

CAMERA FILTERS

By Ira Tiffen

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INTRODUCTION

Camera filters are transparent or translucent optical elements that alter the properties of light entering the camera lens for the purpose of improving the image being recorded. Filters can affect contrast, sharpness, highlight flare, color, and light intensity, either individually, or in various combinations. They can also create a variety of "special effects." It is important to recognize that, even though there are many possibly confusing variations and applications, all filters behave in a reasonably predictable way when their properties are understood and experienced. Most of these properties related similarly to filter use in both film and video imaging. The following will explain the basic optical characteristics of Tiffen and certain other types of camera filters, as well as their applications. It is a foundation upon which to build by experience. Textual data cannot fully inform. There is always something new out there.

In their most successful applications, filter effects blend in with the rest of the image to help get the message across. Use caution when using a filter in a way that draws attention to itself *as an effect*. Combined with all the other elements of image-making, filters make visual statements, manipulate emotions and thought, and make believable what otherwise would not be. They get the viewer *involved*.

Filter Planning

Filter effects can become a key part of the "look" of a production, if considered in the planning stages. They can also provide a crucial last-minute fix to unexpected problems, if you have them readily available. Where possible, it is best to run advance tests for pre-conceived situations when time allows.

Filter Factors

Many filter types absorb light that must be compensated for when calculating exposure. These are supplied with either a recommended "filter factor" or a "stop value." Filter factors are multiples of the unfiltered exposure. Stop values are added to the stop to be set without the filter. Multiple filters will add stop values. Since each stop added is a doubling of the exposure, a filter factor of 2 is equal to a one stop increase. Example: three filters of one stop each will need three additional stops, or a filter factor of $2 \times 2 \times 2 = 8$ times the unfiltered exposure.

When in doubt in the field about compensation needed for a filter that you have no information on, you might use your light meter with the incident bulb removed. If you have a flat diffuser, use it, otherwise just leave the sensor bare. Aim it at an unchanging light source of sufficient intensity. On the ground, face up at a blank sky can be a good field situation. Make a reading without the filter. Watch out for your own shadow. Make a reading with the filter covering the entire sensor. No light should enter from the sides. The

difference in the readings is the compensation needed for that filter. You could also use a spot meter, reading the same bright patch, with similar results. There are some exceptions to this depending on the filter color, the meter sensitivity, and the target color, but this is often better than taking a guess.

Filter Grades

Many filter types are available in a range of "grades" of differing strengths. This allows the extent of the effect to be tailored to suit various situations. The grade numbering range can vary with the effect type, and generally, the higher the number, the stronger the effect. Unless otherwise stated, there is no mathematical relationship between the numbers and the strengths. A grade 4 is not twice the strength of a grade 2. A grade 1 plus a grade 4 doesn't add up to a grade 5.

CAMERA FILTERS FOR BOTH COLOR AND BLACK-AND-WHITE

Ultraviolet Filters

Film, as well as video, often exhibits a greater sensitivity to what is to us invisible, ultraviolet light. This is most often outdoors, especially at high altitudes, where the UV-absorbing atmosphere is thinner; and over long distances, such as marine scenes. It can show up as a bluish color cast with color film, or it can cause a low-contrast haze that diminishes details, especially when viewing far-away objects, in either color or black-and-white. Ultraviolet filters absorb UV light generally without affecting light in the visible region.

It is important to distinguish between UV-generated haze and that of air-borne particles, such as smog. The latter is made up of opaque matter that absorbs visible light as well as UV, and will not be appreciably removed by a UV filter.

Ultraviolet filters come in a variety of absorption levels, usually measured by their percent transmission at 400 nanometers (nm), the visible-UV wavelength boundary. Use a filter that transmits zero percent at 400 nm, such as the Tiffen **Haze 2**, for aerial and far-distant scenes; the Tiffen **Haze 1**, transmitting 29% at 400 nm, is fine for average situations.

Infra-Red Filters

Certain special situations call for the use of black-and-white or color infra-red sensitive films. For aerial haze penetration, recording heat effects, and other purposes they are invaluable. Their color and tonal renditions are very different, however, from other film types (consult film manufacturers for further details). Various filters are used to reduce unwanted visible light. Red, orange, and yellow filters, as used for panchromatic black-and-white film can enhance contrast and alter color. Total visible light absorption transmitting only infra-red, as with the Wratten **#87** or **#89** series of filters, can also be useful. The results will vary with film type and other factors. Prior testing for most situations is a must.

Neutral Density Filters

When it is desirable to maintain a particular lens opening for sharpness or depth-of-field purposes, or simply to obtain proper exposure when confronted with too much light intensity, use a **neutral density (ND)** filter. This will absorb light evenly throughout the visible spectrum, effectively altering exposure without requiring a change in lens opening and without introducing a color shift.

Neutral density filters are denoted by (Optical) Density value. Density is defined as the log, to base 10, of the Opacitance. Opacitance (degree of absorption) of a filter is the reciprocal of (and inversely proportional to) its Transmittance. As an example, a filter with a compensation of one stop has a Transmittance of 50%, or 0.5 times the original light intensity. The reciprocal of the Transmittance, 0.5, is 2. The log, base 10, of 2 is approximately 0.3, which is the nominal density value. The benefit of using density values is that they can be added when combined. Thus two ND .3 filters have a density value of 0.6. However, their combined transmittance would be found by multiplying $0.5 \times 0.5 = 0.25$, or 25% of the original light intensity.

