The Sabatier Effect, aka Solarization

Solarization, somewhat more properly known as the Sabatier effect, is a process which involves re-exposing a photographic print to white light during the development of the print. Both photographic film and paper, and both positives and negatives, can be solarized. The visual effects of this technique are described in broad terms below: these effects can be difficult to predict or to control exactly, but an understanding of the basic factors involved will allow you to experiment wisely and with good results.

[Both of these solarizations were made by the American photographer Man Ray in the 1930s. Both are subtle solarizations, particularly his portrait of the photographer Lee Miller on the left. (The image on the right is a self-portrait with his view camera.) In both, the MacKie lines [see below] are black rather than white: this may be because Man Ray solarized the negatives rather than the prints, or in one or both of these instances he may have used another technique, making solarized prints or negatives as an intermediate step and then printing the final image from those intermediate prints. Again, see much below for details.]

“True” solarization happens when a piece of photographic material (film) is extremely overexposed, typically by photographing the sun itself (hence, solarized). In the area where the film should be most dense, e.g., in the area of the image of the sun, you find instead a light grayish tone. In the print, the sun looks dark, sometimes even black. (Ansel Adams and Minor White encountered this effect, and called the results their “Black Sun” prints.) The usual relationship of exposure to density, where more exposure to light steadily and predictably produces more density in the negative, breaks down in this situation where the film is pushed beyond its limits. If you look through piles of old landscape photographs, you may come across one or two examples of this “true” solarization. Nowadays, probably because of exposure controls on cameras and because of changes in photographic materials, “true” solarization is a rare phenomenon.

The solarization we are concerned with is purely a darkroom technique, and involves precisely timed and controlled re-exposure of the image, rather than overexposure. Like “true” solarization, though, it involves some unexpected reversals of tonalities.
Solarization has many variations, and a wide range of effects can be obtained by varying the first exposure of the photo paper (that is, the exposure made with the negative in place in the enlarger) and the length and intensity of the second “re-exposure” to white light. I will generally refer to this second exposure with pure white light as the re-exposure. Some people may refer to this as the flash exposure. Other factors involve the type of developer used and the exact timing of the re-exposure: that is, how long you develop the print both before and after re-exposing it to white light. Solarization usually becomes more extreme with longer re-exposure times. Furthermore, if your first exposure time (i.e., using the negative) is too long, you may not see much of an effect.

The major observable effects of solarization are a partial reversal of tones (light tones become darker, although dark tones don’t generally get lighter, although they may sometimes look darker because of the darkening of surrounding tones) and the creation of so-called Mackie lines: white outlines at boundaries between areas of different light/dark values. (“Mackie lines,” like “solarization” and even “Sabatier Effect,” is something of a misnomer. The lines which the scientist Mackie noticed in the 19th century in some photographs are a different edge effect than the solarization edge effect. But the term Mackie lines is fairly widely used.) Tones which are light in the original print may become quite dark after the print is solarized, while originally darker areas, though they will not actually lighten with solarization, may not get much darker even after the print is re-exposed and re-developed, and may therefore end up lighter than some of the originally lighter areas of the print. The MacKie lines sometimes help to accentuate the linear character and detail of an image, and often have the effect of visually sharpening the image.

Solarization has been used as a technique for decades now, usually to accentuate the stranger, more bizarre aspects of a photograph, as this technique tends to create an otherworldly effect. Modernist artists/photographers such as Man Ray (an American expatriate who worked in France and who was associated with the Surrealist movement in art), Lee Miller, and Francis Bruguiere were among those who popularized the technique among “art” photographers in the years between the two world wars; their influence can still be felt. Man Ray and Lee Miller, then his student and assistant, stumbled upon their rediscovery of solarization in 1929, reportedly when a light in their darkroom was turned on accidentally during the development of some negatives.

Solarization is a technique which can be applied to any negative in the printing process. In technical terms, it works best with sharp negatives having good contrast; aesthetically, you will have to decide whether the “look” of solarization adds to or detracts from any particular image, and just how much solarization is appropriate.

