



## **TBF Various Rotoclave® Technology Applications**

The **TBF Rotoclave®** system is an automatically controlled, front-loading, cylindrical static pressure vessel that uses saturated steam, under pressure, to sterilize all waste in a batch process (or cycle) for a specific time at temperature (TAT) duration specific to various applications. The static pressure vessel is provided with a unique internal rotating drum designed to contain and mix various materials. While the basic design of each system is similar, the operation can change depending on the specific market application. The following shows only a few of the applications currently being processed in the **Rotoclave®**.

### **I. Municipal Solid Waste (MSW) Processing**

The **TBF Rotoclave®** system is a modular waste processing system that is scaled to fit specific community, or township, applications. Our goal is to make it a sustainable and scalable solution for public/private industries to obtain and operate these systems on a local level, without the need for long-term financial subsidies.

A multitude of methods and policies have been “tried” around the world attempting to **Reduce, Reuse, Recover, and Recycle** the ever-changing diversity of materials contained in **Municipal Solid Waste (MSW)**. These methods have been grossly ineffective due to the cost of getting all the material separated at the source, as well as the problematic handling of the organic components. Organic components typically make up 50 to 60% of the MSW, and due to their mix with other non-organic components, they become difficult, laborious, and costly to separate by mechanical and/or manual methods.

The **TBF Rotoclave®** vessel allows the processing of “unsorted MSW” directly as received from the standard collection trucks. Once the MSW has been dumped from the collection truck onto the Processing Plant Waste Floor, a preliminary separation of “large Items” will be performed. These Large Items (such as refrigerators, machinery, furniture, rolls of carpet, etc.) do not require processing

in the **Rotoclave**<sup>®</sup> vessel since their components can be better recovered for their effective reuse and recycling purpose.

The **TBF Rotoclave**<sup>®</sup> provides the innovative integration of existing technologies into one process for the effective pre-treatment of large volumes of solid waste. One of the more compelling benefits of this application is that the technology is also an effective method of sterilization, allowing **Municipal Solid Waste [MSW]** and **Bio-Medical Waste [BMW]** streams to be combined if needed. This helps to maximize available revenue, while avoiding redundant infrastructure investments, and fully eliminating detrimental effects to human health.

As a result, the **TBF Rotoclave**<sup>®</sup> system technology is ideal for cost-effective, post-treatment, mechanical separation, and recovery of materials. This is applicable in a great diversity of commercial/ industrial applications such as the following:

**A. Reduce, Reuse, Recycle, and Recovery Operations**

This type of operation is financially viable when the client is interested in the mechanical recovery of three types of materials that typically compose MSW worldwide:

1. Materials with a market value
2. Materials without a market value but with Energy Value
3. Materials without market and/or energy value

**B. Waste to Energy Operations**

This type of operation utilizes the various technologies described above, but additionally installs highly advanced technologies that transform the separated **Materials without market value but with Energy Value**, turning them into **Refuse Derived Fuel (RDF)**.

The RDF has been dried using the waste heat of the power energy generation equipment, followed by density separation equipment, removing inorganic fractions as well as small metallic fractions. The result is a highly energy valuable RDF.

The RDF is then fed into a unique innovative solid fuel disintegrator system provided with:

- i. **Feed Bunker Conveyor**

- ii. **Loaders**
- iii. **Controlled Molecular Solid Fuel Disintegrator (DCS), or molecular pyrolizer.** The RDF is disintegrated in the 2<sup>nd</sup> chamber where high beam infra-red rays create an atomic flora, which is fed into the 3<sup>rd</sup> chamber where the re-molecularization occurs with the generation of a synthetic gas (Syn-Gas), which is then fed with a stoichiometric ratio of SynGas and facility air which has been internally heated to the same temperature of the syngas in the system 2<sup>nd</sup> and 3<sup>rd</sup> chamber perimeter.
- iv. **Steam Recovery Boiler (Heat Exchanger).** A triple-insulated, four-pass, high-yield boiler (above 90%) that can provide high-pressure steam.
- v. **Turbine Electrical Power Generator units.** Composed of a single-stage, high-speed, efficient steam turbine. This converts steam into energy by driving a gear reducer from the high-speed turbine operation into a lower speed standard 4-pole electrical power generator. The remaining low-pressure steam is used to power the *Rotoclave*<sup>®</sup> system.

The electrical power generated is used to provide all the facility needs, with the excess sold into the area Electrical Power Grid.

### C. **Biofuels Operations**

Since Biofuels can be produced from plants or agricultural, domestic, and/or industrial biowaste, the **TBF *Rotoclave*<sup>®</sup>** based MSW Processing system is perfect to precede any type of biofuel operation in a waste-derived business or industry.

Since most organic waste components found in MSW are of vegetative cellulosic fraction, the typical technology used with the **TBF *Rotoclave*<sup>®</sup>** for the generation of Biofuels is Hydrolysis; either enzymatic (biochemical) or acid (chemical) for generation of Ethanol.

This type of operation utilizes the various separation technologies described above but particularly targets the already **sterilized cellulosic and hemicellulosic fractions** which have been transformed into a pulp state during the *Rotoclave*<sup>®</sup> process.

In the enzymatic hydrolysis process, through the dynamic action of the hydrolytic enzymes, the cellulose and hemicellulose polysaccharides are transformed into fermentable sugar to generate the needed Ethanol Fuel at the end of the hydrolysis process.

