Need an Energy Efficient Casket?

Jeannie L. Sikora, Engineer, CLEAResult Consulting

ABSTRACT

Kiln drying lumber is an energy intensive process. Although thermal energy represents the majority of the process energy consumed, electrical energy is required to maintain air flow through the lumber. The volume of air flow needed for drying depends on a number of factors including the type of wood used and its moisture content. Greater moisture content consumes more energy. Air flow requirements decline during the production cycle as the lumber's moisture content decreases. This is particularly true with hardwoods such as oak.

This article provides a case study that validates electrical energy savings from the recent installation of five new kilns. The addition of variable frequency drives on twenty-five fan motors at the Matthews Casket Company's manufacturing facility improved process energy efficiency.

ANALYSIS AND RESULTS

Matthews Casket Company manufactures caskets at its facility in York, Pennsylvania. Their process begins with green lumber which is stacked and air dried prior to being loaded into kilns.

Managing air movement using variable frequency drives (VFDs) for the fan motors improved the electrical energy efficiency of the kiln drying process while improving process control [1]. The resulting energy savings were estimated by accounting for seasonal variations in drying time and process requirements based on the type of wood used. Since excessive air flow can negatively impact product quality, product quality was improved during the kiln drying process.

The company purchased five new kilns for its facility. For energy efficiency and process control, management decided to add VFD control of the fans in each kiln. When completed, twenty-five 7.5 HP air circulating fans were operated using VFD controls. After air drying, the product is loaded into the kilns in batches. Fan speeds are set manually and adjusted on a pre-determined schedule based on the moisture content of daily wood core samples. Data are recorded in production logs.

Figure 1. Lumber stacked for air drying prior to the kiln drying process.

Figure 2. Finished caskets on the assembly line.

Key variables impacting energy savings are production volume, incoming moisture content (which varies seasonally), type of wood and fan speed settings. The baseline efficiency for the process considers the new kilns without VFD control. Reduced fan speed throughout the production cycle is necessary for oak. Fans for oak never operate at 100% speed as structural damage is possible in the wood. The baseline assumption for oak is that the kiln manufacturer would install fans sized to meet the 68% fan speed maximum observed in the production logs.

The following assumptions were applied to this analysis:

- Energy savings attributed to wood types other than poplar and oak (comprising 85% of the manufacturing volume) are ignored.
- Days in the kiln and VFD settings from poplar production logs are an average that represents cycles from April to October. For November through March, poplar requires six extra days in the kiln at 100% fan speed. After the initial six days, the fan speed profile matches that of a representative batch from April to October.
- Cycle times for oak do not vary since it is stored indoors.
- 2014 production volume (6.5 million board-feet) is assumed to be the average annual production.
- Typical production is comprised of 60% poplar, 25% oak and 15% of other types of wood.
- Each kiln load contains 40,000 board-feet of lumber.
- The VFD creates a 2% reduction in motor efficiency.
- The fans serving all five kilns have identical fan power curves.

The manufacturer supplied production logs for three batches each of oak and poplar, all processed during the summer of 2015 along with one year of production data (August 2014 through July 2015).

Data correlating electrical power to the VFD fan setting were collected onsite in September 2015 using a Mastech 2205 digital multimeter. While operating the VFD over a range of settings, the electrician measured power consumption. The fan power curve is presented in Figure 3.

Using the fan power curve and the available production logs, energy savings per load were calculated for summer operation and winter operations. A sample calculation from July is presented in Table 1.

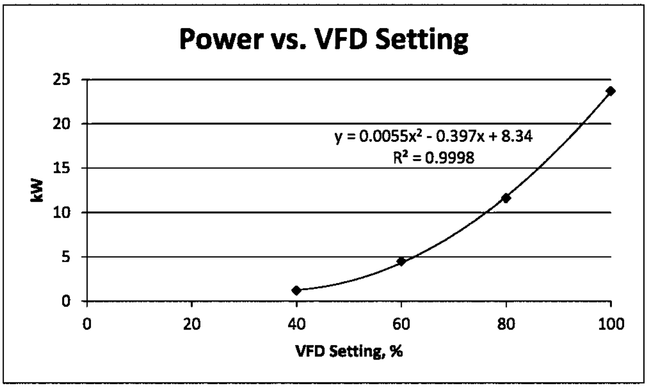

Figure 3. Fan power consumption as a function of VFD setting.

Table 1. Sample production cycle and energy savings.

Day	VFD %	Fan kW	kW_b	hr/d*	kWh savings
July 15	100	23.7	23.2	23.6	-10.9
July 16	100	23.7	23.2	23.6	-10.9
July 171	80	11.8	23.2	23.6	270.3
July 18	80	11.8	23.2	23.6	270.3
July 19	80	11.8	23.2	23.6	270.3
July 20	60	4.32	23.2	23.6	446.4
July 21	60	4.32	23.2	23.6	446.4
July 22	40	1.26	23.2	23.6	518.6
Batch energy savings, kWh/batch					2201

*Excludes time for reversing fan direction

Table 2. Production data for August 2014-July2015 and calculated loads per year.

	% Total Volume	Volume, board-foot	Loads/Year
Board-ft oak	25%	1,615,488	40
Board-ft poplar	60%	3,877,170	97
Board-ft other types	15%	969,293	24
Total	**100%**	**6,461,950**	**162**

The energy savings are calculated for each season and type of wood using the following formula:

$$\text{Energy Savings}_{,i} = \sum_i \frac{\text{Loads}_i}{\text{Year}_i} \text{ X } \frac{\text{Energy Savings}}{\text{Load}_i}$$

SUMMARY AND CONCLUSIONS

The verified annual electrical energy savings for this project is estimated to be 231,143 kWh. Since there is an energy penalty associated with operating a VFD at 100%, there is no demand savings attributed to this project. With a utility rebate of $11,557, an incremental cost for VFD control of $47,755, and an electricity rate of $0.07 per kWh, the simple payback for this project was 2.3 years.

Acknowledgements

The author would like to thank Tad Smith of Matthews International, Don Lewis of Nyle Systems, and Jaymar Davis of CLEAResult for their contributions.

References

[1] Bergman, R. (2010). Drying and control of moisture content. Wood Handbook, Wood as an Engineering Material. Forest products laboratory technical report, chapter 14, FPL-GTR-190. Madison, Wisconsin: U.S. Department of Agriculture.

ABOUT THE AUTHOR

Jeannie Leggett Sikora has worked in the agricultural, residential, commercial and industrial energy efficiency sectors. She is the author of Green Building Strategies, from Plan to Profit. Email: jeannie.sikora@clearesult.com.