Plasma Gasification Facility

Westinghouse Plasma has over 30 years of experience in research, development, testing, design and commercial use of proven plasma torch technology. The Westinghouse Plasma Gasification technology has been in operation globally for the past 10 years and has successfully processed multiple feedstocks.

The Westinghouse Plasma Gasification technology has successfully processed municipal solid waste, auto shredder residue, sewage sludge and a variety of caustic hazardous materials. From a demonstration and pilot perspective, the list of feedstocks processed expands to include biomass, river and petrochemical sludges, ash and over 100 other feedstocks. Westinghouse Plasma Gasification technology provide energy solutions that are commercially proven, environmentally friendly, flexible and economical. Westinghouse Plasma provide service and support for engineering, equipment, design integration, start-up support and service parts, from greenfield solutions to meet the needs of new power or liquids production to retrofits of aging coal and oil fired power generation facilities.

Westinghouse Plasma works with clients to design, develop and build the best solutions for waste processing. From providing 3D and simulation modeling, detailed design packages to real world expertise with a world class team, Westinghouse Plasma helps clients move beyond the design stage by providing assistance to project management details. These details include: material take-off, hazardous operation requirements, management & stakeholder communications, and improved process design. How a plant fits, where it fits, and the logistics surrounding the facility are all factors that must be considered in the planning of a plasma gasification facility. Whether it's analyzing and developing plans for buildings due to weather, road access, and proximity to other neighboring developments or addressing the environmental impact on the surroundings, Westinghouse Plasma is prepared to work with engineering firms to provide a complete solution.

Westinghouse Plasma Gasification Solution

The Westinghouse plasma gasification solution (APGS) using Westinghouse Plasma Gasification technology provides clients with a syngas tailored to meet downstream process needs. Westinghouse works with partnering engineering, procurement and construction firms to provide a fully integrated balance of plant solution. While Westinghouse supplies the critical components of the gasification system, the balance of plant engineering and design is supplied by engineering firms using equipment proven in applications throughout the world.
Plasma Powered Facility Process Overview

A typical facility includes at least one continuously operating gasification reactor. Within the reactor the charge material is gasified into syngas which exits the top of the reactor through two (2) outlets.

The feedstock (municipal solid waste, biomass, refuse derived fuel, hazardous waste), flux, and bed materials are delivered to the plant receiving facility. The feed is metered onto a common charge conveyor which transports the feed to the gasification reactor.

The majority of the metallic and ash content of the feed material forms molten slag, which flows through the tapholes at the bottom of the reactor. The slag is then quenched and granulated upon exiting the reactor. The resulting vitreous granules are conveyed and loaded onto trucks for export off site.

The syngas is the product generated from the feedstock and exits at the top of the reactor. The syngas is cooled and goes through a series of syngas cleaning processes to remove particulate, chlorine, sulphur, and mercury. The clean syngas can be utilized for steam generation, electricity, creating liquid fuels, and chemical development.

![Various Types of Feedstocks]
Recovery of Inorganic Products

Inorganic and saleable products can be recovered from the plasma gasification process. Ferrous iron and fine aggregate are recovered from the molten material exiting the plasma gasification reactor, in addition to crystalline sulfur produced through syngas clean-up. The separation of mixed metals occurs when the molten material from the reactor is discharged into a quench bath. This results in metal modules which are then separated from the aggregate. The remaining slag material, consisting of a wide range of elements, primarily silica, can be used in numerous construction applications and products. All materials recovered add commercial value to the plasma gasification process.

