Successful Filtration

Part 3
Polarising Filters.

When we start to think about using polarising filters to enhance our photographic images, it is even more important to remember my key philosophy behind the use of ALL filtration :

"If you can tell you've used a filter, then your use of it has failed."

It seems with polarising filters that we generally have an instinctive desire to put them in front of our lenses regardless of the prevailing conditions and regardless of whether their use might enhance the final image or not. For this reason it is important that we understand, firstly, how polarising filters work, secondly what effect they might have and thirdly whether or not any effect is likely to be beneficial.

A little bit of physics.

In order to understand exactly what a polarising filter does, it is (unfortunately) necessary to understand a little bit about the physics of light and the way that light waves behave. Of course, this is an extremely complex subject and even if I could, I wouldn't want to try and explain it here. There are a couple of simple concepts, however, that once grasped will go a long way to helping us to understand exactly what the filter does when we place it front of our lenses.

The light that we see (visible light) is a very small fraction of the larger electromagnetic spectrum which includes all wavelengths from the very long (radio waves) to the very short (microwaves). In terms of wavelengths, the visible spectrum extends from the red end (700 Nm) to the violet end (340 Nm) (where a Nm or nanometer is 10 to the power -9 metres).

All electromagnetic waves are produced by vibrating electric charges that have both an electric and a magnetic component. These charges oscillate around the direction of travel giving the apparent "wave" effect, such that if we could view a light wave from the end on it would appear as shown in diagram A.

Any light wave that is vibrating around it's direction of travel in more than one plane is known as "unpolarised" light. Light from the Sun, a lamp or a candle flame is unpolarised. This concept of unpolarised light is fairly difficult to visualise, but for simplicity's sake we can picture unpolarised light as being a wave which has half its vibrations in a horizontal plane and half in a vertical plane as shown in diagram B.

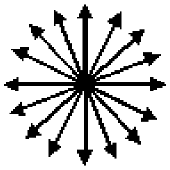

Diagram A

Light coming towards us would appear to oscillate in all planes around its direction of travel.

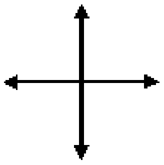

Diagram B

For the sake of simplicity we can picture the oscillations as being split 50/50 between horizontal and vertical.

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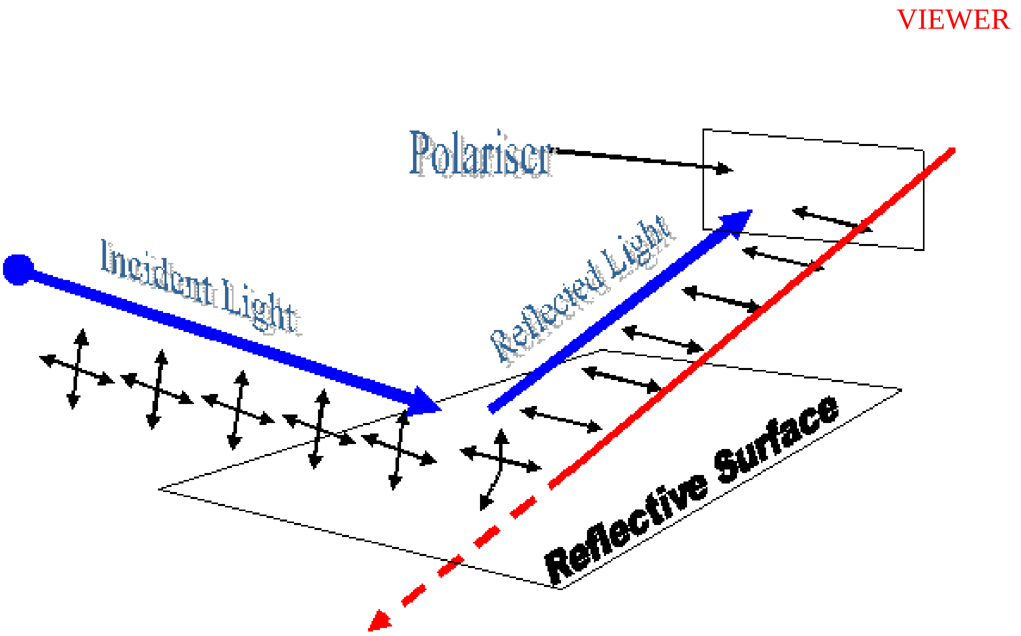
It is possible to transform unpolarised light in to polarised light i.e. light that only vibrates in a single plane about its direction of travel. There are a number of ways that polarisation can be achieved, the most common of which are: Transmission, Reflection, Refraction and Scattering. Polarising filters work by Transmission which I will cover later, but it is worth a brief explanation of the other three methods.