## II. “Dry” Animal Digestion

The two alkaline hydrolysis methods to treat abattoir waste are the Wet Method and the Dry Method. The Dry Method utilizes the water that is already available from the animals themselves (approximately 65% of water by weight is available in most animals). Using the **TBF** dry method requires less steam to bring the digestate to the operational temperature of 150° C (302° F), while greatly shortening the overall process cycle and reducing the operating costs.

The **Rotoclave**<sup>®</sup> drum rotation and tumbling over the internal helix accelerates the animal hydrolysis with the caustic digestate and the steam. The hydrolyzed animal turns into a thick liquid (similar to the appearance of molasses) and, once cooled to the desired temperature (between 65° C (149° F) and 95° C (203° F)), will discharge from the **Rotoclave**<sup>®</sup> drum into the **TBF** provided SS molds, where the digestate cools and gradually solidifies.

The **TBF Rotoclave**<sup>®</sup> Dry Digestor is provided with operating programs adapted to suit the specific animal digestion requirements. Some of the requirements are based on the size of the animal, whether it is frozen, and any local regulatory requirement controlling specific Time at Temperature (TAT). Typically, it takes between 30 minutes to 60 minutes to complete the TAT.

**NOTE: This timeframe is for animals that DO NOT exhibit signs of TSE (Transmissible Spongiform Encephalopathy). A longer TAT in the TBF Rotoclave<sup>®</sup> Dry Digestor processing might be required by government agencies if TSE is suspected.**

## III. Regulated Medical Waste (RMW) Processing

The **TBF Rotoclave**<sup>®</sup> system **thoroughly sterilizes all RMW it processes** in each batch. The batch time can fluctuate according to the size and capacity of the model selected, as well as the waste type processed. The **Rotoclave**<sup>®</sup> system operates on the proximity and precautionary principles, reducing and/or removing the risk as much as possible.

We typically use the following analogy to help clients visualize the thorough Sterilization always achieved in the **Rotoclave**<sup>®</sup> system.

The **Rotoclave**<sup>®</sup> system is analogous to a Clothes Dryer. Due to the constant tumbling, the “Sterilizing Heat” exposes every single material being treated, just as a clothes dryer does when drying clothing. This guarantees the Sterilization of **ALL** processed Waste **100%** of the time.

Static Autoclaves would be analogous to a Clothes Dryer where the drum **DOES NOT** tumble. This would leave a pile of wet clothes in the middle and bottom of the drum, and only the clothing on the outside of the pile would be dried. **In the case of Sterilization, the material in the middle and bottom would be unsterilized with live pathogenic activity.**

The **Rotoclave**<sup>®</sup> system has been designed with safety in mind. Because of the mechanical, hands-free loading process, operators are never exposed to the possibility of infection. No shredding/grinding, sorting, or recycling occurs until full sterilization is complete.

Additionally, beyond the 100% sterility it always achieves, the great versatility of the **Rotoclave**<sup>®</sup> system is its’ capability to process pathology wastes and confidential documents, as many of our facilities do worldwide.

The **Rotoclave**<sup>®</sup> system operates in excess of the “Gold Standard” autoclave parameters. Our process applies vacuum cycles, pressure, and temperatures above the norm for sterilization, and in addition, forcefully agitating the load during the whole batch process.

The range of materials that our clients process in their **Rotoclave**<sup>®</sup> system varies widely, mostly due to local regulatory restrictions. They can range from typical materials that are in contact with any pathogenic activity and/or contact with patients or providers (such as gowns, linens, cleaning and curing materials, medicine containers, and/or infected equipment) to pathology waste (including ER and/or OR anatomical discharges, birthing areas, and disposed animals and/or animal portions from veterinary clinics and schools, laboratories, liquids, blood and blood products, glass, metals), therefore avoiding extra waste-streaming by the generator.

#### **IV. International Regulated Garbage (IRG) Processing**

The U.S. Department of Agriculture, Animal, and Plant Health Inspection Service (APHIS) are responsible for ensuring the welfare of American agriculture by preventing the introduction of animal and plant pests and diseases into the United States.

One essential component for accomplishing this mission is to ensure the **effective sterilization** of this **International Regulated Garbage (IRG)**.

The **TBF Rotoclave**<sup>®</sup> system is authorized by the USDA APHIS to sterilize all IRG entering the US via any of its entry points as controlled by the U.S. Department of Homeland Security (DHS), as well as the U.S. Customs and Border Protection (CBP). The **Rotoclave**<sup>®</sup> system is operated in a batch process, and can be guaranteed exposure to the same sterilizing conditions, unlike continuous processes.

#### **V. Research Material Processing**

As with all the **TBF Rotoclave**<sup>®</sup> system applications indicated above, we can physically modify our pressure vessel, as well as the operational program, to tailor any particular application.

In the past, we have created units that were designed to research operations to study the property changes of Coffee beans, and one other more recently presently studying the effects of coatings in construction materials.

Additionally, we are presently exploring other clients' interesting applications, such as one for the processing of pharmaceuticals, and another for the coating of wood chips.

If you have other applications where a pressure vessel can be helpful in your planned commercial/industrial business, feel free to contact **TBF** today to start a productive research interaction.