

Use of Wood as an Alternative Fuel to Coal and Natural Gas at the Holnam Cement Plant, North of LaPorte, Colorado

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Abstract—The Holnam Company currently operates a cement plant north of Laporte, CO. The plant is attempting to use wood as an alternate fuel to coal and natural gas. The principal objective of this project is to investigate the extended use of wood as an alternate fuel at the plant. Tests conducted at Holnam indicate that wood is suitable for use at the plant and Holnam could use up to 350 tons of clean wood wastes and residues per day. A substantial network of wood suppliers, drawing wood from landfills, wood processors, and forests, will be necessary to meet overall plant requirements. Successfully converting Holnam to wood would provide economic benefits to both Holnam and the community. Larimer County would benefit because the majority of clean wood will be diverted from the waste stream into its landfill. Using forest residues at Holnam could help reduce the risk of wildfire, increase public safety, and improve forest health. We view converting this plant to wood as only a beginning. If Holnam successfully converts to wood as the primary fuel source, then other plants in the region could similarly use wood wastes and residues as fuel.

Introduction

The Holnam Company operates a cement plant north of Laporte, CO. Founded in 1926, the plant currently produces 460,000 tons of cement annually. The plant utilizes approximately 75,000 tons of coal and 3,600 million cubic feet of natural gas annually in the cement making process. Early in spring 1999 Holnam began considering the possibility of converting the primary source of fuel used at the plant from coal to wood. The principal objective of this project is to investigate the extended use of wood as an alternate fuel source to coal and natural gas at this plant. Several private organizations and government agencies are supporting Holnam in their efforts to achieve this objective, including the city of Fort Collins, Larimer County, the Colorado State Forest Service, the USDA Forest Service (State and Private), and Colorado State University. Included in this publication is project background, a brief description of the

cement making process, a discussion of conversion technology, and the process to commercialization. The anticipated benefits and challenges of using wood at the Holnam plant are also discussed.

Project Background

From April until autumn 1999, representatives of Holnam met with Dr. Dennis Lynch (Professor Emeritus, Colorado State University) and Larimer County personnel to discuss the potential of using waste wood from the Larimer County landfill as an alternative fuel at Holnam. In August, John Zerbe (USDA Forest Products Laboratory) visited Holnam to observe the operation and wrote a report regarding the potential for utilizing wood at the plant (Zerbe 1999). A meeting to discuss alternatives for diverting clean wood from the Larimer County landfill occurred in September between representatives of Holnam and the city of Fort Collins Natural Resource Department. In November and December Holnam met with Janelle Henderson (Director of the Larimer County Natural Resources Department) and other Larimer County officials to discuss development of a strategy for diversion of landfill material.

The Coloradoan, a local newspaper, published an article on December 14 on the intent of Holnam to utilize clean wood wastes as an alternative fuel source. On December 16, a public meeting was held in the Larimer County courthouse. Although reviews were mixed, there was generally a positive response from the community toward utilizing clean wood waste at Holman. Also on that day, Channel 9 Television (NBC) of Denver, CO, toured the Holnam plant and filmed a story that aired on that day's 5:00 p.m. newscast. A follow-up article was published by *The Coloradoan* on December 17. Subsequent articles appeared in *The North Forty* newspaper and the Loveland, CO, *Reporter Herald*. Generally, these articles were favorable.

During the public hearing held on December 16, attendees determined by consensus that four principal issues needed to be addressed. These were:

1. Potential fuel sources
2. Transportation
3. Process modifications
4. Air pollution concerns

Four committees were established to investigate these issues. These committees met throughout the winter and spring 2000. Some of the findings are discussed in subsequent sections.

In addition to committee meetings, two public meetings in March and April were held in Laporte, sponsored by the Laporte Business Alliance. The local community had many

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concerns, many of which had been expressed in the previous December meeting and which were being addressed by the committees established at that meeting.

One particular new concern pertained to the Title V permit that Holnam was in the process of applying for. This permit is required by the State prior to using wood or other alternative fuels on a production scale at the plant. The initial permit application (which has since been revised) submitted by Holnam listed a broad range of nonhazardous materials that could potentially be used as fuel at the plant. Even though only clean wood had been used in testing to date and there had been minimal opposition to Holnam utilizing clean wood at the plant, there were concerns that Holnam would burn other materials such as plastics and rubber tires if permitted to do so. Therefore, the community was concerned over what materials Holnam would be permitted to utilize. There were articles in local newspapers reflecting these concerns. In particular, there was considerable resistance to using rubber tires at the plant. There was also concern regarding wood from the landfill. While the majority of this wood is clean, there is a percentage of this wood that is contaminated with a variety of substances including finishes, treatments, and adhesives. The impacts of these contaminants on air emissions are uncertain and need to be investigated. Nonetheless, Holnam was focusing on obtaining a Title V permit to use clean wood.

