Photography I

Filters

Seemingly, one of the most mystifying aspects of photography for the beginner is the use of filters. These lens attachments add a new dimension of creativity to any lens. If used properly and with some forethought, they will become one of the most used tools in your creative arsenal, next to lenses and film. First to understand is what a filter will do. By its name a filter “filters” or removes something. In the case of photographic filters they remove or subtract light. The amount and color of the light it subtracts is dependent upon the filter.

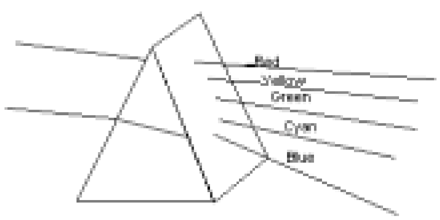
There are five basic types of filters:

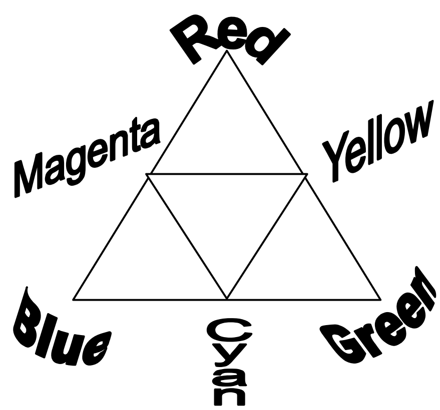
Contrast Control
Color Compensation
Exposure Control
Image Control
Everything else (Special effects)

Contrast Control Filters

Contrast control filters are used almost exclusively for black and white photography. To help understand how to use them, we need to understand how light and the colors of light interact with each other.

Isaac Newton, on experimenting with light, discovered that what we call white light is actually many colors of light combined together. When he passed a thin beam of white light through a prism, the light was separated into its other colors. The word for these many colors “spectrum” was derived from the Greek “spectra” for ghost. Therefore, “ghost image”.





Through further experimentation, it was discovered that there are only three “primary” or main colors of light, Red, Green and Blue. If we combine these three colors one at a time in equal amounts, we get three more colors, Yellow, Cyan and Magenta. These are also known as the “secondary” colors. Combining the three primaries all at once and we get White light again. The diagram below is a good way to remember these different colors of light.

Red, Green and Blue are the primary colors. Red and Green combined together give us yellow. Blue and Green give us a color called Cyan when combined. Blue and Red give us a color called Magenta. Now when we use these colors for viewing, something else happens. We see a color of an object because the object *reflects* that color. A red object is red because it reflects Red light and absorbs Blue and Green light. If we then take a

Red light and shine it on a Cyan image on a piece of paper, we will see Black! Consider why. The Red light contains only Red light. The Cyan pigments only reflect Blue and Green light. None of the Red light is reflected, so we see Black.

This is precisely why contrast control filters work. A Red filter will have the same aspects that Red light will have. It will only let Red light pass, not Blue or Green. Because of this, we can change the contrast relationships between objects in an image. To give an example, let's start with a bowl of apple. Some will be Red, some Yellow and some Green. In a black and white image, these will all appear as medium grays. The image will be a big gray lump!

Our challenge therefore is to get these medium gray apples to turn different shades of gray. Our best choices for filters will be a Green or Red filter. If we use a Red filter, it will make the Red apples appear light, almost white (more Red light hits the film during exposure, making a darker image on the negative and a lighter image on the print). Then Green apples will appear almost black because no Green light from the apples was able to pass through the Red filter. The Yellow apples, reflecting both Red *and* Green light, will appear as a medium Gray.

If we use a Green filter instead, the Red apples will appear dark, the Green apples light and the Yellow apples will still be a medium Gray. In both situations, we have successfully separated the different colored apples into three distinct tones of Gray. Now the image that first appeared as a Gray lump appears as a series of different shapes. Below is a chart that outlines what effect each different filter color would have on the apples we used in the example:

