Mysteries Of The Vortex (Part Two)
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Mysteries of the Vortex Part Two - Archival washers in practice.

Although there is probably more than one definition of what comprises an "archival" washer, there are two features any washer called that name should possess:

1: Separate washing compartments for each print, so that all prints are separated, and so that if a print is inserted fresh from the fixer it is not contaminating the wash cycle of prints already present.

2: A well designed path for the water flow, so that all areas of the print are receiving the same standard of washing.

Some other desirable features, which may or may not be present, are:

- Physical compactness, which in vertical washers is the norm;
- A tank that can maintain its' water level when shut off, to allow for soaking;
- A tank that drains down quickly at the end of the session;
- Dividers that are removable for cleaning, with no unreachable dirt traps;
- A "dump" feature, allowing rapid draining of the washer (only one archival washer presently on the market, that produced by SaltHill, is believed to have this feature).

In most existing designs, these parameters boil down to an acrylic tank divided internally with slots or cell for the sheets, with water introduced and removed by whatever the designer considers to be the most efficient method. On the US market there are a number of manufacturers and considerable competition between them, which has resulted in some very expensive washers with all sorts of added features which may, but sometimes do not improve efficiency.

One washer investigated

This article is not a comparative review of archival print washers. All these tests were performed using what could be regarded as one of the most basic design on the U.S. market. The British made Nova (Figure 1), developed in conjunction with Ilford Ltd., has been marketed in the U.K. for about eight years. It has only recently appeared in the U.S. The design is straight- forward: water is injected through a hole at the base of each slot, moves around the slot in a circular path, and exits over a dam at the top of the slot on the same side as the inlet. Can a design this simple be effective?

Figure 1.
Nova WashMaster print washer, 5-slot version

Flow path of the Nova Washer

Nova washers are available in sizes of 12 x 16, 16 x 20 or 20 x 24 in either 13-slot (ProMaster) or 5-slot (WashMaster) versions. The dividers are formed of acrylic that is highly textured on one face and somewhat less so on the other. Water is injected from an inlet manifold at the base level into each slot through a small nozzle.

This flow pattern is, however, more complex than its appearance suggests. A strong jet of water moves across the floor of the slot, is diverted upwards at the opposite end, and begins to disperse as it reaches the upper areas of the tank. If the inlet pressure is sufficiently high, a rotational flow is induced. The way it operates can be seen by injecting dye into the flow path and watching the sequence of dye dispersion. The dye is introduced into the inlet jet stream, which diffuses the dye concentration. After five minutes, the dye is evenly dispersed throughout the slot and is being progressively diluted. Water waste exits over a weir at the top of the washer. This overflow can be disposed of by allowing it to run into a sink, or through standard plastic plumbing and pipe connections. The least wasteful arrangement is to run the waste into a tray alongside the washer to use as a pre-rinse.

Something to bear in mind is that as soon as paper is inserted the flow pattern becomes considerably less idyllic than the dye patterns would suggest - paper does not lie straight and even, and the path of the flow becomes less easy to read. The issue of contact with the washer walls is a thorny one, so tests were also made to check their effect.

Test procedures

It is worth detailing my test procedure, as it has influenced some of my conclusions.

A Nova ProMaster 12 x 16 inch, 13 slot washer was used (5 slot WashMaster versions of otherwise similar design are also available), running with a water throughput of 1.5 litres per minute (this was measured accurately at the outset). Temperature was March U.K. level, about 7C or 45F. The paper was Ilford Multigrade FB (double weight glossy), in 12 x 16 inch size, and in all tests papers were given 5 minutes in Ilford Multigrade Fixer (marketed as Ilford Hypam in the U.K.) at 1 + 4. Agitation was continuous. This is the highest concentration recommended, and with the 5 minute fix time, represents the worst possible scenario in terms of thiosulphate carried into the wash. Prints were given a very brief pre-rinse prior to entering the washer, and in most tests removed at 5, 10, 15, 20, 30 and 40 minutes, and then subsequently at 20 minute intervals until all 11 were out at 120 minutes. The last prints to be inserted were the first to be removed. As each paper was removed it was blotted off with fresh blotter. And drops of HT-2 solution placed on the surface in the pattern shown (Figure 2).

