

**Mixing Carbon-based
B&W Inksets,
>
“Carbon-6”**

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This PDF looks at several versions of an open-source clear base for diluting carbon-based pigment inks for B&W inkjet printing. My emphasis is 100% carbon pigment for the best, most archival images. My basic design is the “Ebony-6” inkset, which is sold by MIS Associates. I most often just mix my own, in part because I like to experiment with different variations.

I call the user-mixed inkset “Carbon-6” to distinguish it from what MIS sells, but using the Ebony MK, it prints just like the MIS version.

While this PDF looks at dilution bases for pigments, there is a link to the base for diluting Noritsu dyes at the end.

In general, the development of open source B&W inks that we can control more thoroughly seems like a logical step for many B&W enthusiasts and artists. For me, it is part of a continuing effort to improve, explore, and work with my chosen medium.

Carbon-6 was my first open source, user-diluted inkset. It allows extremely smooth, 100% carbon printing on matte papers. All carbon is warm, but Ebony is the most neutral I’ve found. Depending on the paper and printer used, it is capable of making relatively neutral to medium-warm prints.

For those who like a very warm print, the same approach can be used to make a 100% carbon inkset from MIS K4-PK.¹

MIS Associates’ “Ebony-6” inkset is a commercially available inkset for those who do not want to get involved in ink mixing.² “Carbon-6” is the user-mixed, open source version. I currently keep the variations of Carbon-6 limited to dilutions that are also available as MIS Ebony-6 or can be easily derived from Ebony-6.³ Carbon-6 and Ebony-6 are alternatives that are mostly

¹ The mixing percentages would be different for a PK based carbon inkset. For example, the LK density is about 30% PK as opposed to 18% Ebony. Note also that the PK-based carbon inkset does not have the settling issue that Ebony has.

² See <http://www.inksupply.com/eb6.cfm> to purchase Ebony-6 from MIS Associates. See <http://www.paulroark.com/BW-Info/Ebony-6.pdf> for more information on Ebony-6 and dilute Ebony inksets in general. Ebony-6 base may be incompatible with popular color inksets.

³ “EZ” Carbon-6 for the C88+ is a 13.5% carbon mix that is easily made by pouring 2 bottles of MIS Ebony-6 – LC and M – together. See <http://www.paulroark.com/BW-Info/C88-C13-5.pdf> There was an early version of Carbon-6 that used different dilution ratios than Ebony-6.

interchangeable. I use both and think of them as the same. The same profiles work for either.

This 100% carbon pigment inkset approach works well in desktop printers and with matte paper. Wide format printers need some special handling with these inksets.⁴

With respect to print tone, carbon tends to be warm on most papers.

The challenge for me has been to find papers that are neutral enough for the traditional landscape printing I favor. Carbon-6 is “neutral” appearing only on a few papers. My regular paper for neutral-cool printing with Carbon-6 has been Premier Art Smooth BW. It does, however, have brighteners in it. Arches uncoated paper is only slightly warm and well within my range. Now it appears Epson’s Hot Press paper gives us a very good, natural, un-brightened substrate for carbon printing that combines quite neutral tones and high dmax.

For those who want neutral prints on a larger variety of papers, Carbon-6 can be combined with HP PK to make neutral prints. For example, Red River’s non-OBA Aurora Natural with a blend of Carbon-6 and HP-C6 inks for neutral printing makes a very nice print that is more stable than any brightened paper. This is because the HP blended carbon-color pigment inks are more stable than the OBA dyes in brightened papers. The HP-Pk is the most stable neutral, blended gray ink. It dilutes well with the generic base.

The Eboni-based, 100% carbon inkset approach on non-brightened paper probably results the most lightfast and stable, relatively neutral to medium-warm B&W images possible with today’s digital technology. No color pigments are used in the mix, and high quality carbon is extremely stable.⁵

Carbon-6 uses the simple C6 clear base formula, below. For more details relating to the Carbon-6 inkset, see <http://www.paulroark.com/BW-Info/Carbon-6.pdf>

⁴ One downside of the dilute Eboni inksets is their relatively fast settlement rate in wide format printers. All pigments settle, but dilute Eboni requires more agitation than most. In desktop printers this is done automatically when printing because the carts travel back and forth in the printer. With wide format printers, some other method is needed. I simply remove and agitate my 7800 carts before I turn on the printer. Note that the settlement rate is probably due to the relatively large size of the Eboni particle, which is still very small compared to the inkjet nozzle and does not relate to clogging. The large Eboni particle size is a major reason it is more neutral. The alternative, smaller carbon particles such as are used in MIS PK and LK are too warm for me to use in landscapes, but the MIS LK gives a good sepia tone on glossy paper and can also give warmer matte prints (but not sepia, in my view).