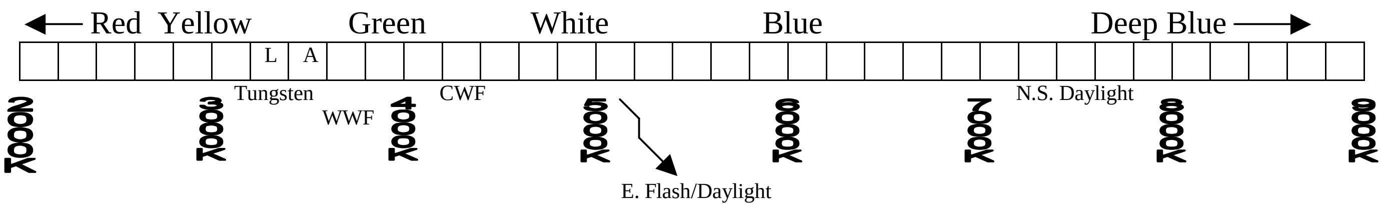
Filter Color Apple Color	**Red**	**Green**	**Yellow**
Red	Lightest	Darkest	Medium
Green	Darkest	Lightest	Medium
Blue	Dark	Dark	Dark
Yellow	Light	Light	Very light
Magenta	Light	Darkest	Dark
Cyan	Darkest	Medium	Dark
Orange (Yellow and Red)	Lightest	Dark	Medium

Creatively and carefully using these filters will give the black and white photographer more dynamic images than they could ever achieve without them. Keeping the color triangle in mind when using them and understanding what happens with filters in general to the light passing through them is the only real key for success.

Color Compensation Filters

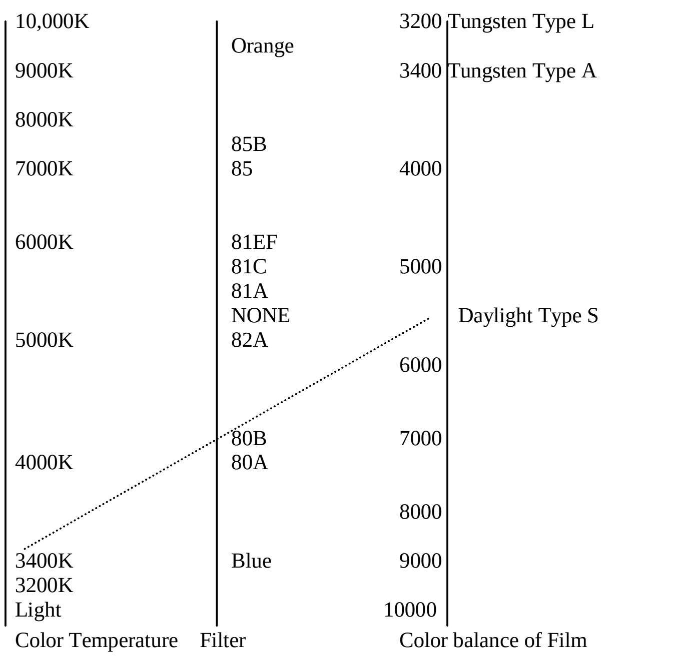
Where Contrast Control filters are used almost exclusively with Black and White films, Color Compensation filters are used almost exclusively with color films. To understand the use of these filters, we need to first understand more about the colors of light coming from the various light sources we have available to us. As part of this, we need to understand Color Temperature.

Color temperature is a theoretical way to describe the color quality of light. Daylight is assumed to be white in color, but we know if we get up early or if we watch a sunset, the colors of daylight will be Red, Yellow, and even Green under special situations! A better method of describing the overall color of a light source needs to be used. The Color Temperature scale uses the Kelvin scale of temperature to describe the general color of a light source. In the Kelvin scale, 0° is that temperature at which all motion in a molecule stops, about -273°C (this is also known as “absolute zero”). If we had an iron bar and heated it up from 0°K, at the temperature that iron bar emitted a certain color of light would be considered that lights “color temperature”. The color temperature scale with typical color temperatures of light is given below:



Color films, specifically color transparency films, are balanced to some type of light. These are usually Tungsten (either Type A, balanced for 3400K or Type L, balanced for 3200K) and Daylight (type S). Color compensation filters are used to alter the light when using a film with a different color balance than the light that is available. An example of this would be the use of Tungsten balanced film under daylight conditions. Normally one would *use* daylight film when working under daylight. Sometimes you are forced to use one type of film or another (it was the only type available or you already had it in your camera). Now you must compensate for this difference through the use of filters.

In the example given, a film balanced for Tungsten light will have an overall blue cast when used under daylight. Since the Tungsten light has a redder or yellower cast, the dyes in the film are combined so that the yellow dye has a lower concentration or is less sensitive than the other dyes. In a similar way, daylight film when used under tungsten light would give a yellowish cast to the image. To get rid of this cast, we use a yellow or blue filter to bring the color balance back into line. Another chart is given below to help choose the proper filter:



To use this chart-

First find the type of film you are using on the line labeled, “Color balance of Film”.

