

# **Feature Article: Color Negatives - The C-41 Process**

*By Paul Rowe, Technical Manager*

For about 20 odd years we have been basking in the warmth of a process that gives us very little problem, and with moderate care, excellent results. Gone are the green underexposed areas of the old C-22. The constant improvement of emulsions by all of the film manufacturers has given us quality results that we could only dream about even 5 years ago.

So why am I sitting here bleating about a process that hardly needs fixing? Because we all need to stop taking the process for granted and understand a little more about what we do when we blindly commit our film.

## **Beginnings**

Let's first look at the C-41 process as it is stated by Kodak, since all of the processes for C-41 are either clones of Kodak, or adaptations. First, Kodak makes their Flexicolor (C-41) chemistry in 1 gallon, 3½ gallon, 5 gallon, and of course larger sizes for the dip and dunk type processors. They offer several options for replenished systems, none of which are practical for small rotary tube processors which are best used as one-shot devices. In addition the Kodak Hobby Pack makes a half liter of solutions for the occasional user. The processing steps for a JOBO Rotary Processor with the Kodak Flexicolor Chemicals are:

Temperature 38.0° C.  
Rotation Speed 75 (or "P")  
Preheat 5:00  
(dry film in tank rotating in water bath)  
Developer 3:15  
Bleach 6:30  
Fixer 6:30 Wash 3:00  
(six changes of water-30 sec.each)  
Stabilizer\* 1:30

\*There has been a great deal of discussion about the use of stabilizer on C-41 films, especially since the awareness of formaldehyde as a carcinogen. Kodak has further complicated this debate by stating that in some cases stabilizer is not necessary. When I asked more questions the facts seem to be that especially some of the professional films require stabilizer to prevent deterioration of the magenta dye coupler. The current Kodak films involved are: VPS III, VPS HC, VP-L, Vericolor Copy and ID, Vericolor Slide, Vericolor Print #4111, and Gold 100. Both Konica and Fuji-Hunt have some chemicals, especially for the mini-lab machines, that are claimed to be formaldehyde free. These apparently work better in the washless environment of the mini-lab. Konica also has a version for one-shot use, as with a rotary processor, but it apparently doesn't work with all films. Further, I have not been able to obtain definitive information on the status of Fuji and Konica films--which require and which can skip a stabilizer?

The safest approach, and one I am taking here at JOBO, is to stabilize all C-41 films, regardless of type or manufacturer.

## **Taking Liberties with C-41**

For those of us who can remember back a few years, it was not long after the introduction of C-41 before several chemical producers had not only duplicated it, but were making adaptations for the amateur market. The first was the introduction of Bleach-Fix, which shortened the time a little, and dropped one bath from the process. Not long after that was an amateur mix that offered a bit more contrast from the developer. This change was a response to complaints that Flexicolor was giving "flat" negatives.

Perhaps the greatest liberty was taken by Photo Technology, the English manufacturer who is represented by JOBO in the U.S. It became readily apparent in the amateur market in Great Britain that the buying and mixing of several different chemical kits, in this case C-41 for negatives and EP-2 for paper, was a hindrance to the customer. They were small users that found the chemical kits going bad on them before they could use it all. The response of Photo Technology was to devise Photocolor II, a two solution kit for C-41 that, with an additive, could also be used for EP-2 paper processing. In the more recent past they have introduced Photocolor FP (stands for film and print) that will process C-41 film and RA-4 paper with the same chemicals, no additive required.

The next step in this evolution was the introduction of certain variations in the C-41 type processes. Prewet of the film was sanctioned by some, a stop bath was championed by others, and a water rinse in lieu of a stop bath has also been

used. These variations have spread to all of the chemicals on the market, not by formal introduction from the chemical manufacturer, but by use and word of mouth among the users, especially in the amateur market and small professional market. You do not find the larger labs or professionals playing with the process. The reason for this is obvious--they are using larger quantities of chemicals and the only economic purchase of the material is from the larger chemical producers, as Kodak, Russell, Fuji-Hunt, Konica, Agfa, Trebla, et al. These manufacturers basically clone Kodak, and the times and steps as outlined at the beginning of this article are followed.

