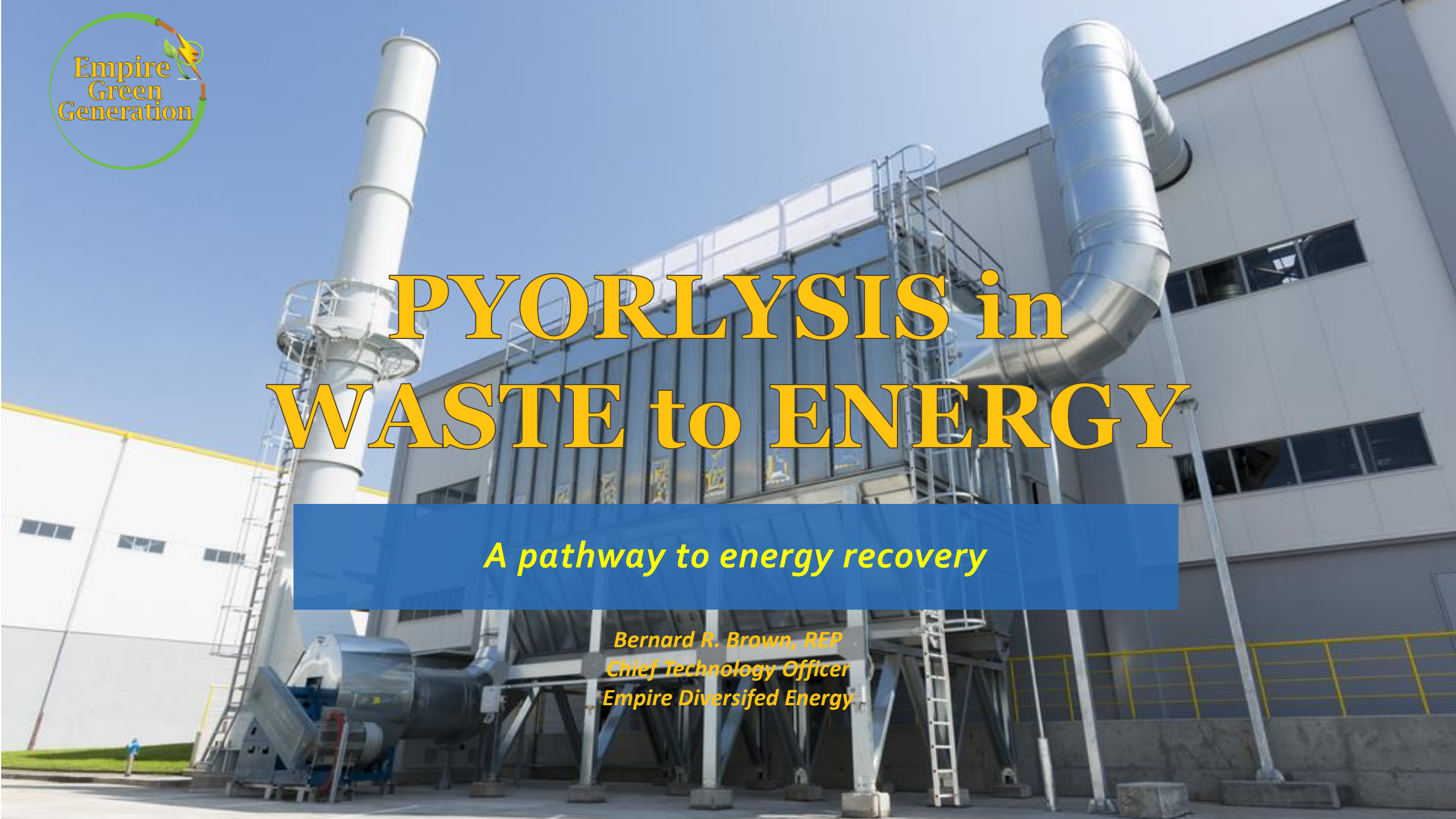


PYORLYSIS in WASTE to ENERGY

A pathway to energy recovery

Bernard R. Brown, REP
Chief Technology Officer
Empire Diversifed Energy

Waste to Energy Overview

Waste to Energy

Waste to Energy is the process of the recovery of embodied energy from feedstock/resources using thermal chemical conversion processes to produce another energy source.

