Archaeological Preservation Research Laboratory Report 17:

Polymerization Potentials of Polyethylene Glycol Compounds Commonly Used In Archaeological Artifact Conservation

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In a previous experiment conducted at the Conservation Research Laboratory entitled Polymerization of Polyethylene Glycol and Glycerine,(APRL Report 16), it was determined that it is possible to alter the viscosity and other physical properties of glycerine and various molecular weights of polyethylene glycol (PEG) using liquid stannous and stannic compounds in combination with a range of crosslinking agents.

The focus of this experiment is to test the polymerization potential of various combinations of crosslinking agents and catalysts applied to polyethylene glycol compounds of a single molecular weight. PEG 500 was selected for this experiment as it is considered to be a general-purpose polyethylene glycol solution that is universally acceptable as a bulking agent for waterlogged wood. In addition to further defining the optimum combinations of chemicals to solidify liquid PEG compounds, this experiment is designed to determine the practicality of attempting to polymerize PEG in waterlogged wood samples.

To determine the various types of chemical reactions that might occur with PEG 500, 200 grams of PEG 500 was placed into a series of six plastic cups. Different crosslinking agents, including methylhydrocyclosiloxane, ethyltrimethoxysilane and isobutyltrimethoxysilane, were added (4% by weight) to the PEG samples and CT-32 and CT-30 catalysts were used to polymerize the solutions. The six chemical combinations are listed below:

Sample	PEG 200 g	Crosslinking Agent 5% by weight	Catalyst 3% by weight
1	500	ethyltrimethoxysilane	CT-32
2	500	ethyltrimethoxysilane	CT-30
3	500	methylhydrocyclosiloxane	CT-32
4	500	methylhydrocyclosiloxane	CT-30
5	500	isobutyltrimethoxysilane	CT-32
6	500	isobutyltrimethoxysilane	CT-30

Each solution was mixed thoroughly and allowed to sit under a vented fume hood throughout the observation portion of this experiment. Observations were recorded for each of the samples at 1-, 3- and 12 hour intervals. During the 1- and 3 hour observation periods, each of the samples was re-mixed with a wooden tongue depressor for one minute. Additional evaluations were made of all samples after they sat undisturbed in fresh air for one week.

Observations

In all cases, gentle mixing of the polyethylene glycol with a crosslinking agent and catalyst caused the solutions to turn a pale milky-white color; the solutions remained in a liquid state during the one minute mixing period. After the initial mixing, however, differences in polymerization rates among the various samples were observed. These observations are listed in Table 2. After several assessments, it appeared that the PEG solutions that were polymerized with CT-30 catalyst have a finer crystalline texture than samples treated with CT-32 catalyst. This bulking ability characteristic may have special significance in artifact conservation, where delicate organic materials may be adversely affected by the formation of larger crystalline structures. Changes in the polymerization rates of samples that contained the CT-30 catalyst were less apparent, if noted at all, during the week-long observation period. Because CT-30 catalyst has a short working time when exposed to air, the polymerization process is finite. Samples treated with the CT-32 catalyst, however, tended to be harder, more brittle, and in some cases, dry and powdery after seven days of curation in fresh air. Since duration of polymerization is an essential aspect of artifact conservation, considerable research needs to be directed at the relationship of polymerization working time as affected by various catalysts, as well as the effects of continuing polymerization within a given organic matrix using catalysts such as CT-32. Data from this experiment suggests that methylhydrocyclosiloxane is an excellent crosslinking agent. Comparative experimentation will be conducted to compare the crosslinking abilities of methylhydrocyclosiloxane and other materials that have been used as crosslinking agents at the Conservation Research Laboratory.

Sample	**1 hour**	**3 hours**	**12 hours**	**1 week**
1	**-Cloudy** **-Milky-white** **-Translucent**	**-Cloudy**	**-Thin paste** **-Lumpy to firm masses with in it**	**-Thick paste** **-Firm and granular in appearance**
2*	**-Cloudy** **-Milky-white** **-Translucent**	**-Cloudy** **-Signs of thickening**	**-Very firm** **-Some surface liquid nearly solid**	**-Hard with little surface liquid** **-Smooth appearance**
3	**-Very cloudy** **-Milky-white** **-Translucent** **-Some bubbling noted**	**-Foam** **-4X the volume of the original liquid volume** **-Definite thickening**	**-Firm solid foam** **-Foam is brittle and powders when pressed** **-3X volume of original liquid**	**-No change** **-Finer granular appearance remains**
4*	**-Cloudy** **-Milky-white** **-**	**-Foam** **-3-4X the volume of the original**	**-Firm solid foam** **-Powdery when**	**-No change** **-Finer**

	Translucent	liquid volume -Definite thickening	pressed -2X original liquid volume -Finer bubbles than sample 3	granular appearance remains
5	-Cloudy -Milky-white -Translucent	-Cloudy -Trails form when gently stirred	-Wet foam -3X original liquid volume but mixture remains wet in appearance	-Much drier
6*	-Cloudy -Milky-white -Translucent	-Slightly thick -Cloudy	-Not solid -Vaseline-like consistency	-Slightly more firm -Very fine granular in appearance

*Samples 2,4 and 6 have a much finer granular appearance-these are CT-30 polymerized samples.

Citation Information:

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