⁵ Using 100% carbon pigments on Arches un-coated watercolor paper may take these images to a level that will appeal to B&W purists, galleries, and collectors who are reluctant to trust any inkjet product, as well as artists who want to tint or paint on the carbon image. See <http://www.paulroark.com/BW-Info/Arches.pdf>

HP-C6 is a similar, user-mixed inkset that takes advantage of Hewlett Packard's Z3100 Vivera PK, a neutralized PK pigment (not 100% carbon).⁶ Wilhelm Research has found prints made with these HP pigments to be more lightfast than the Epson prints. I use HP PK black only in a 1400 for my brochures. However, printers with larger drop sizes will need dilutions of the ink, which HP sells or which can be made with the C6 base. With this approach, neutral B&W printing on a great variety of papers is possible without the need to resort to using separate color pigments. In my centrifuge tests the HP-C6 dilutions appear to be very stable in terms of settling. This inkset should run on most Epson printers.⁷ HP-C6 is discussed in more detail at <http://www.paulroark.com/BW-Info/HP-C6.pdf>

C6 Clear Base Formula

In General

The simplest and probably most compatible base for Epson printers uses water, glycerol (aka glycerin & glycerine), and one or more surfactants. Glycerol is a very commonly used, safe ingredient of many consumer products and even foods. See <http://en.wikipedia.org/wiki/Glycerol> One goal here is to avoid any toxic chemicals.

Clear Base Formula

The clear base formula has evolved and is now in 3 different stages, each of which may have an appropriate use as well as limits. These are designated C6a, C6b, and C6c (with a C6d version being a variant of C6c). The differences are the surfactant mix.

⁶ Note that these HP pigments appear to be a blend of carbon with color pigments, similar in this respect to the B&W neutral or medium warm inksets sold by MIS or Jon Cone. It appears from HP patents that significant effort has been put into matching the fade rates of the color pigments such that the differential fade and resulting tone shifts typical of carbon-color blends is greatly reduced. While I employed some of the same approaches as early as 2004, the extent to which HP can obtain appropriate pigments and test these approaches exceeds what I do. However, as a blended carbon-color ink, I do not expect the images made with these pigments to be as stable as those made with the Carbon/Eboni-6.

⁷ I've used dilute HP PK and currently use full strength HP PK in an Epson 1400, as well as dilute and full strength Eboni, for more than 6 months with no clogs or other problems. See <http://www.paulroark.com/BW-Info/Eb1400.pdf> and <http://www.paulroark.com/BW-Info/1400-NC2.pdf>

C6a – Works OK on Most Epson Printers except the 1400 & 1800 – Originally for the large droplet 7500

The C6a (original) clear base I used for a couple years in a variety of Epson printers is mixed, by weight,⁸ as follows:

55% distilled water,

35% glycerol,⁹ and

10% Kodak Photo-Flo 200.¹⁰

The 35% glycerol amount was determined by measuring the viscosities of many inks that work well in Epson printers. I chose an amount that was near the top of that range to help hold the relatively heavy Eboni particles in suspension better. Note that Epson Gloss Optimizer contains 25 – 30% glycerol, 65 – 74% water, and 1-5% “proprietary organic materials.”¹¹

One or more surfactants or wetting-agents are needed and used in all inksets. This affects the drop formation, paper penetration, cleaning, and as well as other issues. The most common wetting-agent that B&W darkroom workers regularly use is Kodak Photo-Flo. It has been used for years with no apparent long term negative effects on the images or materials. As such, it is a logical wetting agent to use, and adding about 10% Photo Flo results in very smooth printing on most

⁸ Note that if mixing is by volume, the amount of glycerol and Photo Flo glycerol would be adjusted. Glycerol has a specific gravity of about 1.25 and Photo-Flo is about 1.03.

⁹ There are many sources of glycerol. Search for 99.7% glycerin, glycerol, or glycerine. The glycerol I used came from San Jose Scientific at <http://www.scienceshopusa.com/product-p/4347.htm>. Another source is the Chemistry Store. This item is usually at this URL: http://www.chemistrystore.com/Chemicals_G-R-Glycerin_Vegetable_99_7_USP_2.html. If it has been moved go to http://www.chemistrystore.com/Chemicals_A_Z-Chemicals_G_R.html; the 99.7% glycerin is usually the first item. I'm not sure what purity is needed or whether higher purity guards against biological activity. My 99.7% works and I've never seen bio activity. Wal-Mart appears to sell glycerol/glycerin as Campho-Phenique® skin moisturizer – not sure what impurities and fragrances may be there or do. In the UK a pharmaceutical grade Glycerine can be bought from Boots the Chemist in 200ml bottles for about £1.39, look for it on the cough medicine shelf. http://www.boots.com/en/Value-Health-Glycerin-B-P-200ml_852418/.