The Cement Making Process

The Holnam plant north of Laporte uses a unique process to manufacture cement. Limestone is crushed to reduce its size and then blended with materials such as shale, sandstone, iron ore, mill scale, fly ash, clay, or sand into a dry powder. The mix is then normally processed in a calciner that burns the organic material in it and drives off CO₂. It is then fed into the elevated end of the 14.5 feet wide by 190 feet long rotary kiln at the plant. Materials in the kiln pass through controlled zones that heat them to 2,450 °F. Flame temperatures in the kiln exceed 3,000 °F. The intense heat chemically alters the materials forming walnut-sized pellets called cement clinker.

The cement clinker is then cooled. Heat from the clinker is extracted by air flow. This heat is used to supplement the heat from fuels used in the kiln. The clinker is mixed with a proportioned amount of gypsum in a finishing mill where steel balls pound the clinker into a fine powder (cement). The cement is packaged in bags for shipping or shipped bulk to retail outlets and construction sites.

Conversion Technology

In 1999 and 2000, research and testing were conducted to determine the best approach for converting the Holnam plant to wood as the primary fuel source. A series of test burns were conducted and some equipment purchased to facilitate testing. Important findings from this work, along with a brief discussion of wood as a fuel are presented.

Wood has a heating value that ranges between 8,000 and 12,500 Btu per oven-dry pound, with most species falling between 8,000 and 10,000 Btu per oven-dry pound (Inc 1979). Bark ranges between 7,500 and 10,500 Btu per oven-dry

pound. This compares to a range of 6,900 to 14,300 Btu per pound for coal. Based on the type of bituminous coal typically used at Holnam, which has a higher heating value of 11,000 Btu per pound, approximately 1.3 tons of dry wood yields the same amount of heat as 1 ton of coal.

Although heat production is affected by numerous factors (Ince 1979), one factor that dramatically affects recoverable heat generated by combusting wood is moisture. Because wood is hygroscopic it readily picks up and loses moisture. The higher the moisture content, the lower the amount of recoverable heat available from combustion. Therefore, to maximize recoverable heat it is beneficial to dry wood prior to combustion.

In May 1999, the first test burns were conducted at the plant with good results. A subsequent test incorporating wood into kiln feed to test material flow was conducted in August. Also in August, Holnam arranged for the lease/purchase of two screw augers to feed saw dust and fine wood chips into the calciner. In October, the first calciner test burn using dry sawdust fed into the system with the screws was conducted. The calciner responded positively and no air quality problems were detected. A second burn was conducted in November using one load of wet sawdust and one load of dry sawdust. The calciner did not respond well to wet sawdust; however, the dry sawdust burned well and the coal feed was shut off during this phase of the test, proving that wood can replace coal in the system.

Later in November, a test burn was conducted feeding wood chips into kiln feed to test material flow. During December, 21 tons of green pine chips were supplied by the Colorado State Forest Service for testing. Wood chips were fed into the roller mill with the standard raw rock feed. Although the test was short, results were positive. Later in December, a test was conducted to find out if screw augers would handle wood chips. The chips did not feed well through the screw augers and heavier equipment is required.

Testing continued into January, February, and March 2000, culminating with an extended test using 98 tons of green pine chips processed from beetle-killed pine trees provided by the Colorado State Forest Service. Chips were put into the system with both the raw rock feed and the coal feed. Approximately 28 tons of chips were introduced with the raw rock and the remaining 70 tons were introduced with coal. Wood introduced into the coal feed was mixed with coke at a 1:1 ratio by volume, and then with coal at a feed rate of 15 percent wood/coke and 85 percent coal. Generally, these tests were very successful and the wood worked well with existing systems at the plant.

Significant process modifications may still be necessary to utilize wood at all firing systems of the Holnam plant. There is a need to further study how wood can be fed to firing systems and what modifications are necessary to use it. The main barrier has been developing a feed system for wood chips that works well with existing firing systems at the plant. The screw auger system installed for test burns using sawdust did not work well with 1.5 inch wood chips. Mixing rock and wood together to produce "crusher" feed has been successfully tested as one alternative for introducing wood into the process. However, the plant needs the capability to selectively get sawdust and small wood chips to any of the three existing fuel pumps. Feeding wood into the existing coal bin is possible if mixed at up to 10 percent with coal. This

provides some wood feed to all firing points simultaneously; however, this will not be sufficient for complete replacement.

Further testing is scheduled in the future to evaluate systems developed to handle and feed wood. Air emissions from the plant (including stack testing) will be monitored during testing. With the successful completion of this testing, a portion of the plant should be ready to utilize wood on a commercial scale. As noted previously, Holnam is currently in the process of applying for a Title V permit that is required by the State prior to burning wood on a production scale. Conducting this testing is a necessary step toward obtaining this permit. Work required to develop the wood handling systems necessary to completely convert the plant was scheduled to be completed by summer 2000.

