The conservation of wet medieval window glass: A test using an ethanol and acetone mixed solvent system

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This article presents a conservational procedure developed in order to conserve a collection of medieval glass window fragments that have been found on historical grounds and are from varying dates. Stained glass played a key role as a major art form in the middle ages. It was widely used in churches to display biblical narratives to a population that was widely illiterate. It is important to conserve these items since it was the major art form throughout much of this period. The goals of the treatment are to remove water trapped within the fragments and restore the pieces into consolidated groups fit for long-term storage. The treatment uses a mixture of Ethanol and an acrylic polymer to achieve this goal.

The first section of the article discusses the nature of archaeological glass and its decay. It is important to note that the glass artifacts tested in the study are all silicate glasses. Silicate glasses are amorphous and have no crystalline structure; this type of glass is commonly used for windows, bottles, and dishes. Since silica has a very high melting point that cannot be achieved through modern technology, alkali metal oxides have been introduced to lower the melting point so that glass can be made. The alkali metal ions play a key role in the deterioration of these glasses. Aqueous decay occurs in two stages, ion exchange and hydrolysis including breakdown of the silica network of the glass. Alkali metal ions are replaced by hydrogen ions that are accompanied by water. Once the pH rises above 9 the hydroxyl ions begin to attack the silica network itself, causing heavy deterioration. Generally, ion exchange is more damaging when the pH is below 9 and network dissolution is more damaging when the pH is above 9. It is important to know this because you know which type of deterioration is happening at which pH and control the pH to minimize the deterioration. The deterioration of the glass relies greatly on the environment of which the glass is exposed as well as the composition and state of the surface of the glass. The effects of environment of the glass is the most important to know because it is the easiest to control. Water vapor plays a key role in the deterioration, and despite unexplained tests on the effect on humidity it is determined that it is most harmful to the glass when the RH rises above 50%RH. Condensation also plays a role in the deterioration of the glass. Heavy condensation is less detrimental than slight condensation because the bigger droplets that run off the surface will clear ions that have leached to the surface to prevent a buildup of high pH droplets, but it is important to remember that no condensation is ideal. The importance of pH of the environment has already been stressed; this can be controlled by replacement of solution for glass in wet storage or frequent washing for glass on display. These environmental deterioration factors can easily be avoided through careful observation and control. Compositional factors are not possible to control since the composition of the glass is determined when it is made, however it is still important to understand the effects of composition to explain some deterioration. A moderate presence of alkaline earths, aluminum, or phosphorus improves the strength of the glass, however they cannot save the glass from the compositional deterioration known as phase separation, which can cause the glass to appear cloudy. The surface of the glass is its first defense against deterioration and any cuts of scratches allow water to enter into the glass. Some common types of deterioration are fracture, crizzling and weeping, blackening, and pitting which is especially common on medieval glass. Any of these problems will increase the surface area of the glass, which will create more sites for ion exchange and result in rapid attack. It is important to know this so that you can avoid any cleaning procedures that might result in scratches or surface damage, because that would result in even further damage.

This treatment was first developed to treat window glass that was excavated in Bedford, England. The glass was excavated from damp soil and suffered many of the types of deterioration mentioned above. The state of the paint on the glass was varied from fully retained paint to indirect evidence of paint due to deteriorated patterns showing where the paint once was. It is stated that there are methods to discover where the paint once was when there is no visible evidence of paint, however these methods were not used for this particular excavation. In some cases the paint acted as a barrier for the glass and protected it from decay, however a poor paint layer that does not have good fusion to the surface can trap water on the surface of the glass and lead to deterioration. Immediately after excavation the glass pieces were placed in a tap water bath to dissolve soluble salts and then wrapped in plastic and foam and placed in resealable plastic boxes. After two years of storage the fragments had grown a mold in the temporary container. This could be avoided by using ethanol to store the fragments rather than water. Other advantages of using ethanol are that you can stop aqueous attack and it is a reversible process.

Ethanol would carry the risk of being flammable but it is highly advantageous over water.

To prepare for long-term conservation the pieces were examined to collect data and placed in a nylon netting to allow the surface of the glass to get wet. It is important that the pieces stay wet because if they become dry the pieces may shrink and form new cracks. This method introduces a mixed ethanol-acetone solvent system with the already established Paraloid B-72 to dewater the fragments. The reason for using these materials is that it will allow another liquid to refill the cracks where water is held without letting air into the cracks. Ethanol will keep the pieces wet and prevent air from entering the already formed cracks as well as prevent new cracks from forming. It is important that air not enter the cracks because the air would hinder the entry of the consolidant (a solution containing 2 wt% of Polaroid B-72 in 50% acetone and 50% ethanol) and might cause the glass to appear cloudy. Acetone was chosen as the primary solvent in the mixture due to the fact that it would evaporate faster than ethanol. The ethanol will slow the evaporation of the acetone to prevent surface blooming and prevent the consolidant from rising to the surface during drying.

The water was removed from the glass pieces by first being placed into a mixture of water and ethanol to displace the water with ethanol and then after three days placed into a bath of 100% ethanol for three more days. The ethanol would also remove any organic growths that may have formed in addition to displacing the water. The pieces spent the next 3 days in the consolidant solution described above, then dipped into a bath of 100% acetone to remove any excess Polaroid B-72 from the surface. After this the pieces were dried for three days in a fume cupboard and placed into individual bags for storage. The fume cupboard is used to prevent any health risks to the people participating the conservation, however it is noted that a well ventilated, relatively dust free area would suffice for those without access to a fume cupboard.

This process managed to strengthen deteriorated pieces of glass and lightened darkened glass pieces without ruining the paint or damaging well-preserved pieces of glass. For these reasons the technique is considered successful. Other advantages of this system are that it is relatively inexpensive, has minimum health risks, could be performed quickly, and require only basic chemical supplies and equipment. It is cautioned that preliminary tests should be conducted before applying this procedure so no further damage is done. The article does a good job of highlighting important observations as well as any health or safety risks. It stresses to avoid certain practices that can be detrimental to the artifacts and does a good job of giving detailed information about all steps, including tests, of the procedure. A cautionary note is included to urge conservators to test the procedure before putting it to use. This procedure has been proven to be successful and is still responsible by emphasizing careful testing before application.