TREND ANALYSIS OF KILN DRYING DATA

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Introduction

Today, successful kiln drying implies more than high productivity, low operational costs and high-grade recovery. A successful drying operation must also exhibit consistency from run to run and achieve uniform final moisture content throughout the kiln charge. To achieve consistency and uniformity of final moisture content, kiln supervisors must rely on high performance equipment and comprehensive quality control. In addition, they also need to be equipped to carry out detailed data analysis to determine the main sources of problems and therefore enable them to design strategies to eliminate the problems. The ideas presented below illustrate important kiln drying issues that affect operations and how interpretation of the data can assist kiln supervisors to maximize their results.

Final Moisture Content for Industrial Softwood Operations

Final moisture content and the corresponding tolerance range vary according to the final product and therefore end-use. For example, grading rules state that for dimension lumber the maximum acceptable moisture content is 19%. For other types of products, tighter final moisture content ranges are required as is the case for lam-stock products for which the required range is 8 to 12%.

One of the main challenges of any lumber drying operation is to reduce the variation of the final moisture content. Many variables will influence the variation of moisture content at the end of drying. The subject is quite extensive and beyond the scope of the present discussion. In general, kiln supervisors have limited flexibility in relation to extending their drying times. Thus, they have to dry as uniform as possible within the available timeframe.

To avoid producing wet lumber at the end of the drying process, kiln operators frequently opt for targeting moisture content below the desired value and therefore ensure that most of the lumber will be below the maximum acceptable value. Although this practice complies with customer's requirements, it does have a cost to the producer due to the following components:

(1) longer drying times and therefore higher energy costs,
(2) lower grade recovery

These two components have a great impact on profitability of an operation. Longer drying times must be carefully weighed against today's energy costs. On the other hand, lower grade recovery cannot only reduce significantly profit margins but also prevent the producer from competing in certain markets.

Assessing Final Moisture Content

Kiln supervisors normally assess final moisture content by carrying out "hot moisture content checks" while the lumber is still inside of the kiln. They use the information to decide whether the charge is ready to pull out. Once the lumber charge is ready, it is placed in a temporary storage area before it is transferred to the planer. All lumber pieces are assessed for moisture content (normally by a capacitance moisture meter). Frequently, the moisture assessment technology used at the planer differs from that used during the hot checks. As a result, kiln supervisors may have difficulties in relating their results with the assessment carried out at the planer. If the hot checks are measured by a resistance type of meter it may be possible that the results at the planer may indicate a lower moisture content because the capacitance meter will measure an average value through a certain thickness. Thus, it is important to develop a relationship between hot checks and moisture content measurements made at the planer. To establish such a relationship, it is necessary to collect several specimens exhibiting moisture contents varying between 6 and 25% and compare the results to those obtained at the planer moisture meter.

Average Final Moisture Content and its Standard Deviation

Average final moisture content and its standard deviation are the most important parameters for characterization of a drying run. By using these two parameters, it is possible to learn a great deal about the process and the drying schedule used. They can also be used to examine "risk" in terms of under-drying and over-drying. Figure 1 illustrates a typical final moisture content distribution for a softwood mill producing dimension lumber.

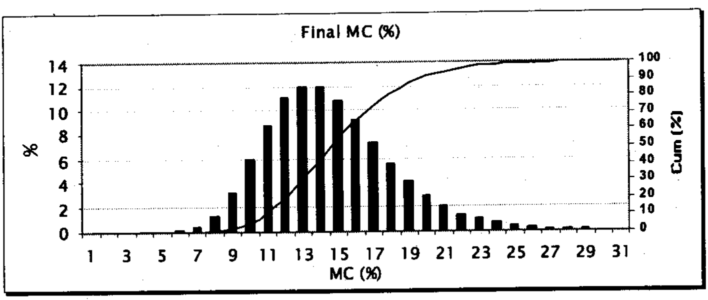

FIGURE 1. Typical final moisture content distribution for dimension lumber.

The average moisture content and standard deviation for the distribution illustrated in Figure 1 are respectively 15% and 3.5%. Under those circumstances, the estimated amounts of under-drying (wets), that is, lumber with moisture content above 19% and over-drying (too dry), that is, lumber with moisture content below 10%, are respectively 13% and 5%. The results shown in Figure 1 indicate that the percentage of wets is too high and therefore may cause problems in the market place.

Over-Drying Versus Under-Drying

Kiln supervisors try to avoid the results shown in Figure 1 by drying below the target moisture content as indicated earlier. If the standard deviation remains the same (this is common in practice), the following results are obtained:

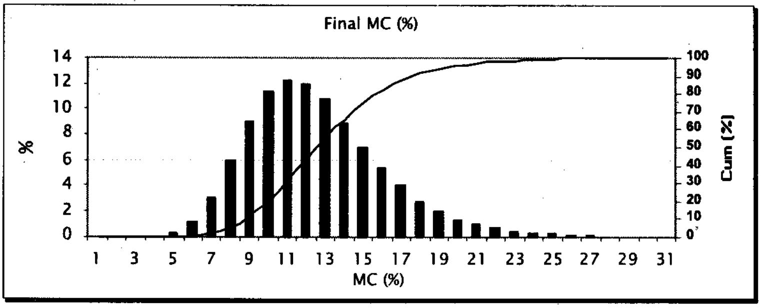

FIGURE 2. Final moisture content distribution.

