NEW AIR FLOW SCHEDULE REDUCES DRYING COSTS AT E.B. EDDY

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Recently, E.B. Eddy's McChesney Lumber Division in Timmins teamed up with Ontario Hydro, Allen-Bradley, and Forintek Canada Corp. to demonstrate potential electrical energy savings in kiln drying. The opportunity explored was the reduction of fan speed at non-critical times in the drying schedule. As a result of this study, McChesney Lumber now varies air flow throughout their drying schedule in the same manner they regulate dry- and wet-bulb temperatures. The incentive was a decrease in drying costs associated with a reduction in electrical energy consumption. For McChesney Lumber, this amounted to approximately 50 percent of their electrical energy consumption at the fans and about $12,000 per year.

The savings were achieved through the installation of an adjustable speed drive (ASD) to vary fan speed. ASD's are commercially available for any size motor and have a proven, industrial track record. In Ontario alone, it is estimated that up to 400 kilns could potentially benefit from the implementation of variable fan speed scheduling.

Dry kiln fans force air through the lumber stack in order to deliver heat to the wood and remove moisture from the board surfaces. Air flow requirements change within the drying schedule as a result of variation in drying rate and the need to raise the temperature of the wood. An ASD allows air flow to be reduced at points within the drying schedule when full air flow is not required.

The total value of wood dried by McChesney Lumber exceeds $15 million per year. Although any cost saving is significant, it is understandable that a mill would be reluctant to install new technology to save $12,000, especially if there were any chance of added degrade or productivity loss. This is perhaps one reason why few mills have implemented reduced air flow schedules despite other studies in North America that have demonstrated significant energy savings. The problem is a lack of criteria from which to establish an air flow schedule that could be guaranteed to have no impact on the rest of the drying operation. The objective of this project was to demonstrate the energy savings and develop a standard procedure that could be used to establish a site specific air flow schedule for any kiln.

McChesney Lumber entered into an agreement with Allen-Bradley to install an adjustable speed drive (ASD) for the duration of the tests. The ASD allowed the

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frequency of the supply voltage to be varied between 30 and 60 Hertz. It was installed on McChesney Lumber's 150 MBM capacity, high-temperature, gas-fired kiln. The kiln is equipped with seven internally mounted fan motors of 15 horsepower each for a total of 105 horsepower. At the time of the study, the kiln was controlled by a pneumatic recorder-controller with kiln conditions pre-set via a cam follower mechanism. McChesney Lumber's normal drying cycle is 21 hours with a maximum temperature of approximately 230°F. The fan speed schedule was developed for mixed 2x4 and 2x6 inch jack pine lumber.

Forintek scientists developed a strategy to establish an air flow schedule with zero impact on drying productivity or final product quality. The first step was to assess the current drying schedule, air flow characteristics, and requirements for air flow throughout the schedule. Three control charges were monitored for drying rate, final moisture content distribution, and temperature drop across the load (TDAL). TDAL is the change in temperature between the entering and exiting air sides of the stack. For this study, it was measured at various points along the length of the kiln with temperatures probes placed directly in the sticker openings.

At full fan speed, the air flow through the lumber stack is approximately 1000 feet per minute (fpm). A typical profile of TDAL at full air flow is shown in Figure 1. The high TDAL periods are within the first three to four hours and between 12 and 17 hours. These are the points where air flow is critical to maintain either the desired heating or drying rate of the wood. The next step was to run the kiln at reduced air flows and monitor the impact on TDAL over the duration of the drying cycle. Test charges were run with average air flows of 800, 650, and 500 fpm. TDAL profiles were compared to identify points where TDAL differed from the control charges. The theory is that if the same TDAL profile is maintained, there should be no impact on other aspects of drying. It was found that at lower air velocities, temperature drop did differ at two distinct time periods within the schedule.

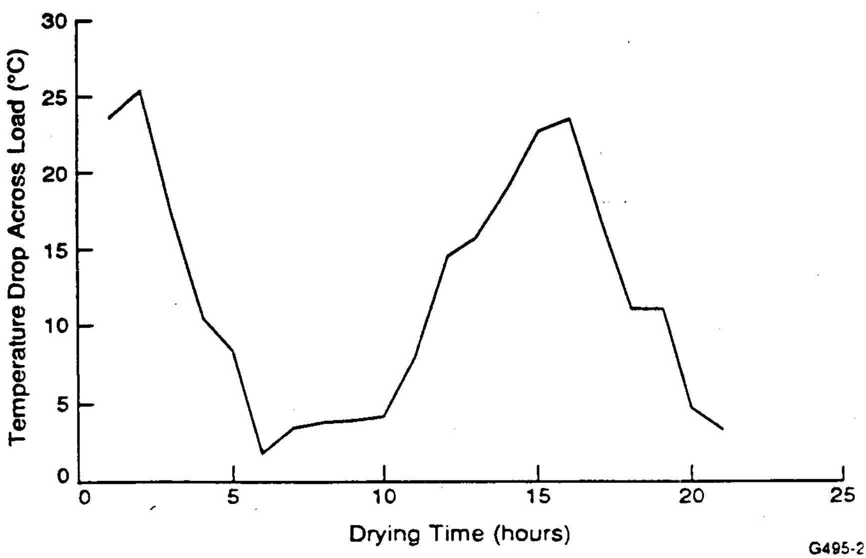

Figure 1. Typical profile of temperature drop across the load for high-temperature-dried, jack pine.

