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Factors influencing- LIGHT and Weather Resistance

OF SCREEN AND PAD PRINTING INKS

Compared to other printing processes the unique features of screen and pad printing inks are not only the high mechanical and chemical resistances but also their excellent light fastness and weather resistance. However, screen and pad printing inks must meet much more demanding quality requirements, such as high resistances of multiple layer prints or resistance values of coloured plastic materials. Often outdoor resistances of several years are required.
To meet such high demands printers have to take various aspects into account.

» Factors influencing light and weather resistance «

- Substrate
- Pigment
- Ink type
- Colour shade
- Layer thickness
- Protection

Basically, any print used outdoor does not last forever. Even the best and most stable colour layer will decompose throughout the years due to exposure to sunlight (especially UV radiation) and weather influences, mainly humidity, temperature changes, composition of air (salt, exhaust gas etc.). Printers can only try to slow down this decomposition process using the best possible high-quality materials.

SUBSTRATE

It all begins with the substrate. If the substrate is not weather resistant, then the applied ink won't be either. The deterioration of the substrate will cause the applied ink to decompose from underneath. Therefore, the first step is to choose a substrate meeting the demanded weather resistance requirements.

Any simple polystyrene board for instance, will show a visible yellowing after only a few weeks, which will continually increase. Also, they will become brittle after only a few months.

Polyester foils, as used for e.g. membrane switches also have a limited suitability. The UV-light of the sun may cause a significant discolouration within only a few months.

PVC materials have different properties. Rigid PVC mostly has an outdoor resistance of 1 year, whereas high quality PVC self-adhesive foils may even last more than 10 years in outdoor applications.

PMMA, known as acrylic glass or also as brand name Plexiglass, also has an excellent light and weather resistance. Illuminated gas station elements are often made of PMMA.
The fact that PMMA absorbs UV-light will also significantly increase the life cycle of the printing inks applied to the reverse side.

PIGMENT

The colours of our screen and pad printing inks are produced with pigments. Generally, we only use especially lightfast pigments (6 - 8 according to wool scale).

An exception are fluorescent pigments (our colour codes 90 to 95), which basically have a limited light fastness and some special colours with a medium light stability offered in two of our UV ink ranges for packaging printing.

Our choice of pigments is the base for long-lasting prints.

The worst "enemy" of pigment stability is the high energy UV-radiation of the sunlight. It attacks the pigments and destroys them sooner or later. Therefore, light resistance of pigments must always be considered in relation to duration and intensity of the sun light.

Naturally conditions vary depending on climate.

The pigments which have the highest resistance against UV-radiation are certain blue pigments. Yellow and red pigments are a little less resistant. Under certain conditions white pigments (titanium dioxide) may even have an adverse effect on light and weather resistance.

For more information please refer to section COLOUR SHADE.

INK TYPE

Ink type (e.g. TP 300, HG, ZMN) refers to the binder system used for mixing with the pigments as specific colours (e.g. Y50, R50, B50).

To achieve long term outdoor resistance not only suitable pigments but also light and weather resistant binder systems are required.

Initially the binder system of an ink type is picked in regard to the substrates and also to achieve certain resistances such as light and weather resistance, mechanical and/or chemical resistances.

Unfortunately, a combination of that all is not always possible.

For the printing of glass and ceramics, some metals and coated surfaces with very high chemical resistances epoxy resins are required. Ink ranges such as **Z/GL, Z, UV/K, UVE, TP 218, TP 260** contain epoxy resins.

Unfortunately UV-radiation will quickly decompose epoxy resins.

Therefore, these ink types are not recommended for outdoor applications, even though they contain high quality pigments.

This also applies for prints on the reverse side of glass if the glass material does not absorb the UV-radiation.

Ink Types like **HG, CX, J, UVN, UVX2, UVU, TP 313, TP 340** on the other hand exhibit good resistance values.