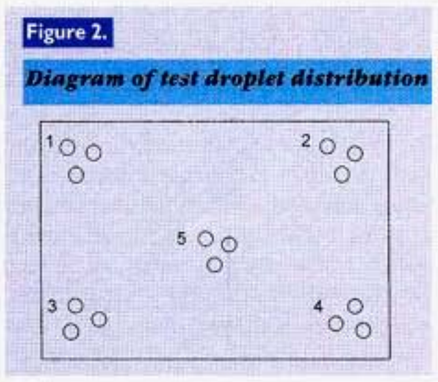


Figure 2.
Diagram of test droplet distribution

Two minutes after the last drop went on, all were blotted and immediately read for density using the reflection head of a MacBeth TR924 densitometer. Position numbers 1 – 4 covered the outer corners of the paper and 5 the exact centre of the paper. Three drops were placed in each position, and any variations averaged between them — values for positions 1 – 5 were then in turn averaged to produce a final figure for the graphs. In some of the tests a few anomalous densities were produced due to the adjacency of the dividers and so forth, and these were disregarded when calculating averages. The time 0 density is always somewhat nebulous, as an even stain does not usually form on the paper straight out of the fixer — most of the stain density precipitates in the HT-2 droplet. Where the zero reading failed, I've put it down as density 1 simply to flesh out the graph. Graphs have been drawn as lines, as this seems the clearest form of display. Where the densities bottomed out earlier than 2 hours, the shorter period has been graphed.

Tests

I performed 10 separate experiments to learn more about how washing in general takes place, and how this washer in general functions.

Test 1: "Control" run

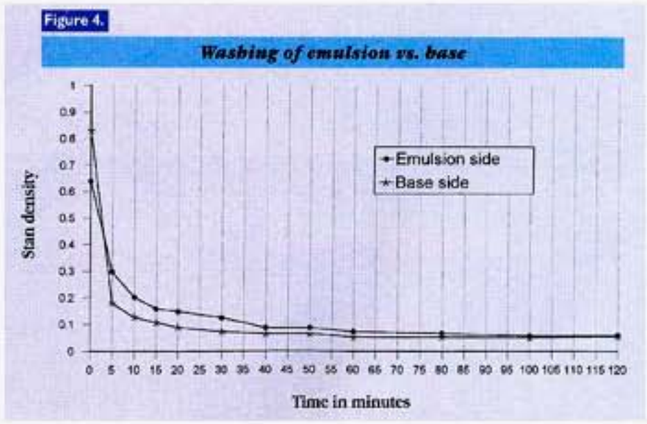
This was a straight forward test of the basic function of the washer, placing test solution as usual on the emulsion side of the paper. This test yielded the results I hoped for and expected. The area in the middle of the print does appear to be slightly retarded in rate of wash relative to the edges, which is probably to be expected with this type of circular water path. Nevertheless, the result is impressive; some areas of the paper are exceeding no 1 patch on the HT-2 chart at 20 minutes, while all areas, the centre included, exceed it at 40 minutes. As one would expect, the thiosulphate loss in the first 5 minutes is significant, is levelling off by 30-40 minutes, and after an hour has virtually flattened off. After 80 minutes there is no further change. By this point the readout from the Kodak chart indicated a hypo level well into archival standards. Hypo levels lower than this are outside the scope of the HT-2 test to detect.

Test 2: Test of washing the paper base

This was done purely out of interest to see how the result matched to the above test to the emulsion side. The result, however, was very interesting, in that the base side washes much faster and more evenly than the emulsion side. The thiosulphate level drops very rapidly in the first 10 minutes, and at the 15 minute mark exceeds the HT-2 no 1 patch in all areas (Figure 4).

This seems contradictory to much received information, the common wisdom being that the fibres of the paper base are what retain the hypo, but possibly not many workers have tested it! More likely, it is the baryta layer which retains the hypo most tenaciously. (this result suggested looking at the washing of un-super coated paper, test 5)

Figure 4.

