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EFFECTS OF ACCELERATED HEAT AND LIGHT AGING ON TEXTILES MARKED WITH FABRIC MARKING PENS

JANET EVENSON AND PATRICIA COX CREWS

ABSTRACT—Despite reasonable concerns that fabric marking pen inks may prove damaging over time, some quilters use them to temporarily mark quilting designs on quilt tops. Unfortunately, no published results concerning long-term effects of these products exist. The purpose of this study was to determine whether marking pen inks contribute to degradation or discoloration over time. Samples were marked with one of three brands of marking pen and subjected to ink removal treatments, followed by heat or light aging. Changes in color and breaking strength were measured before and after heat or light aging. Results showed that a water immersion ink removal treatment is the most effective method for removing marking pen ink and was associated with significantly less discoloration and strength loss than eraser pen removal treatments. This suggests that quilters should use marking pens only if they immediately launder or soak in water their newly completed quilts. Curators considering a quilt for acquisition may wish to ask if marking pens were used. If that is not feasible, then it is advisable to have a specialist examine potential acquisitions for tell-tale traces of marking pen ink. If detected, wet-cleaning prior to storage should be considered.

TITULO—LOS EFECTOS DE ENVEJECIMIENTO ACELERADO POR CALOR Y LUZ EN TEXTILES ETIQUETADOS CON ROTULADORES PARA TELAS. RESUMEN—Los rotuladores para telas son ampliamente utilizados para marcar temporalmente los diseños de los quilts. Con el paso del tiempo, el uso de estos lápices puede producir daño en las telas, según se ha estudiado y observado en álbumes de quilts del siglo XIX en los que se ha aplicado tinta para escribir. No existen resultados publicados acerca de los efectos a largo plazo del uso de estos lápices. El propósito de este estudio, entonces, fue determinar si distintos tipos de rotuladores contribuyen a la degradación o decoloración de las telas a lo largo del tiempo.

Las pruebas efectuadas fueron diseñadas siguiendo los protocolos estándares de AATCC y ASTM. Las muestras fueron preparadas usando tintas solubles al aire, tintas solubles al agua y lápices borradores. Las muestras se sometieron a envejecimiento acelerado por calor y exposición a la luz. Los cambios en el color y la resistencia a la ruptura fueron medidos antes y después de las pruebas. Los resultados fueron variados. Las tintas solubles al aire no "desaparecen," como los fabricantes afirman. Las muestras de prueba exhibieron una decoloración significativa. Las muestras de prueba con rotuladores borrables mostraron una significativa decoloración y pérdida de resistencia. Las tintas solubles en agua mostraron una decoloración y pérdida de resistencia considerablemente menor. Por lo tanto, no son recomendables ni las tintas solubles al aire ni los rotuladores borrables. Los lápices solubles al agua pueden ser aconsejables si van junto con un tratamiento de inmersión en agua, como el lavado.

Es aconsejable determinar el uso de estos rotuladores para tela en quilts que están bajo consideración de adquisición o donación a colecciones de museos. Si la información no está disponible, se sugiere un examen cuidadoso para su etiquetado o marcado. Si es reconocido, una limpieza en húmedo debiera considerarse antes de su almacenaje o depósito por largo tiempo.

EFFECTS OF ACCELERATED HEAT AND LIGHT AGING ON TEXTILES MARKED WITH FABRIC MARKING PENS

1. INTRODUCTION

The resurgence of interest in quiltmaking during the past 30 years has led manufacturers to develop and market a variety of new products to make quiltmaking easier and speedier. One of these products is the temporary fabric marking pen, which is widely available for quilters to mark quilting designs on quilt tops. The inks in fabric marking pens are designed to be impermanent. According to claims on the marking pen packaging, the marks disappear when wiped with a damp cloth or fade away as the ink reacts to moisture in the air; however, reasonable concerns exist that these marking pen inks may prove damaging to fabrics over time.

Simply reading the instructions for use of the fabric marking pens raises some level of concern because the package instructions specify that each fabric should be tested in an inconspicuous place or on a fabric scrap to verify that the ink can be removed. Also, anecdotal reports suggest that marks made using fabric marking pens have later reappeared as yellow stains. As a result, many quilters reportedly will not use marking pens or have discontinued use of them.

