A Black&White Reversal Process In Memory Of Agfa Scala 200x

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1 Disclaimer

The chemicals used in this process description can be mortally dangerous when handled incorrectly. Very toxic gases can occur, aggressive dust can expose your lungs, severe burns to skin and eyes can be the result. Make sure you read and understand the MSDS[1] for each chemical involved as well as the way the chemicals interact which each other.

I do not take responsibility for the consequences that may happen as a result of this recipe. You act at your own risk.

Keep the chemistry locked and out of reach of children. Wear intact gloves that are marked suitable for chemistry, wear protective glasses and clothes, keep a window open while handling the chemicals.

2 Terms of Use

This recipe[2] was created using the documents referenced herein, through internet research and experience sharing with other people interested in photography via internet discussion forums. It was perfected through experimentation. It is not intended by any means to disclose any patent details or violate those that exist in this area.

A GNU Public License[3] is formulated to serve the needs of software. But the contents in this document shall be handled this way: at least a reference

[1] Material Safety Data Sheet, www.chemdat.info
[2] home.snafu.de/jens.osbahr/photography/reversal_processing/osbahr_reversal.pdf
[3] www.gnu.org/copyleft/gpl.html

to this document shall be made when methods or process data is taken and perfected, e.g. to support additional film types or developers.

3 The Scala Experience

In 2005, the photographic community had to accommodate with an unpleasant thought: the traditional vendor Agfa[4] went under administration. Many photographers in the world started thinking what would happen to the legendary Agfa Scala black & white reversal film and its dedicated reversal process that served with stunning results for so many years. Throughout the year, production of film was ceased. A&O[5] appeared as an investor and bought the rights for the Minilabs as well as the chemistry production facilities in Vaihingen. Luckily, A&O decided to continue production of some unique Agfa chemistry, e.g. Rodinal, Sistan etc.

At the end of 2005 it was crystal clear that time had come to find a replacement for the Agfa Scala film and process. A private film stock strategy would certainly not work in case the reversal process could not be kept running. One of the first labs discontinuing the Scala process was Dormoolen[6], Hamburg. Other labs like Studio 13[7], Stuttgart and Mayer[8], Munich are still running the Scala process, but technically it is incompatible with many film emulsions because of the high bath temperature of 38°C, and economically it can be expected that it will become impossible for the labs to run multiple variants of this Scala process to serve the different films on the market when the last Scala roll will have been processed.

4 Alternative Reversal Services

However, in the U.S. there is an alternative offered by DR5[9], Denver who implemented a black & white reversal process that supports many different film types. The drawback for users located outside of the U.S. is that unprocessed film will most likely be exposed to lots of x-rays during shipping.

[4] www.agfa.com
[5] www.ao-services.de
[6] www.dormoolen.de
[7] www.photostudio13.de
[8] www.mayer-lab.de
[9] www.dr5.com

In December 2005, Agenzia Luce[10], Trieste was testing-in reversal processing of Rollei R3 film, and admitted that the results had not been satisfactory yet.

Phototechnik[11], Berlin also offers reversal services, but over many years, the results in reversal processing have repeatedly shown intolerable processing failures.

Under these circumstances it seemed unlikely to have a commercially offered reversal process delivering constant results on Scala quality level for the foreseeable future. As a consequence, it was sought for a home processing solution.

5 Basic Conditions of an Amateur

Those photographers who have done negative film processing and paper printing already can also think of taking the initiative to run a reversal process themselves. The basic conditions for the engaged amateur differ from the professional photographer and the professional lab.

- The amateur can limit the capabilities of the process to a single film emulsion. He does not have customers that he needs to support with a range of different film materials.
- The amateur can invest time to do diligent work on a single roll of film; he can set its own quality standards.
- The amateur can disregard the processing cost per roll of film, as long as budget and passion allows it.
- The amateur may have a very low number of rolls to be processed in a year.
- The amateur can only use chemistry that is available to private households. By law, some chemicals are restricted to people with approved knowledge, others are even restricted to professional users, educational use, research & development.
- Nevertheless, the amateur wants to have the same constantly repeatable results as the professional lab.

[10] www.agenzialuce.it
[11] www.phototechnik-berlin.de

6 Reversal Kits for Self-Processing

By today, May 2006, there are still two commercial chemistry kits on the market, dedicated to Kodak TMAX 100 and Fomapan R100 film. Both are implementing different technical solutions and unfortunately both kits are difficult to obtain from time to time. Also, both kits do not sufficiently serve the need of the amateur to be able to do low volume processing – once the chemical with the worst keeping properties gets unusable, one has to dispose of the remaining ones as well. Not very friendly to the environment.

