Processing Black and White Prints for Permanence at the Boston Photo Co-Op

Revision: V1.5

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Work sponsored by
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The author and the sponsor do not consider this report to be final. Please send comments, etc. to us for incorporation into later revisions at:

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1. Introduction

A large number of the projects I do start off as a dare. This project is no different. It was born the day Carl, the director of the Boston Photo Co-Op, proclaimed the archival washer was really a pacifier and an expensive one at that. I continued sloshing my prints around in the washer, and Carl challenged me to prove this step necessary.

My photo education included the folklore that an archival washer was the only way to get properly washed prints. It seemed time to reexamine this myth, to find out what makes a print “washed”, and the process of washing prints, including defining the archival process.

The rest of this report details the journey and makes some specific recommendations for how to get a black and white print that will be well preserved.

2. Goals Of The Project

As a printer, I am concerned with the product I deliver to my clients. If I claim my prints are archivally processed, I should be able to explain both the process and the definition to my clients and I should feel confident that I will never have a print returned because of signs of degeneration. Obviously some time frame has to be involved; something in the neighborhood of 10 to 20 years is appropriate for the work I do.

Carl has a different set of goals. These focus on minimizing the work, time, and resources needed to make an archival print.

The list below outlines our combined goals:

- Reduce water usage at the Co-Op
- Find a process at the Co-Op that will produce a print with less than $0.7 mg/cm^2$ of thiosulfate in it[1]
- Find new chemicals which make it faster, less expensive, or have fewer health hazards to make a more permanent print
- Verify that the same process for removing fixer will also work for selenium toned prints

3. Defining Archival

Unfortunately, terms like *archivally processed* have turned into marketing hype to sell various pieces of darkroom hardware. Initially, I

[1]Thiosulfate is a chemical byproduct of fixing a print. If left in the print, it will cause yellowing and staining. The concentration of $0.7 mg/cm^2$ is lowest concentration that is detectable without specialized test equipement.

started my research to find out how long to wash a print. In short order, I found creating a permanent print involved much more than than I had initally believed.

A review of the basic photo chemical processes will help us understand what is required to make a print permanent. For now, assume the first 3 steps are develop, stop, and fix with an acidic fixer[2]. The developer plays no part in permanence. The stop bath only determines the capacity of the fixer to *fix* prints.

Fixing the print is the first step in making a permanent print. Fixing does one positive and one negative thing. The first is that it removes all the undeveloped silver halides (undeveloped silver halide is what's in the white area of a print). The second is that the fixer gets absorbed into the print material which is plastic or fiber. Clearly the fixing time must allow for the necessity of removing all the undeveloped silver halides while permiting the least amount of fixer to be absorbed into the paper.

Washing follows fixing. The purpose of this step is to remove the fixer compounds from the paper. The diffusion process is how washing works. If a print is washed long enough, the fixer will be largely removed leaving only minuscule levels behind. There are many variables that determine the minimum wash time. This report will look at the most important ones, including wash aids.

At this point, there are several tests that may be done to determine if all the undeveloped silver halides are removed and all the fixer is removed. For the purposes of this report, a print is considered permanent if the fixer residue is no more than $0.7 mg/cm^2$. The report assumes that fresh fixer is used so no undeveloped silver halides are present.

However, a print meeting the above standard is still not a permanent print. The black areas of a print are a silver oxide, an unstable compound likely to react with chemicals in the air. With the levels of air pollution found in most cities today, this is not an idle concern.

Toning the prints to convert the silver oxide into more stable silver sulfide is an additional step to provide long term stability. Storage and display conditions control how much air the print is exposed to.

4. Washing Is An Expontential Process

Achieving a minimal stain level while conserving water requires understanding the diffusion process by which washing works. I’ll explain

[2]Examples of acidic fixers are Sprint Fixer or Kodak Fixer

the details of washing first and then compare the water consumption of agitation by rotation and print washers.