Waste-to-Energy (WtE) technologies consist of any waste treatment process that creates energy in the form of electricity, heat or transport fuels (e.g. diesel) from a waste source.

Key Technology & Processes

Incineration- the oldest method of waste to energy

Gasification- limited oxygen in the process

Plasma Arc Gasification- uses a plasma arc for thermal destruction of material: produces a very rich syngas

Thermal depolymerization- often used to produce a liquid fuel

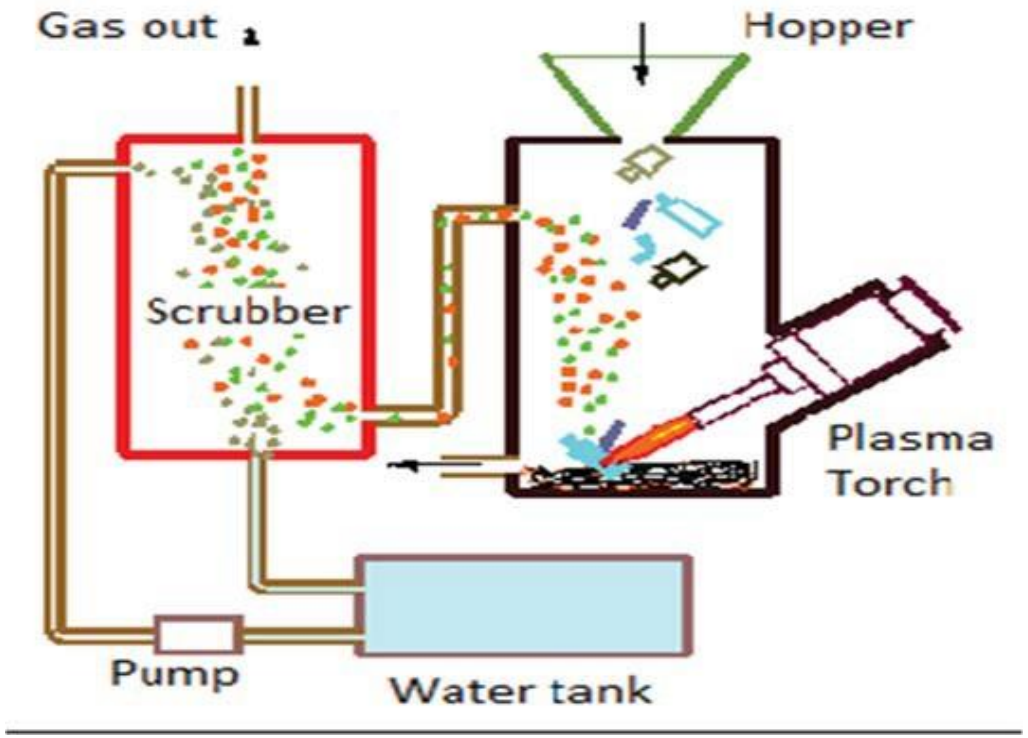
Anaerobic digestion- closed vessel biological decomposition to produce a methane gas

Pyrolysis- high heat in the absence of oxygen

Pyrolysis

Pyrolysis

Empire Green Generation uses thermochemical process using elevated temperature environment in an oxygen-starved closed-loop system using medical waste as a feedstock to produce a synthesis gas (Syngas). Syngas is a mixture of carbon monoxide, hydrogen and other hydrocarbons that is generated from the pyrolysis of the biomass materials from the medical waste. Empire Green Generation will be using 2 Phase Pryrolizers including an Infeed System, along with an HRA retort and Residue Decarbonization system.



