Evaluation of the Use of Aquazol as an Adhesive in Paintings Conservation

Introduction
There are many adhesives available to conservators for consolidation. Adhesive choice is usually governed by material compatibility, stability of the consolidant, reversibility/retreatability options, and the conservator's familiarity with the adhesive. Aquazol is a relatively new adhesive in conservation practice that has shown great potential in a variety of uses. Aquazol is an attractive material because of three of its characteristics: it has a relatively wide range of solubility; it is thermally stable; and it is non-toxic. While it is becoming more widely used, very little general information is available in the conservation literature. Therefore a project was undertaken to gather information on how Aquazol is being used in practice and to perform some basic empirical tests. The testing was designed to determine response to high relative humidity (RH), working properties, adhesion, hardness, flexibility, drying rate, and removability. Since one of Aquazol's virtues is its solubility in water, gelatin and sturgeon glue were tested along with three molecular weights of Aquazol to allow a comparison. In addition, the behavior of Aquazol films made in deionized water (DW) and isopropanol/ water (IP/DW) were compared. Because of the variations in the use of Aquazol in practice, the results of the testing will be present here and the use in practice will be summarized in the next *WAAC Newsletter*.

Characteristics
Aquazol is poly(2-ethyl-2-oxazoline) or PEOX, a tertiary amide polymeric material based on the monomer 2-ethyl-2-oxazoline. (Figure 1). Aliphatic tertiary amides tend to be one of the more chemically stable forms of nitrogen, therefore PEOX might be expected to be relatively stable under ambient conditions. Aquazol is available in three MWTs: 50, 200, and 500. They differ only in chain size and are completely miscible with each other. Aquazol resin is an off-white solid with a glass transition temperature (Tg) range reported by the manufacturers to be 69°-71ºC for the amorphous solid. (Polymer Chemistry Innovations 2002; Chiu et al. 1986). However, a Tg of 55°C is reported for a dried film of Aquazol 500 made from an aqueous solution. (Wolbers et al. 1994; Chiu et al. 1986). Residual water from the solvent will depress the Tg. The Tg may also be molecular weight (MWT) dependant: the lower MWT Aquazols would be expected to have lower Tg.

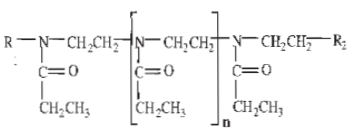

Figure 1. Structure of poly(2ethyl-2-oxazoline) (PEOX), trade name Aquazol.

Aquazol is soluble in water, methanol, ethanol, polypropylene glycol, acetone, methylene chloride, and methyl ethyl ketone, and slightly soluble in toluene and n-pentane, among other solvents.(Chiu et al. 1986). In aqueous solutions it is reported to be pH neutral. This means that the pH of the aqueous Aquazol solution will be close to the pH of the water used. Different molecular weights of Aquazol and some other miscible polymers can be mixed uniformly together without phase separation. It is thermally stable and is stable under artificial aging conditions. (Wolbers et al. 1994).

Its properties include its polymer compatibility; it has the ability to promote adhesion and lamination in a broad range of materials. One of the polymers that it is compatible with is wax.

It has low viscosity and forms a good film. The manufacturer reports that the viscosity of Aquazol is linear with increasing concentration of resin. In water, the solutions have very low viscosity compared to polyvinyl acetate (PVA) in water. In alcohols, the viscosity decreases further. (Polymer Chemistry Innovations 2002).

Its non-toxicity makes disposal easier. (It has been U.S. FDA approved as an adhesive for food labels). No special precautions need to be taken.

Commercially, Aquazol has been used as an additive in an aqueous fluid to quench hot metals because it is environmentally safe; as the main binding agent in water soluble, hot-melt, and pressure sensitive adhesives because of its thermal stability; as an organic binder for advanced ceramic greenware because of its strength at low concentrations; and as an aqueous sizing for fiberglass in order to promote the adhesion of polyesters because of its compatibility. It is used in many diverse applications especially where water-solubility and thermal stability are highly desired. There is interest in using Aquazol for coatings for ink jet printers.

