S.F. IMPIANTI GROUP Ltd

Full West Managment

FWM®

Plant for the treatment of municipal solid waste (MSW) model BIOROT300® having a total processing capacity of 44 tons/hour of mixed urban waste with an average PCI of 2500 kcal /kg.

The **System**

Plant for processing of 44 tons/hour (equivalent to about 365,000 tons/year) of unsorted municipal solid waste (MSW) or similar.

The system, as detailed in the following pages, consists of 3 main sections:

1. **Pre-treatment plant;**
2. **Plant BIOROT300®;**
3. **Energy production plant.**

The system overall is characterized by innovative and patented technology components, with ***air pollution guaranteed less than 30%*** of the limits established ***by European standards*** on this subject, regardless of the nature of the waste entering the plant.

The system works correctly with all types of civil and/or industrial waste, including special hazardous waste and toxic waste, whether solid, liquid or gas.

The actual energy yield of the system depends on the calorific power of the waste actually introduced in the system: the assessments made below are based on the assumption of an average PCI of 2500 kcal/kg.

Summary:

1. Pre-treatment plant

The pre-treatment plant consists of 2 automatic parallel lines for each . **BIOROT300®** able to process until 44 tons/hour, that guarantee a continuity of working up to about 1,000 tons/day on two 8-hour shifts (that means up to a maximum of 1,500 tons/day on three 8-hour shifts) for each plant.

The installation of 2 parallel lines for each **BIOROT300®** ensures the continuity of waste processing, without interruption even during the routine maintenance operations, which are frequent because many components are highly stressed and subject to wear and therefore subject to periodic inspections and parts replacement (resulting in frequent line shutdown).

The purpose of the pre-treatment plant is to shred the input materials and take them to the optimal size to be able to carry out the separation and the recovery of easily recyclable materials:

- ferrous metals (magnetic separation),

- aluminium and other non-ferrous metals (induction separation),

- glass and inert (gravimetric separation),

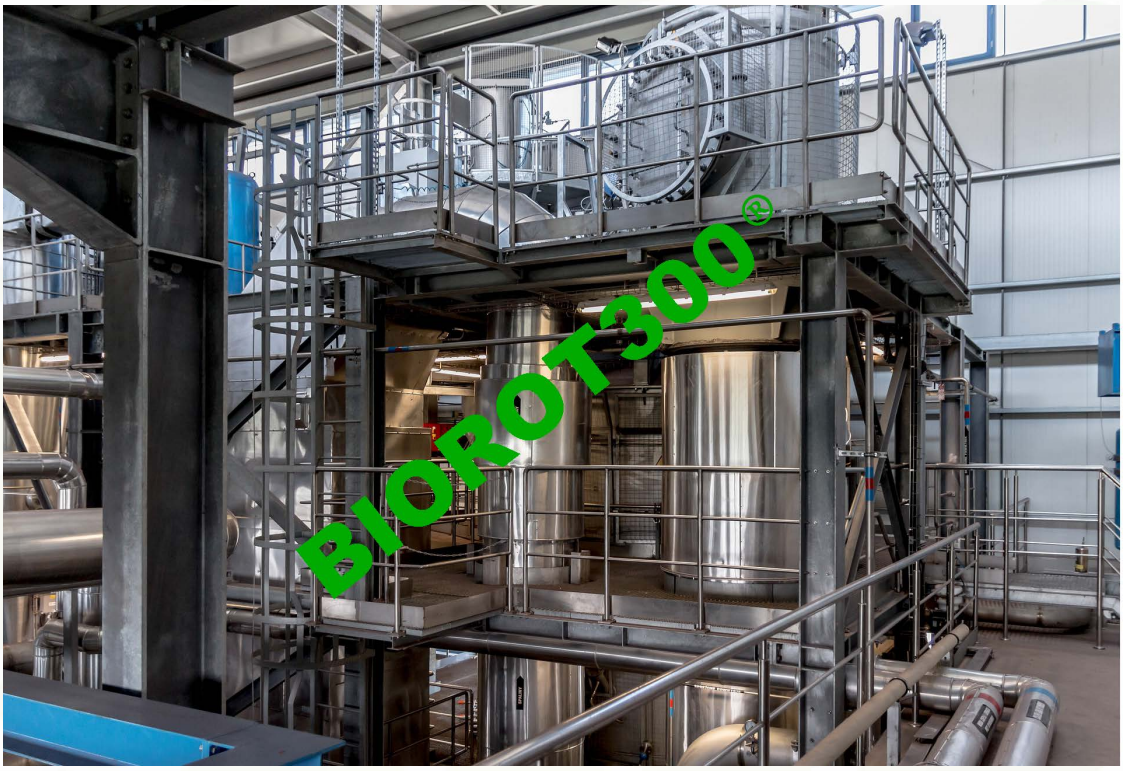
- plastic and tire (optical separation).

