent)	min	10	0	60

Maintenance

NOTE!
During the warranty period, all maintenance work must be performed by the manufacturer or authorised agents.

Safety

Staff

NOTE!
All maintenance work must be handled by specially trained staff.
Ensure that all work on the electrical system is carried out by qualified electricians.

Electrical installation



DANGER!
Danger of Death - Risk of Electrocution!
Contact with live components may cause death. Live electrical components may perform sudden jerky movements and cause extremely serious injuries. To avoid safety risks, please follow the instruction below:

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

Preventing Accidental or Unauthorised Restarts

DANGER!

Unauthorised Restart may Result in Death!

During installation, there is a risk that the power supply is unintentionally switched back on. This puts persons in the hazard area at risk of death. To avoid safety risks, please follow the instructions below:

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

Machine Run-Down Period

WARNING!

Danger of injuries resulting from the run-down period of the composter vessel!

Entering the composter vessel during the motor run-down period may cause extremely severe injuries. To avoid safety risks, please follow the instructions below:

- Make sure that the machine has come to a complete standstill before carrying out maintenance work!
- Make sure that the machine has come to a complete standstill before removing the protective covers!

Improper Maintenance

WARNING!

Risk of Injuries Resulting from Improper Maintenance Work!

Improper maintenance may cause serious bodily or material damage. To avoid safety risks, please follow the instructions below:

- Comply with the specified maintenance intervals.

At least once per shift, check the machine for externally visible damage and ensure that it is in good working order and safe to run. Also check for noise and heat development.

- Exchange damaged parts and deal with faults straight away.

Keep entire machine clean - excessive dirt may cause malfunctions.

Perform all maintenance according to the order of the operational steps given in this manual.

Ensure that all work areas are easily accessible before starting the maintenance process.

Keep the maintenance area clean and tidy. Loosely stacked or scattered components and tools are accident hazards.

Always use a service platform that complies with Health and Safety Regulations. Never climb on the machine!

If components were previously removed, ensure that they have been remounted correctly, that all fastening elements are reinstalled and all specified tightening torques are complied with.

Only use approved operating materials and supplies!

Never run the machine without protective features!

After servicing and maintenance, check that all safety and protective features are reinstalled and functioning correctly!

Falling Material

WARNING!
Danger of injuries resulting from falling material!
Falling material to be composted may lead to extremely serious injuries. To avoid safety risks, please follow the instructions below:

- Ensure that the inlet conveyors are completely empty and that no more material is being fed into the machine before carrying out maintenance work.

Unsuitable Replacement Parts and Accessories

WARNING!
Unsuitable replacement parts and accessories constitute a safety risk! Unsuitable or faulty replacement parts and incorrect accessories may constitute a safety risk or cause damage, malfunction or total failure. To avoid safety risks, please follow the instruction below:

- Only use original replacement parts and accessories authorised by the manufacturer.

Harmful Operating Materials and Supplies

WARNING!
Operating materials and supplies may be harmful to your health!
Long-term exposure to gases may cause lung damage. Long-term skin contact with the operating materials may be harmful to your health. To avoid safety risks, please follow the instructions below:

-Always consult the safety data sheets for operating materials and supplies. If necessary, request the appropriate safety data sheets from the manufacturer.
-Always follow local directives and regulations for handling the process materials.
-If in doubt, wear a light breathing mask.
- If in doubt, wear protective gloves.
-If in doubt, wear safety glasses.

Non-Approved Operating Materials

CAUTION!
Danger of Material Damage Resulting from Non-Approved Operating
!
Materials and Supplies!
Using non-approved operating materials and supplies may cause damage, malfunction or total machine failure. For this reason, make sure that you:

- use only the specified operating materials and supplies.

Environmental Protection

CAUTION!
Please follow these instructions regarding environmental protection when carrying out maintenance work:

- Remove all excess, pre-used or leaked grease from greasing points and dispose of in accordance with local regulations.
- Collect exchanged oils in appropriate containers and dispose of in accordance with local regulations.

