

MICROWAVE PYROLYSIS OF BIO- MEDICAL WASTE

INTRODUCTION

APC Technologies, a Gurgaon based company is in the business of developing customised microwave heating based instruments for diverse applications. The company has also developed microwave heating based equipment for Bio- Medical Waste (BMW) treatment. Two of the equipment, namely, Microwave Disinfection System and Microwave Hot Air Sterilisation System have been tested and certified for their efficacy by a reputed laboratory of Government of Maharashtra.

A major disadvantage of the various BMW treatment technologies is that they result in the generation of secondary waste which requires land filling or incineration for final disposal. Recently we have developed a novel method for the disposal of BMW which not only disinfects/ sterilise BMW but also changes its physical characteristics. This microwave heating based application called "Microwave Pyrolysis" can treat BMW comprising of plastics, cloth and paper and disintegrates it into carbon, oil and burnable gases.

PYROLYSIS

The word is coined from the Greek-derived elements pyr "fire" and lysis "separating". **Pyrolysis** is thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 200 °C .

Pyrolysis thus involves the thermal degradation of organic material in the absence of oxygen. The benefit of this application is taken in the treatment and disposal of BMW and its conversion into useful products such as carbon, oil and burnable gases.

MICROWAVE PYROLYSIS

Microwave heating

Microwaves are electromagnetic waves that enter into or penetrate materials. When exposed to microwave energy, all dipole molecules of a mass are put to vibrations. The friction of vibrating molecules produces heat instantly throughout the volume thus making it more uniform. BMW, which comprises of plastic, rubber, paper etc., is inert to microwaves, which means it can't be heated by microwaves. For heating BMW, therefore, microwave susceptors are used to attain requisite temperatures. Susceptors are those materials which absorb microwaves and themselves attain high temperatures to heat the surrounding media. Susceptors thus act as heating elements in a microwave field.

Underlying Principle

- Microwaves breakdown the carbon bond,
- Exposure to microwaves is accomplished in an anoxic atmosphere,
- Absence of oxygen prevents combustion and causes pyrolysis,
- The pyrolysis products carbon, oil and gases are all useful products. Untreated materials in the waste like glass and needles are simultaneously sterilized.

Advantages of microwave pyrolysis of BMW are

- Microwave heating requires shorter heating times
- For microwave heating, the composition of BMW is less important
- It is one step BMW treatment and disposal method
- It is eco- friendly as there is no secondary waste generation
- By products have potential for revenue generation
- Other materials like glass and needles etc. are sterilized and can be physically separated from carbon

Microwave induced pyrolysis is a comparatively recent process initiated in India by Falcon Microwave Technology that combines the advantage of microwave heating with the environmental benefits and commercial opportunities arising from the pyrolysis of BMW.

MICROWAVE PYROLYSIS SYSTEM FOR BMW

Instrument Features

- SS 304 L pyrolysis reactor
- Wave guides for the passage of microwave
- Multiple magnetrons with forced air cooling with blower
- Vacuum pump for evacuation of reactor chamber and removal of gases
- Condensers for vapor condensation
- Gas collection tank
- Control panel

Description of equipment

The heart of the equipment is a leak proof pyrolysis reactor consisting of a 100 litre horizontal cylindrical vessel with doors on either side. Microwaves are led into the reactor through wave guides. Microwave generation and temperature- pressure control is carried with a PLC. Waste packets are inserted in the vessel through one of the opening. An outlet is provided which is connected to two condensers and a scrubber in series. A vacuum pump is connected at the end to first remove air from the reactor vessel and later on off gases. The microwave generators are put on with the help of the control panel. Pyrolysis starts at a temperature of $>200^{\circ}\text{C}$. The out gases are condensed with the help of water cooled condensers. The gases which are not condensable are passed through a scrubber and then to a gas collection tank. The reaction is complete in ~ 2- 3 hours depending upon the waste type. Conditions for pyrolysis are required to be optimized by the site personnel for best results. The broad specifications are given in Annexure- 1.

BY PRODUCTS

By products of BMW pyrolysis are

- Carbon (~30 - 40 %)
- Oil (~30 - 40 %) and
- Burnable gases (~ 30 – 40 %)
- Untreated Glass, needles are left with carbon and can be separated

ANNEXURE - 1

SPECIFICATION OF MICROWAVE PYROLYSIS SYSTEM (MPS)

Microwave Pyrolysis System: Model MPS/BMW/100L/ 4WG

Specifications

Sr. No.	Parameter	Specification
1.	Microwave distribution system	Multiple magnetrons with diffuser for homogeneous microwave distribution
2.	Microwave power	6 KW, 2450 MHz. Expandable up to 8 KW
3.	Delivered microwave power	User selective from minimum to maximum
4.	Microwave cavity	100 Litre, S.S 304 L
5.	Dimensions of cavity	Dia.: 400; Length: ~ 800 mm
6.	Electronics	Separated from reactor body through wave guides
7.	Wave guides	SS 304 L make
8.	Safety interlocks	Sufficient number of safety interlocks to prevent microwave leakage and exposure to operator
9.	Microwave leakage	< 0.005 W/ Cm ² at 12" distance
10.	Cooling system	Exhaust blower for magnetron cooling
11.	Power requirement	230V/ 50Hz/ 15 A
12.	Vapour collection	Water cooled condensers for oil collection

*The specifications are subject to change depending on the user requirement and without affecting the performance of the system

APPLICATION AND ADVANTAGES

- In house treatment and disposal of BMW
- Disposal of general organic waste
- Useful for centralized BMW treatment facilities
- Reduction in land fill requirement
- Revenue earning from by products

OUR OTHER SERVICES

Knowhow and consultancy for

- Microwave disinfection system
- Mobile units for BMW treatment
- Microwave disinfestation of food grains
- Microwave extraction system
- Microwave sample digester
- Other customized applications R & D applications