The separated materials are collected in order to be used in the plant or for sale.

2. Plant BIOROT300®

2.1. General description

The BIOROT300® is an inclined rotary furnace (***patented***), particularly suitable for the treatment of municipal solid waste (MSW), but it is also very effective for the treatment of generic civil and industrial waste, woody nature waste, biomass or other organic waste materials, even in conditions of high humidity and low calorific power, those require an accurate mixing with the combustion air in order to ensure an adequate combustion efficiency (> 97%).



The plant consists of a central rotating main chamber (***patented configuration***) and two fixed parts at the ends: a load front head and a discharge rear head.

The continuously “hot” loading system, inserted in the front head, is equipped with a hopper of accumulation and feeding, mounted directly above the loading mouth, and it ensures that the input material quantity depends on the temperature present at the interior of the main chamber.

The loaded material advances in the main chamber for the inclination and rotation effect, ensuring complete mixing of the waste. The waste residence time can be adjusted through variation of the speed of rotation of the chamber, thus adapting the process to each type of waste introduced always in order to obtain the lowest amount of produced ash and the absence of unborn matter.

The process is developed in 3 phases, which are realized in 3 successive areas of the main chamber:

Area 1: in this phase takes place the drying of the waste and the first violent combustion with gasification and oxidation of the volatile substances.

Area 2: in this phase takes place the slow combustion of waste with thermal pyrolysis of volatile substance, until exhaustion.

Area 3: in this phase takes place the roasting and the final oxidation of the slags, which are brought close to the melting point (pre-melting of slags).

The pre-melted slags are discharged continuously and collected in a container.

On the discharge rear head is mounted a coaxial burner long flame (patented), able to develop a particularly bright flame (reducing), turbulent and long, which develops for about a third of the length of the main chamber.

At the exit, the pyrolytic gases are added with preheated external air in controlled quantity (controlled secondary air) and they are re-burned in the after-burner chamber with a temperature greater than 1200°C (greater than 1500°C in the case of special hazardous waste and toxic waste with chlorine content greater than 1%) according to the EEC Regulations 2000/76 Annex V.

At the exit, the gases are sent to the flue gas dry cleaning system (patented): **today this system represents the best available technology (BAT) and it has the purpose of making the air pollution next to zero, or below the sensitivity thresholds of the available instruments, so that they can read only something equal to "ZERO"**.

2.2. Waste loading system

The waste loading system requires a temporary collection bunker for the incoming waste (daily storage pit in C.A.), besides different loading devices, even with simultaneous operation, between those described below:

- The loading screw, with adjustable rotation speed, which is used for:
  - ✓ shredded municipal solid waste;
- The loading hydraulic pusher, which is used for:
  - ✓ special hazardous waste and toxic waste, retained in their packaging, - waste resulting from water treatment,
  - ✓ gaseous waste retained in their cases.

- The injection pump, with adjustable flow, which is used for:
    - ✓ pumpable sludge waste,
    - ✓ liquid waste.

All loading devices are equipped with an automatic control system that adjusts the amount of waste entered into the chamber, depending on the temperature present at the interior of the main chamber.

2.3. Slags discharging system

At the end of the process there is a compound that consists of pre-melted slags similar to glassy sand, which are free of unburned, according to EWGA standard, and are able to exceed the biological tests on eluate. The pre-melted slags are discharged continuously, due to the rotation of the chamber, in the sump , below which is mounted a scraper lifting belt (Redler), working under water head, therefore they lose out a fast cooling (thermal quench) in consequence of which they shatter and are reduced to glass sand, conveyed in a container. The water head has the function of cooling the slags' lifting belt, both to ensure a hydraulic seal against the entry of unwanted air in the chamber.