Simply stated, the diffusion process is the migration of chemicals in solution from a concentrated area to a less concentrated area. After a long enough period of time, the chemical concentration is uniform in the solution. To see diffusion in action, fill a glass with water and add a few drops of food coloring. Initially, the liquid at the very bottom of the glass will be clear and the liquid at the top will be the strong color of the dye. During the first few minutes, the dye spreads out quickly creating vivid color trails. Then the liquid at the top of the glass is the strong dye color and fades when it gets to the middle of the glass. The liquid at the bottom of the glass is still clear. All of this has occurred in the space of 10 minutes. After 30 minutes, the liquid in the glass would be a uniform, faint color of the dye. Technically, the difference in time to reach certain points is exponential.

The fixer is no different from the dye. In the early part of the washing, the majority of the fixer migrates to the wash water. However, to remove the residual fixer compounds takes much longer. So, the washing process should change the water completely and frequently in the early stages and be in contact with the prints for a long period of time at the end of the process.

With this understanding, we can compare different washing methods. The basis for comparison is Kodak's recommendation of the washing the prints for 30 minutes with a complete change of water every 5 minutes.

Agitation by rotation, fully defined in section 5.2, is essentially filling a tray with water, sloshing the prints around in the tray, emptying the tray, and starting the cycle over again. An 11x14 tray holds about 4 liters of water, which I will round off to 1 gallon. The process is repeated 6 times so the total amount of water used is 6 gallons.

The Co-Op's 11x14 Oriental print washer holds 9 gallons of water. To have 6 complete changes of water in 30 minutes, means the flow rate is 1.8 gallons/minute. The total water used is a staggering 54 gallons!

Actually, the water used by the washer is much more. All the published reports indicate that until the flow rate reaches 2.5 gallons/minute, the surface of the print is not washed evenly because the washing chambers have dead spots in them. Some washers require an even higher flow rate. To further complicate matters, not all the washing chambers wash at the same rate. Again, the reports indicate that 30 minutes is too short for all the prints to be washed. It is not until 60 minutes is reached that all the prints show uniform low stain levels. So 2.5 gallons/minute for 60 minutes is 150 gallons. In addition to the price of water, there is the cost to heat the water to about 70^{o}.

Unfortunately, the water bill is a major part of any darkroom's operational expenses. Using the print washer is almost the same as making the water bill 10 times more expensive.

5. Summary Of Research

Since the details of finding a fixing and washing procedure are tedious, this section presents a summary of the methods needed to achieve a permanent print. In addition, the results of this research are specific to the Boston Photo Co-op because of variations in water chemistry. Please note that local conditions, for instance – being on the end of a water supply loop or having lots of lead water mains in your area – will affect your results. The best approach is to run your own tests!!

The recommendations are listed in three sections. I begin with information that is important for all black and white papers, and end with information specific to different kinds of paper.

5.1. General Recommendations

No matter what you do, please follow at least these instructions.

- Use an ammonium thiosulfate based fixer rather than a sodium thiosulfate fixer. The ammonium based compound is more water soluble and washers out more easily. Sprint fixer is an ammonium based fixer.
- No matter which fixer is used, or how long the print is fixed, or the fixing procedure used, the print **must** be agitated **continuously** for uniform and complete fixing**!**
- The temperature of the wash water should be between 68°F and 75°F. Water cooler than 68° will slow down the migration of the fixer into the surrounding water. Within this range, the warmer water will speed removal of the fixer. Water warmer than 75° will damage fiber-based papers, may soften the emulsion too much, and may cause the selenium in selenium toned printers to leach out.[3]
- Prints **must** be toned for long term stability. Even if all the fixer compounds have been removed from the paper, the silver is subject to chemical reaction with pollutants in the air. Selenium toner is the most cost-effective solution to use. See section 10. for a detailed toning procedure.
- Washing procedures are subject to many variables. For important work, a test print should be washed along with the final prints. Periodically, the stain level[4] in the test print should be checked.