6.1 Processing Set for Fomapan R100

The Foma[12] process uses a light fogging step that is very inconvenient in terms of workflow and also not clearly specified in terms of light intensity to be used. It might work for plate film to do even light fogging with just the right intensity, but if one does not want to remove the film from the reel during that step, for 35mm it is necessary to use a stronger fogging intensity in order to sufficiently fog the inner windings on the reel that are shaded by its neighbours. Unfortunately, such high amount of light gives the final slide a yellow stain.

There are no other processing times given than for 20°C which will be a difficult game in summertime.

The Fomapan R100 is not available as 120 medium format roll film, and Foma's concept of using the same single use bath for first and second development imposes unnecessary difficulties on integrating other materials than Fomapan R100 into this process, because exhaustion of the developer during first development influences its potency during second development.

According to information from Foma QA department, the chemistry keeps for 8 weeks once opened. The weak point is the developer that quickly oxidises. Storage time can be extended by protective gas, e.g. Tetenal Protectan, and refill into smaller bottles that contain the amount needed for one film roll. It is still not clear why Foma supplies the weak component of its kit in a transparent bottle, which supposedly makes oxidation even quicker. Although its a single shot concept, in the end the low volume user will have difficulties to make use of the Foma kit's theoretical capability to process 8 rolls of film.

[12] www.foma.cz

6.2 Kodak T-MAX 100 Direct Positive Film Developing Outfit

The Kodak[13] kit uses chemical fogging, and it specifies processing times for multiple temperatures and tanks and agitation types. However, the times given for 24°C and rotation tank type together with TMAX 100 exposed at 50 ASA – as suggested by Kodak – do not deliver results that look like Scala at all. Brightness and contrast are well below expectations, but can be adjusted by increasing the first developer time.

As also documented in Kodak's manual, the slides have a yellow-greenish image tone. This can be compensated for using toning. The Kodak Brown Toner that gets recommended there is not available in Europe. Thus the effect of ADOX[14] Selenid toner has been evaluated in various concentrations. Selenium toning increases the density of the final slide by changing the colour with increasing toner concentration or toning time ranging from light magenta via red to dark brown. For a slide that has a basic colour already that means subtractive colour mixing, thus it is impossible to achieve a bright white or fully transparent slide. In addition in the slide projector there appears an interesting effect that can be simulated with a computer screen easily: If the projection or computer screen is the only light source in the room, the eye adapts to the image tone and tries to compensate it. This results in the lighter parts of the image appearing to have the opposite colour. The demand to get rid of the greenish image colour component ends up in an image that appears brown in the first instance and gets shifted towards white in average by our brain, shifting parts into green again, just because brown and green are somewhat opposite on the colour circle.

Using extensively longer first development times than documented by Kodak increases the contrast of T-MAX 100 and delivers brighter images, but the contrast still remains compressed in comparison with Scala.

It gives quite surprising results when switching from T-MAX 100 to Ilford[15] FP4 Plus. Suddenly, there is a much higher contrast and a very good sharpness, both attributes remember us that FP4 and Scala (which is very close in emulsion to Agfa APX 100) are traditional technology films. So, in the Kodak kit it is possible to process emulsions with different characteristics by some adjustment of the times.

The Kodak kit has a nominal capacity of 12 Kodak T-MAX 100 films, in this case limited to the keeping properties of the working strength solutions of 6-8 weeks. The best thing to improve the situation is, as also mentioned

[13] www.kodak.com
[14] www.adox.eu
[15] www.ilfordphoto.com

in the manual, to create working strength solutions in smaller proportions, e.g. $\frac{1}{6}$ of 946ml and use them as single shot. This makes keeping of the first and second developer uncritical because Kodak provides each of them in two stock solutions A and B. However, the weak point in this chemistry ensemble is oxidation of the potassium permanganate in bleach stock solution A which builds brownstone. This creates an additional coloration of the slides. In practice it will be a race against time to have 6 film rolls exposed and processed in single shot mode before the bleach is oxidised too much.

7 Public Reversal Recipes

Looking at the differences between the Foma and Kodak reversal kits, the question raises itself: How to combine the advantages of both concepts and eliminate the weaknesses?