2.4. Gas cleaning system

The ***patented*** flue dry gas cleaning system (**NZEP® Near to Zero Emission System**) ensures that the chimney emissions are less than 30% of the limits established by the EEC Regulations 2000/76 Annex V. The actual values measured duly can be lower up to 90% than the thresholds required by the Regulations.

The concentrations of pollutants outgoing from the chimney can be determined accurately during the design phase using a dedicated calculation software that obtains the expected emissions from the quantity and typology of waste to be treated. Furthermore, with a software based on Sutton's theory, it is possible draw the fallout emissions maps on the cartography of the place and create an accurate forecast of the impact of the plant on the air pollution value already existing in the installation area.

During the operation, the emissions values are continuously measured by means of an analysis control unit with sampling probes and related instruments approved according to the Regulations in force.

The measures done are continuously and automatically compared with alert thresholds, they are recorded on HD for a period of maximum 20 years (data acquisition system DAQ) and they are transmitted to remote operators and to authorities, as specific data and as aggregate information, statistically processed.

The effective pollutant reduction is the result of working conditions in the after-burner chamber where the fumes can reach a temperature greater than 1500°C in the presence of O2 free in concentration higher than 6% vol. and always for a contact time greater than 2 seconds.

These conditions ensure the total destruction of benzoic compounds (dioxins and furans), also if already present in the waste.

The reconstruction of dioxin molecules is prevented by the subsequent very rapid cooling of gas and the injection of urea into the system during cooling. The NSCR system decreases the percentage of Cl free present in the gas thereby it reduces the possibility of re-formation of dangerous macro molecules.

The gas goes through the first stage of pre-dedusting, which favours the deposit of dust due to the lower flue speed (decantation effect) and to the particular motion inside. The dust is removed from tubes effect of mechanical vibration and falls into the collecting hoppers.

Afterwards the gas is sent to the flue gas dry cleaning system where it is mixed with extremely fine chemicals reagent.

In the first stage (high efficiency bag filter), the gas is dry dedusting: the output emissions are lower than 5 mg/Nm^3.

In the second stage (patented), the pollutants are removed by means of a very fast cooling process and the aerosols are collected in a tank.

In the third stage (very high efficiency bag filter), the gas is dry dedusting once again: the output emissions are lower than 0.5 mg/Nm^3.

As alternative to the traditional chimney, the discharge into the atmosphere is made by means of a biofilter, which is able to filter the CO2 and partially convert it into free O2, in addition to eliminate any residual traces of organic or acid substances still present. ***NO CHIMNEY***

On the following pages there are the tables for emission limits in the atmosphere.

Table 1 – Air pollution obtained with first and second stage

Polluting substances	Air pollution half-an-hour average value (unless otherwise noted)	
	Measured value on existing plant	**Limits value**
Dioxins and Benzofurans: Tetrachloro Pentachloro Hexachloro Heptachloro Octachloro Average value over 8 hours	< 0.1 mg/Nm^3 zero (not detected in the measurement made)	< 0.1 mg/Nm³ TE
Total polycyclic aromatic hydrocarbons Average value over 8 hours	0.01 mg/Nm³	0.01 mg/Nm³
Total particulate matter	< 2 mg/Nm³	< 10 mg/Nm³
HCl (hydrochloric acid)	< 20 mg/Nm³	< 60 mg/Nm³
HBr (hydrogen bromide)	2 mg/Nm³	< 3 mg/Nm³
HF (hydrofluoric acid)	1 mg/Nm³	< 4 mg/Nm³
SO_2 (sulfur dioxide)	< 200 mg/Nm³	< 200 mg/Nm³
CO (carbon monoxide)	< 50 mg/Nm³	< 100 mg/Nm³
C.O.T. (total organic carbon)	< 10 mg/Nm³	< 20 mg/Nm³
Nox (nitrogen oxide)	< 200 mg/Nm³	< 200 mg/Nm³
Total heavy metals	< 3 mg/Nm³	< 3 mg/Nm³
Sum over one hour of Hg	< 0.05 mg/Nm³	< 0.05 mg/Nm³
Sum over one hour of Ti + Cd	< 0.05 mg/Nm³	< 0.05 mg/Nm³
Sum over one hour of: As, Sb,Pb, Cr, Co, Cu, Mn, Ni, V, Sn	< 0.5 mg/Nm³	< 0.5 mg/Nm³

All values in the table are referred to dry fumes with concentration of O_2 free equal to 11% vol.and in normal conditions(t.a.= 25°C e p.a.= 101.3 KPa).