Polarisation by reflection

Unpolarised light can, to a certain extent, be polarised by reflection off non-metallic surfaces. The extent of this polarisation depends on two factors: the angle at which the light hits the surface and the material that the surface is made of. I should stress here that this only applies to non-metallic surfaces such as water, snow, asphalt roads, leaves etc. Metallic surfaces reflect light with a variety of vibrational directions and the resultant reflection is therefore unpolarised. Non-metallic surfaces can absorb light that vibrates in any direction other than the one that is parallel to the reflecting surface. As such the resulting reflection contains a majority of vibration in a similar direction and is partially polarised.

If you look at a non-metallic surface, that is reflecting light in this way, the surface itself and (in the case of water or glass) even objects below the surface can be hidden by the "glare" of the polarised reflection. In this case, a polarising filter can be oriented to block this reflected light and allow you to see the surface underneath. This is an effect that is familiar to many of us from travel books showing crystal clear seas with floating boats that almost appear to "hang" in mid-air. A less familiar application comes in to play when photographing autumn foliage. Each individual leaf can reflect partially polarised light, the glare from which partly hides the colour of the leaf beneath. A correctly used polarising filter will reduce this glare and allow a far greater saturation of colour on film.



The unpolarised "incident light" is partially polarised by the reflective surface, creating "glare" to the viewer. The polariser cuts out the partially polarised light allowing the viewer to see beneath the reflective surface (the red arrow).

Polarisation by refraction

Polarisation of light can also occur when a beam of light passes from one material into another by the process of refraction. At the surface of the two materials, the path of the beam changes direction and acquires a certain degree of polarisation usually in a plane perpendicular to the surface in question. This has limited photographic application so I will leave refraction here.

Polarisation by scattering

Light can also be polarised when it is "scattered" while passing through a medium (for example the atmosphere). When light waves strike the atoms in any material they will sometimes cause the electrons of those atoms to vibrate. The vibrating electrons produce their own electromagnetic wave which is radiated outwards in all directions. This new wave then strikes electrons in neighbouring atoms causing them to vibrate at the same frequency. This absorption and the re-emission of the original light wave causes the light to be scattered about the medium in a form that is partially polarised resulting in a "washed out" sky. By employing a polarizing filter in front of our lens, we can block this partially polarised light and reduce the associated glare, resulting in the familiar deep blue of a polarised sky.

Polarisation by transmission – how do polarisers actually work?

From a photographic point of view the key way in which we are likely to encounter polarised light is through the use of a polarising filter. Such filters are made of a special material that is able to block all light that vibrates in any but the specific plane it allows through. Using our simplified model that assumes that approximately 50% of the light is polarised vertically and 50% horizontally, we can therefore assume that our polarising filter will block 50% of the light that hits it. (Note – in our case this is an over-simplification and in fact our filters may block more than 50% - see the section on practical uses for polarisers below). So when unpolarised light hits the filter, it emerges at roughly half the intensity and with all the vibrations in a single plane – i.e. as polarised light.

Note : in the case of the reflection diagram shown above, the polariser is oriented to specifically block the light that is polarised by the reflecting medium i.e. block ALL the reflected glare allowing us to see beneath the surface.

A polarising filter is able to achieve this effect due to the chemical composition of the material from which it is manufactured. It is probably easiest to picture the filter as being completed covered in long chains of molecules that are all aligned in the same direction, a bit like a grating or a picket fence. Any electromagnetic vibrations hitting the filter that are in a direction parallel to the alignment of the molecules are absorbed, those at 90 degrees to the alignment are allowed through.