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[3]There seems to be disagreement among all my sources about the upper limit for the wash temperature. Sources either listed 75° or 80°. I've selected 75° because this report recommends nonhardening fixing solutions to reduce health hazards.

[4]A stain test uses a silver nitrate solution to gauge the amount of fixer in the paper. My stain reagent was the Photographer's Formulary Residual Hypo test. One drop is left on

Clarification of solution: 200ml of Sprint fixer with 800ml of Sprint fixer remover.

- Avoid the use of alum hardener fixers. See section 9.3. for more information.
- In general, a textured surface on a paper makes it take longer to fix and wash. More specific remarks are made in the RC and the Fiber Recommendations sections.

5.2. Agitation By Rotation

One key technique is *agitation by rotation*. This technique removes chemicals from the paper. Through rotation, fresh chemicals are brought in contact with the paper, and the diffusion process becomes more efficient.

Agitation by rotation is an easy procedure to follow. This procedure works best with no more than 10 prints in a tray. If you have more than 10 prints, use more than one tray and while prints are soaking in one tray, agitate the next tray. It is easy to loose track of which print was on the top of the stack so I recommend changing the orientation of the top print. Alternatively, you could have one print face down to remind you of the top of the stack.

To start a cycle, fill a tray half to three quarters full of water. Place up to 10 prints in the tray. Rock the tray so water moves across the surface. First lift the left corner, pause, lift the right corner, pause, and lift the front of the tray. Then take the print on the bottom of the stack, place it on the top, and rock the tray again. Do this for all the prints in tray. Then let the prints soak in the tray. The first 3 times through, the soak time is 30 seconds. The last 3 times through, the soak time is 60 seconds. After the soak, empty the tray and refill it with fresh water. Before putting all the prints in the tray, allow all the water to drain off them.

5.3. Recommendations For RC Papers

RC papers are designed be processed quickly. The steps in this section are designed to get you prints as quickly as possible.

For RC papers, the following is recommended:

- Use one fixing bath of Sprint fixer 2:8 for 20 seconds with continuous agitation with a 10 second drain time[5]. Note the 20 second time is derived from a fresh fixer. As the fixer gets exhausted, the fixing time may increase to 30 seconds.
- Fixer remover is not necessary to get well washed prints.

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the paper for 1 minute and then blotted off. The test stain is examined in room light and compared to the test stains in Kodak's *Black-and-White Darkroom DATAGUIDE*.

[5]Drain time is the amount of time the print is held above the tray to allow excess chemicals to drip back into the tray. The drain time is included in the processing steps because developing, stopping, or fixing is still occuring.

- Follow the instructions for agitation by rotation to wash prints. Use of the print washer is not required and uses a tremendous amount of water. Note that non-glossy surface papers may take a little longer to wash.

Side stepping the issue of whether RC papers are stable for hundreds of years, I have omitted the selenium toning tests. It seems most RC prints are provided for situations where stability is no greater than 5 years. In fact, after several years, the relevance of the image has usually expired.

5.4. Recommendations For Fiber Papers

- Fix prints for twice the clearing time[6] of the paper. Agitation of the print **must** be **continuous.** Be sure to allow all the fixer to drain from the paper. For 11x14 fiber paper, the time is about 30 seconds. See Table 6.1 for the clearing times of the papers tested.
- No general recommendations may be given for the fixing times to include all fiber papers. The results were quite variable. However, papers that had special bases like the Luminos Tapestry and the Kodak Elite did require extended fixing times.
- Wash aids, like Sprint's Fixer Remover, help to speed the removal of fixing byproducts left in the paper. For special papers like Kodak Elite and Luminous Tapestry which are hard to wash, a wash aid is mandatory. In general, papers which have a long clearing time probably have a longer washing time too.
- Efficient washing may be done with 6 cycles of agitation by rotation. At the end of the wash cycle, most fiber papers showed an acceptable stain level. However, if greater permanence is required, place the prints in the archival washer along with a test print. After filling the washer with water, a low flow rate will be sufficient to continue washing the prints. Test the stain level every 15 minutes. If after 60 minutes, the stain level is too high, remove the prints from the washer and place them in a tray to soak for 60 minutes, occasionally agitating the tray.

