

*“Actually, I think the bad reputation began in the 1950s when manufacturers claimed superior strength and water resistance for their white and yellow glues to get craftsmen to switch. These non-issue claims are still used today by suppliers of even stronger and more water-resistant adhesives.”*

Bob Flexner, Popular Woodworking, October 2009

In the 1950s the advent of yellow and white PVA glues started to replace the widespread use of hide glue. Eventually, hide glue was almost totally lost from the woodworking memory. After four generations of ever decreasing use of hide glue, the knowledge about its extraordinary advantages to some woodworking tasks as all but disappeared. Today hide glue is used by luthiers, restorers, conservators, player piano repairman and some woodworkers. Strangely enough, the disappearing act of hide glue appears to mimic the disappearing act of hand planes after World War II. Most woodworkers who take the time to learn how to set up, sharpen and properly use a hand plane are absolutely amazed by the ease-of-use and the expanded woodworking capabilities that are now within their grasp. They are surprised that a tool so fundamentally connected to efficient woodworking could fall out of use.

I hope to show that with a little bit of knowledge about the material and a small amount of overhead in setting up to use it, hide glue has advantages in the modern workshop and will add to the craftsman's woodworking vocabulary.

Hide Glue is worth a look If you are searching for a glue that

- Provides glue joints that last for centuries
- Is extremely strong
- Has properties that are easily modified to satisfy a variety of woodworking needs
- Is easily reversible
- Has unlimited shelf life
- Will be open for 1 minute
- Will be open for 30 minutes
- Will stick to itself
- Will gel in one minute (initial tack)
- Will never gel
- Allows you to glue up without clamps
- Allows you to glue up with clamps
- Allows you to veneer without a vacuum press or a mechanical press
- Is absolutely rigid when dry and will not creep
- Is absolutely flexible when dry and will move with the wood
- Will not impact the finish
- Can be used as a filler
- Is non-toxic

The apparent contradictions above are one of the amazing things about this glue. It is easily modified by the addition of readily available items like salt and glycerin. Hide glue is a form of animal glue. Animal glue is an adhesive that is the result of prolonged boiling of animal connective tissue. It has

been used for thousands of years for a variety of tasks but saw extensive use in making furniture and musical instruments from 1600 A.D. on.

While the long history of hide glue is interesting, the modern woodworker must ask what value this ancient adhesive has in today's workshop. Just because it is old does not make it useful in the 21st century workshop. Pit sawing was an old and useful method that has no place outside of the museum today.

The purpose of this discussion is to examine the practical uses and benefits of hide glue for woodworking today.

- What problems it solves
- What functionalities it enables
- What flexibilities it offers
- What challenges it brings

Additionally, we will address some of the **myths**

- it is messy
- it requires extensive preparation
- it requires expensive equipment to use
- it's open time is way too short
- it is not as strong as PVA glue

## **Blended woodworking**

Modern woodworkers often engage in a Yin and Yang discussion regarding power tools versus hand tools. On one extreme, the "power tool only" advocate views hand tools as a throwback to an earlier era that and are either not necessary or involve too much preparation and training to be useful to them. The "hand tool only" advocate views hand tools as the only pure way to accomplish woodworking tasks and make furniture. A blended woodworker takes advantage of power tools to take care of highly repetitive tasks and do a lot of the heavy lifting of milling and hogging out material for joints while using hand tools to accomplish one-off tasks, properly fit joints, prepare surfaces and make joints that cannot be cut with a machine.

This concept of blended woodworking can be extended to include woodworking adhesives instead of power tools versus hand tools we have PVA glue versus hide glue. As with the two extremes above, I believe the correct answer lies in the appropriate use of both of these adhesives in the modern workshop.

## **The Case for Hide Glue**

The case for hide glue is almost totally established by the unique properties of this adhesive:

- Hide glue dries in two stages – short-term gelling that seizes the pieces and longer-term drying through the evaporation of the median
- It is reversible
- It's native properties are easily modified to accomplish a wide variety of woodworking tasks by the simple addition of readily available additives

## Hide Glue Properties and Woodworking

- Gelling
  - Rub Joints
  - Hammer Veneering
  - Gluing without clamps
- Reversible
  - Repairing made possible
  - Extend the life of chairs
  - Fix veneering problems
- Properties easily modified
  - Change open time
  - Change tackiness
  - Change flexibility
  - Change pretty much anything

## Mixing Hide Glue

Hide glue formulas based on the weight of the materials involved. It is possible to see some small variations in properties from batch to batch of new glue flakes so it is a good idea to mix a small test batch of new glue using the weight formulas. Once the formula has been validated, it is easier and more practical in the workshop to mix future batches using approximate volumes based on the test results.