There are numerous reversal recipes on the internet. Some of them have been created with the intention to be cheaper than Scala. It is not clear which reference was chosen by the authors during design of the process. Often it cannot be verified what the result looks like when the process is executed as intended by the author, because most recipes are based on light reversal and the information on second exposure is not given in measurable units, e.g. in $lux \cdot seconds$.

7.1 Ilford Application Sheet 'Reversal Processing'

This guide[16] is based on two different developers that do not seem to be available anymore in Germany. Ilford suggests to remove the film from the reel during second exposure, it looks like this is for the sake of even fogging. But it does not appear one really wants to try having 1.70 metres sensitive because softened 135 film in hands that still needs to be redeveloped, fixed, washed and flowed. To move it onto the reel again without damaging seems to be very impractical, too.

7.2 Alessandro Serrao 'Diapo bn normali'

Alessandro Serrao executes his process[17] at considerable low temperatures, at $18 - 20°C$, that can only be controlled by those rotation processors that have cold tap water connectivity in addition to the heating. It is not suitable to be run at a room temperature of 22°C.

[16] www.ilfordphoto.com/applications/download.asp?n=11

[17] www.apug.org/forums/showthread.php?t=26091&page=2&pp=10&highlight=reversal

7.3 Kai K. Rechtenbach 'SW-Umkehrentwicklung'

There is a long list of films mentioned in this recipe[18], but Kai Rechtenbach does not mention which films he really proved his recipe with. A rule for deriving the first developer time from the film time table of the negative developer is made which is really too general. It can be seen easily that the author took the table that Agfa provides with Rodinal and added one minute for every film. This is a nice idea, but it does not work for reversal processing if optimum results are to be achieved. The concentrations given for the first and second developer are significantly too low to achieve a suitable contrast in the final slide. The bleach is not strong enough to bleach away the negative image from the fully exposed beginning of a 35mm film. The clearing bath is not strong enough to clear away all traces of the bleach, leaving a yellow stain on the final image. The author mentions potassium thiocyanate as an optional additive for the first developer to achieve a finer grain, but states that his process was designed to work without it for safety reasons. He does not mention that this additive also acts as a silver halide solvent. It would not be a surprise if the author – for good reasons – uses this additive for his own application of the recipe although he recommends not to do so.

8 A Workable Reversal Process

It's a long and painful way to reach this point. Around 50 rolls in total of 120 and 135 film have been shot and processed in the different methods mentioned above, to get a more detailed understanding of the quantities of chemistry required to have a working reversal process. The method of shooting test material changed significantly over time. It began with normal photography, but disappointing results quickly turned that into full concentration of the development process as such, shooting 4 selected test scenes at -1, 0 and +1 f-stops in about 10 minutes.

In the end, this process was optimised to deliver best results with Ilford FP4 Plus exposed at the nominal speed of 125 ASA[19]. When Ilford Pan F Plus is developed like this, it gives the same contrast, but needs to be shot at 12 ASA[20], Ilford Delta 100 has a lower contrast and achieves 50 ASA[21]. For both Pan F and Delta 100, the results are not yet optimal. The slight yellowish-brown image tone together with low effective film speed

[18] www.rechtenbach.de/Stereo/3D_SW-Dia/sw_umkehr.pdf
[19] home.snafu.de/jens.osbahr/photography/reversal_processing/FP4_Plus_Rodinal.jpg
[20] home.snafu.de/jens.osbahr/photography/reversal_processing/PanF_Plus_Rodinal.jpg
[21] home.snafu.de/jens.osbahr/photography/reversal_processing/Delta_100_Rodinal.jpg

may indicate that moderately more silver halide solvent is required in the first developer.

8.1 The Jobo Processor

Jobo has built a series of machinery that is mechanically very simple and suitable for non-professional users. Of course, it would be nice to have a Jobo Autolab at home, but for low volume production it has the disadvantage that cleaning of the numerous PVC-hoses takes additional time. The Jobo CPE-2 Plus does the job of b&w reversal very well.

The cogwheels need lubrication because the CPE-2 Plus will otherwise not withstand the long processing times required here without significant reduction of the nominal 75 rpm in the last minutes, Vaseline is best for that purpose.

It is required to monitor water temperature with a (good old analog) thermometer, because the numbers on the thermostatic knob do not match reality, e.g. 25.5°C selected on the rotary to achieve the desired 24°C. This thermometer should also be used to prepare 10 litres of water having the same temperature. This will assure that film emulsion is not stressed more than necessary.

