

Glue

How Does it Work?

(part one of a series all about glue!)

By SCOTT TAYLOR

Glue is a very important part of bookbinding and almost all other arts in one way or another. The process by which glue sticks to a surface is known as adhesion. Exactly how adhesion works, chemically and physically, is not fully understood, but experimentation suggests a combination of factors. When glue is applied to a surface, the glue molecules seep in and get tangled into the molecular structure of that surface. When the molecules of the glue and the surface get closer together, the natural force of each material attracts the other, and this is what creates an additional bond.

Glues are separated into two basic categories: natural and synthetic. Synthetic glues are created by manipulating polymers created from oil and natural gas into tacky molecules. Natural glues are created by breaking down organic substances into proteins. These proteins are then mixed with water to create glue. Natural glues can be further categorized as animal-based and plant-based.

This installment of "How Does it Work?" is the first part of a series of articles about glues and pastes and will deal with animal-based glues.

Animal Based Glues

There are two categories of animal based glues: milk glue, which uses the extracted casein protein as an adhesive, and hide/bone glues, which contain an adhesive made from the two proteins that compose collagen. These proteins are extracted from animal hide or bone.

Casein Glue



Casein glue is a water soluble milk-based glue that has been used for thousands of years. Chemically, milk is a complex substance composed of a variety of fats and proteins. The most abundant protein in milk is casein, which can be separated from the other proteins and the fats by several methods. Skim milk is

always used in each method to reduce the amount of milk fat that needs to be separated from the protein.

There are four common methods of extracting casein from milk. Heating results in the formation of scum on the surface; the scum is the desired protein. Agitating or whipping causes a layer of cream to form

on the top. The cream contains the casein protein. Or, a special bacteria can be added to the milk. These bacteria then secrete specific enzymes designed to separate the casein from the fats. Finally, the careful addition of certain acids can also separate the protein.



No matter which extraction method is used, once the casein is removed from the milk it must be filtered and buffered to neutralize any remaining acid. This results in a thick curd that is dried and ground to a powder. Casein is sold in art and hardware stores as a powder to extend its shelf life. Unless a preservative is added, liquid casein glue will begin to grow mold after a few days. When you use casein glue, add it to a purified water (distilled is best) and only mix up as much as you will need for that session.

Casein glue has some advantages over hide and bone based glues. It can be applied cold, while hide glues need to be heated to stay liquid; it is more water resistant when it sets, and when mixed with certain chemicals, it dries harder and stronger.

Hide/Bone Glues

Hide and bone based glues are made in three varieties: hide glue, bone glue and gelatin. All three of these glues are created from collagen extracted from animal hide and bone. Collagen is largely composed of two important proteins. Chondrin gives the glue its adhesive strength— how well the glue sticks to a surface. Glutin provides gel strength, which is called Bloom Strength, and is the amount of force it takes to tear the solidified glue apart. One of the most important properties of these glues is that they can be reheated and reused over and over again.

Hide glues, bone glues and gelatin are sold in powdered form. Different strength glues can be made from this powder depending on the ratio of water to glue used when mixing up a liquid glue. These glues are generally available at hardware stores as well as art stores.

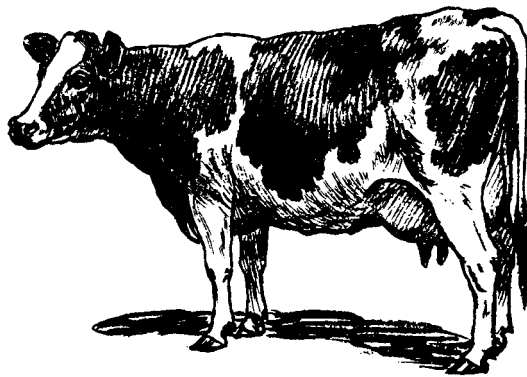
Hide Glue

Hide glue is the oldest known form of glue. Traces of hide glue recently found in present day Israel were determined to be over 8,000 years old. Prior to this discovery, the oldest glue users were thought to be ancient Egyptians who were using hide glues approximately 4000 years ago. For the most part, hide glue is manufactured the same way today as it was several thousand years ago and from basically the same kind of materials.

Hide glue is just that: glue made from collagen extracted from animal hides. Most hide glue is made from scraps of cow hide too small or odd shaped to be useful as leather, but some of the better quality hide glues are made from rabbit skin.

The process for making hide glue is fairly simple, although it is time consuming. First the pieces of hide are cleaned and cut into small pieces, then these are soaked in an alkaline chemical solution called lime (not the fruit). The pieces of hide are removed from the solution and washed in water to remove the lime and hair, then treated with an acid to neutralize any remaining lime.

The extraction process is next. The treated hide pieces are soaked in water and heated for several hours. As



they soak, collagen is leached from the hide into the water forming a dilute glue solution. This solution is drained and more water is added to the hides. The hides are heated again at a higher temperature, more collagen is extracted and the solution is drained. This process is repeated until all of the collagen is extracted from the hide pieces.

The water in the glue solution is evaporated and the remaining substance is allowed to gel and dry forming thin sheets of glue. The sheets are broken into smaller pieces, which are ground into granules or powder, for packaging and sale in art and hardware stores.

Hide glue is prepared by mixing the powder with water and heating until it forms a solution of the desired consistency. A thinner glue will take longer to set and will be weaker; a thicker glue will be stronger. Hide glue tends to be hard and brittle after it sets, unless chemical plastizers are added; so although it is reversible, it is not generally used in modern book arts. Synthetic glues or starch pastes are favored instead. It is, however, still widely used in woodworking and musical instrument repair.

