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Woodworker's Preparation for Winter Gluing

There are a considerable number of fundamental factors in the gluing operation that affect the strength and appearance of a glued joint. The best time for a general review of your gluing operation is prior to seasonal weather changes, such as before winter, and then again in the spring. The factors you should address that I will briefly discuss are: **Moisture**, **Temperature**, **Machining**, and **Clamping**.

Moisture - Moisture is perhaps the most important factor to be reviewed to help prevent open joints. End splits develop only because wood is shrinking, and the only reason wood shrinks is because it is drying. This fact compiled with the information that the end grain of wood dries 50 times faster than the edge or face grain leads us to conclude that the defective panels are too wet for the dry air in the plant (especially in the winter months). Therefore, the ends dry rapidly and shrink much faster than the center, leading to splits. In extreme cases the lumber also splits at the ends. In the spring when the air is full of moisture, the opposite can happen. That is, the end grain could swell resulting in much more clamp pressure on the ends than the mid panel sections, resulting in weak or open joints in the middle of the panels. To be safe it is necessary to keep the moisture content of the lumber within 2% of the moisture content of the air in your plant. Either the lumber should be dried to a lower content or else the plant should be humidified. Generally, drying the lumber 2% less in the winter is helpful for an unhumidified plant. A good rule to follow is an ideal moisture content of 6-8% in summer and 5-7% in the winter. Also remember, incoming lumber should be machined and staged at least 48 hours in the glue area before gluing to equalize. Manually check your moisture daily, at the clamps and when it arrives into the building. As a side note, when gluing squares it is very important to wait at least 24-48 hours between edge gluing and face gluing to give the moisture from the adhesive enough time to equalize.

Here is a helpful conversion chart:

Relative Humidity (percent)	Equilibrium Plant Moisture Content
15%	4%
30%	6%
50%	9%
80%	16%

Temperature – We can't control outside, but you should inside. Hot weather is seldom a problem under 100°F. However, when it's hot the viscosity of your adhesive will become thinner. This may cause running and a lack of pick up on the wheel transferring adhesive to the lumber. I suggest a cloth glue sock on your applicator roller to be sure you are applying enough adhesive when it's thinner in the warmer months. Cold weather, on the other hand, is something you have to take precautions in. Polyvinyl Acetate Resin adhesives are made to perform best at around 65-85°F. These resins are made up of tiny microscopic resin particles suspended in water medium. When the water in the applied adhesive dissipates through evaporation or absorption, these tiny particles begin the drying process to form a continuous film, thus forming a bond. When the temperature (especially of the adhesive) decreases below 45°F, the adhesive increases dramatically in viscosity and the molecular movement will also decrease. Therefore, it takes more time for the adhesive to form a bond and dry, therefore, your clamp times should be longer when it's colder.

A condition known as "chalking" develops when the molecular particles of resin in the adhesive cannot form a continuous film because adhesive temperatures are under 35°F. Basically, the drying process does not take place, thereby forming a chalky white film. Cold lumber will also cause chalking. Because of the shear density and mass in contact with the adhesive, it is very important to keep your lumber warm. Always keep your drums of adhesive on a pallet with air circulation under the drums, not on a bare cement floor.

Once a film has been dried at a temperature above its chalking point, a decrease in temperature will not chalk the dried film. By the same token, when the adhesive has chalked during drying, heating will not eliminate the visible chalking present.

Machining – This is often taken for granted. Next to moisture issues, poor joint preparation is the next biggest culprit for failed or weak glue lines. No adhesive can substitute for poorly machined and improperly fitted glue joints. Check your edge surfaces daily for smoothness. Take a red crayon and run it on its side down the length of your surface to be glued. If you see saw blade chatter marks that look like high and low marks you need to take immediate action. It's best to get your blades sharpened and positioned on a monthly basis. After your panels are taken out of the clamps, surface machining should be delayed at least 24 hours, preferably 48 hours to prevent sunken glue joints caused by unequalized moisture content.

Clamping – Intimate contact of the mating surfaces is necessary to produce bonds of maximum strength. Excessive pressure may result in excessive adhesive squeeze-out and starved joints. Low density wood species should not require more than 100 psi, medium density not more than 150 psi and high density (like oak) up to 200 psi. Generally, clamp time under ideal temperature, pressure, adhesive speed, and moisture conditions should be at least 45 minutes, but can be recommended up to 90 minutes for some high-density hardwoods.

Also generally recommended, is an adhesive spread of between 6-8 mils. The chart below will help you calculate your adhesive usage/needs.

COMPARISON OF SPREAD IN VARIOUS TERMS OF MEASUREMENT			
Film Thickness in Mils	**Lbs. of Glue per M sq. ft.**	**Gallons of Glue per M sq. ft.**	**Sq. Ft. of Coverage per Gal. of Glue**
0	0	0	0
1	5.5	.6	1604
2	10.5	1.2	802
3	17.0	1.9	534
4	22.5	2.5	401
5	28.0	3.1	320
6	33.5	3.7	267
7	39.5	4.4	229
8	45.0	5.0	200
9	50.5	5.6	178
10	56.0	6.2	160

Based on adhesive weighing 9 pounds per gallon.

For adhesives with weights differing from 9 pounds per gallon, a suitable correction factor will have to be applied.

Pounds of glue per thousand square feet has been rounded off to the nearest half pound.

If glue weighs more than 9 lbs. per gallon (for example 9.3) multiply the gallons of glue per thousand square feet by 9.3 to find the pounds of glue per thousand square feet.

Example: 3 mils spread, 9 lbs. glue equals 17 lbs. per thousand square feet. 3 mils spread of a 9.3 pounds glue equals 1.9 x 9.3 = 17.67 lbs.

Most PVA resin wood glues weigh 9-9.2 lbs/gal.

To conclude, in my opinion, understanding the effects of moisture and minimizing moisture content wide variations are probably the most cost-effective measures for minimizing expensive failures in most types of glue wood assemblies.

This basic information is intended as a generalization and may not be a full proof-prevention or cure for every operation of gluing. So many factors and combinations of individual environments can lead to open glue joints. Each case must be methodically and patiently studied and analyzed to make a determination. I would be happy to discuss any specific issues you may have if you give me a call.

Good gluing and best regards,
Vinny Skoczylas
President

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