JOBO has some responsibility, albeit inadvertent, in contributing to the variations and misunderstandings of the C-41 process. When we first began distribution of Photo Technology materials, and in fact right up to the introduction of Photocolor FP, the preprinted instruction sheets from England suggested a stop bath after the developer and before the bleach-fix. While we knew this was not part of the standard Kodak C-41 process, we had to assume that the manufacturer knew more about his chemistry than we did.

From this point on we observed process variations seemingly arise by spontaneous generation. Following the proliferation of pre-wets, stop baths, rinses, et al, we also observed the increase in calls about C-41 problems. Further, there seemed to be little definitive information available on the effect of these variations on film.

## Testing

The only course left was to do our own testing. We wanted to know the effect of the following on film: 1) pre-warm, 2) pre-wet,

3) acid stop bath, 4) water rinse in lieu of stop bath, and 5) the effect of combinations of these variations.

Three films were chosen, Kodak Gold 200, Fuji G-100, and Agfa Optima 125. These were exposed to a JOBO Color Control Card by bright sunlight with a Nikon F-3 set on automatic.

The chemicals of choice were Kodak Flexicolor, and the processing was done in a JOBO ATL-3.

Lastly, densitometer readings were made of the images of the grey squares of the control card, and analysis of these readings give us our conclusions. (Just a little aside here--if you think this sounds like a lot of work for the few lines of conclusions that will follow, you are absolutely right. There was a total of 24 rolls of film exposed, and over 400 densitometer readings had to be made, recorded, and compared.)

## Conclusions

1) Pre-warm (no water in tank), *no* stop bath vs. pre-warm *with* stop bath: No significant differences were observed.

2) Pre-wet (with water in tank), *no* stop bath vs. pre-wet *with* stop bath: No significant differences were observed.

3) Pre-warm vs. pre-wet: Films with pre-wet were 1/6 to 1/3 stop more dense. It is notable that the Fuji film seemed least effected.

4) Pre-warm with stop bath vs. pre-wet with stop bath: Films pre-wet were 0 to 1/6 stop more dense. (I would consider this insignificant.)

5) Pre-warm, *no* stop, *no* rinse vs. pre-warm, *no* stop, *with* rinse:

Films with the rinse between developer and bleach were 1 to 2-1/2 stops more dense.

While there are a few other comparisons which can be made, the evidence only builds further. *Our goal is consistent and predictable processing.* The following conclusions can be inferred from the tests:

1) Pre-wet of the film introduces unpredictable variations.

2) Acid stop bath introduces unpredictable variations.

3) Rinse (using water instead of acid stop) after the developer introduces unpredictable variations.

It should be noted that Kodak says that the introduction of any step between the developer and the bleach in their chemistry does not allow the bleach step to work properly. The carry-forward of residual developer creates the proper pH condition for the bleach.

To assure yourself of consistency, you need to follow the processing steps outlined. If you are using Kodak Flexicolor,

follows the steps and times at the beginning of this article. If you are using Photocolor, proceed as follows:

## **Photocolor II**

Pre-warm 5:00

Developer 3:15

Bleach-Fix 10:00

(Note: If using Universal Bleach-Fix II, this step is 6:00)

Final Wash\*\* 3:00

Stabilizer\*\*\* 1:30

## **Photocolor FP**

Pre-warm 5:00

Developer 3:15

Bleach-Fix 6:00

Final Wash\*\* 3:00

Stabilizer\*\*\* 1:30

\*\*Final wash can be extended. The 3:00 represents six changes of water-30 seconds each.

\*\*\*Stabilizer can be either Master Class E-6 Stabilizer from JOBO, part#303627, or Kodak Flexicolor stabilizer and replenisher, Process C-41 AR, Catalog #159-7475.

For other chemical manufacturers I can only suggest that you follow the instructions packed with the kit. There are no variations necessary to accommodate a JOBO rotary processor with any C-41 chemistry that we know of.

We suggest that you analyze your processing in the light of this information, and certainly try these suggestions. The result can only be more predictable than it has ever been before.

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