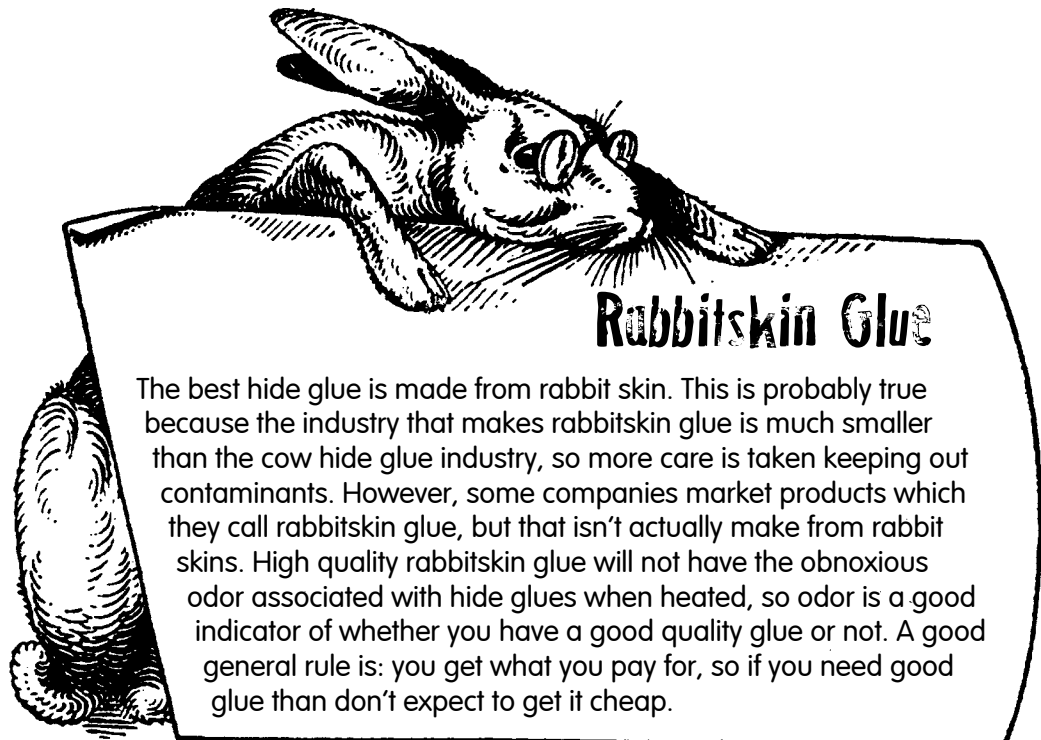
Bone Glue

Bone glue is made in much the same way as hide glue. Bones (mostly from cows) are crushed or shredded and soaked in a lime chemical solution. The bone mass is washed, then heated in water and the collagen extracted, dried and ground as is done in the hide glue process. The main difference between hide and bone glues is that bone glue is acidic and tends to set slower than hide glue. This makes it generally unsuitable for bookbinding but acceptable for woodworking use. Overall, hide glue is considered to be superior to bone glue.

Gelatin

Gelatin is essentially a very pure form of animal hide glue. It is made using the same general process as hide glue but with greater care in order to prevent any contaminants from ending up in the glue. Some grades of gelatin are used in food, photographic products, as paper sizing, and of course, as an excellent adhesive.

After gelatin is extracted from the hide and carefully processed, it is sorted by quality and milled into whatever form is needed to create the grade of gelatin with the desired characteristics. For example, food grade gelatin does not make a good adhesive, and I wouldn't suggest eating gelatin made for adhesives.



Rabbit Skin Glue

The best hide glue is made from rabbit skin. This is probably true because the industry that makes rabbitskin glue is much smaller than the cow hide glue industry, so more care is taken keeping out contaminants. However, some companies market products which they call rabbitskin glue, but that isn't actually made from rabbit skins. High quality rabbitskin glue will not have the obnoxious odor associated with hide glues when heated, so odor is a good indicator of whether you have a good quality glue or not. A good general rule is: you get what you pay for, so if you need good glue than don't expect to get it cheap.

Elmer's Glue-All® - Whats with the bull?

Most people have used Elmer's Glue-All (that white stuff in the squeeze bottle with the bright orange tip). Have you ever wondered why there is a bull on the label?

Well, back in the 1920s, Borden bought the Casein Company of America, a company that produced a milk-based (casein) glue. This seems like a logical move for a dairy company, right? In the late 1930s, Borden adopted Elsie the Cow as their mascot and emblazoned her image on all of their milk cartons. Elsie was such a hit that Borden created her husband Elmer the Bull to join her.

Meanwhile, Borden's glue factory was developing a new casein glue that was finally released in the 1940s under the brand name Cascorez. Sales of the new glue were not good, so the newly named Borden Chemical Division asked the home company

to allow them to use Elsie to promote the glue. The Borden home office did not want Elsie to be associated with non-food related products, so they let Elmer be the spokesbull for the glue instead. Elmer was successful in selling the glue, which eventually became Elmer's Glue-All.

By the way, Elmer's Glue-All is no longer a primarily casein based glue. According to the Elmer's Products Inc. web site, it is "chemical based," and made from petroleum, natural gas and other "raw materials found in nature." The exact formula and ingredients are proprietary, so you never know, maybe they still add a little milk to the mix for old time's sake.

(check out www.elmers.com for cool facts about Elmer's glues and fun projects using their glues)