

28. Drying/ Flattening

Drying is the process of removing water from paper. Flattening involves reorienting the fibers in a sheet so that the sheet is predominantly in one plane. Flattening is a critical operation that can permanently alter the sheet, or the surface of the sheet. Drying and flattening can be done concurrently or separately.

28.1 Purpose

Process of removing moisture (water) from paper as a conservation procedure, such as after washing or lining or as the result of flooding. The moisture can be removed locally or overall; fast or slow; in controlled, semi-controlled or uncontrolled manner; using no pressure, light pressure, moderate pressure or high pressure.

28.2 Factors to consider*

28.2.1 Drying: General*

28.2.2 Emergency drying: Mass Drying*

28.2.3 Flattening: General*

28.2.4 Drying/Flattening step in an overall treatment scheme*

A. Degree of wetness of object to be dried*

B. Level of drying required*

C. Size of area to be dried*

D. Overall strength of paper*

E. Local weaknesses in the paper*

F. Surface texture*

1. Historic /artistic intent*

2. Paper aesthetic considerations*

a. Platemark*

b. Natural curl and/or cockles*

c. Embossing*

G. Deformations to be altered*

H. Speed of drying*

28.3 Materials tool and equipment

28.3.1 Absorbant materials (drying media)A. Blotters*

1. Thin
2. Thick
3. Very thick
4. Soft
5. Hard

NOTE: Watchout for blotters with bluing or added colorants.

B. Felts*

1. Paper makers felts
2. All felted felts
 - a. Thin
 - b. Medium
 - c. Thick
 - d. Hard
 - e. Soft

C. Air (as a drying media)*D. Polyester mat and paper28.3.2 Drying equipmentA. Drying board (homemade)*B. Drying screen (Japanese style)C. Drying cabinet*

1. Covered tray
2. Drying rack
3. Humidity controlled cabinet

D. Drying racks*

1. Serograph drying rack

2. L.C. type rack
3. Single screens
- E. Drum dryers*
- F. Microwave dryers*
 1. Commercial
 2. Small scale
- G. Freeze dryers*
 1. Commercial
 2. Small scale
- H. Forced air dryers*
 1. Forced air only
 2. Hair dryers
 3. Very hot air guns
- I. Tacking irons*
- J. Suction tables*
 1. "Large" suction tables
 2. "Small" suction tables

28.4 Treatments

28.4.1 Air drying

A support is air dried, without pressure fro , without pressure, from a wet or damp state. The air dried sheet is often cockled. This cockling is due to the differential in shrinkage between wet, damp and dry areas of the paper. Air drying is often done on elevated screens so that both sides dry evenly. Blotters can use be used as a drying support but they tend to cause dramatic, local, cockling. Slant drying improves the drain-off somewhat and thus results in flatter, less cockled, supports. Slow air drying encourages the transfer of moisture within the sheet so that evaporation is more even. Slow drying is accomplished by controlling the humidity of the enviorment around the support to be dried, using:

- A. Humidity controled chamber*

1. Polyester paper blanket over object
2. Covered tray
3. Drying cabinet

B. Closely spaced drying screens*.

It has been reported that paper documents dried over several days will be almost cockle free and possibly not need additional flattening*.

Air drying is often followed by flattening with blotters felts or other drying media/technique, see below.

28.4.2. Face-down drying

This technique is used to encourage the preferential drying of a selected surface, e.g. the reverse. By turning a support face down on a non-porous surface, evaporation occurs principally on the reverse surface. Stains, if they might occur, would develop on the reverse. This also encourages stains to be drawn from the front (surface of slow evaporation) to the reverse (surface of fast evaporation) see drying on the suction table, see also stain removal on the suction table .

28.4.3 Slant drying

When a support is first removed from a bath it is very wet. If the moisture is not blotted away it will generally collect in pools, because the paper always cockles lightly when it is removed from a bath. Excess moisture will collect in these low areas slowing their drying rate, locally. The resulting minor stresses cause cockling. Drying on a slant encourages the water to drain away evenly. The support should then dry evenly and possibly with only minor cockles.

