SERICOL Hints & Tips

Advice from FUJIFILM Sericol Technical Services

Printers guide to weathering

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1) Introduction

Screen printing, because of its inherent flexibility of application and use, allows some prints to be placed outdoors for long periods of time. To obtain the maximum outdoor life it is important to understand the effects of outdoor exposure and how to counter those effects.
The greatest effects on prints outdoors originate from exposure to the weather. This is called weathering and this document aims to explore the causes and effects of weathering, how it may be predicted, how it is measured and what may be done to improve the weathering resistance of a print.

It is important to remember that the effects of weathering will occur at all times and in all conditions. What may seem to us as a benign, mild summers day will lead to high levels of exposure to sunlight for the print, whilst a ferocious winter storm will obviously lead to a reduction in sunlight exposure, but will also have effects in terms of water resistance, temperature and other factors.

2) Causes of weathering

The effects of weathering cannot be examined in terms of the ink alone and must also take into account the substrate upon which the ink is printed. It is this combination that will define the outdoor life of the whole print. An ink with a good outdoor life will work well on a suitable substrate but will not last for long outdoors printed onto paper.

2a) Sunlight

Sunlight has by far and away the greatest effect on outdoor prints and of this the majority of damage is caused by the ultraviolet component. Although ultraviolet light only comprises approximately 5% of sunlight, it is responsible for 90% of the damage caused.

The principle effect of sunlight exposure is fading of the print due to the effects of ultraviolet light on the pigments. However, some pigments do not fade but instead become darker, dirtying the original colour. Varnishes may also be affected, often yellowing over time.

Substrates will also be affected by exposure to sunlight, especially paper and plastics. Papers are known to yellow and embrittle with age. Plastics may also show similar effects although some are more resistant than others.
Of the substrates most commonly used for printing, Polyvinyl Fluoride is the most resistant to light followed by polyesters, acrylics and polycarbonates, then PVC. Cellulose derivatives and polystyrene are usually the least resistant. These plastics react in different ways: polyester is likely to show a whitish surface erosion, PVC may crack, embrittle and yellow over time while polystyrene will craze and embrittle quickly.
After sunlight, the other components of weather do not have as marked an effect on outdoor prints but the effects can be significant over time

2b) Air pollution and altitude

Air pollution can also have an effect. Its sources may be natural, for example sea salt or dust, or man-made such as soot from exhaust fumes and industrial gases. Sulphur in exhaust fumes can lead to darkening of some reds and yellows, and the tarnishing of some metallics. Some pollutants such as acid fumes and salt may also have a bleaching effect and soot from exhaust fumes can leave a dirty deposit on the print.

Altitude is also an important factor. Exposure at elevated altitudes can significantly increase exposure to ultraviolet light and therefore significantly reduce the expected life. Altitude can also affect the levels of atmospheric pollution.

2c) Water

Water, falling as rain or as atmospheric humidity, will have effects on water-based inks leading to re-wetting and ink running – for example many inkjet inks have very little water resistance. Water will also affect some substrates, especially paper, materials such as wood and may also lead to the corrosion of some metals.
Rain can also deposit some atmospheric pollution on prints.

2d) Temperature
Temperature, especially extremes of temperature, can also be damaging. In cold conditions the print and substrate may be weakened by low temperature and by the freeze – thaw process whilst high temperatures may soften substrates.
If the substrate has absorbed water, the freezing of this water can have a great effect as the ice expands.

2e) Wind
Wind, especially strong wind, can damage prints by flexing, especially if they have lost their flexibility due to other effects and can also cause abrasion of the prints through the effects of wind-borne dust.
The effects of weathering will never be due to a single factor but rather as the result of the actions of all aspects of the weather prevalent at the time. The most common effect seen is for prints to fade, they may also be seen to darken, tarnish, flake off the substrate, lose gloss level or show crazing. They may also show a white deposit on top, called chalking. This can usually be removed by wiping with a cloth and is usually seen on prints containing a large proportion of white. It may easily be avoided by over-varnishing with an appropriate long-life varnish.