An air flow schedule was suggested by Forintek that took advantage of the ASD's full range. High air flows were used at the start of the schedule, gradually tapered off to half speed through the middle stages, and then accelerated again in the final stages. The schedule was modified over a period of time by Mcchesney Lumber staff and the final format is listed in Table 1. The schedule results in the fans running at full speed for only 33 percent of the drying time.

Table 1. Air flow schedule developed at McChesney Lumber

Time	ASD Setting (Hertz)	Average Air Flow (feet per minute)
0 to 2	52	775
2 to 5	60	950
5 to 11	34	550
11 to 12	42	675
12 to 14	52	775
14 to 18	60	950
18 to 19.5	42	675
19.5 to 21	34	550

Ontario Hydro personnel monitored energy consumption of the fan motors for each of the control and test charges. Figure 2 shows where the 50 percent energy savings were achieved over the duration of the cycle. Electrical energy consumption was reduced from approximately 1300 kilowatt hours per charge to 650 kilowatt hours. The final fine tuning of the schedule by mill personnel may have adjusted this figure somewhat. For example, as the schedule in Table 1 shows, it was decided to run for the first two hours at 52 Hertz. This reduced overall electrical demand by requiring full air flow only after the kiln air had been preheated.

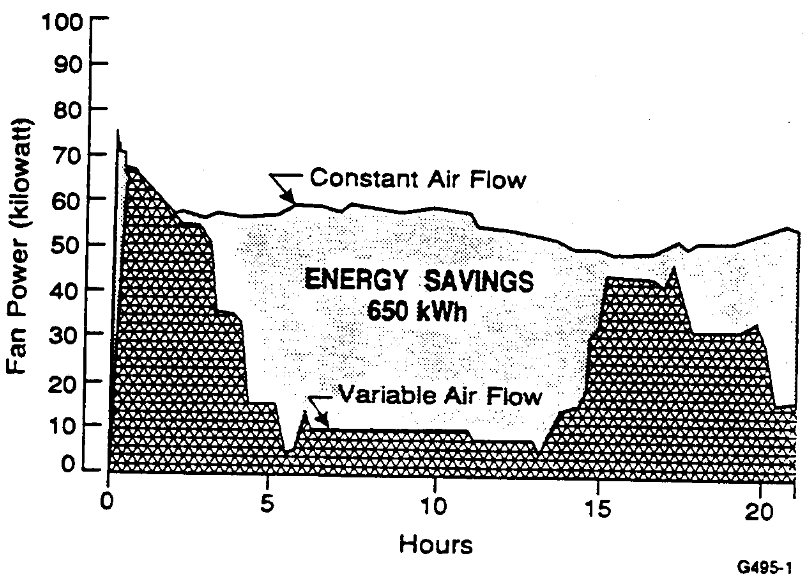

Figure 2. Energy savings associated with implementation of Forintek fan speed schedule.

Forintek and McChesney Lumber staff inspected dry lumber from two test charges for comparison with control charges. Final moisture content distribution was virtually identical with only a slight decrease in the amount of over-dried material in the test charges. Mill personnel noticed no difference on grade recovery or productivity at the planer mill.

The ASD used in this study provided the maximum flexibility in the development of an air flow schedule. However, this is not the only way of achieving a variable air flow. Two-speed motors are much simpler to control, have a lower initial cost, and lower maintenance cost than operating with an ASD. However, you must select what fan speeds you wish to operate with before purchasing the equipment and the opportunities for running at reduced fan speed will be less frequent within the schedule with lower overall energy savings. ASD's allow you to install the equipment and then experiment to develop the best routine for your operation.

Subsequent to the test, McChesney Lumber replaced the single ASD with seven smaller units, one for each motor. The seven ASD's are now controlled through a solid sate kiln controller installed by Coe Manufacturing. This has a slightly higher capital cost than installing one larger unit but offers some operational advantages which McChesney Lumber found attractive. For example, if one unit fails, they can still operate the dry kiln on six fans. Actual payback on the equipment is just over two years.

The procedure developed within this project can be applied on any dry kiln, however, there is no guarantee that the results will be the same. The starting air flow characteristics of the kiln at McChesney Lumber made it an ideal candidate for the application of an ASD. That is, there was a significant portion of the schedule where air flow was well in excess of the lumber requirements. If a mill wishes to consider installing an ASD on an existing kiln, a pre-inspection would be in order. This would involve a detailed sampling of air velocity and an inspection of all the operational factors that affect air flow such as baffles, kiln loading, and lumber piling. The air circulation system should be brought up to peak operating potential before making a decision to install an ASD.

You don't need 1000 fpm of air flow in order to benefit from applying an ASD. Each kiln drying operation has different air flow requirements based on the type of product dried and the temperatures employed. evaluating TDAL patterns will help you determine if there are points within your drying schedule where air flow can be reduced. The procedure is simple and is well described in a full report of this study available from either Forintek or Ontario Hydro. For test equipment, you will require an air velocity meter and a multi-channel temperature recorder. This will likely cost you $2,000 to $3, 000 but is equipment you will use over and over again to monitor the performance of your kiln and troubleshoot drying problems. If you are drying a variety of products, it is likely that you will need to develop a number of air flow schedules. This can only be done once the ASD has been installed.

If you are considering installing a new kiln or new controller on your existing kiln, you may wish to consider installing a system that displays temperature drop data. Many kiln manufacturers now offer the option of installing an ASD when the kiln is built. This may be more cost effective than retrofitting but you will still need to develop your own air flow schedules.