The situation shown in Figure 2, final moisture content of 13%, indicates that the amount of wets is about 6% but the amount of over-dried is approximately 20%. Thus, it is very likely that the amount of degrade due to drying, especially warp, will be too high.

The dilemma faced by kiln supervisors relates to the handling of the under-drying versus over-dried issue and still run a successful operation. Figure 3 examines, perhaps, an ideal distribution for softwood dimension lumber:

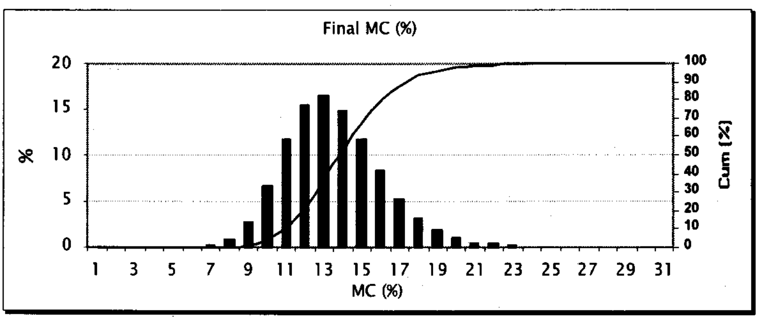

FIGURE 3. Final moisture content distribution.

For the distribution illustrated in Figure 3 (average final moisture content of 14 and standard deviation of 2.5%), the amount of wets is about 3% and the amount of over-drying is only 4%. Under those circumstances, there will be no "moisture claims" and the amount of drying degrade will probably be minimum.

Figure 4 illustrates a distribution for average final moisture content of 13.5% and standard deviation of 3%. In terms of compliance with grading rules and reduction of the risk of excessive drying degrade, the distribution shown in Figure 4 reflects a distribution that can still be considered satisfactory although the drying degrade will likely be higher when compared to the distribution shown in Figure 3.

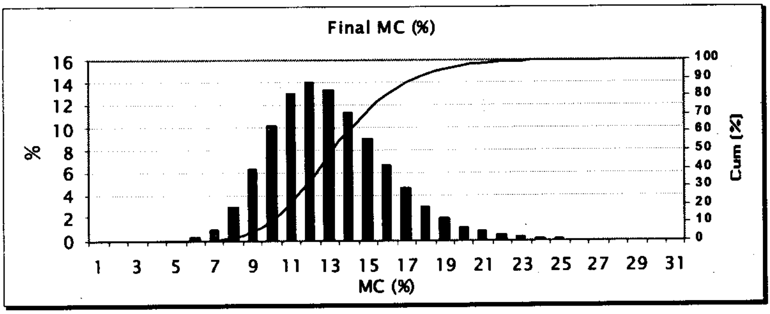

FIGURE 4. Final moisture content distribution.

Impact on Energy Consumption

The longer the lumber stays in the kiln the higher the energy consumption will be mainly because of two reasons:

(1) drying to lower moisture contents consumes more than the necessary amount of energy,

(2) longer drying times will contribute to increased energy losses.

For example, if a typical charge of dimension lumber is dried to 10% final moisture content instead of 15%, the increase in the amount of energy consumed will be at least 10%. In view of today's energy costs, this increase in energy consumption may significantly increase drying costs.

The estimate above is conservative because it reflects only the amount of energy that is necessary to remove the additional amount of water when drying down to 10% final moisture content. In reality, the increase of energy consumption can be significantly higher due to heat losses from the kiln equipment during the extended time to reach the final moisture content value of 10%.

Impact on Target Sizes

Today's sawmills are equipped with sophisticated instrumentation to allow operators to maximize lumber recovery. Thus, more aggressive target sizes are common in softwood dimension lumber operations. In practical terms, it means that if the lumber is over-dried, it will probably be under-sized at the end of the drying process. This is one of the causes for skip at the planer. Thus, sawmill and drying staff must work together to decide on target sizes because it will depend on drying performance or kiln drying equipment performance or a combination of both.

Interpretation of Drying Results

A typical kiln drying spruce-pine-fine (spf) dimension lumber dries about 15 to 17 charges per month. A typical sawmill with four kilns will therefore dry more than 750 kiln charges per year. The represents a wealth of information that can be used to examine kiln performance and optimize drying schedules. The graphs below illustrate trend analysis of the data that are normally collected by kiln supervisors.