Next, find the light source you are working under on the line labeled, “Light Color Temperature”.

Finally, use a straight edge to connect these two points. Read off the filter to use at the centerline.

Filter designations are for Kodak Wratten or their equivalents.

Color compensation (CC) filters can be used on either the camera lens or the light source and in some situations may need to be used on both. A good example of when to use CC filters on the light source can be described in "The Bank President's Portrait".
You are the photographer who will photograph an important bank president in his own bank. This can be known as an environmental portrait. You want to capture both the bank president and the background of the bank itself in one shot. The lighting situation is thus:

- Cool White Fluorescent (CWF) lamps over the tellers
- CWF lamps as the ambient bank lighting
- Tungsten bankers style lamps at the bank and loan officers desks
- Windows to the outside, sunlight coming in the front door

The first question to resolve is which light source to use as the key source that everything else can be balanced to? Since we have very little control of the light coming in from the outside, we will use the daylight as our key source for color balancing. We therefore decide to use daylight-balanced film. However this will make the bank officer's lamps appear too yellow and the overhead fluorescent lamps greenish. The bank president we will photograph using electronic flash (having a color balance that is similar to daylight). To balance the rest of the lights to daylight, we will use special magenta filter material over the fluorescent lamps (we can lay the material on the bottom of the plastic diffusers) and a "cooling" filter material (Wratten 80A or 80B) under the desk lamps. All the lights are now balanced to daylight and the shot looks great!

The use of color compensation filters may not be used frequently by the typical amateur photographer. If they find themselves in more diversified shooting situations, a firm understanding of the use of CC filters can mean the difference between an OK shot and a truly superb image.

Exposure Control Filters

Exposure control filters are perhaps the one type of filter that is overlooked the most by the average photographer. Most would rather use *f-stops* shutter speeds or the choice of film to control the exposure rather than the use of filters. However, when you are forced with situations where your equipment is at its limits and you still have too much light, exposure control filters will be the only recourse you have.

Exposure control filters must work with all films. Therefore, they cannot have any discernable color. Understandably then, they are gray or neutral in tone. Hence, their true names, Neutral Density (ND) filters. Since gray is a combination of all colors in balance, ND filters will absorb light from all colors equally. The term density is helpful to understand. When we speak of density in this application, we are speaking of how much light the filter will hold back. It can also be called "optical density". Optical Density should not be confused with molecular density, such as specific gravity. Molecular density is good to know when we are brewing beer, but not very useful when trying to obtain the proper exposure with our camera!

Optical Density, from here on only referred to as density, can be mathematically described as: *Log 1/T* for film samples or *Log 1/R* for paper samples. We do not have to be mathematicians and understand the equation to use ND filters. The important thing to understand that ND filters are measured in Optical Densities and Density is logarithmic. Each time the density is doubled (allows only half the light to pass) the value of density increases by 0.30. If we have no filter and want to cut the amount of light coming through the lens in half, we would use a 0.30 ND filter. If we want to cut it in half again (to obtain ¼ the amount of light we had we no filter) we would use a 0.60 ND filter and so on.

The nice aspect about this scale is that it works very much like the *f-stops* and shutter speeds in our cameras. If we close down one stop, say from *f*8 to *f*11, we cut the amount of light in half. We could also leave the aperture at *f*8 and just use a 0.30 ND filter in front of the lens to achieve the same exposure level.

A real world example of where ND filters may be useful is a shot of a waterfall. To make the water of the falls blur in the image, giving the feeling of water in motion, a shutter speed of ¼ or ½ of a second must be used. If our exposure meter tells us the lowest shutter speed we can use is 1/8 second (and we have already gone to the highest aperture, say *f*16) are at the limits of our equipment. If, however, we use a 0.30 ND filter, we can now drop the shutter speed to a ¼ second. If we use a 0.60 ND filter, we can drop the shutter speed again to a ½ of a second.

ND filters, as mentioned, are not used as much as they can be. Worst of all we may have a filter in our bag already that we can use as an ND filter!

Exposure Changes Due To Using Filters

Since we are on the subject of altering exposure through the use of filters, it's a good time to discuss how *all* filters alter the exposure. As mentioned previously, a filter, by its name, must remove something. In the case of photographic filters, they are removing (actually absorbing) light. What light they absorb will depend on the filter. A Blue filter for example, will absorb all the Green and Red light, but transmit the Blue light. This means that 2/3 of the light we started with is no longer available for us. This same concept would hold true for the other "primary" colored filters Red and Green.