5.5. Experimenting With TF-4

Included in this test is the Photographer's Formulary TF-4 fixer. Its benefits are supposed to be no acid stop bath, no fixer remover, and shorter washing times.

Unfortunately, because of the chlorine in the water supply, the TF-4 fixer gave off an overpowering ammonia odor. To use TF-4 safely, a powerful ventilation system is required. Covering the tray while not fixing prints will also help reduce the odor emission.

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[6] Clearing time is defined to be the length of time it takes for a piece of exposed film to become clear in a fixer bath. The idea is no less applicable to paper.

The decrease in processing time does not justify the potential health hazards. Because of the extra care required to use TF-4, I decided to conduct the tests only on RC papers.

6. Test Results And Analysis

One of the important components of planning the tests was selecting the papers and chemicals to use. Carl and I chose chemicals which the Co-Op uses and I selected some common, widely available, papers. The Clearing Time Table below summarizes all the chemicals and papers used.

The washing processes used are the 11x14 Oriental washer and an 11x14 tray with agitation by rotation.

6.1 Clearing Time Table

Paper	Clearing time (sec)		
	Sprint 1:9§	Sprint 2:8†	Formulary TF-4
Agfa Insigna	35	20	25
Agfa MC 310 RC	20	20	10
Forte Fortezo Elegance	15	15	10
Ilford Galerie	50	35	30
Ilford Multigrade	60	40	?
Ilford Multigrade III RC Deluxe	15	10	10
Ilford Multigrade III RC Rapid	15	10	10
Kodak Elite[7]	70	65	55
Kodak Polycontrast III RC	15	15	10
Luminos Classic Tapestry X	55	35	45
Luminos Flexicon VC RC	10	5	10
Oriental Seagull	45	25	30
Oriental Seagull Portrait FB-R	20	15	15
Oriental Seagull Portrait RB-R	10	10	10
Oriental Seagull Select VC RP-F	10	10	10

6.2 Stain levels with TF-4 fixer, no Sprint Fixer Remover, agitation by rotation

RC paper	3 washing cycles	6 washing cycles

§Dilution for the one-bath fixing method

† Dilution for the two-bath fixing method

[7]Grade 1 paper was used for this test. The low contrast provided poor resolution between the fixing steps. The results reported here should be viewed as inaccurate. The paper was donated for the project and the expense prevents purchase of a grade 3 paper package.

Agfa MC 310 RC	Exc	Exc
Ilford Multigrade III RC Deluxe[8]	Good	Good
Ilford Multigrade III RC Rapid	Exc	Exc
Kodak Polycontrast III RC	Exc	Exc
Oriental Seagull Select VC RP-F	Exc - Good	Exc - Good

6.3 Stain levels with Sprint fixer 2:8, Sprint Fixer Remover, combined washing methods

Paper	Fix time (sec)	Agitation by rotation		50 minute soak	Oriental washer at low flow		
	Sprint 2:8	3 cycles	6 cycles		15 min	30 min	45 min
Agfa Insignia	40	Good	Exc - Good	Exc	--	--	--
Ilford Galerie	60	Fair	Good	Exc - Good	Exc	--	--
Ilford Multigrade III RC Rapid (No fixer remover)	30	Exc	Exc - Good	Exc	--	--	--
Kodak Elite	90	Poor	Poor	Fair - Poor	Good - Fair	Good	Good
Luminos Tapestry	60	Poor	Fair - Poor	Fair	Good	Good	Exc - Good
Oriental Seagull	50	Fair	Good	Exc - Good	Exc	--	--

7. Performing The Minimum Fixing Time Test

The following procedure was used to determine the minimum clearing time for each paper/fixer combination.