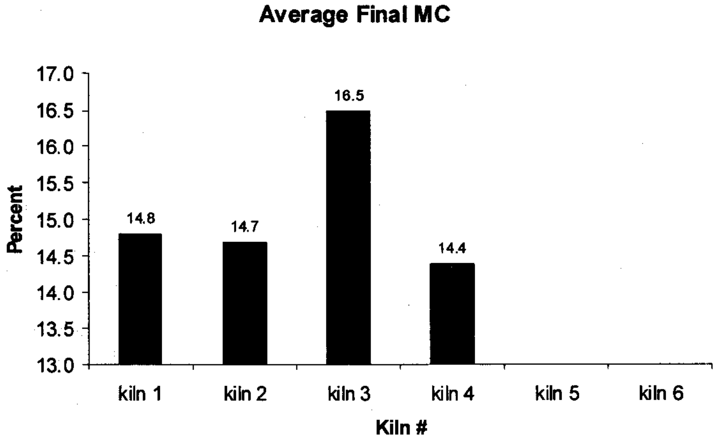

FIGURE 5. Trend analysis for final moisture content

Figure 5 illustrates the final moisture content results for 2x6 SPF lumber. The data correspond to a period of one year. Although all kilns dried the same product during the same period, it seems that the final moisture content for kiln 3 is higher than the moisture content obtained for all other three kilns.

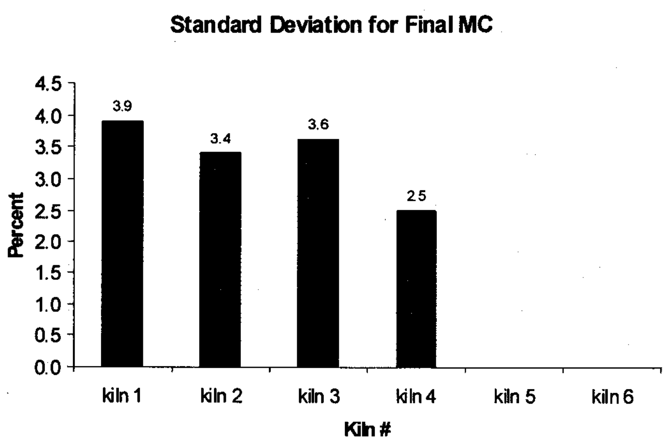

FIGURE 6. Trend analysis for Standard deviation

Figure 6 shows an example in which all kilns dried the same product during the same timeframe but kiln 1 exhibited higher standard deviation. Since this is a trend, it is necessary to investigate why kiln 1 is exhibiting more variation. It would probably be something related to airflow uniformity.

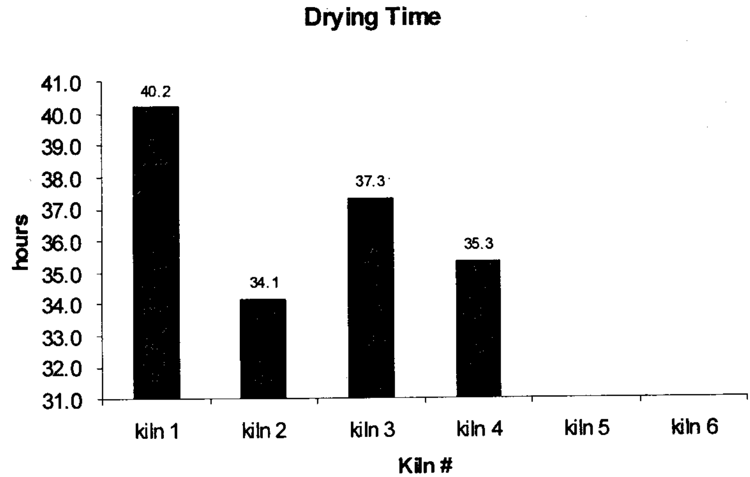

FIGURE 7. Trend analysis for drying time

It is clear from Figure 7 that the drying time for kiln 1 is longer when compared to the other kilns although it dried the same product during the same period. Although the average final moisture content illustrated in Figure 5 was similar to the moisture contents found for kilns 2 and 4, it seems that kiln 1 is not as efficient as the other kilns (larger standard deviation and longer drying times). Thus, kiln 1 would have to have priority in terms of maintenance and/or upgrade.

As demonstrated above, this type of analysis allows kiln supervisors and mill managers to set priorities in terms of equipment, establish realistic expectations regarding drying results and design strategies to optimize drying. As illustrated in Figure 6, it may be possible that the best standard deviation that can be obtained with kiln 1 is about 3.9%. If this is the case, then it might be useful to dry only certain products in kiln 1. It may also be required to evaluate both target moisture content and green target sizes in view of the variability that is expected for kiln 1. On the other hand, once the kiln with the most important problem is identified, it is possible to carry out an economic analysis to evaluate maintenance and/or upgrade needs in view of potential results in terms of moisture content uniformity and quality of the product at the end of drying.