Theories for resin absorption in Balsa panels:

6-4-2022

Theory 1:

High temperatures reduce the strength of wood in two ways. First, there is an immediate and reversible effect. For example, wood is weakened when heated from 75 to 240 °F but regains strength if immediately cooled to 75 °F. The second effect occurs over time and is permanent. When wood is heated for long times at high temperatures, 'it is permanently weakened; the loss of strength remains after the wood is cooled. Roth effects are greater at high moisture content than at low moisture content. Balsa has an extremely high moisture content prior to being dried. These are permanent effects caused by a combination of time, temperature, and moisture content. Strength loss increases as any one of these factors increases. The immediate, reversible effect of high-temperature drying is important in the development of drying defects that result from breakage or crushing of wood cells. When the drying stresses become greater than the strength of the wood, this type of drying defect develops. Therefore, high temperatures early in drying are dangerous. The weakening effect of high temperatures coupled with high moisture content can cause the wood to fracture or be crushed. High-temperature drying for prolonged periods, particularly early in drying when the moisture content is high, may not result in breakage or crushing-type drying defects, but it can cause a permanent loss in strength or other mechanical properties that affect product performance in end use. We can see the effect of high-temperature drying (225 to 240 °F) compared to conventional-temperature drying.

Defect Categories

Most defects or problems that develop in wood products during and after drying can be classified under one of the following categories:

1. The Rupturing of wood tissue

2. Warp

3. An Uneven moisture content

4. Discoloration Defects in any one of these categories are caused by an interaction of wood properties with processing factors.

Wood shrinkage is responsible for wood ruptures and distortion of shape. Cell structure and chemical extractives in wood contribute to defects associated with uneven moisture content, undesirable color, and undesirable surface texture. Drying temperature is the most important processing factor because it can be responsible for defects in each category.

Suite 207, Building 4-B, Taoran Caifu Gang
No 95 Huanghe Road
Dongying, Shandong, China, 257000

+86 189 5403 9950

+86 183 6695 5123

sinopro-group.com

info@sinopro-group.com

Rupture of Wood Tissue Many defects that occur during drying result from the shrinkage of wood as it dries. In particular, the defects result from uneven shrinkage in the different directions of a board (radial, tangential, or longitudinal) or between distinct parts of a board, such as the shell and core. Rupture of wood tissue is one category of drying defects associated with shrinkage. Knowing where, when, and why ruptures occur will enable an operator to take action to keep these defects at a minimum.

Kiln drying is frequently blamed for defects that have occurred during air drying, but most defects can occur during either process. In kiln drying, defects can be kept to a minimum by modifying drying conditions, and in air drying, by altering piling procedures. Surface checks are failures that usually occur in the wood rays on the flatsawn faces of boards. They occur because drying stresses exceed the tensile strength of the wood perpendicular to the grain, and they are caused by tension stresses that develop in the outer part, or shell, of boards as they dry. Surface checks can also occur in resin ducts and mineral streaks. They rarely appear on the edges of flatsawn boards 6/4 or lees in thickness but do appear on the edges of thicker flatsawn or quarter sawn boards. Surface checks usually occur early in drying, but in some softwoods the danger persists beyond the initial stages of drying. They develop because the lumber surfaces get too dry too quickly because of relative humidity that is too low.

Sinopro are currently setting up and running tests to understand this issue with the current problems blade manufacturers are facing with Balsa panels in the production of blades.

We are setting up the testing by producing small 300mm (about 11.81 in) x 300mm (about 11.81 in) sample blocks dried at various levels of time and temperature. We will reduce the moisture levels in the wood strips to below 5% moisture to test if this allows resin to absorb into the wood. We will cut these sample blocks into panels and apply resin to the surface to inspect the reactions.

Our aim is to find out if the incorrect drying methods currently being used can cause damage to the cellular damage to the Balsa that could allow resin to be absorbed.

Suite 207, Building 4-B, Taoran Caifu Gang
No 95 Huanghe Road
Dongying, Shandong, China, 257000
+86 189 5403 9950
+86 183 6695 5123
sinopro-group.com
info@sinopro-group.com

Theory 2:

We have been testing the sections of balsa removed out of processed wind blades from several manufacturers over the past six months. Our observations are based on several factors that have pointed to one cause to how resin could be absorbed into the balsa wood during the curing process of the resin. We all know the hydroscopic abilities of balsa.