1. A strip of paper marked off in 1 inch intervals was exposed to room light. Each interval represents 5 seconds in a fixer solution. The intervals recorded 5 to 65 seconds fixing time.
2. Each strip was soaked for 1 minute in water
3. Each strip was fixed in the graduated steps
4. Each strip was hosed off to remove the surface fixer
5. Each strip was developed face-up in room light for 5 minutes in Dektol 1:2
6. Each strip was in the stop bath for 30 seconds as appropriate for the fixer

[8] Pearl surface

7. Each strip was refixed for twice the clearing time
8. Each strip was washed and dried. The washing procedure was one water change, 3 minutes in Sprint Fixer Remover, and 6 water changes.

7.1. Results For RC Papers

All the RC papers had very quick clearing times. The times are much more uniform than the fiber papers. Based on the results, I would recommend fixing the RC papers for 30 seconds. The Agfa MC 310 had a strip that was harder to read and I recorded a slightly longer time.

I would extend the results for the RC papers tested here to be representative for RC papers in general.

7.2. Results For Fiber Papers

The clearing times are sufficiently spread out that I won't make a general recommendation. The clearing time test is easy to do and I recommend you determine your own clearing time with a grade 2 or 3 paper.

If you do perform your own tests, be forewarned that reading the test strips requires some interpretation. Each section on the test strip represents 5 seconds so being off by 1 section is not a big error at times greater than 30 seconds.

8. Performing The Washing Test

Tests for the RC and fiber papers were all done with 11x14 trays. The procedure for testing the RC papers was:

1. Develop an unexposed 11x14 print in Dektol 1:2 for 1 minute with 30 second drain time.
2. Stop in a water bath for 1 minute with continuous agitation and drain for 15 seconds. The tray was filled with 5 liters of water.
3. Fix in TF-4 for 30 seconds with continuous agitation with 15 second drain time

Paper was processed two sheets at a time, back to back.

The procedure for testing fiber papers was:

1. Develop an unexposed 11x14 print in Dektol 1:2 for 1 minute, including a 30 second drain.
2. Stop in Sprint stop bath for 30 seconds with continuous agitation and with 15 second drain time.
3. Fix in Sprint fixer 2:8 for twice the clearing time, except for Kodak Elite. Refer to 6.1 table for the details.

For the agitation by rotation washing method, the stain level was checked in each of the corners and the middle. No unevenness in washing was detected.

Kodak lists the stain level for all of Kodak's printing papers, except the Elite, to be 1 (Excellent) for adequate washing. Elite is rated at 2 (Good). As the tests bore out, Elite is harder to wash.

8.1. Results For RC Papers

All the RC papers were well washed after 6 cycles of agitation by rotation. The pearl surface paper takes longer to wash because of the textured surface. For this paper, I would use a 60 second soak for the agitation cycles. Also note that a wash aid is not needed.

8.2. Results For Fiber Papers

The fiber papers exhibited a wide range of results for washing. It's clear that a wash aid is required and that 6 cycles of agitation by rotation will not yield a permanent print for some papers. However, all papers showed a significant improvement after a 50 minute soak. For critical work, I recommend doing a stain test on a test print that is processed along with all the exhibition prints.

9. Details On Fixing

9.1. Capacity Of The Fixing Bath

An important caution about fixers is in order. A fixing bath is no longer effective when the concentration of silver/sulfur complexes reaches 1.5 grams per liter (for fiber paper). The fixing bath will still be able to clear the paper (or film), but the silver thiosulfates will not be completely removed. The factor limiting the fixing bath capacity is not the ability to dissolve undeveloped silver halides, but ability to make the thiosulfate compounds soluble so they can washed away with water.

Kodak's silver estimating papers, (CAT 196 5466) may be used to check the silver level.[9] An alternate test might be the Formulary Fixer Test solution FT-1.