The alignment of the long chains of molecules gives the filter what is described as its polarisation axis. By rotating the filter in front of the lens we can select which light is allowed through and which is blocked. in most cases we will be using our filter to block partially polarised light, thereby reducing glare and allowing the true colours of the subject to shine through.

Practical uses for polarising filters

Polarising filters are an essential if often misused piece of photographic equipment. When used correctly they can greatly enhance an image, but when used incorrectly they often cause the result to shout "Hey look at me what a great polarised image!" The key here relates back to my key philosophy mentioned at the beginning of this article. Use of these filters must be subtle – it is important to remember at all times that we are trying to create an image that accurately imitates the way we perceived the scene when we made the exposure.

The traditional use of polarising filters is to darken blue skies. In general a polariser will achieve this ONLY if the camera is pointing at 90 degrees to the direction of the sun. If you stand directly behind the camera, facing the direction the camera is pointing, then the polariser will have it's maximum effect if the sun is directly to your left or right. If the sun is in front or behind you, then the filter will have no visible effect other than to act as neutral density and effectively reduce the amount of light coming through the lens.

Care must be taken when using extremely wide angle lenses. This is because the angle of view that these lenses cover can extend over a large percentage of the sky and, as such, the polarising effect of the filter will be different across the width of the image. In extreme cases this can mean that the sky might look deep blue on one side of the image and pale white on the other, effectively ruining the result.

Care must also be taken not to “over-polarise”. Modern films tend to be particularly sensitive to polarised light and this can result in skies that are rendered as deep navy or even approaching black, which can be completely un-natural. It is important to practice with your film of choice and see how it performs at differing degrees of polarisation. Often the result can come as quite a surprise in that the colour of the sky in the film is even darker than the colour you saw when looking through the filter at the original subject.

As well as the traditional deep blue sky effect, perhaps a more suitable use for these filters is to cut down on reflected “glare” and allow the true colours of the subject to shine through. This is particularly useful when photographing foliage, wet rocks, pavements etc. where reflections can be almost completely removed. Remember though, that if the reflection is part of the subject you want to capture, then the polariser is the last filter you should reach for.

How to use your polarising filter

Most polarisers are made in two parts. An inner ring that screws on to the front of the lens or proprietary filter holder and an outer ring that freely rotates in relation to the inner ring. By altering the amount of rotation of the outer portion, you can control the amount of polarisation that takes place.

There is no need to actually mount the filter on the lens to see the effect, you can simply hold it in front of your eyes and view your scene whilst rotating one of the two rings. This is a good habit to get in to because it teaches you to anticipate how the filter will work in different situations. If you are out in the field on a photographic trip, make a point of taking your polariser out and looking through it in different directions relative to the position of the sun and see how the effect changes.

If you are using an SLR type camera then you can of course attach the filter to your lens and view its impact through your viewfinder.

When it comes to calculating exposure, then those with through the lens meters can allow the camera to adjust automatically. If you use a hand held meter, then you will need to make a manual adjustment for the filter’s effect. The key thing to remember regarding exposure is that the filter will block differing amounts of light and therefore require differing adjustments depending on the amount of rotation (and therefore polarisation) you apply. My polariser can cut the transmitted light by 3 stops when fully polarised, so when using my favourite Fujichrome Velvia 50 film I set the film speed on my spot meter to an ISO of 6!!!!!

It should come as no surprise therefore that you will need to practice with your filter and keep detailed notes, if you wish to confidently predict your results and make correct exposures. Unfortunately there is no substitute for this familiarisation process, but the results can be worth the effort invested.

What Polarising filters are available to buy?

Polarising filters come in all shapes and sizes, and are manufactured by all the major filter suppliers. These include:

- Lee
- B+W
- Hoya
- Cokin
- Heliopan
- Singh-Ray
- Sunpak
- Tiffen

This is by no means a complete list.