Steps to be taken Prior to Maintenance

Always complete the following steps before performing maintenance work on the machine:

1. Put the main switch in the "OFF" position to disconnect the power supply.
2. Protect the switch against unauthorised restarts with a padlock.
3. Ensure that all machine components that might have to be touched during maintenance have cooled down to room temperature before commencing work.

Maintenance Schedule

General

The following sections specify the maintenance activities required for optimal and failure-free operation. Please contact the manufacturer if you have any questions on maintenance work and intervals.

CAUTION!

The specified values are the maximum intervals between maintenance activities and apply to normal usage. If a higher level of wear is detected during the regular check-ups, the maintenance intervals must be shortened in accordance with the actual wear

CAUTION!

Maintenance of the accessories and electrical system must be handled by professionals in accordance with the intervals and instructions contained in the documentation

Composter

Component	Maintenance Activity	Interval	Chapter
Composter vessel	Check for visible external damage	Every day	-

Sludge Box and Container

Component	Maintenance Activity	Interval	Chapter
Sludge Box & Pipework	Check for blockages or leaks and clean	Every week	8.3.4
20L Container	Check for liquid level, empty, if required	Every week	8.3.4

Air Extraction System

Component	Maintenance Activity	Interval	Chapter
Air Fan Condensate	Drain condensate from fan	Every week	8.3.5
Extraction Manifold	Check for leaks, replace, if required	Every month	8.3.5

Maintenance

Cleaning

WARNING!
DO NOT USE Chemicals, Disinfectant or Anti-Bacterial Cleaners because these will Kill the Bacteria that creates Compost!
Composting is a biological process, carried out by naturally occurring microbes. Chemical, disinfectant and anti-bacterial cleaners will kill the microbes and stop the composting process!

Clean the machine and its environment as often as necessary to avoid build-up of food waste and wood dust. Only clean the exterior of the machine.

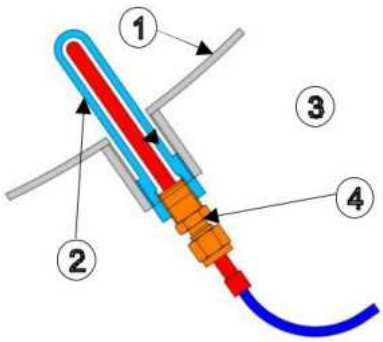
If the machine is not cleaned sufficiently, a dangerous dust/air mixture can build up inside and around the machine (explosion hazard)!

If the machine is not cleaned sufficiently, the machine will start to smell and attract flies!

Vessel Temperature Probe Maintenance

CAUTION!

! Failure to maintain the vessel probes may cause the machine to stop operating. For Vessel Temperature Probe locations, see chapter 7.5.2.
To ascertain if a Vessel Temperature Probe is faulty, see chapter 6.4.2.



Vessel Probe Components:

1. Composter Vessel Wall (grey)
2. Thermowell 12.7mm OD x 80mm Long (blue)
3. Vessel Probe 6mm OD x 150mm Long (red)
4. Male Connector 6mm OD x 1/4"BSP (orange)

To Tighten/Replace Vessel Probe:

1. Turn 'OFF' main isolator to disconnect the power supply.
2. Protect against unauthorised restarts, see chapter 2.7.

3a. **If leaking**, tighten thermowell into vessel wall, or
3b. **If faulty**, replace items 3 & 4, or
3c. **If snapped off**, replace all items 2, 3 & 4.

4. Turn 'ON' main isolator to reconnect the power supply.
5. Test vessel probe is functioning, see chapter 6.4.2.

! Ensure temperature probe is coated with heat transfer grease before fitting.
Wire in accordance with Schematic Wiring Diagram.**CAUTION!**

Sludge Box Maintenance

WARNING!
Never Use Your Hands to Clean the Sludge Boxes!
The mixing augers start automatically and limbs poked into the sludge boxes, may cause serious bodily damage. To avoid safety risks, always clean the sludge boxes with a stick or stiff brush, but never your hands!

