

# MICROWAVES IN BIOLOGICAL WASTE UTILIZATION PROCESSES

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## CARBONISATION OF WASTE

Food processing is one of the most important domains in human activity. Due to such factors like urban development, increasing density of population in cities and economic conditions there has been a noticeable intensification of food production processes.

Factories, which already exist, and recently created for meat, poultry, fish and any other kind of food processing, produce very often enormous amount of waste. Although they use modern technologies to maximize the usage of processed biological material, in most cases waste is still very disturbing and hazardous for the environment. It requires special storage and transportation conditions. Its utilization is difficult and therefore very expensive. Usually this kind of waste contains a lot of water (from 50% up to 90% of the total weight!), it very easily becomes a source of bacterial contamination and offensive odours. Some good example may be poultry waste processing, such as blood, feathers, paws, etc. Similar problems occur when local, huge sewage-treatment plants are being built and the utilization of sewage sludge is necessary.

At present very popular and developed methods of utilization of biological waste, namely the waste consisting of water and animal or plant organic substances as well as organic sewage sludge, consist in preliminary waste dehydration and then incineration. In some cases the incineration is not necessary: after waste dehydration and sterilisation some kind of waste may be used in agriculture, for instance in soil

fertilization. Generally, dehydration of biological waste is an expensive process due to the necessity of vaporization large quantities of water and high temperature of the process that must guarantee sterilization.

This article presents some innovative MCS (Microwave Carbonisation System) technology of utilization of wide range of organic waste. Application of this method, prepared and implemented in the ATON-HT SA company, enables to simplify the procedure of organic waste neutralization. The method eliminates the necessity of troublesome and expensive transportation and in the same time enables to reduce costs of the whole process. The main idea of the method presented is to apply the process of carbonization of the organic substance after dehydration using the microwave energy.

Successive phases of waste carbonization process with appliance of MCS method is shown in a block diagram figure 1.

In the assumed conception the utilized material is dried while being transported along, for instance helical conveyor with intensively heated walls by hot oil flowing through a closed-loop system. The circulating oil is heated electrically as well as with hot effluent gases, enabling energy recover. Steam evaporating from the substance during dehydration process flows through the special passage to a chamber in the first part of the helical conveyor. Next it condenses on the wall of the transporter and pre-heats the cool material

inserted from waste chamber. It enables to recover part of the energy used for water evaporation from the material.

Dried up material is transported into a microwave chamber where it is heated up to high temperature (500 - 600°C) in oxygen deficiency atmosphere, causing the pyrolysis of treated material. Gases released during the process, including pyrolytic gases from the microwave chamber, are delivered via passage equipped with an exhaust fan into a special construction of microwave gas purifier called MOS (Microwave Oxidation System), constructed and developed by ATON-HT. The device includes a special ceramic balls bed heated up by microwaves. Effluent gases with addition of air forced through the layer are heated up to the temperature of 800°C - 1000°C where organic components of gases undergo a complete oxidation (are efficiently burnt).

Hot gases which exit the Microwave Oxidation System (MOS) are used to reheat the oil used for heating up the material in the drying zone in the helical conveyor. Such solution minimizes the consumption of energy necessary for vaporization the large quantities of water from the material.

