Bioenergy Products: The Agripower - air-to-air technology using agricultural and forest waste biomass in a transportable turbine-generated power plant

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The Agripower biomass power plant has been in development over the last 10 years. The project began as the Energeo Agripower and became a reality due to initial funding from the U.S. Department of Defense's (DoD's) Strategic Environmental Research and Development Program (SERDP), the U.S. Department of Energy's (DOE's) Office of Solar Energy Conversion/Solar Thermal and Biomass Power, and the U.S. Environmental Protection Agency's (EPA's) Air and Energy Engineering Research Laboratory (AEERL).

Perry McLain of PMC Biomass LLC has been the designer and manufacturer for the life of the project. In December of 2000, PMC Biomass purchased certain license rights and hardware including a non-exclusive right to U.S. Patent No. 5,121,600.

The Agripower unit is an "open" Brayton Cycle - a turbine using air as the working fluid, which is heated via heat exchangers coupled with a fluid-bed combustor. The benefits of this system are 1) less turbine maintenance because of air working fluid, 2) fuel flexibility, 3) small size (200kW) can be modularized, and 4) utilizes biomass.

The Agripower unit is a 200 kW externally fired gas turbine with a fluid bed combustor and supplemental diesel fired in-line combustor on the turbine inlet. There are two primary flow circuits in the process: a compressed air turbine circuit and a combustion circuit. The compressed air turbine circuit begins with the intake of ambient air by the compressor, which is powered by a direct connection to the turbine. The air is compressed to several atmospheres and exits through a recuperator which transfers heat from the turbine exhaust to the compressed air and improves the efficiency of the system. From the recuperator, the compressed air passes through a convective heat exchanger, recovering energy from the furnace flue gases. Then the compressed air goes to the furnace and receives additional energy via a radiant heat exchanger in the upper part of the furnace above the fluid bed. From the radiant exchanger the compressed air returns to the turbine and expands through the turbine blades to power the compressor and the electrical generator. The turbine exhaust then passes through the recuperator and is either discharged to the atmosphere or utilized for cogeneration. Included, as an integral part of the turbine is a fuel oil combustor which is used for "black" starts of the system. The combustion circuit uses two fans to supply air to the fluid bed and the freeboard air above the bed. Both air supplies are preheated by recovering energy from the flue gases. Biomass fuel is supplied to the furnace by a feed hopper and screw conveyors. Two screws located in the bottom of the hopper regulate the flow of fuel to a third screw which injects the fuel above the fluid bed. The furnace employs both in-bed and freeboard combustion zones. The freeboard zone is well mixed to provide uniform temperatures. The temperatures both in and above the bed are regulated to limit potential problems associated with the ash. After giving up energy to the compressed air through the radiant and convective heat exchangers, the combustion gases pass through a cyclone for removal of the fly ash. From the cyclone, the flue gases are used to preheat the combustion air streams via the air preheaters. An induced draft fan exhausts the flue gases to the atmosphere and is controlled to maintain a slight negative pressure in the furnace above the bed. The motors for the fuel feed screw conveyors and for all fans are variable speed as part of the system control. Feedback from the power output by the electrical generator and the inlet temperature to the turbine are used to regulate the amount of fuel supplied to the furnace. Key furnace temperatures and flue gas analysis are used to control the combustion air supply. Individual controllers are utilized for each principal control loop and are supervised by a computer system providing overall control, including remote dial-in capabilities for monitoring and changing set points.

The Agripower's basic concept has been tested in the 80 kW size in 1989 in Oregon using mill wastes and instrumentation recommendations have been made and reviewed by Sandia National Laboratories. The Agripower biomass plant uses a reliable combination of components; the fluidized bed is now an established technology, and the Solar turbine is available around the world. Potential hazardous conditions to operators are eliminated due to the minimal operating attention and the low pressure (max 60 psi) of the air turbine, versus more than 1,000 psi for steam turbines.

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