It is important to realise that all polarising filters are different, in that they may differ in colour, the amount of light that they block, obviously the thread size for attaching to different lenses, and even the thickness (thinner filters are better at avoiding vignetting with wide-angle lenses).

One key factor is the filter thread size. If you own a number of different lenses that take different sized filters, then you will be forced to buy separate polarisers for each lens. This can be very expensive. An alternative is to purchase a single over-sized filter that can cover all your lenses, such as those offered by Lee Filters and Heliopan. These filters are designed to fit on to a proprietary filter holder that has the advantage of fitting to each of your lenses by a separate (relatively cheap) adaptor. This means that you only need an adaptor for each lens, and use the same polariser for all of them.

The following images show the Lee filter holder system:

The LEE Filter holder system, showing the front adaptor for attaching a 105mm polariser.

The Lee filters 105m Polarising Filter with its associated adaptor.

Personally I use the Lee filter system but own a Heliopan 105mm Käsemann warming polariser.

Käsemann polarising filters consist of an especially colour-neutral polarising film between specially ground and polished cover glasses. Thanks to this expensive mode of manufacture, they produce sharper and more neutral pictures than the usual polarising filters. The additional MRC multilayer coating increases this effect through several gossamer-thin reflection reducing coating layers. Needless to say this is an expensive approach – I recall that my filter was in excess of £200!

Warming polarising filters have a small amount of colour intentionally built in to them – effectively they are slightly yellow in appearance. This is designed to counteract the fact that all polarisers will tend to add a slight blue cast to the image.

Recap!

So here endeth the polarising sermon!!! To recap make sure you familiarise yourself with your filter – not only what effect it might have in differing conditions, but also how it will effect your exposure depending on how, where and when you use it. Most importantly don't over-do it – keep it subtle and this filter will become a key part of your photographic armoury.

Footnote: You will notice a distinct lack of "example" images in this article. This is because in the event that I have used my polariser correctly, then you shouldn't be able to tell that it has been used!

Addendum:

Why is the sky blue and the sunset red?

Although not directly related to polarising filters and their use, I thought it might be interesting to pop this short note at the end of this article.

We take it for granted that on a clear summer day the sky will appear as a deep blue and that at sunrise and sunset it will often produce a spectacular display of red, pink orange or gold. Have you ever stopped to ask yourself why this might be?

Sky Blue

The light that shines towards us from the sun is made of many wavelengths, including all the visible bits between the red and blue ends of the visible spectrum. Without any interference, this light appears as a mixture of all the colours of the rainbow i.e. white light. When this white light strikes our atmosphere, most of the longer wavelengths pass straight through. Little of the red, orange, yellow and green light is affected by the air. The shorter wavelengths, however, at the blue end of the spectrum, are absorbed by the gas molecules exactly as described in the “Polarisation by scattering” section above. This scattering is known as “Rayleigh” scattering (after Lord Rayleigh who first calculated its effect). Because these shorter wavelengths are scattered in all directions, some of this re-emitted light reaches you whichever direction you look and since you see blue light from all directions, the sky appear blue in all directions.

Sunset Red

From within the Earth’s atmosphere at the middle of the day, the sun appears yellow. This is because much of the blue light from the sun is scattered to give the sky its blue colour. The remaining wavelengths appear yellow.

If you were to look upwards from outside the earth’s atmosphere i.e. in orbit around the earth, then the sky would appear black and the sun would appear white. To a certain extent you can experience this when flying at high altitudes on inter-continental flights – the sky directly above will appear much darker than from the surface, because the light from the sun is travelling through far less air to reach you.

As the sun begins to set and approaches the horizon, the light from it has to travel through much more atmosphere to reach you than it does in the middle of the day . As a result even more of the sun’s white light is scattered. As less light reaches you directly, the sun appears dimmer and its colour gradually changes through yellow to orange to red.

The sky around the setting sun may take on many colours. The most spectacular sunsets occur when the air contains many small particles of dust or water enhancing the scattering effect caused by the air alone. The light that reaches you from the parts of the sky near the sun only consists of the longer wavelengths and the sky, therefore, appears various shades of orange, pink or red.