Table2–Air pollution obtained with first, second and third stage

Polluting substances	Air pollution half-an-hour average value (unless otherwise noted)	
	Measured value on existing plant	**Limits value**
Dioxins and Benzofurans: Tetrachloro Pentachloro Hexachloro Heptachloro Octachloro Average value over 8 hours	< 0.05 mg/Nm^3 zero (not detected in the measurement made)	< 0.1 mg/Nm³ TE
Total polycyclic aromatic hydrocarbons Average value over 8 hours	0.005 mg/Nm³	0.01 mg/Nm³
Total particulate matter	< 1 mg/Nm³	< 10 mg/Nm³
HCl (hydrochloric acid)	< 10 mg/Nm³	< 60 mg/Nm³
HBr (hydrogen bromide)	1 mg/Nm³	< 3 mg/Nm³
HF (hydrofluoric acid)	1 mg/Nm³	< 4 mg/Nm³
SO_2 (sulfur dioxide)	< 100 mg/Nm³	< 200 mg/Nm³
CO (carbon monoxide)	< 25 mg/Nm³	< 100 mg/Nm³
C.O.T. (total organic carbon)	< 5 mg/Nm³	< 20 mg/Nm³
Nox (nitrogen oxide)	< 100 mg/Nm³	< 200 mg/Nm³
Total heavy metals	< 2 mg/Nm³	< 3 mg/Nm³
Sum over one hour of Hg	< 0.05 mg/Nm³	< 0.05 mg/Nm³
Sum over one hour of Ti + Cd	< 0.05 mg/Nm³	< 0.05 mg/Nm³
Sum over one hour of: As, Sb,Pb, Cr, Co, Cu, Mn, Ni, V, Sn	< 0.5 mg/Nm³	< 0.5 mg/Nm³

All values in the table are referred to dry fumes with concentration of O_2 free equal to 11% vol.and in normal conditions(t.a.= 25°C e p.a.= 101.3 KPa).

2.5. Quantity of waste processed

The quantity of waste processed continuously in the plant BIOROT300® depends on waste typology available, according to the table below:

Table 3 – Quantity of waste processed

Waste typology	Quantity [kg/h]
RSU with PCI 2500	15.000
RSU with PCI 1800	21.000
Organic waste	60.000
Waste of slaughter	47.000
Animal meals	21.000
Organic pellet	28.000
Hospital waste	8.500
Paper and cardboard waste	10.000
Woody biomass	17.000
Biological sludge	41.000

3. Energy production plant

The energy production plant works on the thermal energy produced by BIOROT300® and it includes an high efficiency boiler, particularly suitable for the production of super-saturated steam up to 51 bar absolute (50 ATE equivalent to about 700 PSI) and at 450°C. The produced steam is went ahead to a multi-stage axial turbine that spins an alternator group able to generate electricity in the desired setting.

4. Reference standard

The design, the materials, the construction, the installation, the start-up and testing will be done in accordance with EU Directives and standards ASTM / DIN / AISI / UNI / CEI besides the national laws applicable to the installation site.

5. Technical data

- Total area required: about 60,000 square meters;
- Covered area required: about 50,000 m² of different heights up to 20 m maximum;
- Quantity of waste processed: see Table 3 ;
- Temperature in the chamber: 1050 ÷ 1350°C
- Temperature in the after-burner chamber: 1400 ÷ 1500°C ;
- Emissive flow: 20,000 ÷ 30,000 Nm³/h ;
- Air pollution: see Table 2 ;
- Quantity of slags discharged: about 6% wt. ;
- Electrical power consumption: 900 Kw ;
- Super-saturated steam flow: 10 ton/h ;
- Maximum boiler working pressure: 60 bar ;
- Steam temperature output the boiler: > 400°C;
- Electrical energy power available: **24 MWe**
- Thermal energy power available: **8 MWt**

6. General condition of supply

6.1. Terms of delivery

Design: 60 days after signing the contract

Construction: 180 days after

Transportation: 30 days after

Installation: 60 days after

Start-up and testing: 30 days after

Total time required: about 360 days after signing the contract, excluded events that involve stops for causes of force majeure.

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