General (and some specific to our set-up) procedures for solarization:

Following usual practice, determine the f/stop and exposure time needed to make a print of somewhat greater contrast and overall slightly lighter tones than normal. Then, make a test strip which you will solarize as follows:

—Although you can use a light bulb for re-exposure, it is easier and more convenient, given our darkroom set-up, to get repeatable effects using an enlarger as your re-exposure light source. We will have one enlarger set aside for re-exposure: stay tuned for special instructions. It is more convenient to have one enlarger set up for the re-exposure than to use the enlarger which has your negative in it. This is because you would have to take your negative out of the negative carrier and possibly make other adjustments to your enlarger before using it to re-expose the print. (If you only have one enlarger, this is exactly what you would do! But since you may have to do more than one solarization to “get it right,” that means you would have to keep taking out and putting back your negative: a nuisance.) Everyone can use the one enlarger for re-exposure of prints being solarized, leaving the enlarger on the same settings (particularly height and f-stop) all the time. And the re-exposure
guidelines (again, listen and look for specific instructions) should give everyone a pretty good starting point for moderate-to-extreme solarization.

—Use the Solarol developer (which works better than regular developer for this process, although regular developer can be used.) If it has not been mixed up yet, dilute the stock solution of the chemical with one or two parts of water. For instance, mix 10 oz. of Solarol stock solution from the bottle with 20 oz. of water at room temperature, or mix 15 oz. of Solarol stock solution with 15 oz. of water. (We need about 30 oz. of Solarol in the tray to allow for effective agitation and processing.)

—Have the small tray of Solarol developer on the plastic-covered baseboard of the enlarger being used for re-development. Make sure that the tray falls within the tape marks, which you should be able to see through the clear plastic protecting the baseboard. (The tape marks the area of light. It’s important that the re-exposure light area cover your entire print.) Check the time carefully as you slide the test strip, emulsion side down, into the Solarol: it’s extremely important that you know precisely when you start the development. Immediately flip the strip over, and begin gently but effectively rocking the tray for good agitation. Develop the strip for 20 seconds. A few seconds before the 20 seconds are up stop agitating and use the tongs to tap the print fully under the surface of the developer. **Make sure that the print is image side up at this point! Re-exposing an upside down print won’t produce a good solarization.**

—At the 20 second mark, turn on the re-exposure light. For how long? This depends upon the intensity of the light being used, which in turn depends upon the height of the enlarger, the f-stop being used, and the light bulb being used in the enlarger. For the time being, I’d like everyone to start off using f11 (and, to repeat some earlier instructions, you will not be changing the height of the enlarger, nor the bulb), and with this f-stop setting, 8 seconds is a good starting point for the re-exposure time. I may give new, updated recommendations as we proceed.

More about the exact timing of the re-exposure:
Changing this timing can have a dramatic effect on the solarization, affecting contrast, darkness, and degree of solarization. It is difficult to generalize on these effects, but it is vital to be aware and in control of the timing so that if you make changes, it is purposeful and you can repeat the process and results. Keep in mind that too short a first development will often create a mottled image. That is, if you make the re-exposure after just ten seconds of development, the resulting print will usually lack crispness and even tonalities. This is because it is almost impossible to agitate well enough to ensure that an image developed for such a short length of time has been developed evenly. And all the slight differences in print density which exist at this point are then magnified by the re-exposure and subsequent continued development.

Perhaps the best advice to follow with regard to timing the re-exposure, beyond keeping track of what you are doing, is to monitor carefully the development of the image. At the moment of re-exposure, you generally should see that the print looks about half developed. Obviously, if your initial print exposure is shorter, it will take a longer first development time for the print to get to the point where it looks about half as dark as you would normally want it to look. This may suggest that, if you wish to lengthen your first development from about 20 seconds to about 30 seconds (which you may want to do to give yourself a bit more time for good agitation and to get yourself set), you should shorten your first exposure time.

—While the print is being re-exposed, do not agitate. In fact, you should stop agitating the print a couple of seconds before the re-exposure, and give yourself a moment to tap the print down, fully submerging it under the surface of the developer. As soon as the re-exposure is complete, carry the tray of Solarol back to the sink area and continue to develop the print with good agitation for an additional full minute.

