



Conserve O Gram

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How To Flatten Folded Or Rolled Paper Documents

Paper records such as maps, newspapers, and documents that have been rolled or folded for long periods of time often may be safely flattened using carefully controlled humidification. Extreme care must be used when initially opening papers that have been folded or rolled. While some papers remain supple over time, others may grow increasingly fragile due to inherent weaknesses, widely fluctuating temperature and relative humidity, or exposure to light and/or to chemicals in the atmosphere. As a result, paper *remembers* creases, folds, and curls. If records are not flattened carefully, they may crumble and their valuable information will be irretrievably lost. Never attempt to open a rolled or folded piece of paper if you are uncertain of its physical condition, particularly if the climate is extremely dry (less than 35% relative humidity).

Because paper is hygroscopic (readily giving off and receiving moisture from its immediate environment), its storage environment should provide a happy medium between low relative humidity that causes desiccation of paper and prolonged high relative humidity that promotes mold growth. However, controlled short-term exposure to high relative humidity (65%-100%) will relax paper, making it easier to handle so that it may be flattened for safer, more convenient handling and storage in the future.

Caution

Humidification treatment is not appropriate for all paper materials. It is strongly recommended that paper objects of high intrinsic, artistic, or associative value be discussed with a paper conservator before any treatment is attempted. Never attempt to humidify papers with water soluble media (watercolors and some inks¹),

friable media (chalk, charcoal, or pastels), or heavily textured media (oil paint). Do not attempt to humidify parchment, vellum, or composite objects (one piece of paper affixed to another).

Procedure

There are three basic steps to humidification: cleaning, humidifying, and weighting or flattening. Each step requires somewhat specialized equipment that can be easily constructed from materials gathered from common sources, such as hardware and fabric stores. *Read the entire procedure before beginning.*

Cleaning. It is important to remember that any dirt on the surface of the paper may become *muddy* during humidification and will set further into the paper fibers. This will make the paper difficult if not impossible to clean in the future. The surface of the paper should at least be swept with a soft, natural fiber brush before humidification. If the papers are heavily soiled, consult a paper conservator about surface cleaning before proceeding.

Before proceeding with humidification, remove fasteners such as clips, staples, brads, and rubber bands. (See *Conserve O Gram* 19/5 for guidance.)

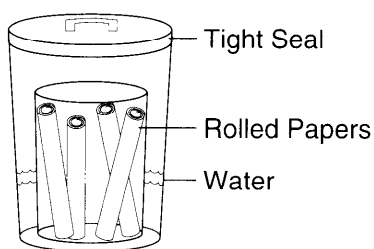
Humidification (equipment). Paper is humidified in a chamber that can be assembled in a number of ways. The choice will be determined by the size, shape, and number of papers to be flattened and by the method of humidification.

There are two commonly used methods of humidification: one uses hot water vapor, the

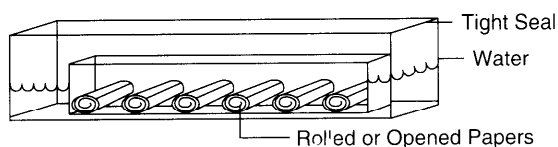
other uses the cool mist of an ultrasonic humidifier. Because an ultrasonic humidifier system requires more costly equipment, it may be more appropriate for larger projects. A cool mist is a gentler process for humidifying paper and is preferred over hot water vapor.

Hot Water Humidification: The most important characteristic of any hot water humidity chamber is that it holds a quantity of water while supporting the papers *without* allowing them to come in contact with the water. Basically any watertight container inside a container with an airtight opening will do. There are several easy ways that this can be accomplished.

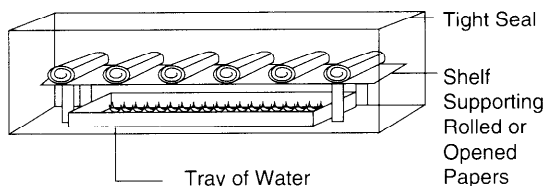
- Two clean plastic trash cans may be used as long as the smaller one fits completely inside the larger, and the larger one seals thoroughly. This type is most appropriate for large rolled papers. However, *never* humidify fragile papers standing on edge this way.