Each filter absorbs a certain amount of light. How this absorption effects the exposure depends on the filter, the color of the light *and the film.* Colored filters will effect some colors more than others, unlike ND filters that effect all colors equally. Due to the color balance of the film, some films will be effected by the absorption factor, or Filter Factor, more than others and, hence there can be different filter factors for different film types.

Before we get to an example, the Filter Factor needs to be explained. Simply put, it is a number that allows us to calculate an adjusted exposure based on the characteristics of both the film type and the filter. There is also a different type of number system to work with. We start with a filter factor of one. For this Filter Factor, there is no exposure change. A filter factor of two indicates that the light has been cut in half, so we must double our exposure to compensate. A Filter Factor of four means we open up another stop (now two stops total) and so on. Each time the Filter Factor is doubled, we open up a full stop.

Below is a table indicating different Filter Factors and the number of stops the exposure must be increased by to give sufficient compensation for the light lost through the filter:

Filter Factor	1	1.2	1.25	1.4	1.6	1.7	2	4	8	16
Stops to Open	0	1/4	1/3	1/2	2/3	3/4	1	2	3	4

An example of the differences there can be for the different film types, using a Wratten 25, Red filter:

Film	Filter Factor for daylight	Filter factor for Tungsten light
Panatomic-X	8	5
Plus-X Pan	6	4
Tri-X Pan	8	5

This is significant for the user of filters to remember. If we rely on in camera meters, much of the exposure change will be compensated for as the meter senses the light change when we attach the filter. The difference between FF4 and FF5 is only about a third of a stop. But the difference between a FF6 and FF8 is ½ stop. This is now on the edge of the exposure latitude of many color transparency films. For some films, the difference can be as much as a full stop.

For this reason, it is always necessary to review the information sheets that come with the filters. Putting them in your camera bag notebook is a great idea. Make sure you label them if the manufacturer has not already done so.

Image Control Filters

There are filters that can actually assist the photographer in the creation of an image. When faced with drastic contrast or lighting situations, seemingly dull atmospheric conditions, excessive glare or reflections, the use of some filters will actually improve the image.

Polarization Filters

Reflective glare from glass or water can both enhance and detract from an image. In those situations where the glare is detracting from the image, a means of removing that glare needs to be found. The solution is readily available and is known as a polarizing filter. What it is used for is easier to explain than how it works, so we will start there.

If we drive our cars on a sunny day, we may notice an annoying reflection on the windshield. The reflection may even reduce visibility to some extent. If we use conventional sunglasses, this “veiled reflection” is darkened, but still remains. If we were aware of the reason for these reflections, we may have spent a bit more money on Polarized sunglasses and the reflection would have been eliminated, completely. The same effect would occur if we looked at the veiled reflection from water. The water would turn into a dark or blue void.

The reflections are caused by light coming in at an angle to the reflective surface. It is veiled because some of the light passes through the glass or water, the rest reflects off it. We see the

light that scatters as it passes through the glass. Now comes the explanation of how Polarizing filters work.

When the light is emitted from a source (e.g., the Sun), the light waves are vibrating in many different directions. As the light hits the clear water or glass, the light waves vibrating in one direction pass through the material, the rest reflect off the front surface. At this point the light is considered to be “polarized” meaning it is all vibrating in the same direction. If we take a special piece of glass and etch very vine lines into the surface of it, we will create a linear screen. This screen will allow light vibrating in one direction to pass but will block the light vibrating in the opposite direction. To allow the filter to be used with light vibrating in various directions, the screen is on a ring that allows the user to rotate it. This is how a polarizing filter actually works.

As the light hits the glass and becomes polarized, we use the Polarizing filter to cancel out that light which is vibrating in one direction (since the rest of the light has already been reflected away from us). We do this by turning the filter until the reflection is no longer visible. For the Polarized sunglasses, the screen is set at a specific angle determined to be best when worn as eyeglasses. A filter for a camera must be more versatile, allowing for light coming from many different directions as well as allowing for both horizontal and vertical compositions.

One of the areas Polarizing filters are of greatest use is the veiled reflections caused by water vapor in the sky. Where before, clouds were hardly visible, they now “pop” out of a beautiful blue sky. Colors can actually seem brighter and more vivid with a polarizing filter. They usually are because you have removed the light scatter caused by the atmospheric water vapor.

