Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

USING SIMULATION TO ASSESS THE PERFORMANCE OF A BREAKTHROUGH WOOD-DRYING TECHNOLOGY

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ABSTRACT

Conventional wood drying technologies dry enormous batches of lumber bundles. However, they are really inefficient and lack the agility needed to satisfy customers' expectations. Researchers recently developed a patented precision drying approach that uses a high frequency technology. By building a discrete event simulation model, it has been possible to predict the impacts, benefits and possible constraints of a continuous high frequency drying system. Analyzing simulation results plots, the user can evaluate and compare different designs. Thus, simulation appears to be an important step between the experimentations with the physical prototype of the dryer and the first in-plant implementation.

1 CONTEXT AND PROBLEM DEFINITION

In the past few years, the forest-products industry has encountered certain difficulties due principally to economic circumstances. To remain competitive and stay in the race, companies need to lower their costs, diversify their products and increase their quality. In addition to being energy intensive, the wood drying step remains a challenge in terms of quality considering that the specialized value-added products need to be in a precise and narrow range of moisture content. Conventional wood drying technologies typically dry enormous batches of lumber bundles. However, they don't allow a lot of flexibility in regard to planning and scheduling. This lack of flexibility is linked to using a batch process whose stopping condition is attained when the majority of the pieces are within a specified range of moisture content. Researchers recently developed a patented precision drying approach that uses a high frequency technology for a portion of the drying process. Wood is first dried in a conventional kiln that is shut down prematurely. Each piece of lumber that isn't yet in the specified range of moisture content is then dried individually using a radio frequency technology. More precisely, the moisture content of each piece is measured at the planer mill. If it is still too high, the piece of lumber is sent to the high frequency electric dryer to continue the drying. This particular process is designed to be continuous and permit certain pieces to be cycled (dried) multiple times depending on their moisture content. On the other hand, the implementation of this mechanism represents a challenge at the operational level: this kind of technology could not be implemented if it were to have a negative effect on productivity and logistic aspects.

2 DEVELOPMENT

By building a discrete event simulation model using SIMIO, we were able to predict the impacts, benefits and possible constraints of the integration of a continuous high frequency drying system on an existing line. While the modeling of this potential high frequency continuous re-drying system has allowed the research team to better understand the impacts on the product flow, it can also potentially help the system integrator to determine the basic specifications of the technology such as the capacity and physical length of the high frequency dryer. Moisture content distributions of typical spruce-pine-fir loads follow a log-normal distribution. Using a continuous radio frequency prototype, we were able to measure how each pass in the high frequency dryer affects this distribution, which turns out to be a stochastic process. Different plant layouts, using the drying characteristics observed, were developed using SIMIO. By using these simulation models we were able to obtain some relevant data concerning the buffer storage units to implement. We were able to compare the layouts on the basis of some key performance indicators such as the mean and the maximum amount of pieces of lumber in the buffer storage units.

Table 1: Overview of some results provided by the simulation

μ σ	15.95 4.07	17.34 4.54	18.33 4.77	19.14 4.87	19.95 5.18	20.97 5.39
Dryer's minimal capacity required (units)	200	400	550	650	800	1050
Average number of pieces in the storage unit located upstream of the dryer (units)	4	7	10	12	16	20
Maximum number of pieces in the storage unit located upstream of the dryer (units)	11	16	21	25	30	34

Table 1 shows a typical example of results we can get for a given plant layout. We suppose the user first defines the annual production capacity needed. Then, for different scenarios of initial moisture content distribution (log-normal distribution parameters μ and σ) corresponding to different raw materials of interest, SIMIO allows us to compute some indicators such as: dryer minimal capacity needed, number of pieces in the buffer storage unit located before and after the dryer, etc. By analyzing results using SMORE plots (SIMIO Measure of Risk and Error), the user can evaluate and compare different designs. For instance, the dryer's minimal capacity required is the minimal theoretical value of capacity where the continuous high frequency drying system doesn't have a negative impact on the overall productivity of the main production line while ensuring that the re-dried pieces are at or below the target moisture content. With this value of capacity and using the information on the dimensions of the treated products, the length and the electric power of the high frequency dryer can then be estimated. At this point in time, the information provided by the simulation model is mainly a support tool for the on-going research project. Further studies and calculations are recommended before the implementation of the final product. Considering that end-user companies have varied needs and objectives, the simulation model will be subjected to modifications and adjustments as needed.

3 CONCLUSION

Simulation appears to be an important step between the experimentations with the physical prototype of the dryer and the first in-plant implementation. Our model permits taking into account operational constraints when designing new industrial processes such as this high frequency continuous precision drying concept. We strongly believe that the use of a discrete event simulation model, when developing new technologies, can be an extremely valuable tool. For many similar projects, this step is a missing link that can help to avoid undesirable consequences and important costs at the implementation step.

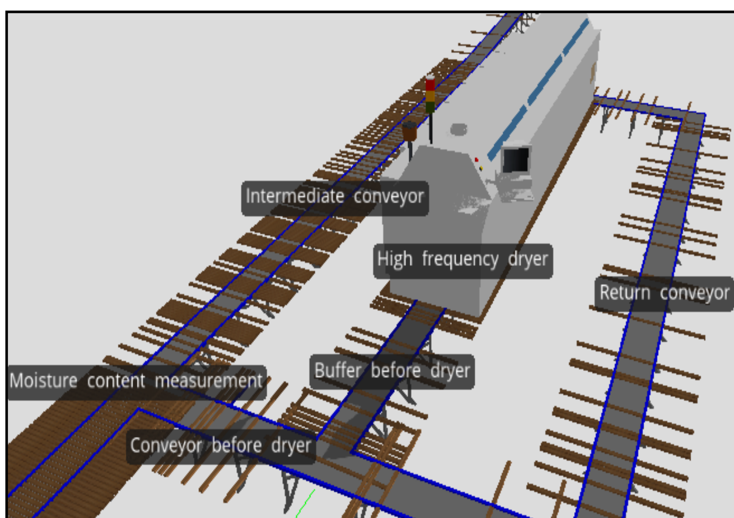

Figure 1: Model overview.