



BLEACHING TEXTILES WITH SODIUM BOROHYDRIDE

The favorite method of bleaching cellulosic textiles at MTS employs the reductive bleaching agent sodium borohydride (NaBH₄.) Wet cleaning cotton, linen, and rayon fibers with the addition of a sodium borohydride bath is beneficial both visually and chemically, resulting in healthier and brighter artifacts. Sodium borohydride cannot be used on protein fibers—such as silk and wool—because they are naturally acidic and sodium borohydride is very alkaline.

How it works

As cellulose ages, hydroxyl groups (-OH) are converted to carbonyl groups (=O), which contribute to a dingy brown or yellow color. Reduction adds electrons to the cellulose, which stabilizes its molecular weight and returns carbonyl groups back to colorless hydroxyl groups. Stains are not generally removed with the addition of sodium borohydride but the overall results are better than wet cleaning with surfactant alone. Remarkably, sodium borohydride is color safe when used at its proper strength, and we have safely bleached many garments and flat textiles with dyed cellulose fibers. Immersing silk or wool textiles in sodium borohydride results in color loss and fiber weakening. NB: we've seen color change on our clothing if accidentally wetted with bleach solution and not rinsed out—flush your clothes with water to deactivate the solution, and wear an apron for best results.

Buying Borohydride

Obtaining 98% pure granulated or powdered sodium borohydride can be challenging. Companies often do not sell small amounts and may require lengthy paperwork. Storing opened containers for a long time can result in reduced effectiveness if the product absorbs moisture from the air. In bulk, NaBH₄ is a hazardous material, so you may also encounter high shipping costs. As of 2016, our supplier of choice is [Boron Specialists](#), which sells 500 g bottles requiring no special shipping. We prefer granules over the powder or liquid form because they are less easily inhaled or spilled.

Setup

Wet cleaning with sodium borohydride works best in a non-metal basin, such as a bathtub or photographic tray, though we have had equally good results in our regular stainless steel wash tanks. We have used this system with good success with cold deionized water, and with only cold and warm tap water. Our preferred setup is a combination of cold deionized water plus warm tap water (we do not have warm deionized water). Your workspace should be set up the same as if you were doing a regular wet clean, including supplies and adequate space for drying. You will need a scale that measures to 1/10 g.

Creating the NaBH₄ solution

We use the 40:1 bath ratio method taught by Susan A. Adler, who published her seminal 1998 article, *Borohydride: An Alternative to Oxidative Bleaching of Cellulosic Textiles*, in vol. 8 of the Textile Specialty Group *Postprints*.

1. Weight of your textile in grams _____ X 40 ml water / g = _____ ml water.
2. _____ ml water X 0.001 g NaBH₄ / ml = _____ g NaBH₄

To make life simpler, you can measure the volume of your wash table or sink at several depths, e.g. .5 inch, 1 inch, 2 inches, etc. Skip directly to step 2 above and make a chart for how much NaBH₄ to use for each depth. Use a deep enough bath to immerse your textile but not so much that it sinks below the surface.

Prepare your NaBH₄ solution in a glass beaker or measuring cup. We prefer to mix ours with warm tap water. You will notice immediately that the solution fizzes, so keep it away from your face. Stir well. The granules may need to sit for 10 minutes before they dissolve completely.

This handout is intended for experienced conservation professionals who know how to wet clean historic textiles.

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Bleaching Steps

- Immerse the textile in a bath of cool water. Use deionized water if available. Tamp gently and allow the textile to soak for 20 minutes or so. If the water is discolored, empty and repeat water baths until discoloration removal ceases.
- Fill the wash tank with the amount of cool water you calculated in step 1 above. Do this using a metric measuring container or by calculating in advance how high you wish to fill your wash tank.
- Slide your textile aside and add in your pre-dissolved sodium borohydride solution to the wash water. Disperse evenly and gently throughout the wash water using gloved hands. Rearrange the textile so that it's lying flat.
- Sodium borohydride is a surface-acting agent, so you will need to gently agitate the water at 30-minute intervals to ensure even contact between your textile and the surface of the water. Rearrange your textile so that each section, including the back and front, spends time on the top. In rare instances, failure to agitate the textile has resulted in streaking and uneven bleaching. If this occurs, resume agitation and streaks should disappear.
- Allow the textile to soak for up to three hours. Monitor for any unforeseen problems and rinse thoroughly if necessary to stop the bleaching process. You will notice fewer bubbles as time passes, which indicates the solution is nearing exhaustion. We have seen little benefit but no adverse effect from bathing a textile in sodium borohydride for longer than three hours.
- At the conclusion of bleaching, empty the tank and fill it with clean water. You can introduce warm water at this stage. If you are bleaching an already-wet cleaned textile, do a minimum of five rinse baths until all bleach solution is out and then proceed with drying.
- If the textile has not already been wet cleaned and you wish to use a surfactant to complete the cleaning process, introduce the surfactant at this stage. For example, we empty the first warm rinse bath and then sponge on a 0.3% solution of Orvus WA Paste in warm water. Because the cellulosic discoloration is generally removed already, leaving the surfactant step until the end allows you to see the soils being released with the Orvus. Soot and dirt are visible as a greyish discoloration when they are removed, as compared to the tea-colored cellulosic discoloration removed earlier.
- Thoroughly rinse the textile until all of the surfactant is removed. When there are no more suds you can feel confident that all of the sodium borohydride is also rinsed out.
- Proceed with drying as you would after a normal wet cleaning. We always employ a cotton wicking cloth when drying cellulosic textiles, as this can prevent any additional cellulosic degradation and soil from depositing on the artifact as it dries. For more on drying textiles see Kathy Francis's 1992 article, Predicting the Drying Behavior of Textiles, AIC Textile Specialty Group Postprints, Vol. 2.



Before



After