In addition to the cautions on packaging and in anecdotal reports, some textile curators, conservators, and scientists (Moore and Eddleman 1991; Ordonez 2002; Wass 2002) have expressed concerns about the use of temporary fabric marking pens. The deleterious effects of selected dyes and inks on fabrics, particularly 19th century writing inks used to permanently mark textiles, have been observed by many individuals (Tímár-Balázsy and Eastop 1998; Ordonez 1992). Because many of these early writing inks contained iron compounds and tannins, many surviving 19th century album quilts exhibit damage caused by the inks (Ordonez 1992). Frequently the fabric has disintegrated wherever the inked signature was inscribed.

No published results concerning the long-term effects of fabric marking pen inks on textiles exist. Only one study concerning fabric marking pens has been published to date. Moore and Eddleman (1991) evaluated the most effective method of ink removal but did not assess whether or not the marking pen inks contributed to fiber degradation or discoloration. They found that laundering fabrics was a more effective removal treatment for ink markings than simply wiping the marked quilt top "with a cloth well moistened with water" as the manufacturers instructions on the marking pen packages indicate.

Because the long-term performance of temporary fabric marking pens has not been objectively evaluated, quiltmakers cannot make informed decisions. The purpose of this research was to determine if fabric marking pen inks and the eraser pen contribute to discoloration or degradation of quilt fabrics over time.

2. MATERIALS AND EXPERIMENTAL METHODS

2.1 MATERIALS

Three brands of temporary fabric marking pens were included in this study: Dritz, Clover, and Crayola. All of the pens contained blue inks.

Crayola washable markers were not developed for the purpose of marking quilts, but rather for ease of removal from children's clothing if accidentally applied when used for drawing and coloring; nevertheless, evaluations were important because a number of quilters use them and some national quilt instructors recommend them. Fabrics used in evaluating the three brands of fabric marking pens included mercerized and bleached 100% cotton print cloth and bleached 50% cotton/50% polyester blend print cloth.

2.2 SAMPLE PREPARATION AND INK REMOVAL TREATMENTS

The samples for this study were cut 6.4 x 12.7 cm (2½ x 6"); the fabric marking pen ink was applied to a 1.3 x 13.3 cm (½ x 5¼") area within each sample. The marked area was controlled by a template and one person marked all specimens in an effort to ensure consistency in pressure and to increase uniformity of application. Because most quilts experience a period of time between marking and ink removal, fabric specimens were held for 30 days under ambient conditions after marking. After 30 days of dark storage under ambient conditions (21±1°C (70±2°F) and 65±1% RH), ink removal treatments were applied followed by light or heat aging.

Ink removal treatments included: 1) no ink removal treatment, 2) removal of ink using its corresponding "eraser" pen (Dritz and Clover only), and 3) immersion in distilled water. Ink removal instructions on the Dritz Mark-B-Gone water-soluble marking pen package specified that "a clean cloth moistened with plain water" should be used to wipe away marks. Instructions on the Clover package suggested removal of the impermanent ink by spraying with water. Based on advice from the Dritz consumer representative, however, we decided that immersion in distilled water would better ensure complete removal of the marking pen ink from fabric and batting.

Available only since the 1990s, eraser pens are a relatively new product for removing temporary marking pen ink. We were interested in whether or not components of the eraser pen formulations would contribute to discoloration or degradation of fabrics marked with temporary marking pens. Only Dritz and Clover marketed companion "eraser" pens for their fabric marking pens. Because Crayola does not produce an eraser pen for its water-soluble markers, the Crayola marked specimens did not receive an eraser pen ink removal treatment. Only the corresponding brand of eraser pen marketed for its respective marking pen was used for an ink removal treatment.

2.3 LIGHT EXPOSURE AND HEAT AGING

For light exposure American Association of Textile Chemists and Colorists (AATCC) standards were followed (1). An Atlas Ci65A Xenon Weather-Ometer with a soda lime filter was used to simulate sunlight through window glass. Specimens were exposed to 20 or 40 AATCC Fading Units (AFUs) of light.

Heat aging was also conducted according to AATCC standards (2). This test method was selected as it is a proven protocol for accelerated heat aging of textiles and the conditions used in

this study were similar to those described by Feller (1994) in aging tests for conservation materials. Specimens were aged in a VWR forced-air oven at 135±2°C (275±4°F) using water to create steam. The samples were exposed to 6 or 36 hours of heat aging because conservation scientists (Feller 1994) have equated seven hours of aging at 140°C (284°F) to a lifespan of approximately 20 years, and 36 hours of aging at 140°C (284°F) to a 100 year minimum lifespan, an expected lifespan for an heirloom.