History in Conservation
Aquazol was originally investigated in conservation as a consolidant for glass because its refractive index is similar (n_D (Aquazol) =1.520±0.001; n_D (glass) =1.529) and because there are very few adhesives for glass. (Chiu et al. 1986; Wolbers et.al. 1994). It has been used as an adhesive, consolidant, and inpainting medium for oil paintings, paintings on glass, painted furniture, and watercolors. (Lewis 1995; Wolbers et al. 1994; Friend 1996). Furthermore, the addition of Aquazol to Paris whiting, among other fillers, results in a carvable filling material. (Friend 1996; Anonymous 2000). It has also been used as a consolidant for severely deteriorated enamel (Magee 1999) and unfired clay figures (Ventikou 2001) as well as a gilding preparation (Shelton 1996; Sawicki 2002).

Empirical Testing
The purpose of the empirical testing was to gain an idea of how the different molecular weight Aquazols compare in use with popular aqueous adhesives. In addition Aquazol in a combination of water and alcohol and blends of the different molecular weights were tested. The adhesives tested can be found in Table 1.

Aquazol solutions were prepared by suspending the resin in a cheesecloth bag in the solvent and stirring with a magnetic stir bar and plate. No artificial or natural aging experiments were done.

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Table 1. Adhesives Tested

Adhesive	Concentration (w/v)
Gelatin	10% in deionized water (DW)
Sturgeon glue	7% in DW
Aquazol 50	10% in DW
Aquazol 200	10% in DW
Aquazol 500	10% in DW
Aquazol 50	10% in 9 parts isopropanol:1 part DW (IP/DW)
Aquazol 200	10% in IP/DW
Aquazol 500	10% in IP/DW
50 and 500 1:1*	10% in DW
50 and 500 1:1*	10% in IP/DW
50 and 500 9:1*	10% in DW
50 and 500 9:1*	10% in IP/DW
Jade 403**	Diluted 1:1 with DW

* Only a limited number of blends were tested for the effect of RH on adhesion.
** Jade 403 was only included in tests for hardness and for moisture uptake and loss.

Adhesion Testing
For adhesion testing, three milliliters of each adhesive solution (unless indicated, all adhesives except Jade 403 were used in tests) was spread onto a four inch square of commercially oil primed linen on a level surface. The canvas had to be pre-wet with ethanol in order to allow the aqueous solutions to spread evenly. The films were allowed to dry for five days. The tape test method (ASTM D 3359-97) using Permacel 99 tape was then followed to evaluate the relative adhesive strengths. A second set of squares was first heat sealed with a hot spatula before testing. A third set of commercially acrylic primed cotton duck squares was also prepared for comparison. The adhesives applied to the acrylic squares all penetrated the squares so well that no measurements could be taken.

At standard room conditions (~70°F, 55% RH), the animal glues were more brittle than the Aquazols. At standard conditions they did not adhere to the primed canvas as well as at elevated RH. The animal glues and the Aquazol 50 and 200 in DW penetrated the ground somewhat, which affected the results. The Aquazol solutions in IP/DW all penetrated the ground so well that no adhesion testing could be done.

The sturgeon glue appeared to adhere to the primed canvas squares better than gelatin. The Aquazols appeared to adhere similarly to gelatin. There were differences between the different MWT of the Aquazols but they appeared to be more dependant on the film thickness than on the MWT. Although the same volume of each adhesive solution was applied to the oil primed canvas squares, the Aquazol 500 formed a thicker film and conformed to the canvas weave less, which influenced how well the Tape Test removed adhesive from the canvas.

Adhesion Testing at Elevated RH
Four sets of canvas squares were prepared as above with a limited set of adhesive solutions. The adhesives compared were Aquazols 50, 200 and 500 in DW, gelatin, sturgeon glue, and Aquazol 200 in IP/DW.

Each set was placed in a RH chamber prepared according to ASTM E104-85. After five days in the chamber, the adhesion was tested with the tape test. (The manufacturer indicates that Aquazol reaches equilibrium at 50% RH, 74°F, in 5 days.)

The relative adhesion in varying RH can the summarized as follows. In general, gelatin and sturgeon glue adhered better to the canvas as the RH increased. The adhesion of the Aquazol to the canvas appeared to decrease as RH increased past 75% RH. All of the Aquazols gelled at 84%, and at 97% RH the Aquazol 50 flowed.