- Two clean plastic or glass trays may be used with a sheet of glass, Plexiglas®, or plastic used to seal the top opening. This type is most appropriate for small to mid-sized folded or creased papers.



- A custom humidity chamber may be constructed in any number of ways. For other examples consult the conservation literature or contact other museums or archives for ideas.



Into the outer container, pour 1 to 3 inches of hot tap water, approximately 43°C - 60°C (110°F - 140°F). Place sheets to be humidified into the *dry* inner container. *Do not allow the water to come in contact with the paper to be humidified.* Wetting paper may cause irreversible damage.

Ultrasonic Humidification:² The most important characteristic of an ultrasonic humidification chamber is that it allows a free and even flow of air throughout the sealed environment. To assemble a chamber, commercially available baker's racks covered with plastic are ideal. Racks may be purchased with custom-fitted plastic covers that are lightweight and easy to clean, seal with a plastic closure (zipper) that resists rusting, and provide an effective vapor seal. An alternative method is to drape polyethylene sheeting over the entire rack and seal it with Velcro® buttons. To support the objects inside the chamber, the rack is outfitted with shelves: plastic screens purchased to size or acrylic egg-crate louvers (used to cover recessed ceiling fixtures) cut to size work well. An ultrasonic humidifier, which emits a fine mist, is placed on the floor or on the lowest shelf. The humidifier should be filled only with distilled water (minerals and biological contaminants in tap water make the equipment difficult to maintain). Several trial runs with non-collection materials will help determine the most effective setting and location for the humidifier within the chamber.

Humidification (process). Regardless of which system is used, the procedures for handling during humidification and flattening are similar. For both processes directions are outlined below. It is important to test the procedure/equipment thoroughly before beginning a large-scale project or treating valuable materials.

Begin humidification treatment early in the day so that the progress of the materials in the chamber can be monitored frequently. *Do not* attempt to humidify objects overnight or when progress cannot be supervised.

Before placing papers in the chamber, lay them on a sheet of spun polyester (e.g., Hollytex[®], Cerex[®], or Remay[®]) for support and set them in the chamber by handling only the polyester. Tightly rolled and/or brittle papers may have to be humidified in stages. Do not attempt to unroll particularly resistant papers for humidification. Initially, place them in the chamber rolled (folded) and attempt to unroll (unfold) them over the course of the day, or over the course of several daily humidification sessions. The safest way to unroll very tight or brittle paper is by scrolling the rolled paper onto a progressively larger archival-quality tube after each session in the humidity chamber.

Place a hygrometer or paper relative humidity indicator in the chamber with the papers to monitor changes in relative humidity. Over time, the relative humidity in the chamber will rise to the 60% to 100% range. Condensation often will collect on the surfaces within the chamber. Do not allow the paper records to come in direct contact with any of these wet surfaces. A sheet of Gore-Tex[®] draped over the papers will protect them from *rain* (dripping condensation) in the chamber. If Gore-Tex is not available, use a sheet of spun polyester to provide protection.

In most cases paper records will relax completely in four to six hours. Check the contents of the chamber hourly to determine how long it takes to relax the particular size, weight, and type of paper. For example, drawings on tracing paper or tracing cloth (*linen*) will not require as long an exposure as ordinary papers. Do not over-humidify. It is possible that the image on the paper will bleed or run or that the surface sizing will swell if left in the humidity chamber too long. Also, permanent distortions (cockling) will occur in papers that become too moist and are not allowed to dry properly. Over-humidified papers may feel tacky to the touch and will be extremely limp and weak.

Some conservators have used fungicides such as thymol (C₁₀H₁₄O) in humidification tanks to

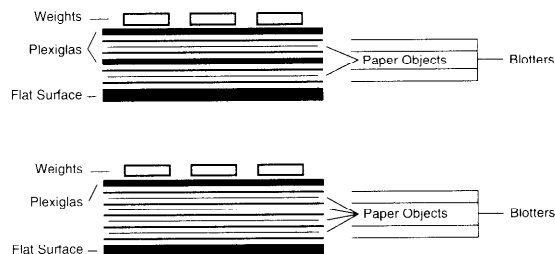
prevent the growth of mold. The use of thymol is not necessary, however, if the duration of the humidification process is limited as described here. (**NOTE:** The Environmental Protection Agency (EPA) has not registered thymol for this use, and so by policy it cannot be used by National Park Service staff.) Should mold develop on the humidification chamber, clean it with a weak solution of chlorine bleach, such as Chlorox[®] and water (one part bleach to twenty parts water), and allow it to dry for at least two days before reuse.