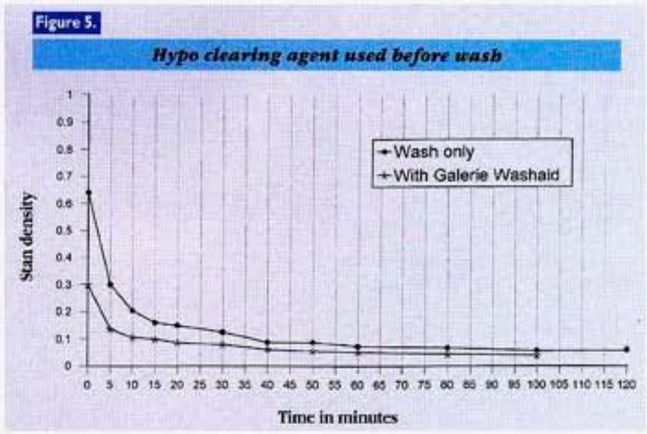


Test 3: Use of hypo clearing agent

On the basis of this test I suggest that it is nonsensical to use an archival washer without employing a hypo clearing agent. The hypo clearing agent (HCA) was Ilford Galerie Washaid at the recommended dilution of 1 + 4, used as an initial bath for two minutes without an initial water rinse. The benefit over the control run is dramatic — the paper at wash time 0 is already at the five minute point of the non-HCA control, but continues to wash very rapidly, and at 10 minutes is almost virtually off the scale for measurable stain. I switched the densitometer onto its blue filter to see if it could differentiate any further, and it picked up a further decline in density up to 80 minutes where it bottomed out. The minimum stain density when using hypo clearing agent was also lower than in any other tests in the whole series, suggesting that it is converting and clearing residual thiosulphate or its complexes which cannot otherwise be clearing with any amount of plain water washing. From the calibration patches (see Appendix for details) a level of 0.01 g/m2 thiosulphate appeared to be reached at 40 minutes, which can be considered acceptable for archival purposes.

Using hypo clearing agent of some sort is the single most important step in washing fibre based papers, and this is true regardless of your aims, whether minimum tolerable standards are sought for the briefest possible wash, or the highest standards of archival permanence are desired. Careful workers are advised to never skip this step.

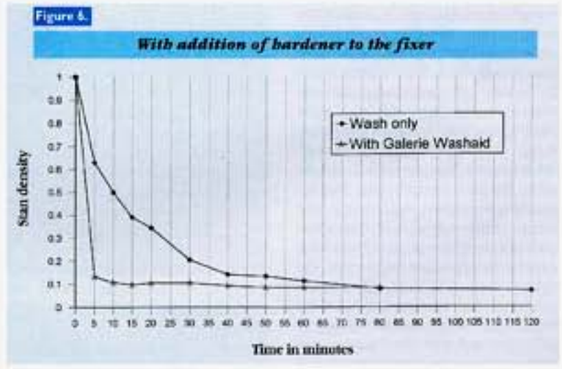
Figure 5.



Test 4: Effect of hardener in the fixer

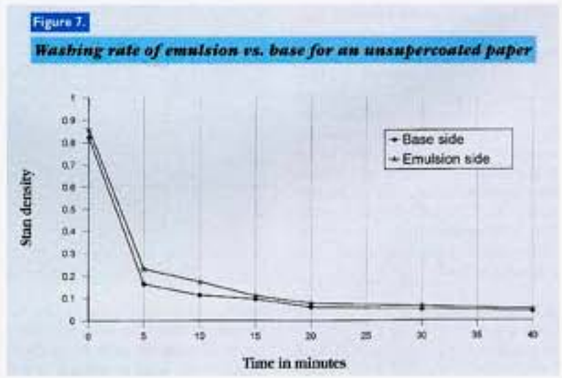
Ilford Multigrade Fixer was mixed at 1 + 4 and Ilford Rapid Hardener added at 1 + 40 to this working solution. Papers were fixed for five minutes with continuous agitation. One run was made straight from the fixer, (surface fixer squeegeed off), and the second using Ilford Galerie Washaid as the hypo clearing agent, diluted 1 + 4 with 2 minutes continuous agitation. The test without hypo clearing bears out everything we've always been told about hardening—the emulsion really does retain the hypo, making for very poor performance in the middle stages of the wash. After about an hour the graph levels off, although a high minimum density seems to indicate retained thiosulphate or thiosulphate complexes that the washing is not touching.
The second run was identical apart from the use of the hypo clearing agent between fix and wash. The improvement in wash efficiency is enormous, and seems to deliver a performance somewhere between the plots in Figure 5 (straight wash/straight wash + HCA).

Apart from the retarding effect on washing, another problem connected with hardening seems to be the accentuation of any relatively poorly washed areas due to adjacency of the dividing walls. In the test without HCA, at the 50 minute mark two areas showed densities of 0.31 and 0.46 compared to an average of the other 3 spots of 0.13. Even in the test with HCA, at the 30 minute point two densities showed up as 0.17, compared to an average in the other three of 0.10. These extreme deviations did not show up in any other tests in the series. This seems to indicate that using hardener in the fixer may exacerbate shortcomings in the functioning of your washer.