2.4 EVALUATION OF COLOR CHANGE AND BREAKING STRENGTH

Following light exposure or heat aging, changes in color and strength were measured. Color change was evaluated using a HunterLab UltraScan XE diffuse/8° spectrophotometer according to AATCC standards (3). An illuminant D65/10° observer was used to calculate the colorimetric values. Total color change (ΔE) was calculated using the CIE 1976 L*a*b* equation. Three measurements were performed per specimen. Because three replicate specimens were used, the mean color difference value for each ink product represents an average of nine measurements.

Warp breaking strength was measured using an MTS Qtest/10 materials testing system according to American Society of Testing and Materials (ASTM) standards (4). The cut strip option was followed, except a 1.3 cm (½") strip instead of a 2.5 cm (1") strip was used. Three replicate specimens were evaluated for each marker/ink removal combination.

Color difference and percent change in breaking strength were assessed by analysis of variance (ANOVA) procedures. When ANOVA procedures showed that an independent variable had a significant effect, Tukey's post hoc mean comparison tests were performed to ascertain where statistically significant differences in means were located (5).

3. RESULTS AND DISCUSSION

3.1 COLOR DIFFERENCES FOLLOWING AGING

In general, the cotton and cotton/polyester samples did not exhibit significantly different amounts of color change following light or heat aging; therefore, only information about cotton fabrics will be presented. In addition, the marked specimens exhibited little difference in amount of color change following either 20 or 40 AFUs or following either 6 or 36 hours of heat aging. This suggests that most color change occurs during the first 20 AFUs of light exposure or the first six hours of heat aging, and little additional color change occurs with additional light exposure or heat aging. Consequently, only results of the effect of 40 AFUs of light exposure and 36 hours of heat aging on color difference in the various marker/ink removal combinations on cotton fabric are presented (Table 1).

As expected, samples receiving no ink removal treatment exhibited the greatest amount of color change. Somewhat surprisingly, however, among the specimens receiving no ink removal treatment, those marked with the Dritz temporary marker pen

Marker/Ink Removal	40 AFUs Light	36 Hours Heat
	Color difference (ΔE_{CIELAB})	
Dritz / no removal	42.5 D	41.4 F
Clover / no removal	32.9 C	31.3 E
Dritz / eraser pen	28.6 C	18.3 C
Crayola / no removal	27.0 C	59.2 G
Clover / eraser pen	15.9 B	26.5 D
Crayola / water	2.7 A	11.9 B
Clover / water	2.6 A	8.4 A
Dritz / water	2.0 A	7.1 A
Control (cotton)	1.8 A	6.9 A

Table 1. Mean comparison tests on color difference values for marker/ink removal combinations on cotton following light and heat aging.

NOTE: Means with the same letter are not significantly different at $p < 0.05$.

Marker/Ink Removal	Breaking strength (% change)
Clover / eraser pen	-86.4
Dritz / eraser pen	-79.5
Clover / water	-24.5
Clover / no removal	-23.8
Dritz / no removal	-17.6
Dritz / water	-12.4
Crayola / water	-4.6
Control / no removal	-1.2
Crayola / no removal	1.6

Table 2. Mean percent change in breaking strength for marker/ink removal combinations on cotton following 36 hours of heat aging.

Marker/Ink Removal	Breaking strength (% change)
Clover / no removal	-46.7
Dritz / eraser pen	-38.8
Crayola / no removal	-35.3
Control / no removal	-34.6
Clover / eraser pen	-30.9
Dritz / water	-27.6
Clover / water	-26.7
Crayola / water	-22.3
Dritz / no removal	-13.0

Table 3. Mean percent change in breaking strength for marker/ink removal combinations on cotton/polyester following 36 hours of heat aging.

exhibited significantly more color remaining after light aging than did the Crayola marker. The ink in the Crayola marker changed hue and lightened somewhat in value.

In general, marked and aged specimens receiving a water immersion ink removal treatment did not exhibit significantly more color change than the controls. A simple water immersion treatment proved to be an effective ink removal treatment for all three brands of marking pens. Only the Crayola marker subjected to heat aging exhibited somewhat more color change than the control. This suggests that if marking pen ink is thoroughly removed by a water immersion treatment, it will not discolor either cotton or cotton/polyester fabrics.

In contrast, all marked specimens that received an eraser pen ink removal treatment exhibited significantly more color change than the controls after both light and heat aging. Additionally, specimens receiving eraser pen ink removal treatments and subjected to heat aging exhibited a brown discoloration not seen in any other ink removal treatment.