9.2. One-Bath Vs. Two-Bath Method

There are 2 methods for fixing prints. The first, a one-bath method, uses a film strength fixer for a short period of time, usually 30 seconds to fix the print. The second, a two-bath method, uses a weaker fixer solution. In the two-bath method, the print is immersed in each fixer tray for roughly 1.5

[9] While Vestal mentioned them in his recent Darkroom Techniques article, I have been unable to buy them easily.

to 3 minutes. The precise length of time to fix the print is twice the clearing time for the paper.

The advantage to the one-bath method is that the paper has less time to absorb the fixer and is therefore easier to wash out. The disadvantage is that the fixing may be uneven across the surface of the paper unless the print is continuously agitated.

The advantage of the two-bath method is that the first fixer removes most of the unused silver salts from the print. The second fixer stays quite fresh and completes the fixing process so that no silver thiosulfate compounds remain. In addition the two-bath method has a greater capacity to fix prints than the one-bath method, provided the first bath is replaced when it is exhausted.

However, as reported in Vestal's book, the one-bath method does not provide washing times as fast as manufacturers indicate. Indeed, the prints fixed with the one-bath method have a much lower amount of fixer remaining after 30 minutes of washing. After 30 minutes, one-bath method prints should be stable. This is not the case for two-bath method prints because they have absorbed more fixer.

9.3. Fixers And Hardeners

All of the testing in this project was done with non-hardening fixer formulations. The hardener is part of the fixer chemical package, and may also be added separately. The purpose of the hardener to make the emulsion tougher and therefore harder to scratch. For glossy RC papers, a hardener will make the print dry to a hard gloss rather than a soft one.

Like most things, hardeners also have characteristics that some people consider undesirable. There are several different chemicals that may be used for hardeners, however, I have only seen alum[10] listed as the chemical in the fixers I tested. The rest of this section will be specific to alum.

The first disadvantage to alum hardener is that it is a mild irritant, and may increase one's sensitivity to other chemicals. The instructions on the Sprint Fixer bottle suggest that the release of sulfur dioxide gases[11] may be increased.

The rest of the disadvantages of alum hardener pertain to changes to the emulsion. Using a hardener increases the wash times, makes toning the

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[10] Potassium aluminum sulfate is the real chemical name. Refer to p. 172, Shaw & Rossol

[11] Sulfur dioxide is classified as an *irritating gas*. Long term exposure may cause damage to the eyes and respiratory system.

print take longer, may make spotting harder, and will cause the emulsion to become brittle if overhardened.

In summary, because of this combination of additional health hazards, my recommendation is to avoid the use of an alum hardener.[12]

10. Details On Selenium Toning

Of all the processes in photography that can destroy a perfectly good print, toning is the number one offender. This section is narrowly focused on toning solely for chemical stability of the silver. Although there are several methods for toning for stability, the method outlined here is designed around safety. There are many published methods that are different from the one below.

10.1. Tonal Shift And Color Cast

Before outlining the reasons for this process, it is important to mention that toning shifts the tonal scale of the print. The selenium toning process converts the silver oxide particles into silver sulfide particles. The chemical reaction that occurs is affected by the structure of the silver oxide particles. In the black areas of the print, the silver oxide particles have a crystal structure. As the density of the black areas decrease to gray, the silver oxide particles loose their crystal structure and are arranged as clumps. The toning process works at different rates on the structures and the result is that the black areas become more dense. Hence the comment that the “D Max” of a print is increased.

Because this toning process emphasizes a short toning time, the resulting print may have an unsatisfactory color cast to it. The restraining agent in the developer is usually responsible for the cast. In Dektol, potassium bromide is used and creates a greenish cast. In Edwal Platinum II, benzotriazole is used which makes prints with a bluish cast. Certain papers, for example, Ilford Galerie, tone slowly making it harder to neutralize the color cast.

If the hue of the print is unacceptable after 3 minutes even with a different developer, try adding 10 to 25 ml of selenium toner per liter to the toning solution. Toning longer than 3 minutes with a solution of this concentration is not recommended.