**Important Note:** Solarized prints often have very complex and generally dark tones. Many prints which look
quite interesting out in daylight will look too dark under safelight illumination. **Do not discard solarizations until you have looked at them under white light; do not try to evaluate them in the darkroom; do not pull prints out of the developer before the full development time has elapsed.** Yanking the print out of the developer only creates a mottled, splotchy print, and you still won’t know what the proper exposure times should be. Insufficient development will only delay the process of getting it right.

—*Fine tune your solarization by changing exposure and re-exposure times and contrast filtration:*

**Longer first exposure times** will generally help maintain the original detail and structure of the image: the final print will appear to be less solarized. **Shorter first exposure times** generally lead to more dramatic solarization, but if contrast is not good, the final print will be extremely dark. **Longer second exposure times** generally heighten the solarization effect, turning the normally-lightest tones of the image very dark. (With a short re-exposure time, these areas may only turn light or middle gray.)

You can use **contrast filters** for both exposures: filtering the white light of the re-exposure enlarger will have an effect (often for the good) on the print. However, additional filtration of the re-exposure light should be a last resort, considered only when the contrast of the image is still too low even after using high contrast filters during the first exposure. **Increasing the contrast of the first exposure generally heightens the solarization effect.** This makes sense when you consider that solarization only happens in areas of prints which have good contrast. The degree of solarization is a matter for aesthetic reflection: some images may come across best with only a very subtle use of solarization, while other images will seem strongest when solarized to an extreme degree.

—*Begin with a good sharp negative having lots of sharp linear detail and areas of contrasting value. “Muddy” and/or blurry images often do not solarize well.*

**Partial solarization** is an interesting technique which requires that you block a part of the print during the re-exposure time. Depending on the shape and placement of the area you wish not to solarize, this may be accomplished with a simple dodging tool (including your hand or a piece of cardboard, or the traditional piece of wire with circle of cardboard attached) or with a shape more specifically cut out of black construction paper or cardboard, attached to a dodging tool, and held between the image and the re-exposure light with the usual degree of movement to avoid hard edges (although that is not as much of an issue here as with traditional dodging). Some prints will partially solarize simply because of the nature of the image. For instance, an image which has high contrast in some areas but low contrast in others will often solarize in only the high contrast areas. This sort of automatic partial solarization can often be visually pleasing.

In order to gain more control of the solarization process (and of photographic printmaking in general), it’s helpful to recognize that a print can be made using multiple contrasts. For instance, imagine that you are working with an image that is not solarizing in a particular area, which is both dark and muddy (lacking in contrast). If you dodge that area during the main exposure, and burn it back in using a high contrast filter (for example, a #4 filter), that area may now have enough contrast and be light enough to solarize as fully as other areas. Areas which you wish to have solarize less can be burned in, either without a filter (this is usually sufficient) or with a low-contrast filter (e.g., a #1 filter).

**More possibilities and food for thought:**

—Consider using your solarized print as a paper negative. The resulting print sometimes is more pleasing than the original solarization. It will exhibit black MacKie lines, and you will be able to adjust the overall contrast and brightness of the image somewhat more than you were able to do in the solarization process. (If you have an idea, even as you begin the solarization process, that you may want to do this, think about printing your
solarization backwards, with the negative dull rather than shiny side up in the negative carrier. In this way, the negative print will actually read correctly left to right.

—A variant of the above, perhaps preferable: Make a high contrast non-solarized print of the image you are working with. Use this print as a paper negative, and solarize the resulting print. Then, take this new solarized negative print and, in turn, use it as a paper negative to make a final print. You may wish not to solarize this final print, in which case it will show black Mackie lines, or you may wish to solarize the final print, in which case it will show double Mackie lines, a set of black and a set of white.

—Experiment with the intensity of the re-exposure light. Normal darkroom print exposure is fairly rational in terms of the relationship between light intensity and exposure time: If we make a good print at a given exposure time and f-stop and then shut the f-stop down one increment (e.g., from f11 to f16), we will need to double the exposure time in order to make a comparable print. That is, we expose the paper for twice as long if the light is only half as bright, as it is at f16 compared to f11. HOWEVER, in the re-exposure phase of solarization, this situation gets complicated. Imagine two re-exposures made of two identical prints (that is, of prints exposed exactly the same way through the same negative for the first exposure). Imagine that one re-exposure is for twice as long as the other, but uses a light only half as bright. While one might think, given usual darkroom logic, that the two resulting solarized prints will be identical, this is not the case. The shorter but more intense re-exposure will often create a solarization with higher contrast. One reason for this may be that development is still going on during the re-exposure. If you consider that a darker print will solarize less, then it makes some sense that the print re-exposed for longer with a dimmer light will solarize less: as the re-exposure is going on, the print is also getting darker and becoming less susceptible to the effects of the re-exposure. (There may be other additional reasons for this strange state of affairs when it comes to the intensity and timing of the re-exposure light.)
Photography:
Basic Steps for Solarization (aka Sabatier Effect)