¹⁰ Photo Flo 200 is approximately 30% Propylene Glycol, 60-5% Water, 5-10% Triton X-100 (or equivalent surfactant). Photo Flo 600 may be the only version available in Europe. It has a higher concentration of surfactant a different version of glycol. It appears to work at the same mix ratio as above, but can also apparently be used at half the amount.

¹¹ For a copy of the MSDS, see <http://www.paulroark.com/BW-Info/Epson-GO-MSDS.pdf>

older or wide format Epson printers. Photo Flo also contains propylene glycol, which is the safe version of glycol and helps the ink composition and cleaning.¹²

The C6 clear base needs better wetting to work well in printers with the very small 1.5 picoliter droplets such as the 1400 and 1800. See “C6b,” below.

Many inks also contain other ingredients for various purposes that do not necessarily apply in all circumstances. The more of these components that are added, the more likely incompatibilities will exist. Thus a minimalist approach seems warranted.^{13 14}

C6b – Needed for 1.5 Picoliter Printers and may be better on many newer printers than the C6a version

The C6b clear base, which I have used with good success in 1.5 picoliter printers such as the 1400, is mixed, by weight,¹⁵ as follows:

55% distilled water,

34% glycerol,

10% Kodak Photo-Flo, and

1% Edwal LFN.¹⁶

¹² Diethylene Glycol is the main ingredient, besides water, in Epson cleaning fluids. See http://www.epson.com/cgi-bin/Store/support/Supportmsdsmain.jsp?BV_UseBVCookie=yes

¹³ Note on biocides: One ingredient that is missing in this minimalist C6 formula is a specific biocide. These are often added to inks to increase their shelf lives. So far, I have seen no evidence of biological activity in the inks made with C6. One ink expert suggested that simply keeping a CIS unit in the dark under black plastic would stop things such as algae. Additionally, some have suggested simply putting a piece of copper wire in the CIS tanks. The heavy metal ions that come off the wire apparently act as a biocide.

¹⁴ Note of pH buffering: Pigments that are stabilized in part by their electrostatic charges are somewhat pH sensitive. It's an open question whether the marginal improvements I've seen in settling rate with pH buffered bases are, on net, a positive addition. Even without any further buffering, the pH stays relatively close to that of the ink, and centrifuge tests show only marginal, if any advantage to further buffering, depending on the dilution ratio. Currently the buffering I've used is 1% (or 2%) TEA with 0.1% (or 0.2%) citric acid. The pros and cons of this step may be explored in further depth later, but at this point, it appears additional buffering is unnecessary and may be a net negative for the more concentrated mixes. These chemicals are available at Photographers Formulary.

¹⁵ Scott Summers, who mixes Carbon-6 for an 1400, calculated that if mixed on the basis of volume instead of weight, the C6b base formula would be (rounded off for simplicity): Water: 32 fl oz; Glycerol: 16 fl oz; Photo Flo: 6 fl oz; Edwal LFN: 0.5 fl oz (1 Tablespoon).

¹⁶ Edwal is approximately 20% (maybe 22%) BASF Plurafac S305 LF, 10% Isopropyl Alcohol, remainder 70% water.

C6b adds the Edwal LFN surfactant that has also been used for many years by photographers with good results. It is relatively thick, so the glycerol content has been dropped 1%.

This version is now (2014) what I consider the “go to” version for most printers, with the caveat that the next version does a bit better on 1.5 pl printers like the 1400 family if Arches watercolor paper is the target paper.

**C6c – Arches Watercolor Paper – For Arches and the 1400
(also works well on all printers with all matte papers)**

Arches Hot Press, uncoated watercolor paper is not intended for inkjet printing. It is a paper from a company that has been making paper for 500 years and is very highly thought of on the art world. Watercolor painters use it regularly and like, among other things, its relatively high gamut. I find it to have the highest dmax of any un-coated watercolor paper, and it (as well as the bright white and “cold press” versions) are the only un-coated papers I’ve used that have what I consider an acceptable dmax. As such, this version of the C6 base has been made specifically with Arches HP paper in mind.