Polarization filters can be used with both black and white or color films. Since they can be used with color films, they are neutral in color. This is the Neutral Density filter that was spoken of previously. We may already have had this filter in our camera bags, but only used it to remove those unwanted reflections. Now, we can also use it as a Neutral Density filter. It will cut the light to the film by 1 to 2 stops, depending on the filter itself. If using an in-camera meter, you can follow it without concern.

There are two types of Polarization filters available for photographic applications. The first and most available are known as “linear” polarizers. These filters employ the fine etched lines, parallel to each other. They would be used with most systems except when the system meters off the back shutter curtain of focal plane shutters. For this metering system, tiny slits in the reflex mirror are used to allow light to pass through to the curtain surface. These slits act like a polarizer themselves and linear polarizers will cause erratic and erroneous readings. For these types of metering systems, Circular polarizers must be used. These filters employ a series of finely etched concentric circles to achieve the polarization effect.

Warming Filters

In color photography, there are times we want the image to appear redder or yellower than it actually is. Reds will appear redder, yellows, yellower, with only minimal effects on the other colors. The filter normally used for this, a Wratten 81A, is a light yellow filter normally used for Color Compensation.

This filter can be combined with a polarizer in one filter. This is handy for those field and portrait applications were the image needs a little more “warmth” and you also need to eliminate veiled reflections.

Graduated Filters

The third category of Image Control filters is a variation on the Neutral Density filter. Here, instead of the filter being all one tone of gray, it begins at one end as a completely clear filter and gradually (hence its name “graduated”) increases in density until it is a 0.30 or 0.60 ND filter at the other end.

These filters are great when the contrast range of the scene is too great for the film. An example of this would be shooting a dark field with a bright sky. The clear portion of the filter would be placed in the area of the dark field and the dark area of the filter would be placed in the sky. Because the filter gradually changes from clear to dark, there is no hard line visible in the image. However, because of the change in the amount of light the filter is allowing through the various areas, the exposure is more evenly balanced and the image more pleasing.

These filters are usually square or rectangular and use special filter adapters to allow the photographer to place the appropriate density level in the proper area of the scene. This is done by sliding the filter up and down, or back and forth, until the desired effect is achieved.

Special Effects Filters

This category of filters encompasses any other filter you may happen to come across. They create special visual effects that enhance the image. These would include some of the following:

- Fog
- Soft focus
- Haze
- Star (4, 6, 8 and 12 point)
- Prism
- Rainbow
- Multiple image
- Speed
- Blur
- Etc.

Although we could describe each here separately, it is best to obtain a filter manufacturer's catalog and search through it until you find the effect you want or need. The assortment is truly astounding.

Using Filters

Using filters are as easy as attaching them to your camera and shooting away, provided you keep the points in mind that have been presented. To attaching filters to your lens, you must know the “filter diameter” of the lens you wish to use. To determine this, look inside the lens cap (it should give a measure of the filter diameter, e.g., 49mm) or look on the edge of the front lip of the lens. You will see a number followed by a "∅" symbol indicating the diameter. You should use this filter size with the lens.

If you own a series of lenses from one manufacturer, they should all use the same filter size, or they will have two or three filter sizes for their entire lens assortment. If you have a series of lenses from differing manufacturers, you probably also have different filter sizes. In this case, you either need to purchase a filter for each lens or purchase a filter for the lens with the largest filter size and use step up rings for your other filters.

Step up rings are inexpensive screw on adapters that attach to your lens and then the filter is screwed into the adapter. They come in various sizes and configurations to allow most any filter to be used on any lens. You may need to combine more than one adapter if the filter size difference is large. There are also reducing rings available that will allow smaller filters to be used on lenses needing a larger filter size. These should be used cautiously. If the reduction is too great, it will start to block the image. This would be much like closing down an iris on the front of the lens.

Another option would be the use of complete adapter systems. These systems use a filter frame and an attachment ring for the lens. Each lens could have a different filter size yet because you are using the system, the filters all attach to the same frame. You would just move the frame from one lens to another, even keeping the attachment rings mounted to each lens. These systems usually use square filter material made of photographic glass or plastic. They are very versatile and considering the different lenses one might have, may be the most economical.

Now go out, get some filters and play. It’s the best way to understand their creative uses.