Test 5: Washing quality of un-super coated paper

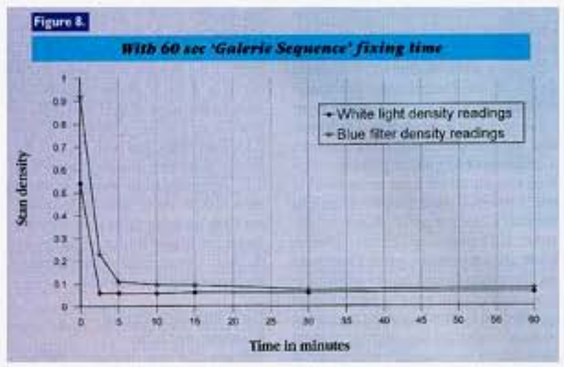
This was done to see if washing standards of the emulsion and base side of a sheet of paper correlated more when using un-super coated paper than when using conventional super coated stock. The paper was Luminos SW Art Non Super-Coated (manufactured in the U.K. by Kentmere and sold as Kentmere Document Art), as the name implies, a single weight matte paper with no super coating. The result appears to back up the findings of Test 2—the base is washing faster than the emulsion, though not to quite the same extent as with the super coated paper, suggesting that the presence of a super coating is a retarding factor in the wash, but also again confirming that the baryta-gelatin emulsion complex washes more slowly than the paper base. The indication is that if one side of the washing cell is working more efficiently, the emulsion should face that side. In the case of the Nova unit, the emulsion should face toward the more highly textured side of the dividers.



Test 6: Washing using controlled short fixing time

A test using the short fixing time from the Ilford Galerie Archival sequence, a carefully monitored 60 second fixing time in rapid fixer at double normal strength, (detailed in Part One of this article under the heading of "Leave it out"). The fixer used was Ilford Multigrade Fixer at 1+4, with continuous agitation, followed immediately with 2 minutes in Kodak Hypo Clearing Agent at normal strength. Washing was in the usual Nova 12 x 16 washer running at 4 litres per minute.

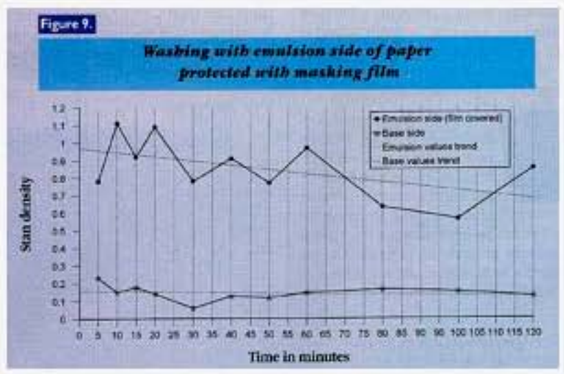
The result shows very clearly that if you want a low thiosulphate level very quickly, this is the way to achieve it. From my own calibration patches I was getting an indication of 0.01 g/m2 thiosulphate after 5 minutes. The white light density reading dropped so quickly that it had bottomed out at 2.5 minutes; readings using the blue filter showed a measurable decline until 30 minutes. The density to blue of 0.07 – 8 at this point can be reasonably extrapolated from my calibration patch values to indicate a thiosulphate level of around 0.005 g/m2.



Test 7: Washing through the base side only

I embarked on this test with the cocksure confidence of the amateur theoretician proving his point. I had always assumed that the hypo in the paper core diffused evenly from both faces of a photographic paper, so if one surface was blocked, the other side would take the strain. The paper was prepared as for other tests, but after immersing in Multigrade Fixer, the paper was given a brief rinse and then dried. Masking film was then applied across the emulsion surface, and the washing run was performed as before. Two sets of readings were taken, one from the front of the paper after the removal of the film (which therefore had not been in contact with the wash water) and the other from the base side. The results are fascinating and totally disprove my original idea, because it appears that with the emulsion face blocked, virtually no washing proceeds in the emulsion layer, and the paper can be considered to be two separate systems with an interior barrier.