Drying Rate
One milliliter of the adhesives was spread onto a clean, level glass slide. The films were dried at standard room conditions. After the films were no longer liquid (~6 hours) they were monitored for weight loss over 10 days on a Mettler analytical balance (±0.005g).

All of the adhesives in water had the greatest weight loss towards the end of the first day. After that time, the changes in weight were so small that they could not be measured accurately with the balance. The Aquazols in IP/DW dried faster: within half of the first day. The weight changes after this time were also small, indicating that there does not appear to be a prolonged drying time for Aquazol.

Moisture Uptake
Aquazol, gelatin, and sturgeon glue are hydroscopic. Their ability to absorb and hold onto water was evaluated by preparing films on glass slides as described in the Drying Rate experiments. The films were allowed to dry for 5 days at standard room conditions before each set of slides with adhesive films was placed into chambers at 33%, 75%, 84%, and 94% RH. The slides were monitored for weight gain, or loss, over 8 days on a Mettler analytical balance. The adhesives compared were Aquazol 50, 200 and 500 in DW, Aquazol 200 in IP/DW, gelatin, sturgeon glue, and Jade 403.

At 33% RH all of the Aquazols appeared to reach equilibrium after 4-5 days and had moisture losses ranging from 4-7%. Gelatin and sturgeon glue appeared to reach equilibrium in 1 day and had moisture losses of 3% and 4% respectively. By comparison, PVA reached equilibrium in 1-2 days, and its moisture loss was 1%.

The results of the moisture uptake experiments are summarized in Table 2. At 75% RH all of the Aquazols appeared to reach equilibrium after 4-5 days and had moisture uptakes ranging from 7-11%. The Aquazol 200 in IP/DW had a distinctly lower moisture absorption level than the Aquazols in DW. Gelatin and sturgeon glue appeared to reach equilibrium in 1 day and had moisture uptakes of 4% and 5%, respectively. PVA reached equilibrium in 1-2, days and its moisture uptake was 0.5%.

At 84% RH all of the Aquazols appeared to reach equilibrium after 4-5 days and had moisture uptakes of 18-23%. Again, the Aquazol 200 in IP/DW had a distinctly lower moisture absorption level than the Aquazols in DW. Gelatin and sturgeon glue appeared to equilibrate in 1 day and had moisture uptakes of 10% and 12%, respectively. PVA reached equilibrium in 1-2 days, and its moisture uptake was 1.5%. (Figure 2).

At 97% RH all of the adhesives tested, including PVA had significant moisture uptake. All of the Aquazols appeared to reach equilibrium after 5 days and had moisture uptakes ranging from 60-70%. However, after day 6, Aquazol 50 in DW began to flow off the slide and could no longer be monitored accurately. Both Aquazol 50 in DW and Aquazol 200 in IP/DW showed signs of loss of adhesion to the glass slide. Gelatin and sturgeon glue appeared to reach equilibrium in 1-2 days, and had moisture uptakes of 35% and 45%, respectively. Gelatin developed mold growth at this RH. PVA reached equilibrium in 1-2 days and its moisture uptake was 13%.

In general it appears that Aquazol takes longer to reach equilibrium when environmental conditions change than gelatin or sturgeon glue, thus it has a slower response time. However, all of the Aquazols absorb more water than gelatin, sturgeon glue, or PVA. It is interesting that Aquazol in alcohol appears to absorb less water than Aquazol in DW.

Shrinkage

Thin films of Aquazol, gelatin, and sturgeon glue were cast onto 0.3mm Mylar in order to allow shrinkage of the films to be observed. One milliliter of each adhesive was spread onto a 5 in. x 2 in. Mylar strip on a level surface. The films were allowed to dry and curl the Mylar film. The adhesives tested were Aquazol 50, 200 and 500 in DW, gelatin, sturgeon glue, and Aquazol 200 in 9 parts IP to 1 part DW.