8.2 The Timer

Sometimes, high-tech equipment can be used to serve the old analog world. In this case voice commands recorded as .wav files are played by a simple Unix shell script on an Apple PowerBook to instruct filling and draining of the chemical baths in the programmed time sequence, just like a car navigation system reminds to stay on track.

8.3 The Process

The process basically consists of the same steps as the Kodak kit process.

1. First Development. This stage is similar to a negative film development, but considerably stronger. Over the entire film a part of the silver is dissolved, no matter whether it was exposed or not, to give a bright and transparent image.

2. Bleach. The negative image created in first development stage is now removed. The film still contains silver in those areas that did not get exposed and developed.

3. Clearing Bath. A yellow stain resulting from the bleach gets cleared here.

4. Reversal Developer. The remaining silver halides get reduced by a chemical fogging agent in the same way it would happen during a light exposure. The silver gets developed to create the blacks of the final slide.

5. Fixer. The remaining silver halides get dissolved. The film is hardened.

6. Image Silver Stabiliser. The silver gets sealed for better long term archival stability. This bath also acts as a wetting agent that lets water run from film during drying without occurrence of lime stains.

The fundamental difference is that only developer, fixer and image silver stabiliser are obtained from the photographic store. The rest of the chemistry is available from different sources: pharmacy, online chemistry stores, etc.

8.4 The Chemistry

8.4.1 First and Reversal Developer

In general, every negative or paper developer can be used. It just needs to be concentrated enough. A good illustration of this is the fact that Agfa Rodinal is typically used at development times roughly comparable to this recipe at 1:25 dilution, but here it is used at dilutions close to the recommended application of Rodinal as a paper developer, in the proximity of 1:10.

Although paper developers are cheaper and maybe slightly finer in grain because of their different formula, Rodinal has been chosen in this recipe because of its legendary keeping properties. Agfa documents officially that Rodinal can be used within six months after opening the stock solution. From real life experience, some users are reporting that a bottle of Rodinal that was opened ten years ago was still working as normal, others are stating that Rodinal still develops fine when it looks black like used oil. Although it would not be clever to risk valuable shots in such a reversal experiment, it seems to indicate that Rodinal is the suitable basis for low (or at least unpredictable) volume processing. To be on the safe side and not to reach the point where prolonged development time would become necessary, Tetenal Protectan is used to seal the Rodinal stock solution after each application.

To a certain degree, the contrast of the slide can be influenced by the amount of developer concentrate used in first and second developer. A higher contrast is achieved by using more concentrate and vice versa. It is not handy

to change the development times instead because this influences the effect of the other developer additives as well, which has other undesired side effects.

First Developer The first developer in this recipe contains potassium thiocyanate (KSCN). You should be warned about this hazardous chemical. It creates highly toxic potassium cyanide gas when it gets in contact with acids. This is the reason why a stop bath must not be used after the first developer. KSCN is strongly hygroscopic, so it is not possible to measure the amount needed for each film, because its weight increases over time with the amount of water absorbed from the air. The only practical way of handling is to create a stock solution, which works quite well because it can be dissolved in water in high concentration. KSCN acts as a halide solvent, i.e. it makes the final image lighter. Without halide solvent the final slide has yellowish-brown image tone and is too dark. The amount of KSCN must not be too high because this would remove too much silver from the film, thus reduced maximum density in the blacks would be the result. KSCN also has the welcome side effect to dissolve primarily coarse silver halide grains, this leads to easily visible finer grain in the final image – it actually makes Rodinal a fine grain developer. The silver halide solvent effect can be achieved with a much less dangerous chemical, sodium thiosulphate, also known as fixer crystals. Sodium thiosulphate is not as reactive as potassium thiocyanate, so a higher concentration is needed, twice as much has been quoted as a starting point for own experiments. But it is not documented that sodium thiosulphate has the fine grain effect.

Reversal Developer The reversal developer used here has a built-in fogging agent, stannous chloride. The amount used is a critical parameter because only small amounts can be used without creating a precipitate in the mixed solution. Using too much also reduces the potency of the developer itself and leads to uneven development in the form of cords as well as a yellowish-brown coloration. Using an insufficient amount leads to a thin slide without the required density in blacks.

8.4.2 Bleach

Because of brownstone that appears in stock solutions of potassium permanganate very quickly in a few hours, the bleach is better created fresh for every film. The correct intensity of bleaching can be controlled through 135 film: the very beginning of the film that gets completely exposed during camera loading shall be fully bleached to become entirely transparent.

