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Topics in Photographic Preservation, Volume 3.
Pages: 46-51
Compiler: Robin E. Siegel

THE USE OF MICROWAVES FOR DRYING FLOOD DAMAGED PHOTOGRAPHIC MATERIALS

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Photographic archivists are aware of the care and attention that the conservation of such documents necessitates. Storage rooms must be climatized according to current standards. All pollutants must be filtered from the archival environment. Despite these precautions, however, archives are never completely safe from naturally produced-disasters, installation failure or human carelessness, all of which can produce serious flooding. Photographic materials, when subjected to water immersion undergo serious damage proportional to the length of time they have been immersed. These documents must be treated very rapidly if they are to be saved from severe deterioration.

Klaus HENDRIKS and Brian LESSER (3) have tested several drying techniques : air drying, with or without prior thawing, and freeze-drying in vacuum chamber. They concluded that the least dangerous technique is air-drying if the mass of soaked documents is not too great. Otherwise, a very large number of documents must be frozen so as to avoid the development of microorganisms. Air drying after thawing is then considered preferable to freeze-drying in vacuum chamber. But this method requires much time, space and handling. We have examined the possibilities offered by a more rapid method using microwave energy.

Principle of microwave drying

Microwaves represent a part of electro-magnetic energy, situated within a frequency of 0.3 to 300 gigahertz, They are composed of a magnetic field and an electric field, the latter acting upon dipolar molecules (particularly water) by orienting the dipoles within the field. When the electric field vibrates at a slow frequency, the dipoles vibrate "in phase" if the molecule is freely-rotating and of low molecular weight. As the frequency increases disorder occurs and molecular friction creates heat.The oscillating electric field also acts upon the positive and negative charges by causing shocks through rapid reversal, acompanied by the release of heat.

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Microwave energy has numerous industrial applications in the heating or drying of materials thanks to these energetic properties.

In 1969, Ivan RYMAN and William OVERTURF (4) experimented with the use of microwave energy associated with air flow for the drying of silver halide films following processing. They were hoping to find the means by which to accelerate drying in a reduced space, while taking into account the fragility of wet emulsions. This research led to the construction of an expensive and complex apparatus.

More recently, André-Jean BERTEAUD(1) and his team have studied the optimization of microwave energy transfer to plane products. Contrary to the household microwave oven, where waves are disordered, single-mode wave guides were used. One application was the drying of sheets of paper developed by Astrid BRANDT (2). The prototype of the apparatus used for that study was used by us to test the drying action of microwave energy on photographic materials.

Description of the microwave drier

The drier includes two over-size single-mode wave guides (patented) fourteen centimeters long, slotted along fifty centimeters lengthwise and two centimeters height-wise. Each wave guide is supplied with a magnetron generator of 2.45 gigahertz whose power is maintained continually between 0 and 800 watts.

The soaked documents are placed on a conveyor with back and forth motion, the speed of which is controlled.

As the documents pass through the applicators, they will, according to their water content, retain a proportional amount of microwave energy ; the rest of the energy will be absorbed by the water found at the extremity of each waveguide. It has been shown that during the paper drying there is a self regulating microwave energy transfer to the paper. A power level of 400 watts and a rate of 6 cm/sec permits the drying of paper in several minutes without any risk of damage.

Experimentation

We applied this method to soaked photographic documents with the above information in mind. For this experimentation, testing was done both on contemporary documents : black and white prints on baryta or resin-coated paper, on color prints, on microfilms and on historical materials (see annex). All samples were immersed in tap water maintained at 19°C. Documents were then drained and blotted in order to eliminate an accumulation of water droplets on the image surface. These droplets could cause non-uniform heating during exposure to microwave energy leading to the formation of heat spots. The documents were then treated in the microwave drier.