Neutral density filters are also available in combination with other filters. Since it is preferable to minimize the number of filters used (see section on multiple filters), common combinations such as a Wratten 85 (daylight conversion filter for tungsten film) with a ND filter are available as one filter, as in the 85N6. In this case, the two stop ND .6 value is in addition to the exposure compensation needed for the base 85 filter.

Color-Grad® Graduated ND Filters

Often it is necessary or desirable to balance light intensity in one part of a scene with another, in situations where you don't have total light control, as in bright exteriors. Exposing for the foreground will produce a washed-out, over-exposed sky. Exposing for the sky will leave the foreground dark, under-exposed.

Color-Grad ND filters are part clear, part neutral density, with a smoothly graded transition between. This allows the transition to be blended into the scene, often imperceptibly. A ND .6-to-clear, with a two-stop differential, will most often compensate the average bright sky-to-foreground situation.

These filters are also available in combination colors, as where the entire filter is, for example a Wratten 85, while one half also combines a graded-transition neutral density, as in the 85-to-85N6. This allows the one filter to replace the need for two.

Color-Grad filters generally come in three transition types. The most commonly used is the "**soft**" gradation. It has a wide enough transition area on the filter to blend smoothly into most scenes, even with a wide angle lens (which tends to narrow the transition within the image). A long focal length, however, might only image in the center of the transition. In this case, or where the blend must take place in a narrow, straight area, use a "**hard**" gradation. This is ideal for featureless marine horizons. For situations where

an extremely gradual blend is required, an "**attenuator**" is used. It changes density almost throughout its length.

The key to getting best results with a Color-Grad filter is to help the effect blend in as naturally as possible. Keep it close to the lens, to maximize transition softness. Avoid having objects in the image that extend across the transition in a way that would highlight the existence of the filter. Don't move the camera unless the transition can be maintained in proper alignment with the image throughout the move. Make all positioning judgments through a reflex viewfinder at the actual shooting aperture, as the apparent width of the gradation is affected by a change in aperture.

Color-Grad filters are best used in a square, or rectangular format, in a rotating, slidable position in a matte box. This will allow proper location of the transition within the image. They can be used in tandem, for example, with one affecting the upper half, the second affecting the lower half of the image. The center area can also be allowed to overlap, creating a stripe of the combination of effects in the middle, most effectively with graduated filters in colors (see section on "Color-Grad Graduated Color Filters).

Polarizing Filters

Polarizers allow color and contrast enhancement, as well as reflection control, using optical principles different from any other filter types. Most light that we record is reflected light that takes on its color and intensity from the objects we are looking at. White light, as from the sun, reflecting off a blue object, appears blue because all other colors are absorbed by that object. A small portion of the reflected light bounces off the object without being absorbed and colored, retaining the original (often white) color of its source. With sufficient light intensity, such as outdoor sunlight, this reflected "glare" has the effect of washing out the color saturation of the object. It happens that, for many surfaces, the reflected glare we don't want is polarized while the colored reflection we do want isn't.

The waveform description of light defines non-polarized light as vibrating in a full 360 degree range of directions around its travel path. Polarized light is defined as vibrating in only one such direction. A polarizing filter passes light through in only one vibratory direction. It is generally used in a rotating mount to allow for alignment as needed. In our example above, if it is aligned perpendicularly to the plane of vibration of the polarized reflected glare, the glare will be absorbed. The rest of the light, the true-colored reflection, vibrating in all directions, will pass through no matter how the polarizing filter is turned. The result is that colors will be more strongly saturated, or darker. This effect varies as you rotate the polarizer through a quarter-turn, producing the complete variation of effect, from full to none.

Polarizers are most useful for increasing general outdoor color saturation and contrast. Polarizers can darken a blue sky, a key application, on color as well as on black-and-white film, but there are several factors to remember when doing this. To deepen a blue sky, it must be blue to start with, not white or hazy. Polarization is also angle-

dependent. A blue sky will not be equally affected in all directions. The areas of deepest blue are determined by the following "rule of thumb." When setting up an exterior shot, make a right angle between thumb and forefinger. Point your forefinger at the sun. The area of deepest blue will be the band outlined by your thumb as it rotates around the pointing axis of your forefinger, directing the thumb from horizon to horizon. Generally, as you aim your camera either more into or away from the sun, the effect will gradually diminish. There is no effect directly at or away from the sun. Do not pan with a polarizer, without checking to see that the change in camera angle doesn't create undesirable noticeable changes in color or saturation. Also, with an extra-wide-angle view, the area of deepest blue may appear as a distinctly darker band in the sky. Both situations are best avoided. In all cases, the effect of the polarizer will be visible when viewing through it.

Polarizers need approximately 1-1/2 to 2 stops exposure compensation, usually without regard to rotational orientation or subject matter. They are also available in combination with certain standard conversion filters, such as the 85BPOL. In this case, add the polarizer's compensation to that of the second filter.