The density readings from the emulsion vary considerably, but are consistently high over two hours. Taking the trend (dotted line), this shows a very slow level of decline. The base side readings support this – a low point shows at 30 minutes but levels are thereafter consistent right through to 2 hours, presumably as thiosulphate leaches across very slowly from the emulsion side. This test seems to indicate the importance of the type of washer dividers – smooth dividers in contact with the emulsion surface are capable of drastically affecting the wash quality. This was checked in test 9.



Test 8: Washing using minimal volume of water

This was done to make an empirical check on what might be regarded as the bottom line for achieving a good quality wash. Specifically, what is the minimum volume of water that can be used to produce an archival wash, using no drainage or replenishment? A starting point was to consider a single tank of water and the quality of wash that can be achieved using simply this one volume. First, disregard the residual hypo in the wash water, and remember what we are looking for is a satisfactory level in the paper. It's easy to forget that the paper is holding a relatively small amount of hypo that's going to be diluted into a considerable volume of water.
The effect of effluent fix in the wash tank is usually cited as having a major influence on the wash quality, and that effluent fixer held within the wash chamber is a serious retarding factor to the later stages of the wash. This is the reason for usual recommendation for the usual high level of water turnover.

If a dump/refill system is not being used, what is the significance of this presence of this residual thiosulphate in the water, which is being progressively diluted as the wash proceeds? The actual thiosulphate present in the print can be calculated by working back from the fixer carryover. When removed from the fixer, the dry weight of a 16 x 20 sheet (62g) has increased to 85g, so it is carrying 23 grams, and therefore in volume 23 millilitres, of fixer. Relating this volume to litres (1000/23 = 43.48) gives a figure for comparing the known thiosulphate concentration.

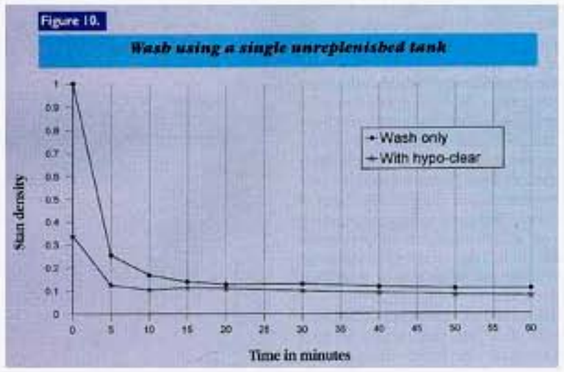
Ilford Multigrade Fixer (again, Hypam to UK readers), in its concentrate form, contains 650 grams of ammonium thiosulphate per litre. Working strength fixer at 1+9 (Universal Rapid equivalent dilution is 1+6) therefore contains 65 grams per litre. From molecular weights we deduce that the thiosulphate content of the chemical accounts for 76% of the total, so the weight of the thiosulphate is 49.40 g.

49.40/43.48 = 1.136 g thiosulphate ion per 16 x 20 print, equating to a level of 5.51 grams per square metre. A 16 x 20 print has a volume of 60ml. If we place 10 of these prints into the washer, we are introducing 230ml fixer into the 50 litre tank. If these prints are washed in one single tank of water until equilibrium is reached, a ratio is established of 50,000/230 = 217.39.

This equates to a final thiosulphate level in the print of 5.51/217.39 = 0.0253 grams of thiosulphate per square metre. While hardly qualifying as outstanding, this level would equate to just below point 2 on the Kodak Hypo Estimator, acceptable as a commercial level of retained thiosulphate. What this means is that a commercial standard should be attainable in an archival washer with no exchange o water at all.

Test 8 was carried out to see if the theory predicts the practical result. Although a 12 x 16 tank was used, the ratio of volume to format is similar.
Ten sheets of Ilford Multigrade Fibre Base paper were processed through Ilford Multigrade Fixer at 1+9 for five minutes, and then given a very brief pre-rinse in a tray of water. They were then loaded into the Nova 12 x 16 washer filled with fresh tap water, and agitation produced by lifting each print in the slot and lowering it back in turn throughout the sequence. The results seem to confirm the hypothesis. A plot drawn from the densities follows the path of the running wash closely, and the thiosulphate level bottoms off at a stain density of 0.11, which indicates a thiosulphate level of about 0.035 g/m2, equating to the midpoint between Kodak Hypo Eliminator patches 2 and 3, and coinciding reasonably well with the theoretical calculation. Repeating the single tank wash with a hypo clearing step achieved an even better result (only marginally inferior to the control running water wash Test 1 without an HCA step) and delivering a final figure of about 0.02 g/m2 thiosulphate. The shape of the single tank plot does not deviate from the running wash control, and actually levels off quite early on at about 20 minutes. This seems to contradict the retardation school of thought, and to confirm the importance of agitation.