In the chart below, the animal glue industry provides water to glue ratios that vary with the gram strength in the type of wood being glued. The higher the gram strength, the stronger the cured glue, and the shorter the working or gel time.

**Typical Water to Glue Ratios<sup>1</sup>**

<i>Glue Grade (Test in Grams)</i>	<i>Porous Woods (Weight, Water to Glue)</i>	<i>Non-Porous Woods (Weight, Water to Glue)</i>	
379	3 – 1	3 ¼ – 1	
347	2 ¾ – 1	3 – 1	
315	2 ½ – 1	2 ¾ – 1	
283	2 ¼ – 1	2 ½ – 1	
251	2 ¼ – 1	2 ½ – 1	General Woodworking
222	2 – 1	2 ¼ – 1	
192	1 ¾ – 1	2 – 1	General Woodworking
164	1 ½ – 1	1 ¾ – 1	
135	1 ¼ – 1	1 ½ – 1	

<sup>1</sup> Animal Glue Industry, page 28

In practice, most woodworkers are working with only one gram strength in their shop at a time (normally 192 or 251).

After a test has been done using the approximate weights recommended by the glue industry, the woodworker will normally modify the viscosity of the resulting glue by adding water or additional glue flakes. The desired result is a glue that flows like thin maple syrup<sup>2</sup>. Once the proper recipe has been established, the woodworker can note the relative volumes of water and glue required in the next future batches accordingly.

For example, when mixing a batch of 192 g strength, good results can be achieved by simply adding about an inch of dry hide glue to the bottom of a jelly jar and adding enough water to submerge the glue by about one half an inch. After allowing the water to be absorbed for about 30 minutes or more, the glue can be heated and used. The resulting product can be made thinner by adding a little water or thicker by adding a little glue. The relative volumes used in his approach were established by noting the approximate volumes being used by the materials in the particular jar being used when the batch test was run.

## Additives

One of the truly remarkable things about hide glue is that it is easily modified to take on new properties. These properties enable a wide variety of woodworking procedures. For example, the open time for hot hide glue can be extended by adding specific amounts of salt or urea to the glue pot. By adding a sufficient amount of salt or urea, hot hide glue can be made into liquid hide glue and operate at temperatures is extraordinarily long open times and a very long shelf life.

Additives Modify the properties of the glue<sup>3</sup>

Additive	Purpose	Comments
Salt or Urea	Extend Open Time	Add 15% urea or table salt by weight. Will extend the working time of 251-grade glue from 1 minute to 5 minutes. Adding even more salt or Urea will convert the glue to "Liquid Hide Glue" and will work at room temperatures without heating.
White Vinegar	Improve Adhesion	Replace 5% of the water by weight with white vinegar
Glycerin	Flexible	Add 5% to 15% glycerin by weight. Softer glue will accommodate wood movement - good for situation such as applying the bonnet board to the top of a highboy or gluing tambours.

<sup>2</sup> Glue viscosity is one of the variables woodworkers modify to suit a particular need for a specific task.

<sup>3</sup> "Hide Glue", American Woodworker April 1998, 55

## Liquid Hide Glue

Liquid Hide Glue is Hide glue formulated to:

- Stay liquid at room temperatures (no glue pot required)
- Have an open time of up to 30 minutes
- Not gel

“Cold liquid animal glues are particularly well-suited as the adhesives in assembly work employing the newer type compression dowels and mortise and tenons. In the use of these specialty assembly aids, the liquid glue furnishes sufficient moisture to expand the compressed wood to fill the joint rigidly and firmly, and the set of the glue is retarded to give the period of tackiness long enough to ensure permanent adhesive anchorage at the joint.”<sup>4</sup>

We noted above that the open time (time before gelling) for hide glue can be extended by adding salt or urea to the hot glue. If the percent by weight rises above a particular level, the glue will stop gelling completely. In addition to not gelling, it stays liquid at room temperatures. The term “Liquid hide glue” refers to hide glue that has been modified with additives so that it can be used at room temperatures and does not require a glue pot. Liquid hide glue can be made in the shop with very little effort using salt or urea or can be purchased commercially. Since liquid hide glue has a shelf life of approximately one year, the woodworker may find it preferable to make liquid hide glue in the shop in small quantities thus ensuring that the glue was always fresh.