Stage 1 in the Process

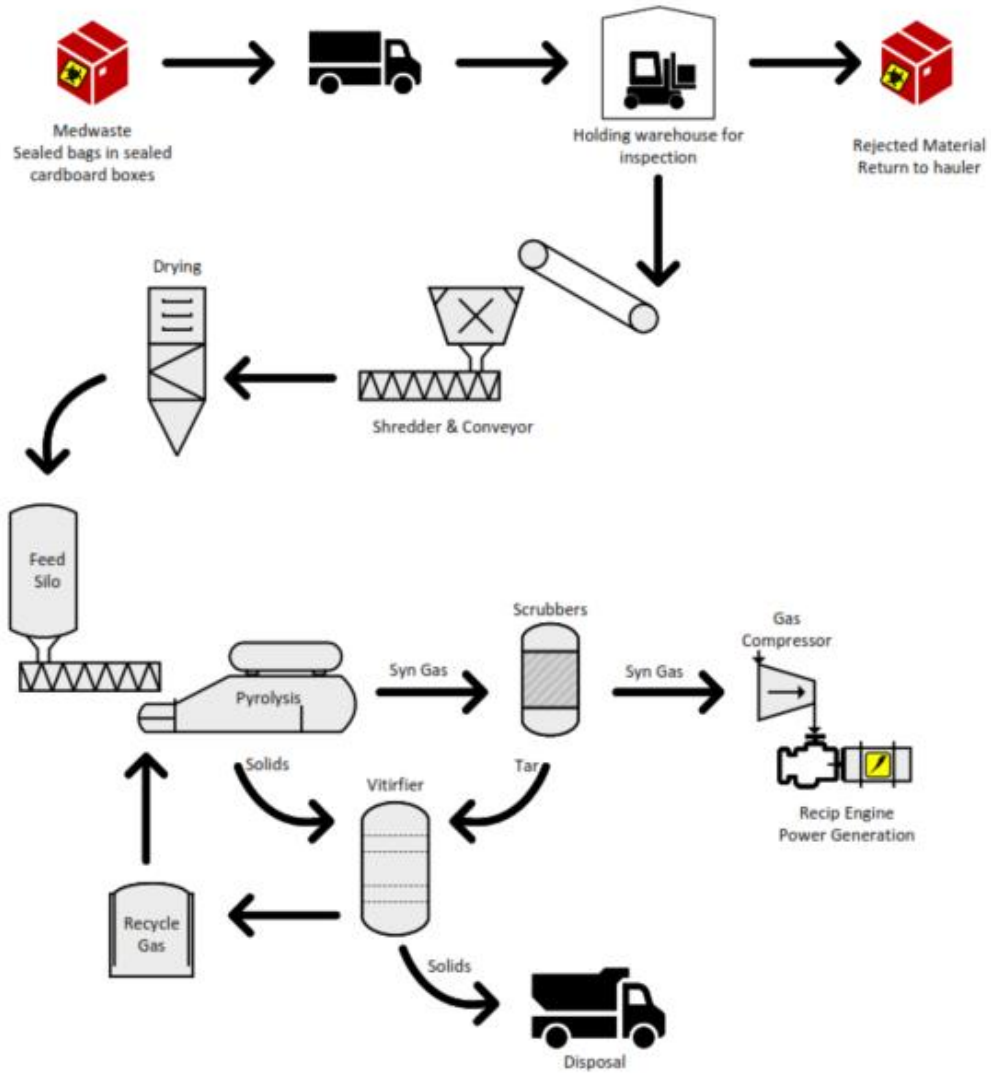
Separating, Shredding, Drying & Recycling

Feedstock needs to be shredded and separated into recyclables and/or feedstock, put through a dryer process, and eliminated through a pyrolysis process, in a closed loop system, that will create Syngas to power the generation of clean energy.

The goal of shredding is to reduce the size of the feedstock to reduce the time needed for thermal breakdown.

Design OVERVIEW

The process is designed to be a closed loop operating system with minimal contact with the feedstock. The project is designed where all byproducts have beneficial reuse, and no waste is sent to a landfill from the process. The project is a true recycling operation.