3.2 STRENGTH CHANGES FOLLOWING AGING

Statistical analyses on the effect of light aging on percent change in breaking strength of the marked cotton and cotton/polyester samples indicated that none of the samples exhibited significantly greater strength losses than the controls following either 20 or 40 AFUs of light exposure. Because light aging did not contribute to significantly greater strength losses in the marked specimens than in the controls, these data are not presented.

In contrast, cotton and cotton/polyester samples exhibited significantly different levels of strength loss following heat aging; therefore, strength data for both cotton and cotton/polyester specimens are presented (Tables 2, 3). In addition, significantly greater strength losses were exhibited by specimens exposed to 36 hours of heat aging versus 6, as might be expected.

Cotton samples receiving eraser pen ink removal treatments exhibited the greatest strength losses (~80% loss), while the specimens receiving no ink removal treatment did not exhibit significantly greater strength losses than those receiving the water immersion ink removal treatment. The damaging effects of the eraser pen ink removal treatment suggest that components of the eraser pen formulations are particularly damaging to cotton fibers in the presence of heat.

Cotton samples marked with both the Dritz and the Clover brand fabric marking pens exhibited significantly greater strength losses than did the specimens marked with the Crayola marker. In fact, the specimens marked with the Crayola marker did not exhibit significantly greater strength losses than the control.

In contrast, on the cotton/polyester fabric none of the marking pen and ink removal combinations shown in Table 3 proved significantly different from the control in terms of strength loss. Although it is evident that specimens receiving water immersion ink removal treatments generally

exhibited lower amounts of strength loss than those receiving the eraser treatments, the differences were not significantly different than the strength losses exhibited by the control.

4. CONCLUSIONS

In summary, water immersion was the most effective ink removal treatment in terms of both light exposure and heat aging for all three brands of marking pens. The eraser pen caused significant discoloration following both light and heat aging. It proved to be an undesirable ink removal treatment.

In terms of strength losses for light aging, neither cotton nor cotton/polyester samples exhibited significantly different amounts of strength loss than the control, regardless of ink removal treatment. In terms of heat aging, however, cotton samples receiving eraser pen ink removal treatments exhibited significantly larger strength losses (~80% loss) than the cotton/polyester samples that had eraser pen ink removal treatments. The damaging effects of the eraser pen ink removal treatment on cotton suggest that components of the eraser pen formulations are particularly damaging to cotton fibers in the presence of heat.

In addition, cotton samples marked with the Crayola marker exhibited no more strength loss than the control. In fact, both the Dritz and the Clover brand fabric marking pens exhibited significantly greater strength losses following heat aging than did the samples marked with the Crayola marker.

In conclusion, quilters should be advised to avoid using eraser pens to remove the marking pen ink, especially on 100% cotton quilt tops. In addition, it is recommended that quilters use marking pens only if they plan to launder or soak the quilt in water afterwards. Clearly, some long term risks of discoloration associated with the use of temporary fabric marking pens exist unless a water immersion ink removal treatment is used.

Curators and textile conservators may wish to ask quilters or donors if marking pens were used on a quilt being considered for acquisition. If this is not feasible, a textile specialist should examine potential acquisitions for tell-tale traces of marking pen ink. If noted, wet cleaning the object prior to long term storage should be considered.

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NOTES

Specific AATCC protocols used in this study are as follows:

1. AATCC 16-1998: Colorfastness to Light. Option E test procedure.

2. AATCC 26-1999: Aging of Sulfur-Dyed Textiles. Accelerated, Alternate Oven Test.

3. AATCC Evaluation Procedure 6, Instrumental Color Measurement.

4. ASTM D5035-95: Standard Test Method for Breaking Force and Elongation of Textile Fabrics.

5. Tukey's post hoc mean comparison test is a statistical test used to compare means and identify which means are significantly different from another.

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Wass, J. 2002. Personal communication. Curator, Illinois State Museum, Springfield, IL.

SOURCES OF MATERIALS

Crayola® washable markers (Patent # 5968241)
Binney & Smith Inc.
1100 Church Lane
Easton, PA 18044-0431
Tel: (800) 272-9652
www.crayola.com

water soluble markers and eraser pens
Clover™
13438 Alondra Boulevard
Cerritos, CA 90703
Tel: (800) 233-1703

Dritz® water soluble markers and eraser pens
Prym-Dritz Corporation
P.O. Box 5028
Spartanburg, SC 29304
Tel: (800) 845-4948

Mercerized and bleached 100% cotton print cloth (Style 400M) and bleached 50% cotton/50% polyester blend print cloth (Style 7426)
Testfabrics, Inc.
415 Delaware Avenue
P.O. Box 26

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