28.4.4 Forced air drying

- A. Hair dryer*
- B. Suction table ("Large" type)*
- C. Very hot air guns*

28.4.5 Blotter and felt drying/flattening

Blotters and felts are used to absorb moisture from paper supports and hold them in a flat plane while the fibers are set (through the establishment of hydrogen

'type' bonds and physical entanglement which occurs during the various stages of drying) into their new configurations. Blotters and felts come in a variety of grades, qualities, thicknesses and densities. Blotters tend to hold a support flatter while felts allow it to move (somewhat). Weight is generally used to insure good contact with the blotter or felts and to reinforce the intended, new configuration. The length of time that a damp object stays within a stack of blotters or a pile of felts varies depending upon sheet dampness, hydroexpansivity and weakness (tears, folds, losses); the blotters or felts absorbency and slickness; and the weight of the stack/pile or dead weight resting on the object to be flattened. It is traditional to change the blotters or felts in contact with the support so that the drying process will proceed relatively quickly, release the hold the drying media has on the support so that the sheet can shrink (dry free of stress) or allow the object to be checked occasionally for unexpected problems. Common practice suggests that three blotter/felt changes are necessary with ever increasing blocks of time between changes, e.g., 15-60 min.; 30 min. - 4 hrs.; 2hrs. - several days.

Generic treatment steps

- A. Arrange blotters or felts or both prior to use.
- B. Remove object from bath or other moist environment.
- C. Place a thin polyester web sheet on an open pile of blotters, felts or both.
- D. Place thin polyester web, place another polyester web over the object, place the remainder of the pile of blotters or felts (any number, as required) on the object (actually on the polyester web).
- E. Place glass or Plexiglas weight on a pile of blotters or felts as a platten or as a weight, add weight if desirable.
- F. After 15-60 min. remove weight, and absorbant material resting on object, check for irregularities, remove object sandwich, relocate object sandwich in a dry portion of the pile of absorbant material. Replace absorbant material, glass platten, and weight as above.
- G. After 30 min. to 4 hrs., repeat the step F.
- H. After 2 hrs. to several days, repeat step F.

28.4.7 Felt drying*28.4.8. Special blotter/felt drying techniques*

A. Foam padding

B. Blotter cutouts

C. Others

28.4.9 Stretch drying: Japanese drying screen technology*

There are many variations of this technique; although the technology is generally similar. The Japanese drying screen is the piece of equipment used for drying and flattening. It allows for the controlled evaporation of moisture from the support. Moisture generally evaporates from the exposed surface, but the surface against the paper membrane also evaporates at a much slower rate. Flattening is achieved because the margins of the support are attached to the drying board while the support shrinks (dries). The Japanese screens have a semi-non-stick surface which allows continued use of the screen. Korean and Chinese screens are similar but do feature some differences. As the moisture evaporates the support and lining shrink. This shrinkage causes the support to be pulled flat but also dry with built-in stresses. This can result in damage if the traditional Japanese drying/Flattening process are not considered: the Japanese climate is humid. Western climates are much less humid; therefore, drying on Japanese screens proceeds much more quickly, even violently, which can lead to curling at a minimum and damage if conditions are favorable.

A. Japanese school #1*

B Japanese school #2*

[Essays on the various schools of Japanese technique]

28.4.10 Other Oriental techniques

A. Chinese techniques

B. Korean techniques

28.4.11 Stretch drying face-in

The traditional Western adaptation of the Japanese techniques has been to dry lined supports face-in on the screen. This protects the image surface and stretches the lining causing flattening. The lining paper is stretched flat. The objects support is pulled

flat because it is still damper than the lining. The objects support is pulled into an expanded state by the lining, is held in an expanded state; through it's attachment to the drying board. The order of drying is: lining, paste ,support, however it is not sequential (first one, then the next). The faster the drying rate (lower humidity) the more sequential; the slower the more even. Even drying results in linings that are dimensionally stable, usually don't curl and have not subjected the support to severe stress. Face-in drying, after lining, allows the object's support to shrink less than face-out drying, because the objects support is damper after the lining has taken it's new configuration.

