Wood-Pellet-Fired Boilers Provide Highly Efficient, No-Fuss Operation

Burn automatically with air-friendly emissions profile

The Pennsylvania Department of Conservation and Natural Resources (DCNR) is the managing agent for the Keystone State's 2.2 million acres of public forests. For a new office and maintenance facility—the Resource Management Center—in Weiser State Forest in eastern Pennsylvania, it wanted a district hydronic heating system fired by a renewable fuel—ideally, wood.

After reviewing several proposals, the DCNR chose a solution offered by ATI Systems Inc., a hybrid representative/distributor/engineering-services organization based in Conestoga, Pa., whose founder, Carl Longenecker, has found a way to burn wood automatically at near-condensing efficiencies with an air-friendly emissions profile vastly beyond traditional wood and coal burners.

"What ATI Systems brought to the table exceeded what we were looking to accomplish," Jason Adams, CBCP, one of two full-time mechanical engineers employed by the DCNR, said. "It burns wood pellets, does it efficiently, and doesn't require labor hours to keep it running."

Forestry Facility

The Resource Management Center includes a 10,000-sq-ft, 20-person office building and a 5,500-sq-ft shop for servicing heavy equipment. The buildings' in-slab radiant floors are heated by two redundant Fröling P4 automatic high-efficiency wood-pellet-burning boilers imported by Lyme, N.H.-based Tarm USA Inc. What makes the boilers unique is their automatic operation, which includes a vacuum-based self-feeding system, variable-speed venting, self ignition, onboard computer-operated combustion adjustment and analysis, a self-clean mechanism, and the ability to modulate output.

The boilers operate at near-condensing efficiencies. Everything from ignition to pellet loading is automated. The boilers share a main mechanical room with a super-insulated, 400-gal. buffer tank. All supply and return lines run underground.

The new office building is heated via water pumped under the parking lot from the main mechanical room.

The larger boiler modulates between 30 and 130 MBH, while the smaller unit modulates between 20 and 85 MBH. The two boilers run at about 86-percent efficiency. To improve the efficiency and responsiveness of the system, Longenecker incorporated a heavily insulated 400-gal. buffer tank that enables long run times.

Although Fröling boilers are subject to testing at or above ASME standards in Europe, Pennsylvania does not recognize the foreign certification. This meant Longenecker had to design around an open—or atmospheric—boiler loop.

The Fröling line includes cord-wood-, pellet-, and wood-chip-burning models, but the pellet line has the broadest size range, with outputs between 10 and 500 MBH.

No Pressure

One-and-a-quarter-inch supply and return lines increase to 2 in. in diameter where the boilers are plumbed together. Both supply the buffer tank, which acts like a massive flywheel, reducing on/off cycling and maximizing responsiveness to heating loads. The tank has four temperature sensors connected to the boilers' onboard controls, which tell the boilers how much energy remains, when to fire, and when to shut down.

The tank is simply that—a tank, no coils inside. On the far side of the tank, a small Bell & Gossett circulator draws from the top of the water column, sending heat through a brazed-plate heat exchanger. On the receiving end is the

connected load for both heavily insulated buildings.

To compensate for water expansion in the system, a riser pipe reaches up to the shop's mezzanine, where three 20-gal. galvanized-steel tanks allow the water level to rise and fall. Open to the atmosphere, the tanks are "sealed" by pouring a thick layer of vegetable oil over the surface of the standing water. The "non-pressurized" boiler loop hangs around 5 psi, simply from the head pressure of the standpipes and tanks in the mezzanine.

The Pressure Is On

On the pressurized side of the heat exchanger, insulated pipes drop into a covered manhole in the floor of the mechanical room. From there, water heads to the buildings. There are three REHAU radiant manifolds throughout the shop and seven radiant manifolds located in

The wood pellets, seen here inside of a day bin, are sawmilling byproducts. Only compressed wood—no bonding agent—is used in the making of the pellets.

the office building across the parking lot, about 300 ft away.

To deliver water safely and economically, flexible, pre-insulated tubing was buried below the frost line. The blue, corrugated outside carrier houses thick foam insulation and one-and-a-quarter-inch cross-linked-polyethylene (PEX) lines.

"We went with double pipes on the home runs to the office buildings," Adams, who was involved in the design of the pressurized portion of the system, said. "Each corrugated line contains two pipes, just in case one is ever compromised. The spare remains capped and unused. The price increase between dual and single pipe was minimal, so it seemed worth the expense to have the extra insurance."

Shrouded in steel cabinets, the manifolds in the shop deliver water to half-inch PEX lines to heat the floor slab. The same is the case with the office building, except there is an additional 80-gal. buffer tank between the underground supply pipe and the manifolds. An automatic glycol makeup system from Wessels Tank Co. keeps the pressurized portion of the system safe in the event of a system rupture.

Hands-Free Renewable Energy

"About a year ago, I did a field analysis of the different fuel sources we have available in the Northeast," Longenecker said. "Cord wood—when used in a high-efficiency gasification boiler—was the least expensive. The downside is that you need to be around to light and stoke the unit, not to mention cut, split, and stack. Then came natural gas, but that's not always an option. Wood pellets were a very close third, roughly half the cost of LP (liquefied petroleum) and oil."

Longenecker prefers wood pellets because—in the correct boiler—they are a no-fuss fuel. Hardwood sawdust is pressed into pellets that resemble large rabbit food. A delivery truck blows the pellets into a 29-ton outdoor silo. From the silo, pellets are drawn through flexible thermoplastic tubing by high-velocity vacuum, filling a roughly bushel-sized day bin attached to each boiler. Two fire gates and an inclined fuel-drop tube in each boiler keep flames from reaching the stored pellets.

"The boilers are nearly silent during

A brazed-plate heat exchanger allows the pressurized and atmospheric portions of the system to work together seamlessly.

operation," Scott Nichols, who owns Tarm USA, said. "Because filling the day bin is noisier, you can program the boiler to draw pellets at a certain time of the day or, for example, avoid filling between 9 p.m. and 8 a.m."

The boilers light themselves using electric heat guns upon a call for heat.

According to the U.S. Department of Agriculture Forest Products Laboratory, a ton of pellets contains 16.4 million Btu. When pellets were delivered before commissioning in September, the price was $170 per ton. The Btu equivalent in No. 2 fuel oil would have cost more than $400.

The Resource Management Center is ready for all that winter can throw at it.

Information and photographs courtesy of Dan Vastyan, an account manager for Common Ground, a trade-communications firm based in Manheim, Pa.

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For Design Solutions author guidelines, call Scott Arnold, executive editor, at 216-931-9980, or write to him at *scott.arnold@penton.com*.