Failure to maintain the sludge boxes may cause a blockage, allowing leachate to build-up in the machine, and cause the compost to become severely wet.**CAUTION!**

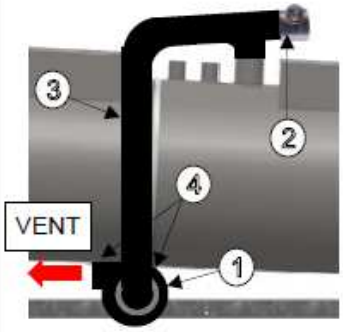
Clean Sludge Boxes:

1. Turn 'OFF' main isolator to disconnect the power supply.
2. Protect against unauthorised restarts, see chapter 2.7.
3. Unscrew the two retaining lobe nuts from the sludge box lid and put to one side.
4. Remove sludge box lid and flush drain pipe with water.
5. Carefully withdraw the sludge box filter.
6. Clean the filter using hot soapy water and allow to air dry. Do not use disinfectant or anti-bacterial cleaners.
7. Refit the filter into the sludge box.
8. Refit lid and hand tighten the lobe nuts.
9. Turn 'ON' main isolator to reconnect the power supply.

Air Extraction System Maintenance

! Failure to maintain the air extraction system, by allowing condensate to build up, may stop the water vapour removal and cause the material to become severely wet.**CAUTION**!

The air extraction system consists of:



1. **Centrifugal Air Fan**
Extracts air at a flowrate of up to 2870 l/min.
2. **Butterfly Damper Valve**
Manually balance the extracted air flow by adjusting the damper valve, 0° = Fully Open and 90° = Fully Closed.
3. **Air Extraction Manifold**
Connects fan via Ø110mm PVC soil pipe.
4. **Rubber Flex Seals**
Connect the pipework to centrifugal air fan.

Remove Condensate from Centrifugal Fan:

Any condensate in the fan can damage the motor, therefore on a weekly basis ensure the drain port, on the bottom of the fan (indicated by a red arrow), does not become blocked.

Check Extraction Manifold for Leaks:

The extraction manifold is constructed from Ø110mm soil pipe with rubbers seals. These seals can perish over time and need to be inspected every month and replaced, if necessary.

Also the manifold is connected to the centrifugal pump via rubber flex-seals, which will need the jubilee clips checking and tightening, if necessary.

Machine Faults

This chapter describes possible reasons for faults, as well as trouble-shooting steps. Machine operation must only be resumed once the fault has been rectified.

In case of frequent faults, the maintenance intervals should be shortened to reflect the actual usage.

Staff

NOTE!
All troubleshooting must be handled by specially trained staff.
Ensure that all work on the electrical system is carried out by qualified electricians.

Electrical installation

DANGER!
Danger of Death - Risk of Electrocution!
Contact with live components may cause death. Live electrical components may perform sudden jerky movements and cause extremely serious injuries. To avoid safety risks, please follow the instruction below:

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.

Preventing Accidental or Unauthorised Restarts

DANGER!¶
Unauthorised Restart may Result in Death!¶
During installation, there is a risk that the power supply is unintentionally switched back on. This puts persons in the hazard area at risk of death. To avoid safety risks, please follow the instructions below:¶

- Ensure that all power supplies are switched off before work commences and that a safeguard against unintentional restart is provided.¶