A key property of liquid hide glue is that it does not gel at room temperature. This makes it operate similar to yellow carpenter's glue. In addition to working at room temperature, the additives result in a glue that has an extraordinarily long open time (up to 30 minutes) as well as a shelf life of months versus days. However, the removal of the ability to gel makes liquid hide glue unsuitable for hammer veneering or doing rub joints.

Titebond, Franklin, Old Brown Glue are commercial liquid hide glues. Titebond and Franklin have been formulated to retain the viscosity of yellow glue at room temperature. Old Brown Glue benefits from being warmed and kept in tepid water. This is particularly true if the shop is cold. The liquid hide glue formulated in my shop is very similar in operating properties to Old Brown Glue. The more gel suppressant added to the formula, the less viscous the resulting glue will be at room temperature (up to a point).

## Formula for Liquid Hide Glue

The formula provided by the Animal Glue Industry is:

*The following cold liquid animal glue formula is suggested for the specified application:*

*10 parts by weight 285 g test animal glue<sup>5</sup>*

*20 parts by weight water*

*2 parts by weight gel suppressant (specific references made to thiourea)*

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<sup>4</sup> Animal Glue Industry, page 30

<sup>5</sup> Eugene Thordahl suggests this formula for test strength of 285 to 315

*The dry glue is swollen and cold water until soft (1 to 2 hours); melted in a jacketed container at 145°F; the dry gel depressant chemical added and dispersed in the warm glue solution; the additives cool to room temperature is ready for use.*

A little experimentation was required to adjust the recommended formula above for (1) the 192 gram strength glue used in my shop and (2) the use of urea or salt in place of the thiourea noted in the formula. Adjusting the amount of water can be easily calculated by using the “Typical Water to Glue Ratios” table above for the difference between water for 285 strength and 192 strength. Is is necessary to increase the gel suppressant from 2 parts to 3 parts to get a workable room temperature glue. I have no idea whether the increased gel suppressant is required because of the switch from thiourea or because of the change in the strength or both. Even at 3 parts gel suppressant, the glue becomes quite viscous when left overnight and must be warmed in a bath of water to achieve a workable viscosity. My formulation works very much like “Old Brown Glue”.

## My formula for Liquid Hide Glue

Mixture ratios by weight

Glue Strength	Water	Glue	Salt or Urea
192	16	10	3

Mixing by weight requires a scale and a bit of effort. After settling on a ratio that works, it is possible to convert the weight formula to a volume formula for easier use in the shop. As the density of the glue, urea and possibly the salt can vary based on the granularity of the product being used, users should validate the conversion table for their products.

Weight to Volume Conversion Table

	Ounces / TBS	Grams / TBS
Water	0.50	14.2
Glue	0.40	11.3
Urea	0.33	9.2
Salt (table)	0.64	18.1

By applying the conversion table to the ratio by weight table and making some allowances for practical simplification, the volume formula below is found to produce good results.

Mixture ratios by volume to produce about 5.5 ounces of Liquid Hide Glue

Glue Strength	Water TBS	Glue TBS	Salt or Urea TBS)
192	6	5	2

## Test for quality of glue

*Test: 1 oz glue (2 tablespoons) in 1 lb water (about 1 pint) let sit 12 hours. pour off surface water and weigh glue gel. 5 times the original weight or more is excellent. Solidity and coherency of the mass indicates the strength.*

*To test for glue quality before bonding, use one ounce of glue\* per pound of water\*\*. Wait 12 hours for the glue to take up the water, fully. If the glue appears dissolved into the water, it is no good. If, when you pour off the water, the glue stays coherent to a degree, this is usable as glue. Now, weigh the mass of jelly glue. If it weighs 5 times or more its initial weight, it is excellent glue. And the solidity and coherency of the mass will tell you how strong it is going to be!<sup>6</sup>*

*\* One Ounce of Glue equals about 2 Tablespoons*

*\*\* One Pound of Water equals about One Pint*

The extracted text above for testing glue uses one ounce of glue equals two tablespoons. I use one ounce of glue equals 2.5 tablespoons based on actually weighing the glue in my shop. In fact, I doubt that this will make any difference to the glue test. I point out the difference only to acknowledge the discrepancy in this document.

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<sup>6</sup> "Facts About Hot Hide Glue by Craig Brouger." Facts About Hot Hide Glue by Craig Brouger.