Process to Commercialization

Wood as the primary fuel source at Holnam requires that two key issues be addressed. These are completing modification of existing plant processes to accommodate wood (addressed previously) and procuring an adequate supply of low cost wood in a form suitable for use at the plant. To date test burns have shown that wood can be used to fuel plant processes. Although preliminary studies indicate that a sufficient supply of wood exists, there is a need to establish a delivery system for getting wood to the plant, including collection (sorting), size reduction, drying, and transportation.

Based on testing conducted at the Holnam plant, clean wood material in the form of sawdust or chips up to 1.5 inches in length work well with existing systems. To maximize recoverable heat from combustion, it is important that the wood be dry, preferably having a moisture content of less than 10 percent. Based on economic constraints, wood will also have to be low cost. Four potential sources of low cost wood have been identified by Ward and others (1999):

- Municipal waste
- Construction waste and demolition debris
- Primary and secondary wood manufacturers
- Forest residues

Some information has been generated on potential sources of wood. A preliminary wood biomass report by Lynch (1999) noted that 187,237 tons of waste was delivered to the Larimer County landfill in 1996. An estimated 29,563 tons of commercial wood waste (primarily construction debris) and 2,410 tons of wood from residential waste were included in this total. In 1997, the Larimer County landfill received 166,683 tons of waste. The reduction was due to the establishment of a new Waste Management landfill near Ault and the majority of their waste streams went to that landfill. In 1997, an estimated 26,318 tons of wood were in commercial waste delivered to the Larimer County landfill, which amounts to approximately 72 tons per day. Additional wood could come from the Waste Management landfill. Waste Management estimated that they currently receive approximately 1 ton of construction wood waste per day.

Because wood is often intermingled with other construction debris, the clean wood suitable for fuel at Holnam would have to be sorted. Lynch (1999) reported that all parties contacted suggested that some type of wood collection system should be possible. Once collected the wood must be

reduced to a suitable size through chipping or other more suitable methods. Whatever the method of sorting and size reduction, the consensus is that the tonnage of sorted clean wood suitable for fuel would be something less than the total amount delivered to the landfills. Based on fuel requirements provided by Holnam, up to 350 tons of wood per day will be required to convert the plant entirely to wood; therefore other sources of wood will be required.

Another potential source of fuelwood for Holnam is primary and secondary wood manufacturers along the Front Range of Colorado. Primary manufacturers along the Front Range include several small sawmills, while secondary manufacturers include millwork, cabinet, and furniture companies. Residues from secondary manufacturers have a relatively high percentage of hardwood with good Btu value. In addition, this wood tends to be relatively dry and as a result, burns well. Several local manufacturers have provided wood for testing. In one test where oak and maple residues were used, Holnam was able to cut off the coal feed to the calciner for several hours. While none of the primary and secondary wood manufacturers individually generate a substantial amount of wood residues, collectively they do. Therefore, further investigation is needed to determine the amount of low cost wood that could be procured from these manufacturers. Other possibilities, including used pallets, should also be investigated.

The forests of Larimer County could also be a significant source of supply for Holnam. Lynch (1999) commented that the private, State, and Federal forest lands in the county have more trees existing now than at any time in recorded history. Lynch reported that NEOS Corporation estimated over 1.4 million tons of wood could potentially be removed from Larimer County in forest restoration projects. These materials would have to be removed, chipped, dried, and transported to Holnam, resulting in a cost. Based on preliminary estimates, in the absence of government subsidies, supplying wood from the forest to Holnam within economic guidelines for fuel costs established by the company will be a challenge. However, because of the enormous resource and potential public benefits, there is a need to investigate how this might be accomplished.

Larimer County and the Colorado State Forest Service have also initiated a project to assist private land owners with disposal of residues from their properties. Ten mobile collection sites are going to be established strategically in the county and these sites could present a wood supply opportunity for this project.

Benefits and Challenges

The economics of utilizing wood at Holnam are tied closely to collection, size reduction, transport, and drying costs. The company is anticipating making a significant capital investment (in excess of \$1 million) to build a system capable of handling wood. In accordance with corporate guidelines, the payback period must not exceed 3 years. This limits the amount that Holnam can pay for wood wastes and residues. Given size reduction and transport costs, which depending on haul distance could easily exceed economical limits, it is generally thought that the wood will have to be procured at little or no additional cost. Fortunately, there are sources of

wood, particularly waste wood destined for landfills, that can be diverted at an acceptable cost. In addition, Holnam will attempt to take full advantage of tax credits associated with using biobased fuels. These tax credits could potentially improve the economics of converting the plant to wood fuel.