Certain camera optical systems employ internal surfaces that themselves polarize light. Using a standard (linear) polarizer will cause the light to be further absorbed by the internal optics, depending on the relative orientation. A **Circular Polarizer** is a linear one to which has been added, on the side facing the camera, a quarter wave "retarder." This "corkscrews" the plane of polarization, effectively depolarizing it, eliminating the problem. The Circular Polarizer otherwise functions in the same manner.

Polarizers can also control unwanted reflections from surfaces such as glass and water. For best results, be at an angle of 33 degrees incident to the reflecting surface. Viewing through while rotating the polarizer will show the effect. It may not always be advisable to remove all reflections. Leaving some minimal reflection will preserve a sense of context to a close-up image through the reflecting surface. A close-up of a frog in water will appear as a frog out of water without some tell-tale reflections.

For relatively close imaging of documents, pictures, and small three-dimensional objects, in a lighting-controlled environment, as on a copy stand, large plastic Polarizers mounted on lights aimed at 45 degrees to the subject from both sides of the camera will maximize the glare-reducing efficiency of a polarizer on the camera lens. The camera, in this case, is aimed straight at the subject surface, not at an angle. The lighting Polarizers should both be in the same, perpendicular orientation to the one on the lens. Again, you can judge the effect through the polarizer.

SPECIAL EFFECT FILTERS

General Information

The following filter types are available in a wide range of grades useful in both color

and black-and-white imaging. They have no recommended filter factors, but may require exposure compensation based on several things. Filters that lower contrast or create flare, where contrast and/or light intensity is higher, will do more for any given grade. Working with light, the more they have, the more they can do. The same filter, in two different lighting conditions, may produce two different effects. With diffusion, or image softening filters, higher contrast scenes appear sharper, needing more diffusion, than scenes of lower contrast. Diffusion requirements will also vary with other conditions. Smaller film formats will allow less diffusion, as will large-screen projection. Color may allow less diffusion than black and white. Producing for television may require a greater degree of diffusion to survive the transition. These relationships should cause you to choose exposure and filter grade based on the situation and personal experience. Prior testing is always recommended, when possible.

Diffusion Filters

Many different techniques have been developed to diffuse image-forming light. Stronger versions can blur reality for a dream-like effect. In more subtle forms, diffusion can soften wrinkles to remove years from a face. The optical effects all involve bending a percentage of the image-forming light from its original path to defocus it.

Some of the earliest "portrait" diffusion filters still in use today are "nets." Fine mesh, like a stocking, stretched across the lens, has made many a face appear youthful, flawless. More recently, these can be obtained as standard-sized optical glass filters, the Tiffen **Softnet** series. These function through "selective diffusion." They have a greater effect on small details, such as wrinkles and skin blemishes, than on the rest of the image. The clear spaces in the mesh transmit light unchanged, preserving the overall sharp appearance of the image. Light striking the flat surface of the net lines, however, is reflected or absorbed. A light-colored mesh will reflect enough to tint shadows, either lighter, which lowers contrast, or also adding its color, while leaving highlight areas alone. The effect of diffusion, however, is produced by the refraction of light that just strikes the edges of the mesh lines. This is bent at a different angle, changing its distance to the film plane, putting it out of focus. It happens that this has a proportionately greater effect on finer details than on larger image elements. The result is that fewer wrinkles or blemishes are visible on a face that otherwise retains an overall, relatively sharp appearance.

The finer the mesh, the more the image area covered by mesh lines, and the greater the effect. Sometimes, multiple filters are used to produce even stronger results.

As with any filter that has a discrete pattern, be sure that depth of-field doesn't cause the net filter lines to become visible in the image. Using small apertures, or short focal length lenses make this more likely, as will using a smaller film format, such as 16mm vs. 35mm, given an equal field of view. Generally, mid-range or larger apertures are suitable, but test before critical situations.

When diffusing to improve an actor's facial appearance, it is important not to draw

attention to the presence of the filter, especially with stronger grades, when diffusion is not required elsewhere. It may be desirable to lightly diffuse adjacent scenes or subjects, not otherwise needing it, to ensure that the stronger filtration, where needed, is not made obvious.

In diffusing faces, it is especially important that the eyes do not get overly soft and dull. This is the theory behind what might be called circular diffusion filters. A series of concentric circles, sometimes also having additional radial lines, are etched or cast into the surface of a clear filter. These patterns have the effect of selectively bending light in a somewhat more efficient way than nets, but in a more radial orientation. This requires that the center of the circular pattern is aligned with one of the subject's eyes, not always an easy, or possible, task, to keep it sharp. The rest of the image will exhibit the diffusion effect.

A variation on the clear-center concept is the **Center-Spot** filter. This is a special application filter that has a moderate degree of diffusion surrounding a clear central area that is generally larger than that of the circular diffusion filter mentioned previously. Use it to help isolate the main subject, held sharp in the clear center, while diffusing a distracting background, especially in situations where a long lens and depth-of-field differentiation aren't possible.