## Modern Applications for Hot Hide Glue

In addition to using Hot Hide Glue or Liquid Hide Glue for general gluing applications, the gelling properties of Hot Hide Glue enable some unique woodworking methods.

### Hammer Veneering

- Coat the substrate with thin glue
- Dampen the outer surface of the veneer with hot water to prevent it from curling
- Lay veneer on the glued surface smoothing it out from the center to exclude air
- Heat a section with the iron moving it constantly to prevent the iron from sticking
- Squeeze the glue out towards the edges with overlapping strokes
- Each section must be cooled and bonded before moving on to the next section

### Toothing

There are quite a few references to “toothing” on woodworking blogs relating to discussions about hammer veneering. More often than not “toothing” is recommended and claims are made that it improves the grip and improves the glue surface. The proof offered is that period craftsmen toothed their veneers and substrate before hammering.

In fact, period woodworkers toothed just about everything to get it leveled out - including their hand sawn veneers. Until the early 1900, it was believed that hide glue made a mechanical bond and that toothing helped improve the bond. We now know that hide glue makes a chemical bond that is not improved by toothing. Modern veneers are WAY TOO THIN to tooth and there is no need today to “flatten” boards that have seen the benefit of a jointer or planer.

If multiple sheets need to be joined to complete the surface

- Lay down one sheet completely
- Lay down a second sheet overlapping the first sheet by about 1 inch
- Cut through both sheets through the centerline of the overlap
- Remove the overlap cutoffs – add more glue if necessary
- Hammer down the join
- Tape the joint if necessary

Using this process makes it easy to veneer substrates of any size.

### Rub Joint

Rub joints are an effective way to join boards or join furniture elements that may be difficult to clamp like knee blocks or corner blocks.

The method used by Ian Kirby <sup>7</sup>

- Hot glue is applied to completely wet both edges
- With one board in the vise, the second is positioned and rubbed back and forth a few inches while bearing down on it with as much force as possible to squeeze out the glue
- As cooling and gelling took place, rubbing becomes more difficult, and squeeze out reduces
- Before the glue gels, the top board is accurately positioned side-to-side and end to-end with the bottom board

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<sup>7</sup> “When Hide Glue Ruled the Workshop.” *Woodworker’s Journal*, December 2007



- The jointed board can be released from the vise and put on the floor resting upright against the wall on a support stick
- No clamps required

## Wood Filler

Hide glue mixed with sawdust can be used to fill small defects.

- Place a small amount of hot hide glue in a small plastic container and float it in the water bath
- Make a supply sawdust with a dull scraper or use some collected earlier in the project.
  - Consider using a lighter wood as the mixture with the glue will be dark
- Add the sawdust to the hide glue and make a thick paste
- Fill the defect with the paste
- After it dries, add more if the defect is not filled (repeat until filled)
- Sand or scrape to blend with the surface

For more information about gap filling see “Some Experiences with Flexible Gap-Filling Adhesives for the Conservation of Wood Objects” by Don Williams - Proceedings from the symposium “Facing the Challenges of Panel Paintings Conservation” organized by the Getty Conservation Institute

## Sizing and Grain Filling

The following is an extract from “Animal Glue Industry”. It is a single isolated paragraph and the only reference to using hide glue for filling. After a little experimentation, I found that hide glue does make an excellent filler. The exact mixture ratio is not critical. A 9:1 water to glue by volume produced good results.

“The use of animal glue sizes in the finishing of quality furniture services is not commonly known by the public at large. In this process a warm animal glue solution of approximately one pound of glue per gallon of water is applied to the wood surface and let dry. The compression grain is raised and the glue fills porous exposed wood structure. On sanding, a glasslike surface is obtained, which is stable against moisture changes in which takes a lasting final stain or finish.”<sup>8</sup>

After experimenting with hide glue as a grain filler, I settled on the following process:

- Cut some hot hide glue with water to triple the volume
- Brush in the watered down mixture (rub it in vigorously)
- Allow to dry. Scrape and sand.
- Repeat if necessary
- Apply two coats of dewaxed shellac
- Rub with #0000 Steel Wool and wax

Shellac is my preferred topcoat but any topcoat will work on a surface filled with hide glue.

Additive	Purpose	Comments
Water	Sizing and Filling	Add water to thin the glue to whatever viscosity desired. Brush in vigorously. I use a formulation of 9:1 water to glue by volume OR add enough water to hot hide glue to triple the volume. Adjust the mix to whatever you find effective.

<sup>8</sup> Animal glue industry, page 31

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