28.4.15 Stretch drying face-out

This is an adaptation of the preceeding technique. It reverses the order of drying and allows constant viewing of the object during drying. In low humidity conditions this is vitally important because the object is subject to great stress and could possibly rip or be otherwised, damaged. During face-out drying the object dries first, to a more normal demension, and under less stress than with face-in drying. The shrinkage of the lining, later in the drying scheme, pulls the object's support flat. The order of drying of the object is: paste, lining, support (similar cavwets about sequence apply). It is quite possible, if the hygroexpansivity of the lining and support are not matched, a curl will result; usually concave.

28.4.16 Stretch drying face-in or face-out drying with broad margins that are kept wet

This is an adaptation of the above technique that takes into consideration the dangerously fast shrinking, drying and stretching of the lined support attached by it's margins, under low humidity conditions, to a drying board. The margins between the area pasted to the board and the object are wet, usually with a brush, and kept wet so that the wet area will expand preferentially through the strain of drying, rather than damaging the support, weakneing the support or stretching the support to a non-original size.

28.4.17 Friction drying*

28.4.18 Western stretch drying: fixed and semi-fixed*

A moisture expanded sheet is pulled flat by the strain of shrinking, during drying, because the edges of the support are held semi-immoble by weight or attachment to an immovable object.

- A. Western stretch drying, weighted parimeter*
- B. Guard and drying board*
- C. Wrap around matboard*
- D. Dacron web/Plexiglas technique*

28.4.19 Local drying and flattening*

[Essay on the speed of treatment, removing local deformations(dents creases, tears, crumples, cockels) achieving surface effects, pros and cons of local vs overall drying; and manipulation of fiber net works by localized expansion ,i.e., closing "yawning" tears.]

- A. Contact drying using the Small Suction table*
- B. Contact drying using the tacking iron*
- C. Contact drying using localized blotters and weight*

28.4.20 Localized forced air drying using a hair drier

Directed hot dry air can be used to control the moisture content of paper or media. It should however, be used with great caution on paper supports, because permanent distortions from localized cockling can result. Control of the force of the air(blower motor control) and its temperature is desirable, but a skilled conservator can overcome these problems, especially in an emergency.

If media has started to bleed in a water bath or during an humidification process, it may be necessary to dry the support and/or media quickly to avoid additional bleeding or loss of media. The evaporating surface is the one, the bleeding media will migrate to. If the media is moving and no other means is available to stop it (see "Small" suction tables) drying the reverse of the support will draw the media toward the reverse. This will minimize the effects of the damage or pull a stain away from the obverse. If the drying is done in stages it is possible to minimize the visual effects of the bled media. Lowering the overall moisture content of the paper will slow the bleeding. Keeping the paper moist will allow the bled media to be drawn to the reverse. Excess drying can result in additional damage due to cracking of media. If attempts will be made to reduce diffigurement, (after the emergency is over) the support should not be over dried because this will tend to set the damaged media. Localized applications of

moisture ,i.e., water on a small brush can be applied to the perimeters of the damaged design; capillary action will draw the water into the bleed area , if the reverse is then dried again the displaced media can be parially pulled to the reverse. Several attempts may be necessary. Severe damage to the design and support can result (loss of design, just more loss of design or setting of the bled media) if great skill is not practiced during this emergency treatment.

Localized drying can be used to reform or reshape a fiber mat (paper) that is "sprung" open or is distorted due to cockling, curling, rolling, folding or creasing. Drying a fiber mat sets it into a new configuration. If a damp area is dried, it shrinks locally. The remaining damp area around the dry area stretches to make up for the minute amount of lost space. This phenonom can be used to advantage to remove distortions.

28.4.20 Forced air drying using a cool air source*

END

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