

**CLEAN HEAT, STEAM AND ELECTRICITY  
FROM  
RICE HULL GASIFICATION**

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**ABSTRACT**

PRM Energy Systems, Inc, completed the installation of a 330-ton/day biomass gasification system for Cargill Rice Milling of Greenville, Mississippi in 1995.

The PRME Biomass Gasification system converts unground rice hulls/straw and other biomass fuels to **PRME Naturally™Gas** which is burned in the boiler furnace delivering 115 million Btus/hr to an existing boiler/power island to produce 6.5 MW of electricity and 15,000 PPH of process steam for the rice parboiling facility.

The PRME Biomass Gasification system includes: the fuel metering bin and structure, the refractory lined Model KC 218 Reactor/Gasifier, the combustion tube and chamber, the gasifier cooling water system, ash discharge/cooling assembly, multi- zone gasification air supply, multi- zone combustion air supply, rotary feeders and instrumentation required to provide automatic control over the process.



**THE FACILITY**

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The major components of the system were fabricated and shipped on August 24, 1995 by river barge down the Arkansas river to the Port of Greenville, Mississippi. The barge arrived at Greenville on August 29th. Components were off-loaded onto trucks and transported approximately 5 miles to the Cargill site and erected directly onto the foundations. The combustion tube refractory was installed in the fabrication shop and the gasifier refractories were gunned in place on site. Erection of the gasifiers and combustion tube was completed on October 14th. Installation of control instrumentation was essentially complete and bakeout of refractory was completed on October 24th. Boilout of the boiler and blowdown/testing of steam lines started on November 1st and continued until December 5th, when the turbine was placed into service.

Two bolted metal bins, each with a capacity of 150 tons, were supplied by Cargill for rice hull storage and feeding to the PRME metering bin. Cargill also supplied the ash conveying system which receives the rice hull ash from the water cooled ash cooling conveyor and transports the ash to the ash storage and loadout bin.

The **PRME** Biomass Gasification system includes: the fuel metering bin and structure, the patented KC Reactor/Gasifier, the combustion tube and chamber, the gasifier cooling water system, water cooled ash discharge conveyors, multi- zone gasification air supply, multi- zone combustion air supply, rotary feeders and instrumentation required to provide automatic control over the process.

The KC Reactor/Gasifier consists of a high temperature refractory lined cylindrical steel shell that is mounted in a vertical position on heavy structural steel supports. The lower portion of the reactor contains an appropriately sized fixed grate. The cross sectional area of the upper portion of the gasifier is reduced to provide the turbulence required to ensure proper mixing of the product gas and the combustion air that is introduced into this area of the gas combustion tube. The refractory lining consists of the appropriate thickness of insulating castable and high-temperature dense castable that is applied by gunning after the shell is erected. The lining is secured by stainless steel anchor clips attached to the shell.

Fuel is metered to the gasifier from the fabricated steel metering bin. The bin is equipped with level controls, an infeed leveling conveyor and a variable speed outfeed conveyor that delivers fuel to the gasifier. The speed of the outfeed conveyor is automatically adjusted by the gasifier control system to maintain a pre-set first stage gasification zone temperature. The discharge from the outfeed conveyor is directed through an impact weigh metering device that provides precise indication and control of the fuel feed rate. The feed system is installed complete with the necessary support steel, platforms and access ladders. The first stage temperature setpoint is manually adjusted to compensate for the average moisture content of the fuel being gasified.

Fuel is introduced into the gasifier by a water-cooled screw conveyor that discharges into the drying and heating zone of the gasifier. The gasification process is controlled by the proportioned application of gasification and combustion air in a manner that supports efficient gasification. Residence time in the gasifier is varied by a residence control system that is adjusted to achieve the desired carbon content of the ash discharged from the gasifier. The use of mechanical bed agitation, precise gasification air control and zoning produces a clean, combustible gas that can be burned in the combustion tube and chamber for drying applications or in the radiant section of a boiler. The gasification rate is controlled by the demand of the dryer or boiler.

The hydrocarbons contained in the gases are thermally cracked and burned in the combustion tube and chamber. The resulting clean hot air can be cooled and blended with recirculating air to maintain the desired temperature in drying applications or directed to a boiler for final combustion. At the Cargill project, the biogas is combusted in the boiler furnace. The gas combustion tube includes an emergency vent stack to safely exhaust gas to the atmosphere in the event of a failure of the induced draft fan.

The unique design of the KC Reactor/gasifier makes it possible to remove practically all of the ash and particulate matter from the bottom of the gasifier, continuously and automatically. Particulate carryover that occurs with other types of solid fuel combustion systems is greatly reduced. The extremely low particulate concentration in the gases leaving the gasifier makes it possible to direct fire a boiler without hot gas cleanup and to comply with particulate emission regulations without the use of expensive emission control equipment.

Various components of the gasifier are water cooled to insure reliable operation and longevity.

The power generating center is equipped with a standard high pressure heat recovery type water tube boiler, 450 psig/650<sup>0</sup>F, with a refractory lined furnace section where the final combustion of the biomass gases takes place, a high pressure condensing steam turbine/generator, economiser, condenser, deaerator, cooling tower and all of the auxiliary piping, valves, pumps, motors, drives, fans and controls necessary for a completely functional power center.

The gasifier and power center are equipped with all of the instrumentation and control devices required for complete, automatic operation of the system. The metering bin feed system, gasifier system and the ash discharge system all have an interlock control scheme functioning through the process controller. These interlocks are designed to shut down each system if a malfunction occurs that could cause damage to the gasifier. The metering bin level controls are interfaced with the feed stock storage bins to provide a uniform feed rate to the metering bin.

The gasifier instrumentation and control system provides sequential operation of the gasifier feed and ash discharge systems, PID control loops which adjust conditions within the gasifier to achieve efficient gasification of the feedstock, temperature and pressure

transmitters which signal the process controller, and a video display terminal for operator interface with the control system, motor control centers and wiring. The instruments are integrated with the main boiler master control.

*PRME* provides trained service personnel to supervise the erection, start-up and commissioning of the equipment and train the clients operators in the proper operation and maintenance of the *PRME* system. The training program includes classroom and on-site training as well as supervision of operators during initial operation of the system. Additional training and supervision can be provided at additional cost should the client deem that it is required.

*PRME* has biomass gasification systems operating in Malaysia, Australia, Costa Rica, Italy and the United States.