Another portrait diffusion type involves the use of small "dimples," or clear refracting shapes dispersed on an otherwise clear optical surface. They can be round or diamond-shaped. These are capable of more efficient selective diffusion than the net type, and have no requirement to be aligned with the subject's eye. They don't lower contrast, as by tinting shadows, as light-colored nets do. These dimples refract light throughout their surface, not just at the edges. For any given amount of clear space through the filter, which is relative to overall sharpness, they can more efficiently hide fine details than net filters. A more recent development, the Tiffen **Soft/FX®** series involves a minutely detailed series of patterns, made up of tiny "lenslets," each with a greater degree of curvature, with more optical power, than that developed by the dimples previously mentioned. This produces a maximum of selective diffusion efficiency for any given amount of overall sharpness.

Taking diffusion to yet another level, where keeping the existence of the filter from being readily apparent to the viewer is of paramount importance, is the **Diffusion/FX®** Series of filters. Available in Black and Gold Series, these are a combination of finely etched surface texture, with a unique pattern that maximizes the ability to reduce wrinkles and other fine details, with an internal pattern of very fine dots, which add subtle edge-diffraction effects. In addition, the Gold Diffusion/FX also incorporates a mild reduction of contrast, and a subtle gold "warming" tint, for improved skin tones.

The **Glimmerglass** is the first series of filters with a 'psychological edge.'" Tiffen has developed the Glimmerglass series of filters for "making people look their best." A new type of diffusion filter, the Glimmerglass subtly softens fine details in a unique manner, while adding a mild glow to highlights. As contrast is also reduced, the look is one of

enhanced beauty. A first in this field is the fact that the filter is both effective to look at as well as to look through. The filter has a distinct silver sparkle that has been found to be doubly useful. When production starts and people see the glittering on the front of the lens, they become more confident in the knowledge that the filter is working for them and they may also turn in a better performance.

The above types of filters, though most often used for "portrait" applications, also find uses wherever general sharpness is too great, and must be subtly altered.

Sliding Diffusion Filters

When attempting to fine-tune the application of diffusion within a sequence, it can be invaluable to be able to vary the strength of the effect while filming. This can be accomplished by employing an oversized filter that has a graduated diffusion effect throughout its length. It is mounted to allow sliding the proper grade area in front of the lens, which can be changed "on-camera." When even more subtle changes are required, maintaining consistent diffusion throughout the image while varying the overall strength, a dual "opposing gradient" filter arrangement can be used.

Fog, Double Fog and Pro-Mist®

A natural fog causes lights to glow and flare. Contrast is generally lower, and sharpness may be affected as well. **Fog** filters mimic this effect of atomized water droplets in the air. The soft glow can be used to make lighting more visible, make it better felt by the viewer. The effect of humidity in, say, a tropical scene can be created or enhanced. In lighter grades, these filters can take the edge off excess contrast and sharpness. Heavier grades can create unnatural effects, as for fantasy sequences. In general, however, the effect of a strong natural fog is not produced accurately by Fog filters in their stronger grades. That is because they are too fuzzy, with too much contrast, to faithfully reproduce the effect of a thick natural fog. For that, Double Fog filters are recommended.

Double Fog filters have milder flare and softening characteristics than standard Fog filters while exhibiting a much greater effect on contrast, especially in the stronger grades. A very thick natural fog will still allow close-up objects to appear sharp. So will a Double Fog filter. The key to the effect is the much lower contrast combined with a minimal amount of highlight flare.

Pro-Mist® filters generally produce highlight flare that, by staying closer to the source, appears more as a "halo" than will the more outwardly extended flare of a fog filter. They create an almost pearlescent glow to highlights. The lighter grades also find uses in toning down the excessive sharpness and contrast of modern film and lens combinations without detracting from the image. Black Pro-Mist filters also create moderate image softening and modest-to-strong highlight flare, but without as much of a lightening effect on shadows.

Smoque® filters create the look of smoke without the hassle. Mechanical generators are often used to add atmospheric haze to a scene. This could be for enhanced realism in places where smoke is normally encountered like a nightclub, or the scene of a fire. Most often, the smoke is added to create a certain "look". The difficulty and cost of using this equipment and the fact that it is less desirable to work in a smoke-filled environment, make the Smoque filters valuable as a way to get a similar look without the need for the generator or the smoke it produces. The Smoque filters can be used to create the look alone or in addition to a more modest application of real smoke. They allow greater base level consistency, especially outdoors in the wind, and you don't have to wait for it to settle or be replenished, as with real smoke.

Contrast Control Filters

There are many situations, such as bright sunlit exteriors, where proper contrast is difficult to maintain. Exposing for either highlights or shadows will leave the other severely under or over exposed. Tiffen **Low Contrast** filters create a small amount of "localized" flare near highlight areas within the image. This reduces contrast by lightening nearby shadow areas, leaving highlights almost unchanged. Tiffen **Soft Contrast** filters include a light absorbing element in the filter which, without exposure compensation, will reduce contrast by also darkening highlights. Use this latter filter when lighter shadows are not desired. In both cases, the mild flare produced from bright highlights is sometimes used as a lighting effect.

Another, more recently developed type of filter reduces contrast without any localized flare. The Tiffen **Ultra Contrast** filter series uses the surrounding ambient light, not just light in the image area, to evenly lighten shadows throughout. Use it where contrast control is needed without any other effect on sharpness or highlight flare being apparent.