To further increase the bleach intensity has no advantage, but the huge disadvantage of extremely softening the emulsion, up to the point where it falls off the base material.

8.4.3 Clearing Bath

One possible source of yellow stain on the slide is a too weak clearing bath. However, it should not be more concentrated than necessary.

8.4.4 Fixer

The fixer needs to contain acetic acid in order to harden the emulsion that is already very soft at this process stage. Too much hardener creates cords when not washed long enough.

8.5 Creating the Solutions

In order to create the solutions, a little bit of equipment is needed. Apart from the usual equipment to measure the amount of liquids, that should be available and marked carefully for usage with one chemical only, in order not to measure KSCN concentrate and sulphuric acid with the same measuring cylinder, there is a digital scale required that permits to weigh very small amounts in 0.01g resolution. But these are no longer expensive.

8.5.1 Stock Solutions

Potassium Thiocyanate Because of the hygroscopic behaviour of KSCN it happens that the crystals are wet already when delivered in its container. That's why it is best to rely on the labelling. In order to measure the amounts easily, two stock solutions with different concentration can be created. First the 25% solution,

KSCN 25% solution	
KSCN	80g
Distilled water to make	320ml

then the 2.5% solution.

KSCN 2.5% solution	
KSCN 25%	25ml
Distilled water to make	250ml

Sodium Metabisulphite A stock solution can be created, it keeps well. On the other hand there is no big advantage, because a digital scale is needed anyway. In this recipe no stock solution is used for it.

8.5.2 Working Strength Solutions

All working strength solutions are designed for single shot convenience. They need to be collected in separate containers after use – do not spill them together, the result would be toxic gas – and disposed of via an authorised organisation.

First Developer The liquids just need to be poured into the bottle for the first developer in the sequence listed, the closed bottle inverted twice, done.

First Developer	
Water	210ml
Potassium Thiocyanate KSCN 2.5%	10ml
Agfa Rodinal	40ml

Bleach An Erlenmeyer flask should be used to prepare the bleach. Fill it with water first and then add the sulphuric acid. Never do it the other way around, because it would have the same spattering effect as with water spilled into hot edible oil. Add the potassium permanganate and stir until it dissolves. It helps to hold the flash slightly tilted, then it is possible to feel for the remaining crystals during stirring. The better the crystals get dissolved the lower is the risk to have blotches on the emulsion and on the slide. Pour out the bleach into the bottle very slowly to achieve that crystals which are still not dissolved remain in the Erlenmeyer flask. If a few millilitres remain there this is not a problem.

Bleach	
Distilled water	250ml
Sulphuric Acid H_2SO_4 38%	10ml
Potassium Permanganate $KMnO_4$	0.25g

Clearing Bath The metabisulphite dissolves very quickly in water even without stirring, just by reverting the bottle a few times.

Clearing Bath	
Water	260ml
Sodium Metabisulphite $Na_2S_2O_5$	1g

Reversal Developer As the amount of stannous chloride is very small – a few crystals only – a kind of weighing scale is needed that makes it easy to pour it into the water, a small piece of paper will do the job. Stir until the crystals have dissolved and the solution is uniformly foggy. Keep stirring and pour Rodinal slowly in. There will be no precipitate.

Reversal Developer	
Water	230ml
Stannous Chloride $SnCl_2$	0.05g
Agfa Rodinal	30ml

Fixer Just pour the liquids into the bottle and invert twice.

Fixer	
Water	230ml
Maco LP-Fix Supra	25ml
Tetenal Hardener	5ml

Image Silver Stabiliser Just pour Sistan into water and invert the closed bottle twice.

Silver Image Stabiliser	
Water	247ml
Agfa Sistan New	13ml

8.6 Processing Times

Jobo CPE2-Plus 24°C 75rpm	
Processing Step	Time in minutes
First Developer	10
Water	*0.5*
Water	*0.5*
Bleach	3.5
Water	*0.5*
Water	*0.5*
Clearing Bath	2
Water	*0.5*
Water	*0.5*
Reversal Developer	8
Water	*0.5*
Fixer	4
Water 10x	*2*
Image Silver Stabiliser	1

Slowly unroll the film for drying. Pay attention to small threads that can peel off the emulsion at the edges of the film where the reel releases them.

Do not wipe away the foam, this will damage the film. It will dry without remains in about an hour.

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[22] Analog Photography User Group, www.apug.org