Syngas Clean-up

The syngas clean-up process removes unwanted chemicals from the syngas, preventing harm to human health, the environment and the facility’s equipment. Syngas clean-up options are based upon feedstock and syngas application (ie: electricity or liquids). Based on the plasma gasification facility’s inputs and end products, the engineering, procurement and construction for the facility will design the optimal syngas clean-up system based on the specific application and configuration. One example for syngas clean-up used in a power generation process: upon exit from the gasification reactor, the syngas is rapidly cooled and particulate matter is removed by mixing with process water in a venturi scrubber and spray tower. Further removal of particulates occurs in a wet electrostatic precipitator. The temperature of the syngas is decreased and the pressure is increased to condense any moisture from the syngas. Removed process water is treated on-site to be reused within the facility. Any mercury present is removed as the syngas passes through activated carbon beds with sulfur being removed by a hydrolysis reaction and conversion to crystals. Following this process the syngas is used to generate power.

FROM LOW VALUE FEEDSTOCKS

TO HIGH QUALITY PRODUCTS

By-product: Inert, Benign Vitrified Slag

Aggregate for use in Construction

Rockwool Insulation produced from Glass Slag
Commercially Operating Facilities

Energy Recovery from Hazardous Waste Facility, India

Biomass-to-Ethanol Facility, PA, USA

Energy Recovery from Waste, Minama-Mikata Facility, Japan
Process Flow Diagram, Utashinai Facility, Japan

Energy Recovery from Waste, Utashinai Facility, Japan
Conceptual Design of a Plasma Gasification Facility

Westinghouse Plasma uses state of the art technology and proprietary simulation tools to further advance commercial solutions utilizing Westinghouse Plasma Gasification technology. Advanced 3D modeling tools provide the ability to share balance of plant solutions with clients and provide modeling of the gasification island to allow for accurate materials estimates, land requirements, maintenance access, operator interfaces, and safety corridors.

With multiple configurations and multiple designs, Westinghouse Plasma works closely with clients to specify project needs – from concept through execution of engineering, construction and operations.

Next Generation Plasma Gasification Design

Through knowledge and experience gained at our commercially operating facilities and pilot facility, the Westinghouse Plasma Gasification technology is in its fourth generation design and optimization. Westinghouse Plasma solutions have continued to evolve in their commercial design development. With an almost 10 year track record of commercial operation, the Westinghouse Plasma technology has further evolved through expanded product offerings, balance of plant integration, comprehensive performance assurance guarantees and proven reliability.

As part of the technical generational developments, a new process eliminates the need for metallurgical coke in the Westinghouse Plasma gasification reactors. As a replacement, the alternative bed material is comprised of residual material created during the gasification process. The new innovation recycles virtually all of the potential waste generated by the process.

**PHASE 1:** Acquisition of Westinghouse Plasma
- In 2007 Westinghouse Plasma sold only plasma torches and provided basic engineering preliminary diagrams.
- Our customers wanted a more complete solution...

**PHASE 2:** Expanded Product Offering
- During 2008, Westinghouse Plasma expanded the gasifier vessel design and expanded scope of the gasifier island to include: - Quench system - Slag system - Refractory optimization
- As well, Westinghouse Plasma used independent third parties to perform detailed capital costing.
- Westinghouse Plasma now offered a full “gasifier island” which can be integrated with other conventional equipment to create energy.

**PHASE 3:** Integrated Product Offering
- During 2009, Westinghouse Plasma integrated its gasifier island into the complete energy facility doing independent engineering on the steam cycle, combined cycle power island, the syngas clean-up, and the feedstock handling systems.
- Westinghouse Plasma took all of the independent engineering and got to a +/- 10% level of costing on the gasifier island and also a full 3D model on the entire energy facility.

**PHASE 4:** Improved Product Offering
- Reduced capital by approximately 30% through:
  - International sourcing
  - Design optimization
- Reduced operational cost by approximately 30% through:
  - Metcoke bed replacement
  - Reduced parasitic load
- The Westinghouse Plasma facilities are now able to get facility performance guarantees through a leading engineering company, Technip.
Components of a Plasma Gasification Facility

- Air Skid
- Deionized Water Skid
- Westinghouse Plasma Torch (MARC 11)
- Power Supply System
- Venturi and Direct Contact Spray Scrubber - Air Pollution Control
- Plasma Gasification Reactor
3D Modeling of a Plasma Gasification Facility