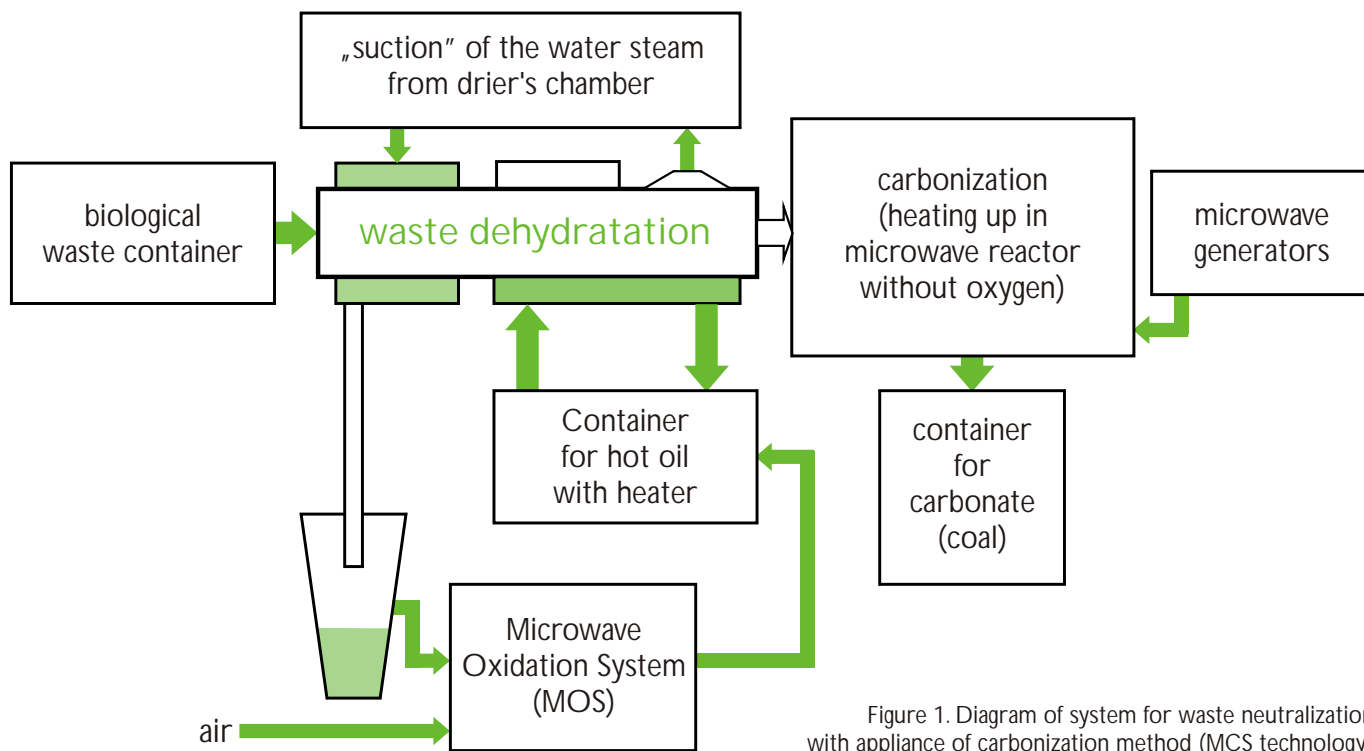


Figure 1. Diagram of system for waste neutralization with applience of carbonization method (MCS technology)

This shortly described thermal waste treatment might be applied in many ways, depending on the kind of processed waste, its composition and possible way of managing the products of the process.

In many cases, in order to neutralise waste sludge, only dehydration and sterilization are required (to achieve efficient destruction of hazardous bacterial flora). System for conduction of such a process will not be equipped with microwave reactor to perform carbonization, but only with a container to enable quick cooling of dried sludge.

Other version of the system based on the described technology is device for wastes neutralisation on poultry processing plants. Such waste might contain blood, feathers, paws and other materials useless in production process. Similar solution might be applied in neutralisation of veterinary waste, for example wastes after occurrence of hazardous animal diseases, such as rabies, bird flu, etc. In those cases, it is justified to apply full waste carbonization, because waste reuse after dehydration is not allowed,

due to the possibility of contamination with bacteria, which are highly resistant to sterilisation.

Figure 2 shows an exemplary system, which might be used in neutralization of post-production waste, for instance in poultry

processing plants, meat processing plans, fish processing plans or in neutralization wastes of poultry farms.

The device presented on Fig.2 is a closed-loop and wasteless system. There are the following types of

