Archaeological Preservation Research Laboratory Report 7:

Silicone Bulking of Waterlogged Cork Using PS340, PS341 and PS343 Silicone Oils

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As a means of comparing the bulking capabilities of PS340, PS341 and PS343, six waterlogged corks from the 1692 provenance of excavations at Port Royal, Jamaica were chosen for conservation using these siloxanes. Generally, the conservation of corks which are as badly waterlogged and disintegrated as these six specimens is a problem for conservators and often, treated artifacts are badly shrunken and distorted artifacts with no diagnostic value. Experimentation on the neck of an onion bottle with its cork firmly in place proved that PS343 could be successfully used to conserve compound artifacts consisting of glass and cork, but no experimentation had been done to date to allow for the comparison of the bulking capabilities of the three main silicone compounds.

Of the three siloxanes used for this experiment, PS343 is the heaviest in molecular weight with a rating of 120 mers. PS343 is much heavier in weight than the heaviest polyethylene glycol (PEG) compounds used at the lab. PS341 has a molecular weight of 35 mers making it roughly equivalent in weight to PEG 1450. PS340 has a molecular weight of 5-6 mers, making it roughly equivalent, but slightly lighter that PEG 400, which has a molecular weight of 10 mers.

Before treatment, all six corks had been stored in a polyethylene bag in fresh tap water and prior to treatment, all of the specimens were placed into a large vat and rinsed with running water for two days. Before treatment, all of the corks were photographed, drawn and then the wet weights and the dimensions of each specimen were recorded for comparison with post treatment data, as a means of determining the overall effectiveness of each silicone oil as a bulking and stabilizing agent. Care was taken to weigh each sample on a sensitive balance beam scale as well as on an electronic scale. All measurements were recorded using a set of digital readout, electronic calipers. Sample designations and treatment schedules are listed below:

Specimen	Designation	Wet Weight (g)	Wet Length (cm)	Wet Width (cm)	Treatment
1	C1	10.50	3.60	2.13	Air Dry
2	C2	6.70	2.83	1.73	PS343
3	C3	6.70	2.84	1.95	PS341
4	C4	5.00	2.86	1.66	PS341
5	C5	6.50	3.09	1.73	PS343
6	C6	4.00	2.64	1.62	PS340

Specimen C1, which was air-dried, was removed from the last fresh water rinse bath and placed in the center of a table, where it was allowed to air- dry for the same length of time that was required to silicone bulk the other corks. The remaining corks were all placed into a communal bath of acetone as a means of dehydrating them in preparation for silicone bulking. To facilitate the process, the beaker containing the acetone and specimens was placed into a freezer mounted vacuum chamber and a vacuum of minus 26.5 Torr was applied to the specimens for eight hours. To ensure that all of the corks remained submerged in the acetone bath, a piece of light mesh screen was bent into position, forming an constricting barrier which prevented the corks from floating to the surface of the acetone. During the first four hours of vacuum aided dehydration, vigorous bubbling was noted rising from all specimens. After four hours of applied vacuum, the rate of bubbling from the samples decreased rapidly until very few bubbles were observed. After eight hours of acetone dehydration, the absence of bubbles indicated that all free water had been removed from the specimens. With the dehydration process completed, the used acetone was decanted from the beaker and with fresh acetone added, all five corks were stored in the freezer for twelve hours.

In preparation for bulking, three smaller beakers were placed in the freezer's vacuum chamber. Beaker one was filled with five ounces of PS340 silicone while beakers two and three were filled with equal amounts of PS341 and PS343 respectively. All of the samples were placed into bulking agents according to the treatment schedule, and placed into a vacuum chamber with a pressure of 26.5 Torr applied for five hours. The vacuum was then turned off and the samples were allowed to remain in solution in the freezer for twelve hours. With silicone bulking complete, all of the corks were removed from their beakers and placed into a cotton specimen bag for additional bulking using methylhydrocyclosiloxane as a cross linking agent. As before, the corks were submerged in the cross linking solution and placed into the freezer's vacuum chamber. After a vacuum of 26.5 Torr had been applied to all of the corks for a period of one hour, the specimens were removed from the freezer.

While the five corks were undergoing bulking in their respective silicone oils, a warming oven was preheated to 135 degrees Fahrenheit in preparation for curing the samples.

Similar in setup to many of our other experiments, a containment chamber consisting of an inverted polypropylene pail with a tight fitting lid was placed in the warming oven. In the center of the lid, a flat dish was positioned containing two ounces of CT-30 catalyst. Over the dish, a small piece of expanded steel mesh was positioned in order to expose the rope samples to the fumes of the catalyst. A single layer of paper towel was placed on the mesh prior to positioning the cork samples as a means of absorbing the free flowing silicone escaping from the samples. Once the samples were in place, the body of the chamber was positioned so that it formed a tight fitting seal with the base of the chamber. The warming oven door was then closed and the corks were exposed to the fumes of the catalyst (Figure1).