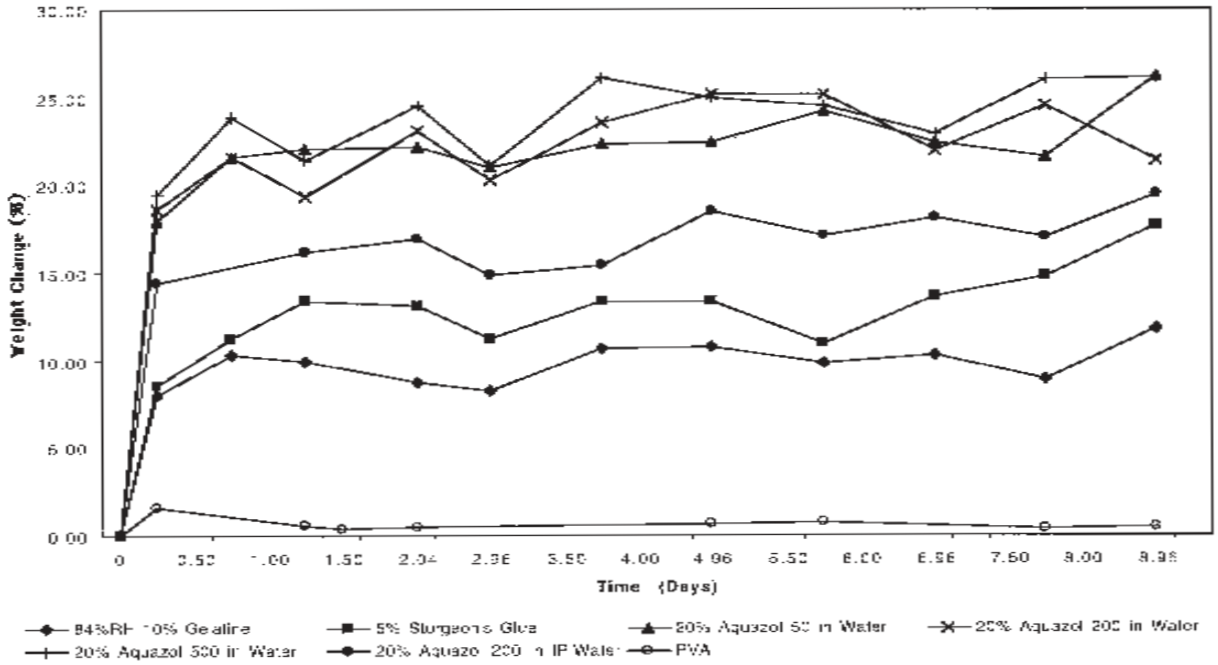
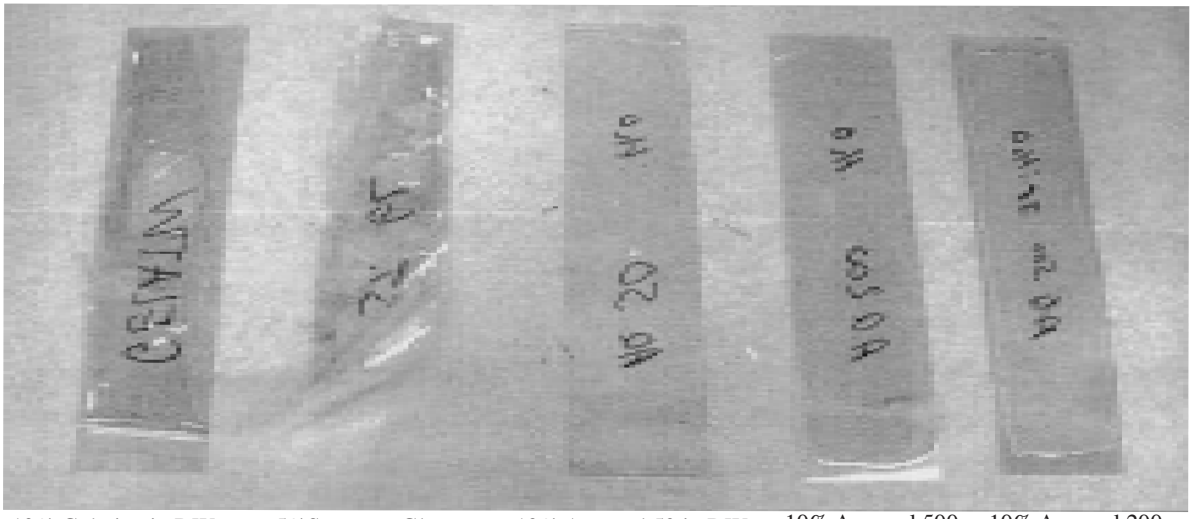