When the balsa has a moisture content above 10%. Even in localized areas. The defeat of resin absorption is prevalent. The bound moisture will evaporate and be released into the surface application of resin during the processing stages of wind blade lamination.

This release of the bound moisture will dilute the viscosity of the resin to such an extent that it can now be absorbed into the surface of the balsa wood easily. The higher the moisture levels in a localized area the larger the amount of resin will penetrate the balsa wood.

Through the validation of tests carried out the absorption of pure resin into the surface of balsa wood is 0-3% minimal unless the balsa shows signs of fractures or excessively deep drill holes during processing.

The dilution of the resin by 10% showed signs of absorption into the balsa surface by up to 2mm before curing took place to stop absorption.

At 20% the resin can penetrate the surface to the depth of over 5mm before curing takes place with the resin.

We tested balsa at a moisture level over 14% and as high as 20% to conclude our finding. It was observed at the highest levels of moisture the resin was diluted enough to be completely absorbed into the localized area of a panel.

The type of test carried out can be deemed as a simple laymen's method of observation.

We first used a disk sander to form a concaved surface on the test sample of pieces 50mm (about 1.97 in) x 53mm (about 2.09 in) and 20mm (about 0.79 in) thick. This gave us a minimal localized surface area for absorption. Also, to pool and contain the liquid on the surface area.

A 5ml (about 0.17 oz) syringe was used to measure the different dilutions of water and resin in our tests.

We first tested the amount of water necessary to fully penetrate the sample size. This was 1ml (about 0.03 oz). 20 minutes was the tested period at 150m3/kg for full penetration.

Once realized we started testing resin at different diluted percentages. The higher the dilution percentage the longer the curing time. Thus, giving the resin more time to be absorbed deeper into the test samples.

Our observations showed that the different density of each sample behaved differently. Higher density balsa tends to absorb over a wider surface area with less penetration into the wood. Whereas the lower density did the opposite. The penetration stayed local and want deeper at a set point in the test sample. We tested samples at 101-150-188-264m3/kg.

After setting a base line for absorption with just water, we proceeded to test resin absorption at different diluted percentages. Similar characteristics incurred with diluted resin, as with water.

Observations of further defeats such as delamination found to happen with mainly the localized absorption of resin in the lower density wood. We could not property measure the true amount of heat build-up in this localized area with the current equipment we were using. The formation of white/cloudy spots happened in both the higher density and lower density samples. The more absorption in a localized area of the lighter density wood, the deeper color the spot appears to form. The wider area the absorption in higher density wood created a larger paler white spot.

Theory 3:

Heat: We did tests with resin at different temperatures to observe the degree on viscosity change in resin. Our observations showed a huge change in the viscosity. Ok we do not have a Brookfield Viscosimeter; we used a simple viscosity cup and timed the results. Once the resin reaches high temperature it can become as thin as water. This could be a cause for the easy absorption of resin in balsa. The lighter density wood would readily absorb resin at this thin of a viscosity. Heavy wood has a slower absorption rate then lighter density. Being able to measure the exact amount of absorption before polymerization incurs is very difficult due to the intrinsic nature of a natural material like balsa. We weighted the sections of wood prior to testing and then again after absorption incurred. Every sample piece was different.

With blade manufacturers, turning up the heat in the blade molds now to meet the high pressure of order commitments they are facing is not helping the situation. The size of the molds we are now using is another cause for concern. Control of the heat evenly and accurately throughout the entire length of an offshore blade mold is near impossible. We will have localized hot spots in the mold. Now the percentage of these hotspots that will incur exactly where a section of low-density wood is rare. Nevertheless, it is happening. We still get a few absorption defeats in the blade processing. We think that once this happen the excess resin starts to pool in a localized area, this has a conductive effect of generating more heat, thus instigating more viscosity change leading to increased absorption in this localized area. Polymerization using external heat sources has always had issues. The control of heat over a vast area the size of an offshore blade is nothing short of challenging. Another issue is with diluents/extenders, the overuse of these additives to achieve the right viscosity and maintain an excepted increase in extending the volume of resins for cost purposes needs closer monitoring and testing.

If we were to combine all these issues into one container of balsa what would be the outcome?

These are theories, based on nonprofessionals' observations of a natural material and the cause and effect simple logic plays in the defeat issues we are examining. Sinopro-Group has not commissioned any professional scientists or laboratories to carry out tests. These tests are in a potting shed environment.

Report prepared by:

Doug Combs

Global Operations Director

Sinopro-group.com