1. Choose a negative which you think will make an interesting solarization. Make a test strip or strips of it enlarging it to 8 x 10, following normal procedures but using, if necessary, contrast filters to get a good somewhat high contrast exposure. Note all exposure information. Process normally (one minute with agitation) in either Solarol or regular paper developer.

2. Expose an entire test strip for roughly 3/4 of the time you have determined in step #1 would give you a good exposure. This means that your test strip would, if left unsolarized, look snappy (tending towards high contrast) and a bit too light.

3. Make sure that anyone working near the re-exposure enlarger is aware that you are about to use it. They should put any photo paper away, to prevent its getting fogged.

4. Make sure that the re-exposure enlarger is ready. Set the timer to a reasonable time for re-exposure (about 8 seconds is a good starting point). If you have reason to believe that someone has changed the f-stop of the enlarger lens recently, check with me to make sure it is set appropriately. Note where the area of light will fall so that you know where to place the image for re-exposure. This area of light should be bigger than the small developer tray.

5. Carefully noting the time when you do this, slide your test strip — emulsion side down — into the Solarol and flip it immediately a few times to get good agitation. Continue to agitate the print well by gently and continuously rocking the tray. (But avoid splashing and sloshing!) After roughly fifteen to twenty seconds of development, turn the print image side up and make sure that the paper is all under the liquid. (Tap it under with your tongs.) Let the developer settle.

6. Carefully carry the Solarol tray with your print over to the re-exposure enlarger (unless you started with it there already, which may be better) and place the tray so that it falls within the area where light will fall. After about 20 to 35 seconds of development (i.e., since you put the paper in the tray) turn on the enlarger light. The exact timing of this is crucial, and is something you will probably need to experiment with.

7. After re-exposure, continue development with agitation in the Solarol for another minute. During this second development period, carry the Solarol tray back over to the corner of the metal sink. (The print will get agitated while you carry the tray, so don’t worry about that.) This way, you will minimize the spillage and dripping of Solarol onto the floor when you carry out the next step, which is . . .

8. Transfer the print to the stop bath (red tray) and continue processing as normal. Note: Absolutely do not put your print in the regular print developer!

9. If the solarized test strip looks how you want it to look, proceed to make the final print. If it does not, adjust first and second exposure times, contrast filtration, and the timing of re-exposure. Adjust one thing at a time to avoid confusion and make notes. It is helpful to write down information on the back of your test strips with a black Sharpie (marker) before beginning processing to determine which procedures/times produced which results.

10. Notes on making adjustments/improvements:

   - Increasing the contrast of the print often helps. You can use a filter with a higher number during the first exposure. You can also use a high contrast filter (e.g., #4) when re-exposing the print, but this is usually not necessary
- Areas of your solarization which appear too dark and lacking in detail can be improved by burning-in somewhat during the first exposure.

- If your entire solarization is too dark, try either lengthening the first exposure or shortening the second exposure. If your first exposure (with the negative) is too short and the image too light, then the re-exposure light will darken too many areas of the print too much.

- There is not one single “right” time or degree of solarization. Some images will look good solarized just a little bit, while others will work better solarized dramatically.

What produces a more dramatic solarization? — High contrast, a relatively shorter first exposure, and a relatively longer re-exposure.

What produces a more subtle solarization? — Lower contrast, a relatively longer first exposure, and a relatively shorter re-exposure.

Remember too that, all other factors being constant, if you compare the results of two re-exposures which should, under “normal” circumstances (that is, when making regular, non-solarized prints) give identical results, one being for twice the time as the other but using the lens stopped down one stop, the exposure using the brighter f-stop and the shorter time will give higher contrast results than the exposure using the dimmer f-stop and the longer time.