

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

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This PDF looks at 3 versions of an open-source clear base for diluting carbon-based pigment inks for B&W inkjet printing. There are 2 inkset types I have used with this base: First and foremost, “Carbon-6” and its variations for 100% carbon matte paper printing (based on diluting MIS Eboni MK) and, secondarily, what I call “HP-C6” (based on diluting HP Z3100 Vivera PK) for a dilute glossy compatible inkset and cooler matte paper printing.

User-mixing of inks will probably appeal to former darkroom workers, purists, and people who want to have the best image stability for the least cost.

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 Eboni 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.<sup>1</sup>

MIS Associates’ “Eboni-6” inkset is a commercially available inkset for those who do not want to get involved in ink mixing.<sup>2</sup> “Carbon-6” is the user-mixed, open source version. I try to keep the variations of Carbon-6 limited to dilutions that can be easily derived from Eboni-6, so that those not interested in mixing or who feel more comfortable with a commercial ink will be able to duplicate what I do with Carbon-6.<sup>3</sup> The same profiles should work for either.

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<sup>1</sup> 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% Eboni. Note also that the PK-based carbon inkset does not have the settling issue that Eboni has.

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

<sup>3</sup> For example, “EZ” Carbon-6 for the C88+ is a 13.5% carbon mix that is easily made by pouring 2 bottles of MIS Eboni-6 – LC and M – together. See <http://www.paulroark.com/BW-Info/C88-C13-5.pdf>

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.<sup>4</sup>

With respect to print tone, Carbon-6 is “neutral” appearing only on a few brightened papers. My regular paper for neutral-cool printing with Carbon-6 has been Premier Art Smooth BW. For those who want neutral prints on a larger variety of papers, 100% carbon inksets may not be suitable. For example, I’m increasingly using Red River’s non-OBA Aurora Natural with a blend of Carbon-6 and HP-C6 inks for neutral printing because I think the HP blended carbon-color pigment inks are more stable than the OBA dyes in brightened papers.

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.<sup>5</sup>

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>

**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).<sup>6</sup> 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

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<sup>4</sup> 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. Regular use of the printer and manual agitation of the carts in some way is recommended for consistent results. Regular linearization is also a good practice. 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 my uses but may be good sources of carbon for those who like warmer prints.

<sup>5</sup> 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>

<sup>6</sup> 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.

to be very stable in terms of settling. This inkset should run on most Epson printers.<sup>7</sup> 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. The differences are the surfactant mix.

#### **C6a – For Most Epson Printers except the 1400 & 1800**

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

55% distilled water,

35% glycerol,<sup>8</sup> and

10% Kodak Photo-Flo.<sup>9</sup>

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.”<sup>10</sup>

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<sup>7</sup> 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>

<sup>8</sup> There are many sources of glycerol. The glycerol I used came from San Jose Scientific at <http://store01.prostores.com/servlet/thescienceshop/the-1704/GLYCERINE-USP-99.7-pct-/Detail>; another source which is less expensive is <http://www.chemistrystore.com/glycerin.htm>. Even Wal-Mart appears to sell glycerol/glycerin as Campho-Phenique® skin moisturizer.

<sup>9</sup> 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.

<sup>10</sup> For a copy of the MSDS, see <http://www.paulroark.com/BW-Info/Epson-GO-MSDS.pdf>

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 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.<sup>11</sup>

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.<sup>12 13</sup>

### **C6b – 1.5 Picoliter Printers**

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

55% distilled water,

34% glycerol,

10% Kodak Photo-Flo, and

1% Edwal LFN.<sup>14</sup>

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<sup>11</sup> 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](http://www.epson.com/cgi-bin/Store/support/Supportmsdsmain.jsp?BV_UseBVCookie=yes)

<sup>12</sup> 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.

<sup>13</sup> 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.

<sup>14</sup> 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).

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%.

### **C6c – Arches Watercolor Paper**

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.<sup>15</sup>

The tentative C6c clear base I have been testing with a 2200 and on Arches HP is mixed, by weight, as follows:

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

As the newest of the base variations, this mix may have involve more uncertainty. However, so far, 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 a visible difference will take more experience with actual prints, and may vary with printer and paper used.

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

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<sup>15</sup> Tergitol 15-S-7 is available in quart quantities from Chemical Marketing Concepts at 860-354-2278. The cost for a quart is \$68. If people want to try this I might make it available in smaller quantities. See <http://www.dow.com/surfactants/products/second.htm> for more information on Tergitol.

different for different printer setups. I'm currently staying with this fairly high viscosity version until further testing is completed.

Enjoy the journey.

Paul

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