Flattening. The final step in the process is drying and flattening under precisely controlled conditions. It is important to remember that moist paper is weak and very vulnerable to damage. Handle it with the utmost care.

Remove papers from the chamber by lifting the polyester. Avoid unnecessary handling of moist papers. Do *not* allow papers to come in contact with water droplets in the tank. If papers are still resistant to flattening, return them to the chamber being careful not to over-humidify.

To dry humidified papers, sandwich them between sheets of a blotting material and under fairly heavy weight to prevent cockling. Place humidified papers between archival-quality blotter paper sheets. Do not use the blotters more than a few times. Staff who expect to do a considerable amount of flattening may want to purchase clean wool felts. These make an ideal blotting material and they can be reused indefinitely. A sheet of one-half-inch-thick Plexiglas cut to an appropriate size and with smoothed edges (to make it safer to handle) may be used to provide both a smooth, flat surface and heavy weight. If this material is not available, a smooth board or one-quarter-inch-thick plate glass will do. Additional weights such as books or bricks covered in paper may have to be added on top of a lightweight board to achieve the desired result.

Dry the objects on a flat, smooth surface since distortions in the drying surface are easily transferred to the paper. Also make sure that the surface is sturdy enough to hold the weight. Lay out one piece of blotting material on the drying surface, then one sheet of humidified paper, then another blotter. It is possible to stack several of these *sandwiches* and dry them all under one weight; however, for best results, weight each sandwich individually.



Leave the paper under weight overnight, or for several days if time and space allow. If papers are drying cockled, it may be necessary to change the blotters several times during the flattening process.

If papers are not adequately relaxed after one session, the process can be repeated, provided the paper is allowed to dry thoroughly between sessions. If papers are still resistant to flattening after three attempts, consult a paper conservator for advice.

Store flattened papers in archival quality folders or mats and then in archival quality document or print boxes.

Flattening Photographs

In consultation with a paper/photographic conservator, modern photographs generally may be relaxed and flattened using this process as well. However, place *nothing* on the emulsion surface during drying. Once the photograph is removed from the chamber, place the photograph on a blotter, and weight only the borders of the photograph as it dries.

The *Conserve O Gram* series is published as a reference on collections management and curatorial issues. Mention of a product, a manufacturer, or a supplier by name in this publication does not constitute an endorsement of that product or supplier by the National Park Service. Sources named are not all inclusive. It is suggested that readers also seek alternative product and vendor information in order to assess the full range of available supplies and equipment.

Notes

1. To test for solubility, dip a sterile cotton swab in distilled water, and roll it over a clean paper blotter until the blotter no longer swells from moisture. Then gently rock the swab over a small portion of the media. Inspect the swab for any media that may have been dissolved.
2. Detailed written instruction on the ultrasonic humidification process, as a pre-published paper by Susan L. Page (to be published in *Restaurator* in 1995), presented at the 8th Annual NARA Preservation Conference, is available from the author, c/o National Archives and Records Administration, Preservation Policy and Services Division, Washington, D.C. 20814.

Sources

Natural fiber brushes and archival-quality paper blotters are available from conservation, archival, and artist material suppliers.

Baker's racks made of stainless steel or anodized aluminum with welded construction are available from food service equipment manufacturers or distributors. Ultrasonic humidifiers, plastic screening, and polyethylene sheeting are available from hardware stores. Acrylic egg-crate louvers are available from lighting supply stores.

Velcro and spun polyester (e.g., Hollytex, Cerex, or Remy) are available from fabric stores or suppliers of archival-quality materials. Gore-Tex is available from conservation materials suppliers or from W.L. Gore and Associates, Gore-Tex Fabrics Division, P.O. Box 1130, Elkton, MD 21921. Wool felts are available from felt manufacturers or industrial fabric suppliers. Consult a paper conservator for specifications.

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