Because the availability of wood could be seasonal or periodically in short supply, coal and natural gas systems currently in place at the plant can be used as backup. The plant currently stockpiles 6,000 tons of coal, which is a 1 month supply. Approximately 7,500 tons of wood, a supply for a comparable period, would also be stockpiled, if available.

Environmentally, there should be a reduction in air emissions from the plant if wood is burned in place of coal. Zerbe (1999) reported that combustion of wood should be relatively free of sulfur, heavy metal, and particulate emissions when compared to coal. The absence of sulfur could be a major benefit because Holnam currently scrubs sulfur from coal with calcium oxide (CaO). Although CaO is abundant, reducing the level of scrubbing could potentially increase cement yield and reduce the amount of calcium sulfate that must be disposed of. Although clean wood is relatively free of heavy metals, there is potential for introducing contaminated wood into the process; for example, lead paint found in demolition debris from older buildings. It will be important to follow EPA regulations to separate clean wood for recycling from contaminated wood. Particulate emissions from complete wood combustion are anticipated to be relatively low because the ash content of wood is small, typically around 1 percent. This compares to greater than 5 percent for the coal currently used by Holnam. In either case, ash becomes an integral part of the plant product.

Additionally, there are direct benefits to Larimer County and local city governments. Using this wood as fuel provides an alternative to disposing of wood in the landfill. At the Larimer County landfill, removing wood from the stream of trash into the landfill will save space, extending the life of the landfill. Based on the estimated value of space at the landfill determined by the county, removal of wood wastes could save over \$1 million annually. Another potential benefit to the landfill is a reduction in methane gas emitted from wood decomposition. If done soon enough, this could eliminate the need for a \$2 million methane recovery system.

Using forest thinnings and residues would also provide benefits to the community. Forests found in the region are typically composed of dense overcrowded homogeneous stands of small diameter trees with little or no commercial value. Thinning out these stands and promoting the concept of defensible space around homes and other structures would increase public safety by reducing fire risks. Reducing stand densities would also improve forest health. Proper management of both private and public forest lands is often hindered by the lack of places to take forest residues. They are typically burned, which contributes to poor air quality, or are sent to a landfill. The establishment of 10 mobile collection sites throughout Larimer County should help.

Once capital costs are recovered, the plant should see a significant reduction in the cost of doing business, because energy represents a significant portion of that cost. Therefore, the plant should become more competitive and profitable to operate. Improving the profitability of the Holnam plant has

many potential benefits to the local community. Even though plant processes are continually upgraded and modernized, this plant is relatively old, so there are always concerns of the plant closing because of an inability to compete with cement manufactured at newer state-of-the-art facilities. Plant engineers estimate that there are sufficient raw materials available at this location to operate for at least 50 years. Successfully completing this project should help keep the relatively high paying jobs at the plant in the area and stabilize the local economy for many years.

There will probably be a need to form a company to supply wood to the Holnam plant. This company would likely operate as a small private business employing four to five people. It would collect, sort, and process wood into a size suitable for use at Holnam. The company would probably operate from a base located rurally in the area around Laporte, using two or more trucks to transport wood.

Concerns expressed at public meetings were related primarily to the impact of wood combustion on air emissions from the plant and the impact of increased truck traffic on the local road system and community. As discussed previously, it is thought there should actually be an improvement in air quality over that experienced with burning coal. Testing and monitoring of stack emissions by an independent consulting firm will be necessary to verify that the plant is in compliance with air quality standards. A study needs to be conducted to minimize the impact of transporting wood on local roads and community. The study must consider the location of wood suppliers in relationship to the plant, establishing truck routes and travel times that minimize impact. This evaluation will be ongoing as the number of suppliers and the flow of wood into Holnam increases.

There was also some concern expressed about introducing wood in certain phases of the cement making process. Zerbe (1999) stated that there was the potential for fire (and a remote possibility of explosion) in the roller mill operation at the plant if wood was introduced at this location. This was because of the dust cloud created by the milling operation and the high temperature of the gas stream flowing into the mill. In extreme conditions the gas stream entering the mill can exceed the flash point of wood, and if concentrated wood dust came in contact with the gas at this point, a fire (or explosion) could result. However, mixing the rock feed with the wood and then introducing it into the roller mill appears to minimize this risk because limestone is relatively inert and comprises 92 percent of the material mass. This coupled with additional safety precautions (primarily reducing the temperature of the gas stream into the mill, which has been done) should allow for the safe introduction of wood into the process at this point.

Conclusions

If Holnam successfully converts to wood as the primary fuel source, other cement plants throughout the region could similarly investigate using wood wastes and residues as fuel. Because of the preliminary research at Holnam, several other facilities have already expressed an interest. There are also Holnam plants in Canon City, CO, Montana, Utah, and Oklahoma that could potentially use biomass as fuel if the LaPorte plant successfully converts.

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