Star Effect Filters

Lighting can be enhanced in ways that go beyond what exists in nature. **Star** filters create points of light, like "stars," streaking outward from a central light source. This can make lighting within the scene take on a more glittering, glamorous appearance. This effect is produced by a series of thin lines etched into the flat optical surface of a clear filter.

These lines act as cylindrical lenses, diffracting light points into long thin lines of light running perpendicular to the etched lines. Lines on the filter positioned horizontally produce vertically oriented star lines.

The size and brightness of the star lines produced are first a function of the size, shape, and brightness of the light source. You have additional control through the choice of a particular spacing between the lines on the filter. Generally these spacings are measured in millimeters. A 1mm spacing has twice as many lines per unit area as a 2mm spacing. It will produce a brighter star for any given source. Spacings offered generally range from 1mm to 4mm, as well as both narrower and wider for specialty effects.

The number of directions that lines run in determines the number of points produced. Lines in one direction produce a two-pointed star, just a streak through the center of the light. There are 4, 6, 8, 12 and more points available. With an 8 or 12 point filter, the many star lines will tend to overpower the rest of the image, so use them carefully. Although the more common types have a symmetrical arrangement of points, they can also be obtained with asymmetric patterns, which tend to appear more "natural," less synthetic. Examples of these latter types are the Tiffen **Vector-**, **Hyper-**, **North-**, and **Hollywood Star** filters.

As with any filter that has a discrete pattern, be sure that depth of field doesn't cause the filter lines to become visible in the image. Using small apertures, or short focal length lenses make this more likely, as will using a smaller film format, such as 16mm vs. 35mm given an equal field of view. Generally, mid-range apertures or larger are sufficient, but test before critical situations.

FILTERS FOR BLACK AND WHITE IMAGING

Tone Control Filters

Black and white imaging records only tonal differences between colored objects, which appear as black, white, or different shades of gray. Proper rendition depends on your own desires, and, for film, the differences between film sensitivity to colors and that of the eye. The latter is due to the fact that most panchromatic emulsions used are more sensitive to blue, violet and ultraviolet than to other colors. Therefore, blue appears as lighter on film than it does to the eye. This can make a blue sky light enough to appear a similar shade of light gray as the clouds that are in it, making the clouds "disappear." A more "correct" cloud presence is obtained through the use of a yellow filter, such as a Wratten **#8**, which can absorb blue light, darkening the sky to more closely match what the eye would see. The **#8** also acts as a general compensator for most subjects, giving a tonal rendition similar to that of the eye. Deeper colors, further to the red end of the spectrum, such as Wratten **#15** deep yellow, **#16** orange, and **#25** and **#29** red filters will produce progressively deeper and artificially more dramatic renditions of blue sky.

Remember that, since these filters act on color differences to produce tonal differences, the required colors must be present. The part of the sky you are recording must be blue to be affected. Sky sections closer to the sun, or nearer the horizon, are generally less blue than elsewhere. Use of a graduated neutral density filter can darken a sky relative to the foreground, but will not increase contrast between a blue sky and the clouds. In most situations where color-contrast and tone adjustment is involved, these filters work similarly for black-and-white video as for film.

Using filters for contrast control can be a matter of artistic preference, or of necessity. It is possible for two disparate colors, say a certain orange and blue, to record as the identical tone, eliminating any visible difference between them. Filters will lighten objects of their own color and darken those of their complement. Complementary color pairs are: green-red; orange-blue; violet-yellow. An orange filter in the above case will

darken the blue, and lighten the orange; a blue filter will perform the reverse.

A green filter, such as Wratten **#11**, can be used to lighten green foliage, to show more detail. It may also be used to provide more pleasing skin tones outdoors, especially against blue sky.

Any filter used for the above purposes will have a greater effect if slightly underexposed. Its function depends on absorbing light of its complementary colors to increase the proportion of light of colors similar to itself. Exposure compensation is often needed to allow proper image density, but the relative difference is reduced by the addition of light at the absorbed wavelengths through additional exposure.

FILTERS FOR COLOR

General Information

Recording color involves knowing more about light sources than is necessary for black-and-white imaging. Sunlight, daylight, exterior lighting at different times of day, incandescent, fluorescent, as well as other artificial sources, all have color characteristics that vary significantly. We see images through our eyes only after they are processed by our brain, which has the ability to make certain adjustments to the way we see color. White will still appear white to the eye in various lighting, so long as we don't have more than one type visible at a time. Film has no such internal compensation. It is designed to see only a certain type of light as white - all others will appear different to the extent of their difference. Filters are required to provide the necessary fine-tuning.

Knowing that light is a form of energy, we can theoretically view it as energy emitted from a hot object, usually termed a 'black body,' that gives off light as a function of its temperature. The color of that light can be measured in degrees Kelvin (K). The normally encountered types of light can be categorized by certain anticipated color temperatures, or can be measured with a color temperature meter.