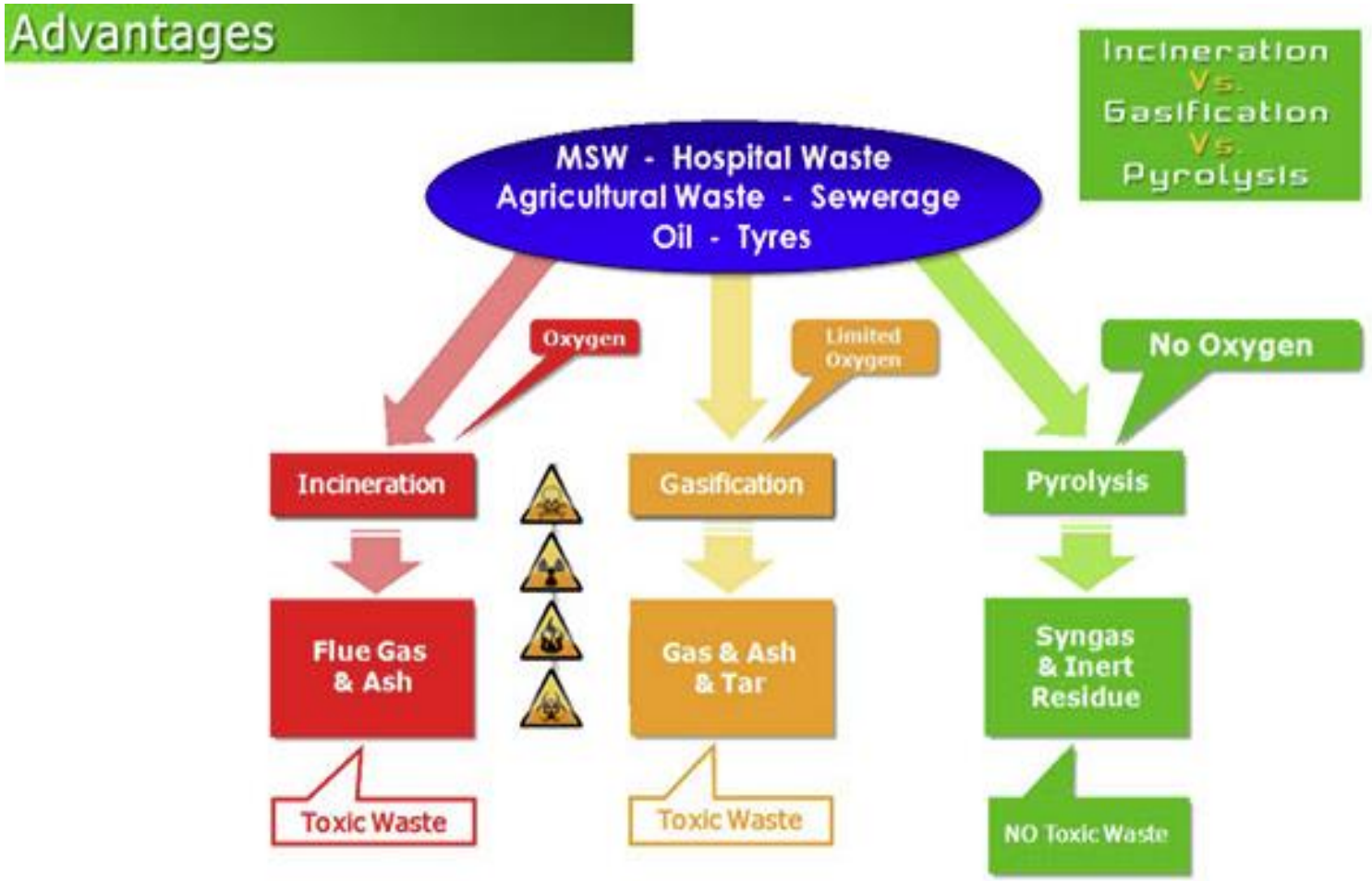


The GOAL of POWER GENERATION OVERVIEW

Power Generation

Depending on the project size the synthesis gas produced from the process can be used to feed into a power generation set. Gas clean up is required and is often one of the most expensive part of the process.

Advantage of Pyrolysis



Projects are Ideal for Brownfield Development

Technical Feasibility

Proven Technology

Overview Process Description

The process has the waste material entering a granulator/shredding unit to reduce the size of the solid waste to generate a more uniform consistency. The wastes exiting granulated/shredded are fed into the dryer. All received waste material will be fed into the granulator/shredder to allow for the processing in the dryer.

Shredding/Chipping

The process requires material/feedstock to be reduced before entering the pyrolysis system. The goal is to reduce the surface area of material to allow for a faster thermal decomposition time while inside the pyrolizer. The shredding system is considered an emission source point based on the technology system and will be the largest impact on maintenance.