Figure 2. Moisture uptake at 84% Relative Humidity

Table 2. Summary of Moisture Gain

	75% RH		84% RH		97% RH	
Adhesive	Days to Equilibrium	Weight Change (%)	Days to Equilibrium	Weight Change (%)	Days to Equilibrium	Weight Change (%)
10% Gelatin	1	4	1-2	10	1-2	35
7% Sturgeon Glue	1	5	1-2	12	1-2	60-70
10% Aquazol 50, 200, 500 in DW	4-5	10-12	4-5	18-23	5	60-70
10% Aquazol 200 in IP/DW	4-5	~8	4-5	~15	5	60-70
Dilute Jade	1-2	~0.5	1-2	~1.5	1-2	~13



10% Gelatine in DW | 5%Sturgeon Glue | 10% Aquazol 50 in DW | 10% Aquazol 500 in DW | 10% Aquazol 200 in 9:1 IP:DW

Figure 3. Shrinkage of Adhesives on Mylar

Both gelatin and sturgeon glue curled and shrunk quite a bit. The Aquazols did not seem to shrink much at all. (Figure 3).

Ease of Removal

A volume of each of the adhesive solutions was applied to a 4 in. x 4 in. smooth, glazed black ceramic tile. Because of the differences in wetting ability of the different solutions, the volume of solution applied in order to get complete coverage ranged from 3-6 ml.

The tiles were allowed to dry at ambient conditions for 5 days. Removability was a subjective evaluation of how each test solvent removed the film by gently rocking a swab containing minimal solvent over the surface. Conservators in the conservation department of the Los Angeles County Museum of Art tested DW, IP, ethanol, and acetone as solvents. They made observations about how the films reacted to each solvent, the time it took to remove the adhesive with each solvent, and their personal solvent preference for re-

Table 3. Removablity Results.

Adhesive	DW	Isopropanol	Ethanol	Acetone
Gelatin	Easily removed.	No effect.	No effect.	No effect.
Sturgeon glue	Easily removed.	No effect.	No effect.	No effect.
Aquazol 50 (in DW or IP/DW)	Resin smeared or turned gummy.	Resin smeared or turned gummy.	Best.	Best.
Aquazol 200 (in DW or IP/DW)	Resin smeared or turned gummy.	Left tideline, smeared or turned gummy.	Left tideline, smeared or turned gummy.	Best.
Aquazol 500 (in DW or IP/DW)	Resin smeared or turned gummy.	Left tideline, smeared or turned gummy.	Left tideline, smeared or turned gummy.	Best.
Aquazol 50/500 1:1	Resin smeared or turned gummy.	Left tideline, smeared or turned gummy.	Left tideline, smeared or turned gummy.	Best.
Aquazol 50/500 9:1	Resin smeared or turned gummy.	Left tideline, smeared or turned gummy.	Left tideline, smeared or turned gummy.	Best.

moving each adhesive. The adhesives tested are listed in Table 1 (excluding Jade 403).

The Aquazol solutions in alcohol wet the tiles better and spread more evenly than those in DW. The protein solutions also wet the tiles well. Of the Aquazol solutions in DW, the higher molecular weight resins wet better than the lower. The results of the removability tests are summarized in Table 3.

Ethanol was criticized because it spread quickly into the resin and could not be easily controlled. When the resin became gummy, it often left a residue even when mechanical action was used. There was no significant difference between Aquazol solutions made in DW or IP/DW. The mixtures of Aquazols showed no significant difference in their response to the solvents from that of the pure Aquazol resin coatings.