Although this result is interesting, it does not imply a recommendation to turn the tap off—in practice, the absence of agitation due to water entering the washer would significantly slow the time in which equilibrium could be achieved. But it is worth bearing in mind as the bottom line requirement for acceptable washing and, if agitation were applied mechanically or by re-circulating the water, even with limited exchange, it would be quite viable as a practical washing method. It shows it is possible to wash to an archivally good standard in only one tank of wash water with no addition, drainage or exchange, as long as the tank is sufficiently large. This also indicates why a wash based on exchanges of water rather than running water can be effective, and why washing regimens which alternative agitation with still water soaking also work well. This result has especially far-reaching implications for darkroom workers who want to use fibre paper but who live in areas where fresh water is in severely short supply [see "The ideal archival washer (yet to be manufactured)" under "Conclusions" below].



Test 9: Test of smooth vs. textured dividers

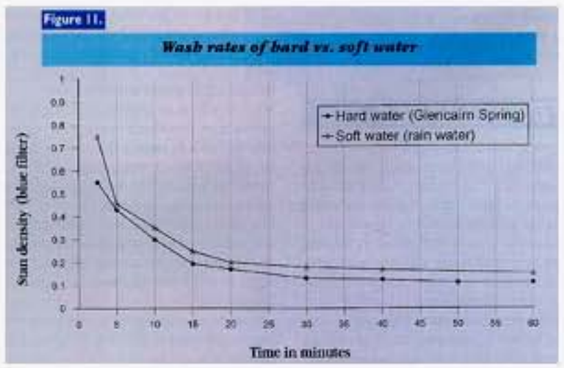
Nova very kindly made up some completely smooth dividers for testing purposes. To get some idea of the importance of the makeup of the cell walls, I used whole sheet silver nitrate testing as detailed in the Appendix. HT-2 spot testing could be compared to looking at a landscape through a keyhole—testing the whole sheet is like suddenly having the door opened. It's also educational, in that sloppy technique shows up like a beacon: there was such an incidence of heavy stains due to traces of hypo on my fingers that I stopped and redid the series with fresh vinyl gloves for each print. [This should be a considered warning to us all—Ed]

The results appear to bear out findings from previous tests. The five minute test with standard textured dividers shows the level of stain as in Test 1, but this is quite uniform, marginally better across the bottom, which was in the stream from the inlet jet. The smooth divider shows more variation, and this is made more apparent with the 10 minute sheets. The sheet washed with the textured divider is washed quite evenly, while that from the smooth divider shows one area washing well while most of the bottom of the paper is giving a high stain level. This trend continues. At 20 minutes the sheet from the textured cell is clear of stain, while that from the smooth cell is still showing uneven stain densities, albeit becoming much lighter. At 30—40 minutes both types of divider were showing consistent even-ness. This problem seems to be associated with the emulsion side, presumably because as well as washing inherently more slowly, but also because, being smoother, it is more likely to adhere to a smooth divider. The pattern of mottling seemed random, but more tests need to be made to see if there is an underlying trend. A paper hardened during fixing is even more likely to wash unevenly in a washer with smooth dividers.

Of course, two cells in a standard Nova washer inevitably have smooth surfaces—those formed by the side walls of the unit itself! As suggested above, whenever possible, place the emulsion of the paper to the textured or most highly textured wall. If not fully loading the washer, leave the cells empty.

Test 10: Efficiency of soft vs. hard water

Extremes of hard and soft water were used as specimens. The soft side was provided by collected rainwater, which showed a pH of 4 (acid) while the hard water used was Scottish spring water called Glencairn Spring, which has a marginally acid pH of 6 and a composition, in mailgrams per litre, as follows: bicarbonates 81, sulphates 9, nitrates 3. The paper used was the same Ilford double weight MG FB, cut into 3" squares and fixed for five minutes in a 1+4 Multigrade Fixer and washed with semi-continuous agitation in 500ml quantities in trays, the water being replaced at 10 minutes intervals. For maximum density discrimination, blue filtration was used in the densitometer readings. The results were startling, showing a significant difference in the effectiveness between the samples. At the end of one hour the hard water had produced a thiosulphate level 0.01 g/m2, an acceptable archival standard. By comparison, the soft rainwater got off to a slower start and maintained its separation—at one hour, the reading showed a level of 0.02 g/m2, which is a barely commercial level.