Dryer

The dryer will be a typical two pass, co-current, direct contact dryer. The hot air used to dry the shredded material will, by direct contact with a hot gas stream, rapidly heat the waste stream up to a temperature sufficient to dry the solid materials. The dryer will vaporize the high vapor pressure materials that may be present in the stream. Mainly, this will be water. But some other materials could be vaporized in the dryer.

The composition of the waste material exiting the dryer will be controlled to have a moisture level of approximately 10%. No free liquids will be in the solid waste stream when it exits the dryer. The vapor stream generated by the drying process, is directed to the RTO for destruction.

The final dryer configuration will be designed to meet the requirements of this installation. This will be done during the final equipment design phase of the project.

Technical Feasibility Report

Pyrolysis

The solid waste material is next processed by the pyrolysis unit. Pyrolysis units are typically used in many industries in various conditions to heat a specific material line under very controlled heat and atmosphere (internal) conditions. Most pyrolysis systems can handle however various feedstocks will impact the quality of the synthesis gas being produced.

The pyrolysis unit will heat the waste material in a very low oxygen environment. This design will breakdown the carbon, hydrogen in the material allowing the carbon, hydrogen and other volatile materials to separate and form an carbon rich gas. This is the synfuel. The exit temperature needed to generate the synfuel from the waste streams will be constantly monitored and be adjusted to provide the desired outlet gas composition.

The synfuel gas stream will be divided into two streams based on the current operational capacity of the system. One stream will be utilized to fuel the dryer heating system. The other will be directed to a condensing scrubber system. Tars and other organic materials will be separated from the fume stream in the scrubbers. These tars and organic materials will then be utilized as fuel for the process and also to operate electric generators.

Technical Feasibility Report

Vitrifier
The processed solid materials from the pyrolysis unit will be transferred into a secondary heating device. This will increase the temperature of the solids to a level that will further reduce the carbon and other lower vapor pressure materials in the solid waste stream.

The vapors generated in the vitrifier will be induced into the pyrolysis unit heating section to provide fuel for the pyrolysis unit. As with the pyrolysis unit, the fumes from this component will then be directed to the RTO.

RTO
The RTO is a standard design unit that will accept the fumes and fuels generated by the process. Fumes from the dryer, after passing through a cyclone to remove particles, will be heated to a temperature sufficient to meet the regulatory requirements.

Technical Review
The major components of this system are well defined in the industrial community. The major components have been utilized to process many materials. Wood, sewage sludge, oil sludge, MSW and other materials have been successfully processed to reduce the carbon content of the material processed. These systems tightly control the atmosphere in the specific component to achieve the desired results. Specifically, the pyrolyzer and the vitrifier are utilized to process the waste materials. The dryer and RTO are units that prepare and then finally clean the specific streams. The focus of this review is the potential applicability of the pyrolyzer and the vitrifier.

Medical waste has not documented as a major waste stream being processed by strict pyrolytic methods. Most medical waste incinerators use a two stage system. The first is a partial pyrolysis system where the oxygen content is maintained very low to generate organic rich gases without oxygen. The gases then go the secondary unit that supplies oxygen to complete the combustion of the gases. Typical heat recovery and gas cleaning devices are utilized on the end to meet the regulatory requirements.

The proposed method takes the partial pyrolysis of the current medical waste incinerators a step further. By totally eliminating the oxygen in the pyrolysis section, the resulting gases will be cleaner and more adaptable to utilization as a synfuel. As such, the proposed system would be able, with the proper detailed engineering for all of the components, to handle the medical waste stream.