Flexibility
Films of the adhesive were cast by pouring the solution into a 3 in. x 4 in. area defined by a dam of non-silicon caulking on 0.3mm Mylar. A non-silicon release spray was also used. Up to 21 ml. of each solution was required to cast a homogeneous film. The films were allowed to dry for 10 days before testing. The dried films varied in thickness: gelatin 0.26mm; sturgeon glue 0.10mm; Aquazols 0.20 to 0.27mm. Uniform film thickness was not attempted for this preliminary comparison and also proved unnecessary as the Aquazols were much more flexible than the animal glues. Flexibility was tested by bending the free films over a series of dowels ranging from 1/16 in. to 1 in. in diameter, as described in the Mandrel Bend Test (ASTM D 4338 -97).

The gelatin film was very brittle and could not be bent at all. The sturgeon glue film was very fragile but could be bent slightly. However it cracked when wrapped around the 1 in. dowel. All of the Aquazol films were rubbery and flexible and did not break or crack on even the smallest dowel. The films made from Aquazol in DW were less rubbery than those made in IP/DW. Of the films made in DW, Aquazol 500 was stiffer than Aquazol whether 200 or 50. The films made in IP/DW did not exhibit this distinction. The films made from blends of Aquazol 50/500 did not demonstrate any differences from the sheets of pure resin.

Hardness
Hardness was determined by following the pencil hardness test as described by ASTM D3363-00 using Staedler Mars Lithograph 100 Proart Graphic Drawing Pencils. Films cast on glass slides, prepared as described in Moisture Uptake, were used. Dilute Jade 403 in DW was also tested for comparison. Film thicknesses were measured with a micrometer. The film thickness of gelatin and sturgeon glue was 80 and 40um, respectively. The film thickness of the Aquazols was between 20 and 60um.

All of the Aquazol films were relatively soft compared to gelatin and sturgeon glue. The Aquazol films were gouged rather than scratched by the pencils. The gelatin and sturgeon glue was scratched by a mid-hardness pencil (B and 2B). It appeared that there was a slight correlation between increasing molecular weight and increasing softness. This indicates that there may be a very small amount of residual water acting as a plasticizer. The 9:1 Aquazol 50/500 was slightly harder than the 1:1 ratio combination. Also, the films from Aquazol in IP/DW were slightly harder than those in only DW. By comparison, PVA appeared even softer than the Aquazols, with even the softest pencils causing troughs instead of scratches. This is most likely due to incomplete drying.

Handling and Application Procedures
A simple consolidation test was done to compare penetration and adhesion. The adhesives were applied by brush to an early 19th-century test painting with very thin flaking paint by brush, with and without a Mitka suction table. The adhesives were applied to 1 in. squares, allowed to dry, and cleared with DW. The edges of the squares were scribed with a scalpel and Permacel tape was rubbed on and pulled off, similarly to the tape test described above. (Figure 4). Two squares of 10% Aquazol 200 were also heated with a hot spatula or a hot air dryer before testing. These tests are very empirical due to the non-uniform nature of the paint. The adhesives tested were Aquazol 50, 200 and 500 (10% in DW), gelatin, sturgeon glue, and Aquazol 200 (10% in 9 parts IP to 1 part DW). Two drops of Triton-XL 80N were also added to 25 ml of gelatin and to 25 ml of Aquazol 200 in DW to see if the surfactant would aid in penetration. The adhesives and application methods were compared by the amount of paint remaining within the square relative to gelatin and sturgeon glue.

The application method turned out to be very important. When the adhesives were applied by brush to the surface of the painting, none of them (including gelatin and sturgeon glue) reached the underside of the paint layer. When the adhesives were applied with a brush using the Mitka suction table, it was found that all of adhesives penetrated better. Gelatin and sturgeon glue had the best adhesion. The Aquazols in IP/DW had better penetration and better adhesion than those in DW. Aquazol 200 in DW or IP/DW appeared to be the best adhesive for this paint, equivalent to gelatin and sturgeon glue. The Aquazol 500 in IP/DW also gave good results, but not as good as gelatin or sturgeon glue. The poor results of Aquazol 500 in DW is most likely due to its inability to penetrate beneath the paint layer. Also, the poor result of the Aquazol 50 in DW or IP/DW is most likely due to its weak strength relative to the Permacel tape used.

The addition of Triton to gelatin or Aquazol 200 in DW did not appear to change dramatically the amount of adhesion. The application of a hot spatula or hot air dryer to Aquazol 200 in DW after drying did appear to increase the adhesion slightly.