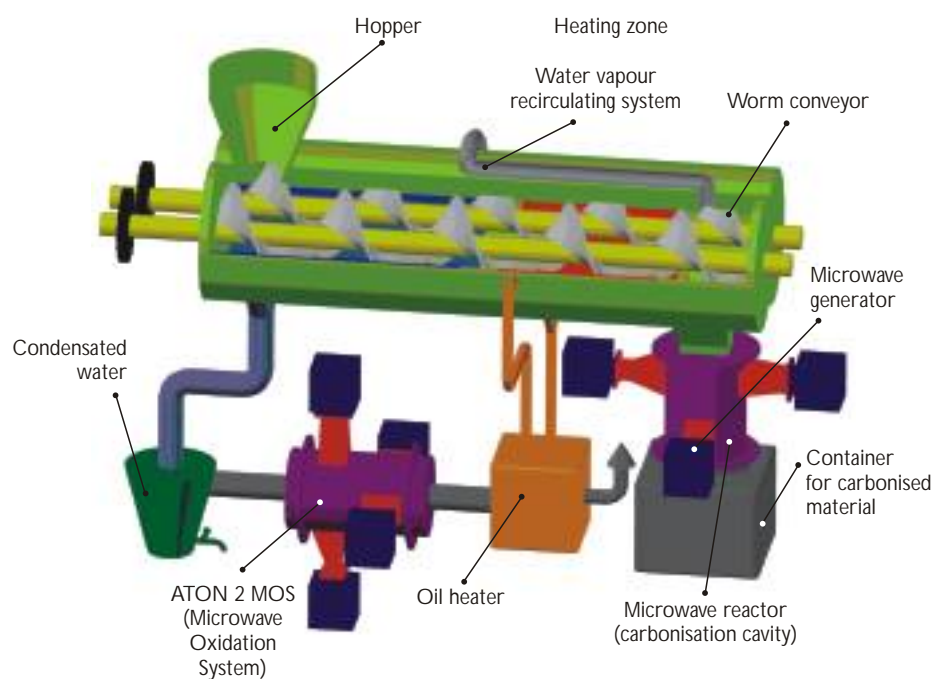


Figure 2: Diagram of a system for organic waste carbonization.

process residues:

- oxidised gases from MOS;
- condensed water;
- carbon as a solid product of carbonisation process.

Most important characteristic features of MCS system:

- Low energy consumption, due to recovery of most of the energy used for vaporization of water.
- Pyrolytic gases released from microwave reactor undergo after-burning process in Microwave Oxidation System (MOS) and the energy obtained in this process is used for additional heating up of oil, which heats up drier's walls. This technology allows considerable reduction of necessary energy consumption in dehydration of waste.
- The process is wasteless, because its only residue is carbonate (coal), which might be used in many branches of industry, for example in pharmaceuticals. Moreover, the alternative solution assumes burning coal - the energy obtained in this

process might be used for heating up oil.

- Gasses emitted during the process do not contain any hazardous substances and are not the source of offensive odours due to appliance of MOS oxidation system, which fully oxidises organic substances.
- Implemented system based on described technological concept might be fitted on containers and transported directly to waste storage sites it enables to conduct the waste carbonization process at waste storage site (in situ). This method eliminates necessity of troublesome and expensive waste transportation.

### Summary

Technology of dehydration and carbonisation of organic waste is consecutive example of successful application of microwave energy in waste neutralisation process. This solution is a result of continuation of scientific research and development based on the first innovative

technology of MTT concerning neutralisation of asbestos, introduced by ATON-HT SA. Works concerning neutralisation of asbestos proved the necessity to purify gases from hazardous substances derived from asbestos waste contaminated with paint, oil or gases with asbestos fibres, what finally resulted in construction of Microwave Oxidation System (MOS). But on the other hand, tests concerning thermal processing of waste in MTT Reactor, including organic waste, plastic, etc., have shown some unique possibilities related with carbonization and pyrolysis of some substances. Combining MTT method and MOS reactors leads to development of MCS technology. As a result detailed technological solutions is being formed. Those methods and technologies are of crucial importance in neutralization of wide group of waste, including ones highly hazardous for people and for environment.

## CASE STUDIES

### 1. Poultry industry waste.

Technical parameters:	
Capacity	500 kg/h
Water content	90%
Oil heating system power, max	400 kW
Water condensing system efficiency	50% min
MCS reactor power	10 kW
MOS reactor power	10 kW
Installed power of the system	420 kW
Power consumption during process (typical)	220 kW
Functioning mode	Continuous
Heating-up time	30 min

Process residues:

- biological carbon with highly developed surface;
- water after water vapour condensation;
- exhaust gases (air and water vapour)

## 1. Catering waste.

Technical parameters:	
Capacity	100 kg/h
Water content	70%
Oil heating system power, max	60 kW
Water condensing system efficiency	50%
MCS reactor power	10 kW
MOS reactor power	10 kW
Installed power of the system	80 kW
Power consumption during process (typical)	50 kW
Functioning mode	Continuous
Heating-up time	20 min

Process residues:

- biological carbon with highly developed surface;
- water after water vapour condensation;
- exhaust gases (air and water vapour)