3) Geographic location
Geographic location and positioning of the print will have a very great affect on the weathering resistance of a print. A print in a sunny environment such as the middle-east will fade faster than one in the UK. A print in the tropics will degrade at least twice as fast as a similar print in a temperate climate because of the effects of humidity, temperature and sunlight. Positioning also has an effect (in the northern hemisphere) – a north facing print will last much longer than a south facing print due to the amount of light caught, whilst a vertically mounted print will last longer than one tilted toward the sky.
A print placed behind glass will be protected from inclement weather, as well as the glass filtering out a large proportion of the UV light. However, IR energy will still pass through the glass to affect the print.

Fig 1 shows a map of Europe divided into three zones. These three zones approximately relate to a “Northern European Climate”, a “Southern European Climate” and an intermediary zone. All of the factors mentioned above make generalised predictions difficult. However, the map provides guidance on possible shortening of external life due to geographical location.
It should of course be noted that the lines are representations of gradual changes (not step changes) that take place as exposure increases to a more “aggressive” climate.

4) Predicting the effects of weathering.
For applications where prints will be outside for long periods of time, it is important to know that they will last for the required length of time. A variety of methods exist to predict how long a print will last and to measure the effects of weathering.

4a) Artificial weathering
To avoid lengthy outdoor exposure, artificial weathering techniques have been developed using machines called weatherometers. The climate of choice is replicated through the use of controlled humidity, high intensity xenon lights, water sprays and dark cycles to represent night time. By using high intensities and temperatures, the equivalent of a years outdoor exposure may be reduced to a period of a few months or weeks.
These methods are reasonably accurate and obviously give the advantage of a faster answer than outdoor exposure. However, because the weather is highly variable, artificial weathering cannot directly replicate it. International standards have been set for artificial weathering to ensure that tests are directly comparable. Common examples of these are as follows:

BS 2782 / ISO 4892 – British & European standards for accelerated weatherometer testing
SAE J1960 – an American standard for the exposure of exterior automotive parts, very similar to ISO 4892

4b) Controlled outdoor exposure
For the ultimate in accuracy, controlled outdoor exposure tests are conducted. These are arranged as a series of prints set into a frame arrayed at 45 degrees from the vertical and south facing (in the northern hemisphere), to receive maximum sunlight. Tests in this manner will often be carried out at different locations throughout the world to replicate variations in different climates. This is a good tool for short term tests of less than a year.

Standards for outdoor exposure include BS 3900 part 6

5) Measuring the effects of weathering
It is easy to compare the light fastness of an unexposed print to an exposed print but this is very subjective. Techniques have been developed to quantify the changes in prints due to outdoor exposure.

5a) Grey scale
The grey scale is a method of quantifying contrast. It consists of a set of 5 pairs of increasingly contrasting grey shades. By comparing the contrast in these 5 pairs of grey shades to the contrast between an exposed print and an unexposed print, the closest matching grey pair may be identified. This may then be used as a measure of the weather resistance of the print. This method relies on the fact that the grey scale is set as an international standard.

5b) The blue wool scale
The blue wool scale is an internationally recognised method of quantifying light fastness, defined under the British Standard BS1006. The scale consists of 8 different strips of wool, each dyed with a blue dye of differing light fastness. The scale ranges from 8 (excellent – very low rate of fading) to 1 (very poor – extremely fast fading). The blue wool scale is not a linear scale but is rather logarithmic, so that each increase in level is greater than the previous. When exposed in the same manner as the print for the same length of time, the level of fading of the print may be matched to that of the equivalent strip of wool to give a measurement of the light fastness of the print. The blue wool rating is related to the print and the exposure – another print with a higher ink deposit will fade slower, leading to a higher blue wool rating. Conditions of printing and exposure should be specified when quoting a blue wool rating.

Both the grey scale and the blue wool scale are subjective and open to interpretive errors so rely on the ability of an experienced operative to compare both the scale and the print for an accurate reading.