Color Conversion Filters

Color Conversion filters are used to correct for sizable differences in color temperature between the film and the light source. These are comprised of both the Wratten **#80** (blue) and the Wratten **#85** (amber) series of filters. Since they see frequent outdoor use, in bright sunlight, the #85 series, especially the #85 and #85B, are also available in combination with various neutral density filters for exposure control.

Light Balancing Filters

Light Balancing filters are used to make minor corrections in color temperature. These are comprised of both the Wratten **#81** (yellowish) and the Wratten **#82** (bluish) series of filters. They are often used in combination with various neutral density filters for exposure control. They are often used in combination with Color Conversion filters. Certain #81 series filters may also be available in combination with various neutral density

filters for exposure control.

Color Compensating Filters

Color Compensating filters are used to make adjustments to the red, blue or green characteristics of light. These find applications in correcting for color balance, light source variations, different reversal film batches, and other color effects. They are available in density variations of Cyan, Magenta, Yellow, as well as Red, Blue, and Green filters.

Decamired® Filters

Decamired filters are designed to more easily handle unusual color temperature variations than the previously mentioned filters. Available in increments of both a red and a blue series, Decamired filters can be readily combined to create almost any required correction. In measuring the color temperature of the light source, and comparing it to that for which the film was designed, we can predict the required filtration fairly well.

A filter that produces a color temperature change of 100 deg. K at 3400 deg. K will produce a change of 1000 $\frac{1}{K}$ at 10,000 deg. K. This is because the filter relates to a visual scale of color. It will always produce the same visible difference. A color change of 100 $\frac{1}{K}$ at the higher temperature would hardly be noticed.

To allow simple calculation of such differences, we convert the color temperature into its reciprocal, that is, to divide it into '1.' Then, since this is usually a number with six or more decimal places, we multiply it by 10^6 , or one million, for convenience. This is then termed the '**mired value**,' for **micro reciprocal degrees**. It identified the specific change introduced by the filter in a way that is unrelated to the actual temperature range involved.

To see this more clearly, let's look at the following changes in color temperature from both the degree and mired differences. Numbers are degrees Kelvin, those in parentheses are mireds:

9100 (110) to 5900 (170) = difference of 3200 (60)
4350 (230) to 3450 (290) = difference of 900 (60)
4000 (250) to 3200 (310) = difference of 800 (60)

From this, you can see that, although the degree differential varies as the range changes, the actual filtration difference for these examples, in mireds, is the same.

To use this concept, subtract the mired value of the light source from that of the film. If the answer is positive, you need a reddish filter; if negative, use a bluish filter. Mired-coordinated filters are termed as **decamireds**. Mired value divided by ten yields decamireds. The 60 mired shifts, above, would be produced by an R6 filter, where the higher values were that of the lighting. Sets of such filters generally come in values of 1.5, 3, 6, and 12 decamireds in both B (bluish) and R (reddish) colors. These numbers are additive; that is, a pair of R3's produces an R6. An R6 plus a B6 cancel each other out to produce a neutral gray.

Fluorescent and Other Discontinuous Spectra Lighting Correction

Since filters never actually add color, but only absorb certain wavelengths to increase the relative proportion of others, the original light source must have the colors you want in it to start with. Some sources are totally deficient in certain wavelengths, which cannot be added back using only filters. This is particularly true of many types of metal halide lighting. With other lighting types, such as fluorescent, color temperature measurements may not provide the correct filter requirements since color temperature theory is based on having a continuous spectrum, meaning light at all wavelengths. It is possible for a light source to have a sufficient spectral distribution to emulate a correctable color temperature when so measured, but its effect on film can be very different.

Fluorescent lighting generally produces a greenish color overcast. Each of the many lamp types varies in color, and it can be difficult to know the precise correction even with a color temperature meter, a set of CC filters, and running some tests. There is available, however, a filter type developed as an average correction for the most commonly encountered fluorescent lamps.

As produced by Tiffen, this filter is called the **FL-D®**, for use with daylight corrected media, or the **FL-B®**, for use with tungsten corrected media. Both are designed to yield good-to-excellent color under fluorescents, without the need for a meter and a variety of CC filters.

Mixed Lighting Situations

A question often arises of what to do when there is more than one type of lighting used in a scene. The key to this is to first try to make all the light sources behave the same. That is, to choose one that predominates, correct the camera for that, and correct the other lighting with 'gel' filters made for them. You can convert daylight coming through a window with a gel placed over the window, that will make it a similar color temperature as the predominant tungsten, or even fluorescent, lighting inside. Then correct the camera for that type of light. There are many such combinations that will work, which one to choose is often a matter of economics. Filtering a factory of fluorescents with gels, or filter tubes, may cost far more than just gelling up the occasional window.

If there is no way to correct all the lights for one color temperature, try to minimize the intrusion of those for which you cannot correct to the camera. Sometimes, this can be used to advantage. The cool blue light from outdoors through a window can make the tungsten-lit interior seem that much warmer, and cozier. Once 'normal' color is within reach, frequently a variation can be even better. It all depends on your purpose, and the story you are telling.