All of the samples were visually examined before and after drying. Gray scales were used to measure density variations, for contemporary prints on baryta or resin-coated paper. A test card permitted us to verify the legibility of the microfilms.
First, we exposed each sample individually to the optimal conditions established for the drying of paper : a power of 400 watts and a rate of passage of 6 cm/sec. The documents were maintained flat using a non-woven sheet.
Among the historical documents no alteration was noted for the salted paper prints, for the albumen prints nor for the gelatine negatives that were in a relatively good state of conservation. However, the gelatine of certain photographs adhered to the non-woven sheet used to keep the documents flat. This was notably observed in the case of little or unhardened gelatine or on gelatine severely deteriorated by microorganisms.
Contemporary black et white prints on baryta or resin-coated paper did not seem to be affected by the microwaves. No variation of density was observed. Loss of gloss was equivalent to that caused by air-drying. Deformation of the prints was, however, less significant.
The color prints tested revealed a small density variation which did not exceed that for air-drying. Legibility of the silver-gelatine, diazoic and vesicular microfilms was unchanged. On the other hand, the A.B.Dick microfilms were destroyed during the first exposure to the microwave energy. These microfilm process developed to continually bring information up to date, comprises a photo-conductor (phenylene diamine derivative) that melted upon contact with the microwave action.
During the second testing phase, we investigated the potential dangers of more severe conditions of microwave energy application.
Two soaked black and white silver prints were exposed, immobile, on the conveyor bed for fifteen minutes, to the microwave energy at the maximum power (800 watts). No change was observed.
Surface temperature was measured with an infra-red pyrometer, Modeline 4, model 4402 C (IRCON Company). The highest value reached was 35°C.
Minimum drying time for silver print was determined by the weighing of the document before and after water immersion and following different microwave exposures. For example, for a power of 2 watts and a passage rate of 3 cm/sec, twelve passages through the waveguides were required, corresponding to an exposure time of two minutes.
Black and white silver prints on baryta paper were dryed in stacks of twenty, under these same conditions. The large amount of water retained by the wet documents caused an over-heating : the surface temperature reached 75°C. The dry prints stuck together . It is therefore important to treat each document individually.

The possibility of drying photographs in their sleeves was tested, without success. The plastic sleeves, which are impermeable, kept documents from drying. Paper sleeves, (neutral or alkalin, glassine) stuck to prints following the drying treatment. This had also been observed during air-drying treatment. It is, therefore, imperative to remove the document from its envelope and to dry them simultaneously so as to avoid mixing up the documents : the envelope often carries important references and inventory numbers.

Conclusion

We have concluded from this study that water-soaked photographs in relatively good state of conservation may be advantageously dried using microwave energy if the proper precautions are taken.

The documents must be exposed one by one under the wave guides after their sleeves have been removed.

It is imperative to sort out the prints and to separate those with very fragile deteriorated gelatine layers which do not stand up to microwave treatment.

Such restrictions obviously represent an obstacle in the case of the treatment of a massive water-soaked collection. However, drying with microwave energy is much more rapid than air-drying. Its pace may be increased by the use of an apparatus possessing more than two single-mode wave guides.

At the present time, the action of microwave energy upon microorganisms is being investigated by the laboratory. Following early results, the sterilizing effects seem to necessitate a temperature that is incompatible with photographic emulsions.

Acknowledgments

I would like to thank Mr. DELMOTTE of the Molecular and Macromolecular Organization Lab of the National Center for Scientific Research at Thiais, France , for his generosity in lending us the microwave drier.

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ANNEX

MATERIALS SOAKED AND DRYED

Modern Processes

-BLACK AND WHITE PRINTS
- ILFOBROM
- ILFOSPEED MULTIGRADE
- KODABROM
  - -BARYTA PAPER
  - -RESIN COATED PAPER
- GUILLEMINOT
  - -BARYTA PAPER
  - -RESIN COATED PAPER

-COLOR PRINTS
- EKTACOLOR 74 RC
- EKTACHROME 19
- AGFACOLOR MCN 310
- CIBACHROME

-MICROFILMS
- XIDEX BLACK DIAZOIC
- XIDEX VESICULAR
- KODAK VESICULAR
- A.B. DICK

Historical black and white processes

- SALTED PAPER PRINTS
- SILVER ALBUMEN PRINTS
- P.O.P. PRINTS
- SILVER GELATIN GLASS PLATES
- CELLULOSE NITRATE NEGATIVES
- CELLULOSE ACETATE NEGATIVES