6) Effects of Weathering

6a) Colour change

Colour is a difficult thing to quantify. It is very easy to perceive but hard to communicate. It is also hard to quantify colour change as well, especially to give a measure of the degree of change. To do this requires a spectrophotometer. This will allow an absolute value to be attributed to the colour, and likewise any changes in colour. This colour change is usually expressed as a value called “Delta E” (DE).

A DE of 0.5 between areas of colour will be practically indistinguishable, whilst a DE of 100 may be approximated to the difference between black and white.

A value of DE may be defined as the difference between an exposed and unexposed print where the colour change due to weathering has reached an unacceptable level.

It must be remembered that DE only defines the amount of change of a colour, and does not communicate in which way the colour has changed (eg the red component has faded). Because different colours are perceived differently, the same change in DE may give the impression of a lesser degree of change in one colour to another e.g. a large DE in yellows may not be easily seen, whereas the same DE in a blue will give an easily visible difference. Changes in DE are also not easily reproduced through weathering. It is for these reasons that the Grey scale is a more robust method of determining visual changes in a colour.

6b) Cracking, crazing etc

One of the effects of weathering is that prints may crack or craze (a fine network of small cracks). The degree to which this has happened is defined by reference to one of several international standards, which consist of a diagram showing different levels of cracking / crazing. The nearest diagram may be used to define the level of cracking / crazing of a print in reference to the standard.

6c) Gloss level

Weathering can lead to a reduction in gloss level of prints. A Gloss meter is used to measure this change. By shining a light onto the print at an incident angle of 60 degrees and measuring the amount of light reflected from the print, the amount of light reflected from the print may be expressed as a percentage of the incident light, giving a useful reading of gloss level. This may then be used to compare an exposed and unexposed print.

7) Advice on how to reduce effects of weathering

Weathering cannot be avoided but its effects can be minimised. This is done by choosing a suitable ink and substrate and applying the ink in an appropriate manner.

7a) Avoid matt finishes

Matt inks, by the nature of their finish, will hold onto atmospheric dirt deposits. The matt finish also allows the ingress of water and other materials more efficiently than a gloss finish. Although some matt inks have good lightfastness, they should be coated with a suitable gloss over-varnish to give good weather resistance.