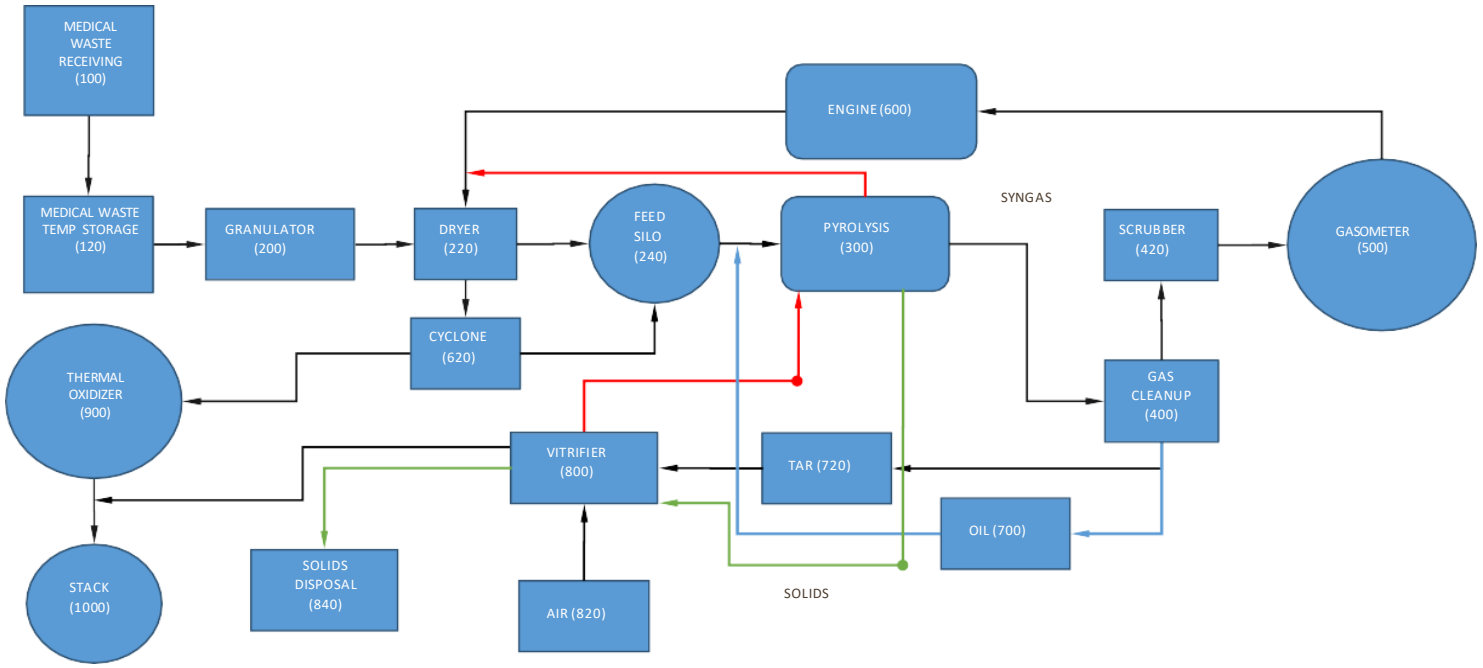
Technical Feasibility Report

Area of Concern

The basis of the current design is predicated on the medical waste characteristics published in several papers. Changes in the regulatory and economic climate have changed the characteristics of the medical waste. These changes may or may not be of consequence to the detailed design of the system. With the proper design of all components, this area of concern can be addressed.

Conclusion

This system, when designed to handle the potential variations of any and all wastes that may be fed into it, should be able to gasify the waste stream to produce a synfuel



Block Flow Diagram

SUSTAINABILITY

Social Responsibility & Sustainability

ESG AND LOCAL DEVELOPMENT

Commitment to being a good corporate citizen and considerate of ESG issues and stakeholder concerns in all areas of its operations

Preference to hire locally to aid in boosting a strong local economy

Alignment of corporate goals built on respect and trust with the interests of our host communities

Implementation of its vertically integrated plan to expand operations by developing and investing in its existing relationships and business partnerships.

Making every effort to create the most positive environmental impact

Waste Market Summary

Waste production and generation is not going down.

The global waste market is currently valued over $1 trillion a year. The two most common methods of waste reduction globally is burying and incineration, both green house gas generators.

As waste production continues to increase every year despite efforts to recycle and reduce waste generation. On average the waste industry has seen a 1% growth every year.

COVID-19 saw a major increase in the generation of medical waste in the United State and globally. This increase has caused a spike in the need for technology to handle the destruction of medical waste as incineration is the primary process used for destroying waste that can be sent through an autoclave.

Source

https://www.statista.com/statistics/246178/projected-global-waste-management-market-size/

End of Presentation

www.empirediversifiedenergy.com
www.empiregreengen.com

CONTACT

Bernard Brown, CTO
bbrown@empirede.com

Company Address
1400 Main Steet
Follansbee, WV 26037
Phone 304-914-4624
Fax 304-914-4625