A. Warming oven
B. Containment Chamber
C. 5 corks
D. Screen with paper towel supporting corks
E. Flat tray holding catalyst

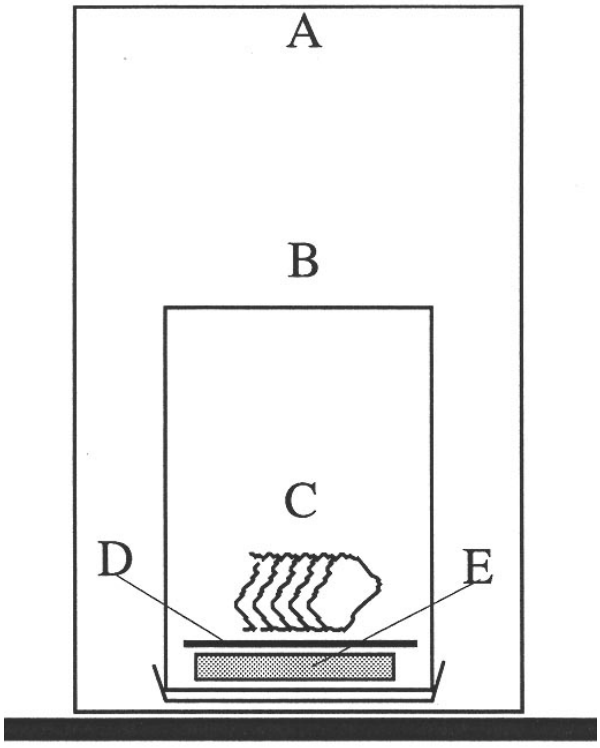

Figure 1. Warming Oven and Containment Chamber Set-up.

After two days of curing in the warming oven, all five of the corks were removed from the warming oven and stored in a plastic bag at room temperature for an additional day. At that time, the five bulked samples and sample C1, the air-dried samples were all weighed and re-measured. Figure 2 is a photograph of the six corks before conservation. Figure 3 is a photograph of the same corks after conservation. While sample C1, in the upper right hand corner of the photograph, has obviously experienced extreme shrinkage, most of the other samples have retained their shape reasonably well. Post conservation data and percentages for shrinkage for each sample are listed in Figure 4.

Observations

Shrinkage rate analysis for all six samples yielded some interesting results. Predictably, sample C6 which was conserved with the lighter molecular weight silicone experienced the greatest amount of cross sectional shrinkage (width), as well as a high degree of shrinkage longitudinally (length measurement). The two samples bulked with PS341 silicone (samples C3 and C4), experienced less cross sectional shrinkage than sample C6 although longitudinal shrinkage in these two samples was greater than that observed in C6. The degree of cross sectional shrinkage in samples C2 and C5, which were bulked with PS343 silicone was completely eliminated and both of these samples experienced much less longitudinal shrinkage.

Molecular weight of the various bulking agents appears to not have been a factor in determining the percentage of weight loss incurred in the samples that were tested. Samples C2 and C5, shrank on average as much as samples C3 and C4 which were bulked with a lighter molecular weight silicone. The relatively constant weight loss from these samples, excluding the air-dry sample, represents the loss of free water from the samples.

Conclusions

Compared to the control sample C1, which was air-dried, all of the corks had successfully been bulked to some degree, since their rates of shrinkage were well below the rates of dimensional change noted in the control sample. The lower rates of longitudinal and cross sectional shrinkage in samples C2 and C5, the PS343 bulked samples, indicate that this heavier molecular weight bulking agent was most successful in bulking and preserving the diagnostic features of the corks. After curing, sample C6, which was bulked with PS340, was noted to have split in half. Although some degree of bulking had occurred in the sample, the lighter molecular weight of PS340 silicone offered no cohesive strength to the cork, allowing the sample to split, presumably from the stress of handling. Apart from retaining dimensional features, PS343 treated samples C2 and C5 are also more aesthetically pleasing since the small imperfections noted on the surfaces of the waterlogged samples remain present in the conserved samples.

Sample	Wet Weight (g)	Conserved Weight (g)	%Change	Wet Length (cm)	Conserved Length (cm)	%Change	Wet Width (cm)	Conserved Width (cm)	%Change
C1	**10.50**	**.987**	**-90.60**	**3.60**	**2.60**	**-27.77**	**2.13**	**1.80**	**-15.49**
C2	**6.70**	**3.00**	**-55.22**	**2.83**	**2.70**	**-4.59**	**1.76**	**1.76**	**0.00**
C3	**6.70**	**3.80**	**-43.28**	**2.84**	**2.40**	**-15.49**	**1.95**	**1.85**	**-5.13**
C4	**5.00**	**3.95**	**-21.00**	**2.86**	**2.45**	**-14.34**	**1.66**	**1.60**	**-3.61**
C5	**6.50**	**2.00**	**-69.23**	**3.09**	**2.80**	**-9.39**	**1.73**	**1.73**	**0.00**
C6	**4.00**	**2.00**	**-50.00**	**2.64**	**2.28**	**-13.64**	**1.62**	**1.45**	**-10.49**

Citation Information:

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1998, "Silicone Bulking of Waterlogged Cork Using PS340, PS341 and PS 343 Silicone Oils", Archaeological Preservation Research Laboratory (APRL), Report7 , World Wide Web, URL, http://nautarch.tamu.edu/APRL/report07.htm, Nautical Archaeology Program, Texas A&M University, College Station, Texas.