Staining is the biggest source of print defects, and is caused by silver being redeposited on the paper. This happens when the toning solution has been used to capacity, or when there is fixer remaining in the paper.

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[12] Vestal in his book says that he uses a hardener so he can dry his prints in a blotter book. My opinion of a blotter book is that is another source of contamination in the persuit of archival processing. Stick with fiber glass screens.

10.2. The Toning Process

The toning process described below has the following advantages:
- Minimization the formation of sulfur dioxide gasses
- Reduction of the amount of selenium absorbed into the fiber base
- Increased capacity of the toning bath
- Reduction of the possibility of print staining

The toner should be mixed as 50 ml of Kodak Rapid Selenium toner for cold tone papers to1000 ml of fixer remover. For warm tone papers, use 25 ml of toner. I do not recommend Sprint Fixer Remover because it has a blue indicator dye that makes it impossible to judge the toning hues. A solution of 1.75 oz of HEICO Perma Wash to 2 L of water works well.

To tone prints, follow these steps:
- Completely fix and wash the prints. Six cycles of agitation by rotation should be adequate. For papers like Kodak Elite, a stain test would be in order since the base absorbs much more chemicals.
- If the prints are dry, prewet them in a tray filled with water.
- Tone the prints for 1 to 3 minutes with agitation.
- To stop the toning, place the print in a running water bath. A tray siphon and deep tray should be fine for this step.
- After all the prints are toned, perform the wash aid step and wash again.

10.3. Results Of Washing Toned Prints

Tests to see how toning influenced the washing process were performed only with Ilford Galerie. After toning, the prints were processed in Sprint Fixer Remover. After washing with 6 cycles of agitation by rotation, the stain level was checked. The stain level was better than “Good”.

11. Notes

11.1. Alternative Methods For Archiving Images

I suggest people give serious consideration to having the photos scanned onto PhotoCD if long term access is important. PhotoCD is the most cost effective way to achieve permanence. In addition, since most photos are not the end product, but usually part of a media presentation, a PhotoCD will allow much easier integration into the presentation.

11.2. Interesting Information Uncovered During Testing

This section records some interesting things that happened during testing.

The stain on the papers after redevelopment is not black or gray, but rather a rust color.

The Oriental Select VC RP-F is the thinnest paper tested. The Luminos Classic Tapestry X paper floats and needs careful attention to make sure it stays immersed in the solutions. The Oriental Seagull fiber paper was by far the glossiest fiber paper.

11.3. Procedures That Did Not Work

Omitted from the Clearing Time Table is the procedure that did not work. Vestal suggests in his book that hypo eliminator could be combined with the fixer for a more efficient process. I tried mixing 200 ml of Sprint fixer and 800 ml of Sprint fixer remover mixed at 1:9. The results were disastrous. The clearing time increased to 50 seconds and the indicator was almost neutralized. My conclusion is the Sprint fixer remover is a different chemical compound from the hypo eliminator.

12. Topics For Future Research

Unfortunately, the amount of effort needed to do this work far exceeded the time allocated for it. As a result there are some questions that remain unanswered. Here are some of the ideas that I did not get to test:

- Find out how Edwal HypoCheck works. Is it different from the Photographer's Formulary FT-1 test?
- Test the evenness of washing in the archival washer

13. Acknowledgments

Thanks to the following people who assisted me in performing the tests:

- Rebeca Carman
- David Zadig

14. So Just Who Are These Guys?

The best is saved for last. David Gabbé is Co-Op member with a background in engineering and a high degree of curiosity. David is one of the few serious active black and white photographers and has not been seduced by the ease of color printing.

Carl Mastandrea is the director of the Co-Op. Thanks the to Carl, local area photographers have a convenient, affordable, and safe facility to pursue black and white, and color processing. Photography is not done in a vacuum and the Co-Op provides a great opportunity for photographers to exchange ideas. In addition, the Co-Op has provided a series of community programs addressing the needs of teens through seniors.

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