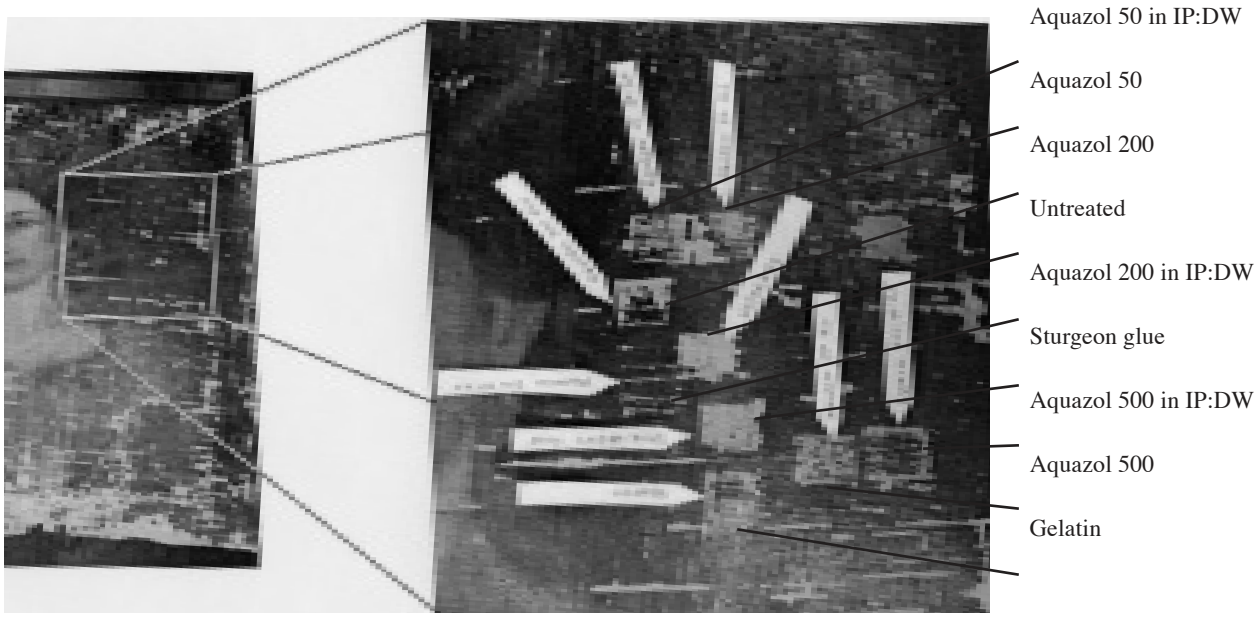


Figure 4. 19th c, *Portrait of a Woman*. Test areas: adhesive solution applied by brush with suction, after Tape Test. Note: The sturgeon glue test area did not have adequate penetration.

Observations

A distinct odor was noted during the preparation of the Aquazol solutions which did not diminish very much over the course of this study (~6 weeks). Chiu et al. mention that the monomer 2-ethyl-2-oxazoline has a musky, amine-like odor. (1986). The manufacturer suggested that the odor may be due to some residual initiating agent, methyl tosylate also known as methyl 4-toluene sulphonate. Wolbers et. al. speculated that the hydrolysis product, p-toluene sulphonic acid could be present in Aquazol. The odor of the Aquazol solutions was not identified during this study.

The films made from Aquazol 200 and 500 in 9:1 IP: DW cast on slides or Mylar, had a lumpy appearance in raking light. This may be due to the sequestration of water-swollen resin after the rapid evaporation of the IP. The effect did not seem to affect the adhesive's properties in any way.

Discussion and Conclusion

Aquazol has potential as a consolidant, but, as usual, its use depends on the circumstances. The three MWTs give conservators a choice of adhesive strength by varying concentration, solvent, and application method. In addition the thermoplastic and thermostable nature of the resin gives a longer working time than sturgeon glue. It may not be as strong as PVA or BEVA 371, however, especially at the lower MWTs, it may have better penetration.