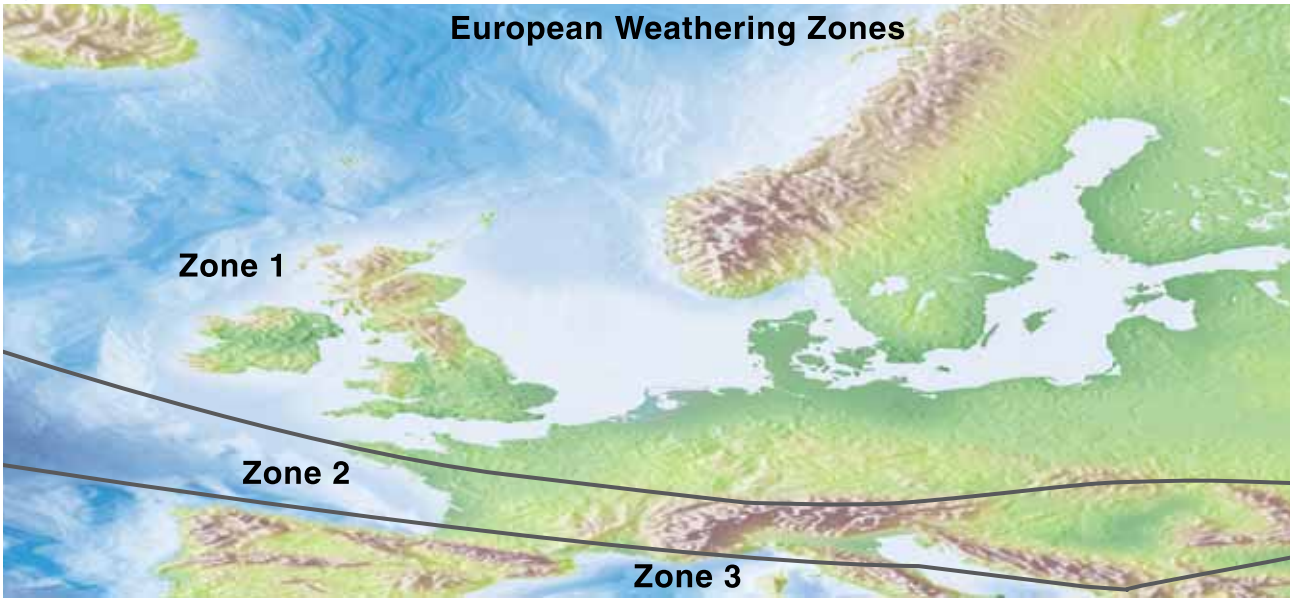
7b) Over varnish

Over-varnishing will protect a print from the effects of atmospheric pollution and water. Specific over varnishes exist which contain UV inhibitors and high-grade resins. These can increase the lightfastness of a print and can also help prevent some of the effects of the other components of weather. However, they will not prevent ‘weak’ pigments from fading, merely increase slightly the time they take to fade.

7c) Limit small proportions in colour matches

Colour matches intended for outdoor use should avoid

Figure 1



Prints placed in zones 2 and 3 will have a shorter exposure life than similar prints in zone 1. As a general guide, prints in zone 2 will have an outdoor life of approximately 60% that of zone 1, and prints in zone 3 a life of approximately 50% to those in zone 1.

small proportions of individual colours in the recipe.
A small colour component will be perceived to fade quickly, greatly altering the appearance of the whole colour.

A similar problem is found with large quantities of white in a colour match. Because white pigment does not fade easily, pastel colours with a small concentration of coloured pigment and a large concentration of white will fade rapidly to white. For similar reasons, large quantities of varnish should be avoided in colour matches for external exposure.

7d) Increase ink deposit
The visible effects of fading due to light are related to the thickness of the ink film – a thick film will take longer to fade than a thin film. To take advantage of this, using a coarser mesh, for example a 90 mesh with a solvent-based ink, to increase ink deposit may prolong outdoor life.

7e) Use a long life substrate and ink combination.
A suitable long life substrate should be used. Examples include Avery Hi-S Cal 5000 series and 3M Scotchcal self-adhesive vinyls and acrylic sheet such as Perspex and Plexiglass. Most inks with a long outdoor life tend to be solvent-based inks for plastics. UV inks for plastics may have an outdoor life of two years and specialised UV inks are available with a 5 year life, However, because of the inherent transparency of UV inks, they tend to have reduced outdoor life compared to solvent-based systems. Information on the outdoor life of an ink will be available from the ink supplier.

8) Current outdoor life expectations.
The following tables list the current outdoor life expectations for our key ink ranges in zone1.

Please see the Product Information Sheets for each range for further information. Product Information Sheets are available from your local Customer Service Centre or the FUJIFILM Sericol website: **www.FujifilmSericol.com**

UV Inks

InkRange	Outdoor life (Months)	Exceptions
Uviplast Series		
2000 UP	12	UP164 - 8 months
3000 QR	24	-
Multidyne LY	12	-
Omniplus UL	24	UL164 - 8 months
		UL121 - 8 months
Hiflex ES	30	-
Uvispeed Series		
Gloss UG	12	-
Matt UM	12	UM064 - 3 months
		UM021 - 6 months
Poster AZ	3	-
Citylite VZ	3	-
Multiflash UZ	24	UZ164 - 8 months
		UZ121 - 18 months
		UZ114 - 12 months
		UZ064 - 18 months

Solvent-based Inks

InkRange	Outdoor life (Months)	Exceptions
Multidyne LO	24	LO164
		LO191
		LO064
		LO114
Multispeed IQ	24	IQ164
Plastijet XG	24	XG043
		XG102
		XG113
		XG124
		XG164
Polyplast PY	24	PY113
(See also PYEL below)		PY164
		PY064
		PY078
		PY114
Polyplast PYEL (Extra lightfast)	72-84	
MattPlast MG/MH	24	MG164 - 12 months
		MG190 - 12 months
		MG461 - 3 months

SERICOL
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