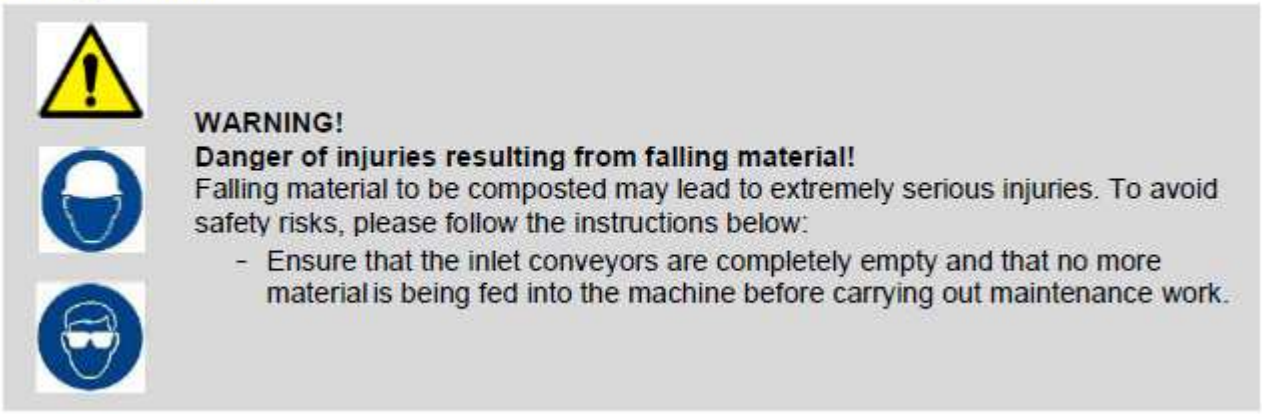
Machine Run-Down Period

WARNING!¶
Danger of injuries resulting from the run-down period of the composter! Entering the composter vessel during the motor run-down period may cause extremely severe injuries. To avoid safety risks, please follow the instructions below:¶

- Make sure that the machine has come to a complete standstill before carrying out maintenance work!¶
- Make sure that the machine has come to a complete standstill before removing the protective covers!¶

Improper Troubleshooting

Falling Material



Steps to be Taken Prior to Troubleshooting

Always complete the following steps before any attempts at troubleshooting:

1. Put the main switch in the "OFF" position to disconnect the power supply.
2. Protect the switch against unauthorised restarts with a padlock.

Machine Fault Table

General

Fault	Possible Cause	Troubleshooting
HMI display blank	Mains power supply has failed.	Check incoming power supply.
	Fuse F1 has blown.	Replace 6.3A 5x20mm fuse.
	Main switch in ’OFF‘ position.	Turn ’ON‘ main switch.
Machine not operating	Machine in ‘STANDBY MODE‘.	Start machine on HMI,
	Hopper Lid is open	Close hopper lid.

Composter Drive Motor

Fault	Possible Cause	Troubleshooting

Temperature Probes

Fault	Possible Cause	Troubleshooting
Vessel Temperature Probe not operating	If HMI alarm "Vessel Probe # Open Loop" is active, then vessel probe is faulty.	RTD sensor failed or damaged, replace, Check wiring for electrical faults and repair, if required.
Ambient Air Temperature Probe not operating	If HMI alarm "Ambient Air Temperature Probe Open Loop" is active, then probe is faulty.	RTD sensor failed or damaged, replace, Check wiring for electrical faults and repair, if required.
Exhaust Temperature Probe not operating	If HMI alarm "Exhaust Temperature Probe Open Loop" is active, then probe is faulty.	RTD sensor failed or damaged, replace, Check wiring for electrical faults and repair, if required.

Heater Mats and Sensors

Fault	Possible Cause	Troubleshooting
Heater Mat 1 or 2 not heating	If HMI alarm " MCB Trip – Heater Mat #" is active, then MCB12 or MCB13 has tripped.	Reset MCB12 or 13 Check wiring for electrical faults and repair, if required. Check heater mat 1 or 2 for electrical faults and replace, if required.
	If HMI alarm "Heater Mat # - Sensor Open Loop" is active, then probe is faulty.	RTD sensor failed or damaged, replace, Check wiring for electrical faults and repair, if required.

Sludge Boxes and Container

Fault	Possible Cause	Troubleshooting
Compost too wet due to Leachate not draining from vessel	Sludge box blocked.	Clean sludge box
	Drain pipework blocked.	Clean pipework
	Container full of leachate.	Empty container

Air Extraction System

Fault	Possible Cause	Troubleshooting
Fan not operating	If HMI alarm " MCB Trip – Exhaust Fan" is active, then MCB11 has tripped.	Reset MCB11,
		Check wiring for electrical faults and repair, if required.
		Check fan for electrical faults and replace, if required.
Compost too dry	Damper valve too open.	Increase valve opening,
	Fan run time too long.	Decrease fan run time, see chapter
Compost too wet	Fan or manifold blocked.	Clean condensate,
	Damper valve open too wide.	Reduce valve opening, r
	Condensate drain port blocked.	Clear drain port
	Fan run time too short.	Increase fan run time