Color-Grad® Gradated Color Filters

Similar to graduated ND filters (see earlier section for additional details), **Color-Grad color** filters are also produced in a wide range of standard and custom colors, densities, and proportions for many applications. A Blue-to-Clear filter can add blue to a white, hazy sky without affecting the foreground. An Orange-to-Clear filter can enliven a tepid sunset. Color can be added to the bottom of the scene, as with a Green-to-Clear filter used to enrich the appearance of a lawn.

Stripe filters are another type of graduated filter, having a thin stripe of color or neutral density running through the center of the filter, gradating to clear on either side. These are often used to horizontally paint various colors in layers into a sky, as well as for narrow-area light balancing.

Coral Filters

As the sun moves through the sky, the color temperature of its light changes. It is often necessary to compensate for this in a variety of small steps as the day progresses, to match the appearance of different adjacent sequences to look as if they all took place at the same time. **Coral** filters are a range of graded filters of a color similar to an 85 conversion filter. From light to heavy, any effect from basic correction to warmer or cooler than "normal" is possible. Corals can also compensate for the overly cool blue effect of outdoor shade.

Sepia Filters

People often associate sepia-toned images with "early times." This makes **Sepia** filters useful tools for producing believable flashbacks and for period effects with color film. Other colors are still visible, which is different from original sepia-toned photography, but appear infused with an overall sepia tint. Tiffen offers three types: #1, a mild version to enhance cool/bluish lighting such as outdoor shade, and overcast daylight; #2, twice the color density of the first, with applications for flashbacks and setting a "period" atmosphere; and the #3, which has the same sepia coloration as the second, but also combines a mild fog effect, which works very well together in many situations.

812® Filter

The Tiffen **812** is a mild warming filter. It finds use in adding additional color to flesh tones. Bluish reflections from black skin can also be reduced. The 812 is such a useful addition that it is manufactured in combination with other effects. These are called "warm" versions of **Pro-Mist**, **Soft/FX**, **Polarizer** and others.

Didymium Filters

The Tiffen "ENHANCING Filter" is a combination of rare earth elements in glass. It completely removes a portion of the spectrum in the orange region. The effect is to increase the color saturation intensity of certain brown, orange, and reddish objects by eliminating the muddy tones and maximizing the crimson and scarlet components. Its most frequent use is for obtaining strongly saturated fall foliage. The effect is minimal on objects of other colors. Skin tones might be overly warm. Even after subsequent color timing or

correction to balance out any unwanted bias in these other areas, the effect on reddish objects will still be apparent.

Underwater Color Correction Filters

When imaging underwater, the light you are recording is filtered by the water it passes through. Longer wavelength reds and oranges are absorbed until only blue is left. The actual effect is determined by numerous factors, such as light source (sun or artificial), water quality, and the water path. The latter is the distance the light travels through the water. In natural (sun)light, this is the depth of the subject from the surface plus the subject-to-camera distance. For artificial lighting, it is the light-to-subject-to-camera distance. The longer the water path, the greater the filtering effect of the water. In many cases, certain **color compensating** filters can absorb enough shorter wavelengths to restore better color balance. The difference between corrected and uncorrected color can be dramatic. The use of faster speed films, cameras (video) and lenses will facilitate the use of light absorbing correcting filters.

Differences Between Camera and Lab/Post Correction (Film & Video)

It is the job of the lab timer to fine-tune the finished color rendition of the production. This accounts for variables in exposure, print stock and processing. Timing can also be used to impart certain color effects, both for densities available in the film emulsion to work with, and is limited to the range of variation of the optical printer. These are much more limiting than the multitude of colorants in the real world, and the number of ways in which adjustments can be made at the camera. Filtering on the camera brings the lab that much closer to the desired result, providing a greater latitude of timing options. The same is true for video post-production color correction.

With film, there will be times when counting on the lab is either the only choice, or can produce some unusual effects. When faced with a low light situation, in daylight using tungsten film, it may be necessary for exposure reasons to pull the 85 filter and correct in the printing. When you do this, however, neutral gray tones will appear slightly yellow, even when all else looks correct. This effect can be used to artificially enhance lush green foliage colors through the addition of yellow. It may have other uses, but you will not achieve the same result as if you had used the 85 filter.

With video cameras having internal white balance capability, use filters to at least partially correct the color of the lighting to more closely match what the camera is set up for. This will make it easier for the camera circuitry to accommodate the correction needed, as well as allow additional range for further color effects that may not be possible otherwise.

LL-D®

The **LL-D** was designed to help in the above situation primarily when using film. It

requires no exposure compensation, and makes sufficient adjustments to the film to enable the timer to match the color of a properly 85-filtered original. It is not an all-around replacement for the 85. Use it only where needed for exposure purposes, and for subsequently printer-timed work.

SPECIAL APPLICATION FILTERS

Contrast Viewing Filters

Balancing lighting by eye is a matter of experience. Decisions can be aided through the use of contrast viewing filters. These are designed to handicap the eye, with its much greater range of apparent densities, to resemble the range of the various types of film. Use contrast viewers to judge relative highlight and shadow densities. There are viewers for black-and-white film, as well as various viewer densities for color film. A darker viewer is used for slower film speeds, where you would tend to use brighter lighting. Faster film, which can be used in dimmer settings would require a lighter viewer.

