

EXPERIENCES DRYING HIRAKAKU BEAMS IN A VACUUM RADIO-FREQUENCY KILN

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We were retained in cooperation with Carroll Hatch & Associates and Pacific Power and Light to compare the drying results of three different drying processes. The three comparisons were between conventional steam heated kilns, dehumidification kilns and vacuum radio-frequency (VRF) kilns. This particular study was performed essentially for the comparison of energy usage and our role was to have input as to quality, time, and degrade of the various drying processes. While we have had exposure to the first two types of drying processes we had not experienced the VRF drying process. This study was in response to a request by a small producer of Japanese export beams. His interest in the RF system was two-fold. First was quality and the second was speed. This client's primary product is 105- and 114-mm by 3- and 4-meter long beams. This is a product that requires careful and protracted drying schedules in both conventional and DH kilns. This client was converting from a green product to a dry product for the first time and wanted to minimize his inventory turn around time and capital cost associated with conventional drying. The client felt the DH method for his particular product was unacceptably long with little relief from the capital investment. It was decided to do a test by drying in a Heat Wave VRF kiln in Castlegar, BC.

When we arrived on site at the Heat Wave location the beams had been re-packaged and loaded into the machine for drying. We had wanted to get a green weight before drying so we asked them to back the charge out of the kiln and put it across the scale. While they were performing that function we connected the PP&L energy computer to the main breaker. In a matter of an hour we were reloaded and ready to start the kiln. The drying process is monitored by an extensive computer system that tracked and graphed almost every component in the VFR process. The first step in starting the kiln is closing and locking the large airtight doors.

Once the proper seal has been achieved then the pumps start creating a vacuum in the drying chamber. The Heat Wave kiln is taken down to 40 millibars to create an environment of 95% vacuum. Reverse of the method used in conventional drying, the VRF starts out with the highest kilowatt usage (50kW) at the beginning of the charge and reduces gradually to (10kW) as the charge dries. One of the ways the computer monitors the charge is through the tracking of water removal through the collection tanks. Since the chamber is at low temperature and sealed, all of the water is collected into tanks and then pumped away as the tanks fill. The computer records the dump times and amounts that are removed. Therefore if you know the weight going in you can mathematically calculate the volume of water that would be removed for your particular ending moisture content. We weren't experienced enough to rely on the other information provided by the controls (dielectric index); however, we could readily relate to water removal as a way of determining when the charge was complete.

After pulling the charge to have it weighed and connecting the power-recording computer, the charge actually started drying at 10:30 am Monday morning. At approximately noon on Tuesday Jim Zwick of Heat Wave assured us that the charge was

nearing completion and he estimated the charge to be complete at or near 9pm that evening. We continued to monitor the charge and spent the rest of that afternoon calculating the volume of water being exhausted in the form of vapor from the vacuum pump. This vapor was estimated to have a 140 wet bulb and a 140 dry bulb on average, with a velocity of 1000 fpm. During a 48 hr cycle we estimated that an additional 498 pounds of water was being removed that was not being recorded.

We returned at about 8pm and the kiln had shut itself down by achieving the dielectric index set point. We released the vacuum and pulled the charge. Using a hammer type moisture meter we found the ends of the beams to be at 15 to 18 percent; however, when we checked the sides of the beams they showed 25 to 30 percent. It was decided to restart the kiln and let it run for a little longer. Jim Zwick re-started the charge at a power level of 25kW and let it run until 8:00 am Wednesday morning. The elapsed time of the drying cycle was 39 hrs 37 min. We had previously estimated that the total amount of water to be removed would be approximately 980 liters. At the time we stopped the charge the recorded amount of removed water was 899 liters with an estimated 80 liters still in the tanks therefore showing an approximate removal of 979 liters. This led us to believe that sufficient amounts of water were removed to achieve the desired moisture content. We released the vacuum and pulled the charge.

Based upon touching of the outside of the load we determined the wood temperature to be approximately 90 degrees. We calibrated the needle moisture meters and probed the wood. We used several Delmhorst meter configurations, consisting of a short needle, a 1-1/8" needle, a 3" needle and two Wagner surface meters. We found that the sides were 24 to 22 percent and the ends were 15 percent. This was particularly puzzling to us given the water removal information and the other indicators that Jim Zwick had assured us pointed to a dry charge. We wondered if the meters were calibrated correctly and decided to check the wood temperature with a thermocouple. We accomplished this by measuring the center of the piece and then setting that distance on the 3" needles so as to probe to the center of each piece. We then inserted the probe the measured distance removed the needles and then inserted the thermocouple. The thermocouple showed that the interior wood temperature varied from 130 degrees to 162 degrees. When we recalibrated the meters for the interior temperature of the load, the readings did in fact show the load dry. The corrected readings were 12 to 18 percent. All of the pieces in the charge fell within a tight range and none were outside specifications.

Generally we were favorably impressed with the results. We found that the checking was very minor and that the shrinkage was in the 1 to 1-1/2 % range. There was no evidence of twist, warp or damage around the knots. We believe these results compare favorably with high quality conventional kiln operations drying similar products. There were some mechanical problems with the machine that Heat Wave will design out of the next one built. These minor annoyances are to be expected with any prototype machine. The kiln did a fast and high quality job of drying the beams. We believe the quality would be improved with more experience operating the kiln. We could also see the time further reduced due to uninterrupted run as well as fine-tuning the control variables.