Conclusions

Degree of water exchange

Something I found surprising is that the traditional view that the presence of effluent hypo in the wash water can have a retarding effect is without substantial foundation, at least at the concentrations we're dealing with here. Still water washing with sufficient agitation in a large enough fixed volume will still deliver a good thiosulphate level, and the presence of dilute fixer does not appear to have a significant effect on clearing time at either end of the washing sequence.

Agitation

The fundamental requirement is water movement at the surface of the print within a wash system, however this is generated. Water flow achieves this easily and effectively, although this can be looked on as wasteful of water when flow is arrived at from water inlet pressure. A small number of changes of adequate volume in a closed system that was well agitated mechanically or by re-circulation will give a good result.

Know your washer

The term "archival washer" is a bit of a misnomer, as any such product will only yield "archival" results if used properly. Although my tests were confined to the Nova washer, most washers described as archival washers on the market are well thought out and can be expected to produce similar standards of wash quality when used correctly. The Nova washer is possibly more sensitive to variations in water throughput than other types, as the correct throughput, which is linked to manifold pressure, is fundamental in getting its turbulence running properly.

With any washer, however, an optimum throughput exists, and the easiest way of checking is with HT-2 solution. A little testing may establish that you can produce a more even wash in a shorter time, using less water than you do now with your current procedures. To run a steady throughout of water, a header tank system may be an improvement on running off a rising main, which can often vary in pressure depending on local demand. On the other hand, some washers of other makes require mains pressure to get their design idiosyncrasies (such as air turbulence) operating.

Above all, don't regard an archival washer as a means of saving washing time, but instead as a device providing an environment in which an established wash time can be expected to provide a guaranteed standard.
Position of the prints within the slot

There would be no problem if photographic paper were thin sheets of stiff, non porous material. As it is, paper exhibits more familiar qualities when wet, in that it tries to spread itself it is confined within. Moreover, its behaviour varies from one paper type to another. Many papers when thoroughly wetted show the reverse of the curl they have when dry and this tends to thrust the emulsion side towards contact with the cell wall. Quite a few manufacturers suggest that their unit holds the print in the exact centre of the washing cell, but this may not always be true in practice. As the print is lowered into a slot, it will tend to slide towards one divider—if there is a textured side and a smooth side available it will usually opt for the smooth one. The Salthill unit seems to be the only washer on the market to have features designed to fully overcome this problem. Smooth dividers in contact with the emulsion definitely and drastically retard the wash time in these areas, as shown in Test 9.

However, an observation: while "sticking" is not often encountered, "hovering" is, meaning that the emulsion surface drifts into close proximity with a smooth cell wall. So if one wall is smooth and one textured, place the emulsion towards the textured side. Be very suspicious of any system that uses racks with dividers in close proximity to the paper surface. It is significant that papers hardened during fixing seem to be much more prone to uneven washing due to adjacency problems with the cell wall.

Prints will generally align themselves in positions that are disruptive of the flow pattern, and the only way to allow for this is to establish a minimum wash time for the worst scenario, and then not undercut it. Rather than fret over the way a print is sitting in the slot, establish a wash time that you know will be effective regardless of paper orientation—and use the most valuable aid of all, hypo clearing agent, as your guarantee.

Do the HT-2 test

One thing I discovered is that the HT-2 test is simple to carry out and gives clear and useful information. Originally I had been thinking in terms of carrying out the Methylene blue tests for these articles, but I'm glad I didn't, because I doubt that the results would have been as useful. The methylene blue test is unnecessary unless one needs absolute quantitative results (perhaps comparing one type of washer directly against another at different times), and it is a time consuming procedure that requires a number of special reagents and a spectro-photometer. For all practical purposes, a few tests can be made relative to the "blitzkrieg" campaign that can be mounted with HT-2. The HT-2 test is qualitative, not quantitative. It is not much use in detecting extremely low levels of thiosulphate, but it provides a quick, simple and inexpensive check of the wash quality in early and mid stages of washing, results which can be extrapolated to reasonably estimate the result of an extended wash.