With Arches, the penetration of the paper and smoothness of the print appear to be enhanced with yet another surfactant – Dow Tergitol 15-S-7.¹⁷ What it appears to do is control the wicking of the ink out on the paper fibers. That is, it controls bleed and dot gain a bit better than C6b.

The C6c clear base I have been using for a couple of years is mixed, by weight, as follows:

- 55% distilled water,
- 33% glycerol,
- 10% Kodak Photo-Flo,
- 1% Edwal LFN, and
- 1% Tergitol 15-S-7.

¹⁷ Tergitol 15-S-7 is available in quart quantities in the U.S. from Chemical Marketing Concepts (Dow) at 860-354-2278 for \$175. Note that a commercial address and a resale number will be requested by Dow. Tergitol may also be available for closer to \$34 from <http://www.sigmaaldrich.com/catalog/product/sigma/15s7?lang=en®ion=US> . See <http://www.dow.com/surfactants/products/second.htm> for more information on Tergitol. In Europe, Tergitol may be available from Univar Europe (www.univareurope.com). Contact Tim Goodwin, Territory Account Manager - Southern Sales, Leslie Court, Western Industrial Estate, Lon-Y-Llyn, Caerphilly, CF83 1BQ, UK, T 02920 855300, F 02920 855331. If small quantities are not sold by this company, contact Dow customer information at +800-3-694-6367 or +31-11567-2626.

The Dow surfactant appears to be very compatible with all the other ingredients and add enough smoothness with Arches to be worth the effort.

The additional smoothness with this surfactant is incremental. Whether there is enough difference in actual printing to warrant heroic efforts to find, particularly Tergitol, is an open question.

With Arches, lower viscosity inks penetrate the paper better, but they are also going to settle faster. Balancing the smoothness v. settlement rate may be different for different printer setups. I'm currently staying with this fairly high viscosity version until further testing is completed.

C6d

This is a modification of C6c based on mixing the raw ingredients of the photographic darkroom wetting agents Edwal LFN and Photo Flo 200. The percentages of the surfactants may be slightly different than in the darkroom wetting agents because I've optimized them for inkjet printing with the Epson 1400 on Arches watercolor paper, while still keeping the ability to print smoothly on coated inkjet paper.

With respect to the new substitutes for the old darkroom wetting agents, I use the names "Photo Flo 5%" and "LFN 20%." The percentages indicate the percentage of each that is the active surfactant, which in each case is the same chemical(s) as the original formulations by Kodak and Edwal. Tweaking the surfactant percentages to balance the printing performance on Arches as well as inkjet paper was the main effort that went into this iteration.

The tentative C6d clear base I have been testing with a 1400 and on Arches Hot Press is mixed, by weight, as follows:

55% distilled water,

33% glycerol,

10% "Photo-Flo 5%"

1% "LFN 20%", and

1% Tergitol 15-S-7.

As used in the mix above,

Photo Flo 5% =
30% Propylene Glycol
5% Triton X=100

65% Water

LFN 20% =
20% BASF Plurafac S305 LF
10% Isopropyl Alcohol
70% water

Note that the increased Tergitol increases the dry-down time. Even with a hair dryer, waiting a few hours is important. Tergitol limits dot gain on Arches, producing sharper images and reducing mottling with the 2% Eboni blend particularly. Most of the gain is had by 1% Tergitol and the slightly reduced Triton X-100 in the Photo Flo 5% (Kodak's would be about 7-8%).

MIS Associates' Pre-Mixed Generic Bases

MIS now has the generic base mixes, including that for the dyes, pre-mixed on its web site. These are arranged by the mix -- C6a, b, and c, as well as the dye mix. Pint and gallon volumes are offered.

See the following for most of the versions of the clear base discussed above:

<http://www.inksupply.com/product-details.cfm?pn=PR-C6ABASE-PT>

<http://www.inksupply.com/product-details.cfm?pn=PR-C6ABASE-GL>

<http://www.inksupply.com/product-details.cfm?pn=PR-C6BBASE-PT>

<http://www.inksupply.com/product-details.cfm?pn=PR-C6BBASE-GL>

<http://www.inksupply.com/product-details.cfm?pn=PR-C6CBASE-PT>

<http://www.inksupply.com/product-details.cfm?pn=PR-C6CBASE-GL>

And for the Noritsu dyes:

<http://www.inksupply.com/product-details.cfm?pn=PR-CLEARBASE-PT>

<http://www.inksupply.com/product-details.cfm?pn=PR-CLEARBASE-GL>

Enjoy the journey.



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