Penetration of the resins appears also to be assisted by either making the adhesive solution in a lower surface energy solvent, such as alcohols or ketones, or by adding a small amount of alcohol or ketone to an aqueous solution. Increased penetration into the canvas and ground of the Aquazol solutions in IP: DW increased the adhesion of the resin to the test pieces. In addition, Aquazol solutions in IP: DW responded less dramatically at 75% and 84% RH than Aquazol solutions in DW alone. This appears to indicate that the solvent choice affects the rate of moisture uptake.

Within experimental error, the Aquazols were comparable to gelatin and sturgeon glue in their ability to adhere to the test samples. Sturgeon glue appeared to have the best adhesion and penetration while gelatin compared well with the Aquazols. As MWT increased, there was a slight decrease in adhesive strength of the Aquazols. This appears to be due to the ability of the Aquazol 50 to penetrate into the ground layer and to form a thinner film at a 10% concentration than Aquazol 500.

The aqueous Aquazol films dried at similar rates to gelatin and sturgeon glue, while solutions in IP: DW dried somewhat faster. Within the sensitivity of the balance used, there does not appear to be a prolonged drying time for Aquazol. However, the hardness and flexibility tests indicate that there may be a small amount of residual solvent after 10 days of drying. The Aquazols were very flexible and elastic while gelatin and sturgeon glue were brittle. Aquazols in water showed some distinction in flexibility (50>200>500) while the film from IP: DW solutions did not. This may be due to residual water, trapped within the polymer matrix after the rapid evaporation of the IP, acting as a plasticizer. Gelatin and sturgeon glue films also shrank substantially during drying while the Aquazols did not. The Aquazols were much less hard than the protein glues as well. Again,

solvent choice affected the results: films from IP: DW solutions were slightly harder than those from aqueous solutions.

In concurrence with Wolbers et al, acetone was the fastest at removing a dried Aquazol film while water was the slowest. The slow swelling and solvation of the Aquazols by water is an indicator of its slower response time to high RH conditions compared to gelatin and sturgeon glue, which respond more rapidly.

From this work it appears that RH has to be considered when choosing Aquazol, especially the lower MWT resin. All of the adhesives tested, including Jade 403, take up moisture. However there are clear differences. Jade 403 takes up very little moisture, even at high RH, while gelatin and sturgeon's glue take up quite a bit more. Aquazols absorb the most moisture, however at a slower rate than the other adhesives. In addition, Aquazol in IP/DW absorbs less water than Aquazol in water. In general it appears that at RH levels at 75% and below, there is no significant decrease in adhesion of the Aquazols. However, at 84% and above, all of the Aquazols gel and do not appear to adhere to the substrate very well. These RH are high within the context of standard museum conditions, and it is unlikely that they would apply in most situations.

There is evidence from Lewis and Wolbers (1995) that Aquazol interacts with metal ions to form complexes, in a similar manner to proteins. The metal ions create bridges between and within the polymer chains to form large networks. Their results indicate that Aquazol-bound paints, or Aquazol as a consolidant in contact with paints with appreciable amounts of soluble metals, may be slower to respond to RH changes and re-solubilization in water than pure Aquazol films on tiles. This effect may be a critical factor in the success of Aquazol in a conservation treatment at elevated RH.

Ongoing Research

The odor of the Aquazol solutions was not identified. Further investigation is continuing through the generosity of the Los Angeles County Museum Conservation Center. In addition, sample films on glass slides are undergoing natural and artificial aging tests at LACMA where color and density are being monitored. The results of theses continuing investigations will be reported in an upcoming *WAAC Newsletter*.

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NOTE

Part two of this article will describe the results of a questionnaire given to a small group of conservators about their experiences with Aquazol. The author would be happy to have information from anyone who wishes to contribute. You can receive the questionnaire by emailing jarslanoglu@yahoo.com. If you would prefer just to send a few paragraphs, that would be welcomed as well.

Our play's chief aim
has been to take to bits
great propositions and their opposites.
See how they work,
and let them fight it out.

spoken by the Marquis de Sade in the film version of the play *Marat/Sade* or *The Persecution and Assassination of Jean-Paul Marat as Performed by the Inmates of the Assylum of Charenton under the Direction of the Marquis de Sade,* by Peter Weiss