Although I used a densitometer to try to pull a little more information from the results, the visual check provided by the HT-2 estimating chart is quite adequate to get a good picture of how your washing system is operating. Making up your own series of calibrated reference patches (detailed in the Appendix) is a way of fine tuning the washing tests to your own standards. But you can also take the view that for all practical purposes there is no need to worry about the g/m2 of thiosulphate: just wash until there is a minimal, barely visible stain density.

The full sheet test uses a lot more silver nitrate, and you cannot expect to get much life out of the reagent—there is such a high carryover of wash water (resulting in precipitation of insoluble silver salts) that it probably has to be used one shot only. It does, however, give a full picture of any problems that may be picked up by the HT-2 spot tests. You might perhaps want to reserve full sheet testing as a one time check when investigating the action of a new washer, or as a final test for your standard washing regimen.

Use hypo clearing agent

The benefits of using hypo clearing agent are so dramatic in terms of time and water saved that it is pointless to aim for a high standard without employing this step. If for some reason you need to use hardeners in the fixer, hypo clearing should be considered especially obligatory. As I said in Part 1 of this article, the importance of this step cannot be overstressed: the use of hypo clearing agent is absolutely essential to good washing technique.

Look at the implications of the Ilford archival processing sequence

The Ilford archival processing sequence takes the benefits a stage further by limiting the uptake of thiosulphate at the outset. Even if you do not follow the full sequence, you can adapt it to your working method. Time the fixing stage carefully for one minute in fresh double strength ammonium thiosulphate fixer, move the prints into a running water rinse, then complete hypo clearing and final washing to suit your normal technique.

As we go to press *[1996]*, Nova is launching a new washer called the SpeedMaster FB that is likely to be valuable if you wish to incorporate the Ilford sequence into your workflow. It has 10 slots for washing and two for hypo-clearing agent. Since the only time-critical stage of the Ilford sequence is fixing, the SpeedMaster FB will allow for a more relaxed way of working while still using the sequence; time in the HCA is not absolutely critical, so you could simple leave a print in the HCA as you go to make another print or set up another negative, returning several minutes later to transfer it to the wash.

The ideal archival washer (yet to be manufactured)

A washer designed and built to work with maximum efficiency would fill rapidly, using high pressure water from the rising main. Water injection would then shut off automatically, and a pump would recycle that water through it for a given selectable time. Then, automatically, it would dump completely, refill, and the process would be repeatable as many times as desired.

Another idea which has been on my mind is the concept of reverse flow, switching the input of water from one end of the unit to the other. It's ideal for washing clothes—why not prints? If either of these ideas ever gets into production, I'll take a sample in lieu of royalties.

All in all there are so many variables it is not possible to do more than suggest the guidelines above. At the end of the day, satisfactory washing involves striking a balance between your aims imprint quality and permanence and what you can expend in terms of time, inclination, space, water supply and budget in order to realise them. Throwing money at the problem does not entirely solve it — whatever solution you opt for, you have not bought yourself peace of mind until you have tested it.

Appendix

Procedure for two-bath fixing

Make up two separate fixing baths at the same volume. Fix the prints in the first bath for half the fixing time and then transfer them to the second bath for the remainder of the time. Continue to work in this way until the first bath has fixed the recommended number of prints (40 8 x 10 prints per litre in the case of Ilford Multigrade Fixer). Then discard this first fixing bath and replace it with the second, and prepare a completely fresh second bath. Repeat this cycle four times and then mix new baths.
If five cycles are not used in one week, mix fresh solutions at the start of the second week.

Test procedures

The HT-2 test

An easily conducted test for retained hypo in prints (or film) is the Kodak designed HT-2 test. In this, a drop of a solution of silver nitrate and acetic acid is placed on the print, left for two minutes then blotted off. A silver sulphide stain will result, the density of which can be compared to a chart supplied by Kodak. This chart gives an approximate read-off of grams/square meter thiosulphate remaining in the paper. The chart and test solution are not expensive, and the lifespan of the solution is about two years.

An improvement on this visual estimation is to stabilise the sheet after the test, and read it with a densitometer. The sheet is immersed in sodium chloride, followed by a conventional fixer, to remove the excess silver ions. After washing and drying, the densities of the stained spots compared with each other and with the base density.

An extension of the HT-2 test is whole sheet immersion in silver nitrate and acetic acid, which gives a more complete picture of what is happening, though of course it requires using a lot more silver nitrate.

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