The Tiffen **#1** viewer is for black-and-white imaging. The **#2** viewer is for film speeds to 100; **#3** is for faster film. They can be used for video, as well, with the **#3** being better suited for lower light levels. The green **#4** viewer is for process photography. The blue **#5** is for blue screen work, as well as for setting up color video monitors.

Day-For-Night

Day-for-night (DFN) photography is an effect that makes a scene recorded in daylight to appear as if it were at twilight. This is usually accomplished by the use of a filter that both underexposes by about two stops, and can also produce a bluish color overcast. Lighting, contrast, and other factors contribute to the reality of this effect.

Tiffen offers the **Cool DFN** filter, which is a lavender-blue color traditionally associated with dusk or twilight emulation with day-for-night effects. The Tiffen **Monochromatic DFN** filter is a bright yellow-green, almost the color complement (opposite) of the Cool DFN. When you use this, and perform the necessary color-correction in post processing, you will not have all of the original colors available, producing a more realistic monochromatic effect that simulates actual silvery moonlight. Choice of which one to use is a matter of opinion. Both require an additional underexposure by ½ to 1-1/2 stops above not compensating for them in the first place. Advance testing is recommended.

Close-up and Split-Field Diopter Lenses

Close-up lenses allow for closer focusing than would otherwise be available with the unaided camera lens. These are especially ideal for nature subjects. Cutting such a lens in half produces the Tiffen **Split-Field** lens. This can be used to have two fields of focus, one very near, the other very far, in one scene.

OTHER FILTER CONSIDERATIONS

Effect of Depth of Field and Focal Length Changes

Standard color filters generally function without change through variations in depth of field and focal length. This may not be true of many of the "special effect" filter types. There are no solid rules for predicting the variation in filter effect due to depth-of-field or focal length changes. There are some things we can expect, however. Let's look at a fog/mist type filter that causes a light to glow, or flare. Take the example of a certain grade filter where we can see that the ratio of light diameter to glow diameter is, say, 1:3. As we view this through a changing focal length, we will see that the ratio remains the same, although the magnification will vary accordingly. So the decision to use a filter of a different grade to maintain a certain appearance at different focal lengths will be based on wanting to change the ratio, as opposed to any otherwise corresponding relationship. Tests are advisable for critical applications.

Sizes, Shapes, and Mounting Techniques

Filters are available in round and rectangular shapes in many sizes. Round filters generally come supplied with metal rings that mount directly to the lens. Frugal filter users might find it preferable to use adapters allowing the use of a set of filters of a single size with any lenses of equal or smaller sizes. Round filters also can be supplied with self-rotating mounts, where needed, as for polarizers. They can be readily stacked in combination. Rectangular filters require the use of a special filter holder, or matte box. They offer the additional benefit of allowing slidability, for effects that must be precisely aligned within an image, such as graduated filters. In all cases, it is advisable to use a mounting system that allows for sturdy support and ready manipulation. In addition, the use of a lens shade at the outermost mounting position (from the lens) will minimize the effect of stray off-axis reflections.

Multiple Filter Use

When any single filter is not enough to produce the desired results, use combinations. Choose carefully, to minimize the number required. Usually the job can be done with no more than three filters. Use filters that individually add to the final effect, without cancelling each other out. For example, don't use a polarizer, which can increase color saturation, in combination with a low contrast filter which reduces saturation, unless it works for some other reason (the polarizer could also be reducing reflections, for instance). Generally, the order they are mounted in is not important.

Secondary Reflections

Lighting can cause flare problems, especially when using more than one filter. Lights in the image pose the greatest difficulties. They can reflect between filter surfaces and cause unwanted secondary reflections. Maintaining parallelism between filters, and

further aligning the lights in the image with their secondary reflections where possible, can minimize this problem. In critical situations, it may be best to make use of a matte box with a tilting filter stage. Tilting filter(s) of good optical quality only a few degrees in such a unit can divert the secondary reflections out of the lens axis, out of the image, without introducing unwanted distortion or noticeable changes in the filter's effect.

Custom (Homemade and Field-Ready) Filters

There will be times when you need an effect and don't have time to obtain one ready-made. Certain effects can be produced that, although different from factory filters, can be useful in a pinch, or for unusual custom situations. Net diffusion effects can be produced as they were originally, by stretching and affixing one or more layers of stocking material to the lens end, held in place with a rubber band. There are also numerous things you can do if you have a clear filter (or several) available. Petroleum jelly can cause flare or diffusion, or even some starlike streaks, depending on its application, to a clear filter, spread with a finger or cloth. The chief benefit here is that the effect can also be applied only to selected portions of the scene. Breathing on a clear filter can produce interesting, but temporary fog-like results. Using cut gels can simulate certain graduated filter effects. When doing this, be sure to keep the filter close to the lens, and use larger lens openings, to keep the visible edge as soft as possible.

To facilitate making your own filters in certain standard square or rectangular sizes, Tiffen offers **Net Frames**. These are unique channeled metal frames that replicate the outer size and shape of 3x3, 4x4, 4x5.65 or 6.6x6.6 size filters. Use them to stretch one or more fine nets, or other material, and yet have a filter that can readily fit any standard matte box. They can be re-used to create new effects over and over again.

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