For especially long-term outdoor applications, however, certain 2-component inks are recomended e.g. **Z/PVC, ZMN, Z/DD, TP 267, TP 307**.

Example for fading of colour pigments due to sun light

Comparison between "new" and "old"

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COLOUR

Colour or colour mixture is another decisive factor for long-term colour stability.
Take our **C-MIX 2000** range as an example.

12 strong and brilliant colour shades with a medium to high transparency, which are suitable for matching of PMS, HKS and RAL shades on white substrates. Each colour only contains one pigment (= mono pigmentation). Those base colours used with the right ink range are ideal for long-term outdoor prints.

The weather influences the white pigmentation which by photo-chemical reaction will form a disturbing, mealy, milky white chalk layer on the surface of the printed ink layer. Therefore, highly opaque whites are not recommended for long-term outdoor applications.

This effect does not only show on screen and pad printed products. It is a common issue in nearly all coating technologies, e.g. like on company buildings with colour coated corrugated metal plates.

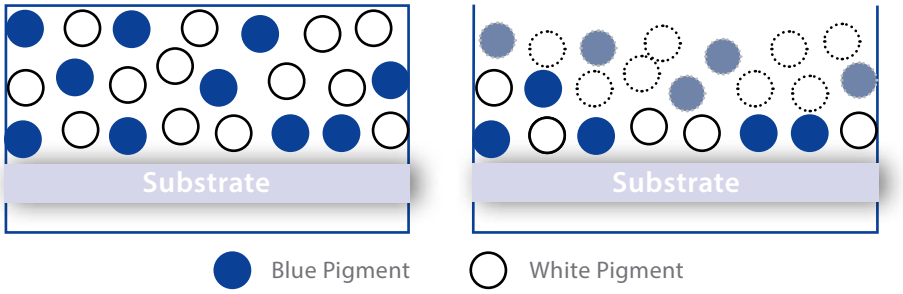
Therefore, colour is much more stable. However, if adding high amounts of varnish, the colour will fade.

UV-radiation will destroy the pigments. So, colour of prints with a low pigmentation will change sooner.
This also applies to colour mixtures which only contain a low portion of one colour shade.

Chalking of ink layer

Chalking of ink layer
The high content of white pigment in the light blue will quickly result in a chalking effect on the colour surface. When rubbing off the original colour will reappear (more or less) as shown on the picture on the left.

Schematic representation of chalking



Cream-white or very light transparent colours are much more tricky, e.g. a light milky blue, a creamy read or a touch of a transparent yellow. The higher the content of white or varnish in an ink is, the shorter will be the light and weather resistance of the prints.

High white content (> 20 %) in an ink mixture will increase the tendency to chalking.
The more white is contained, the higher is the risk of chalking.

If such plates are light blue there will be more large-scale chalking on building parts with significant light and weather influence after about 3 – 4 years than on the building parts in the shade.

A couple of years ago the railway company had a similar problem with creamy-red coated trains and light blue signs in the train stations.

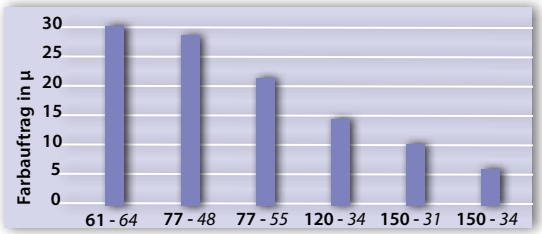
Now the trains are bright red and the signs dark blue.

LAYER THICKNESS

In addition to pure and intensive colours you can also achieve better resistances against weathering using high layer thickness.
The thicker the better.

Cars or metal building fronts are coated in multiple layers up to 100µ. In screen printing applications the dry ink layer is about 5µ to 20µ depending on the screen fabric

used. Multiple pad prints (2 – 3 times) applied with optimum ink transfer may achieve 20µ. Screen fabrics ranging from 54 – 120 threads/cm are used for solvent based inks and fabrics of 120 – 150 for UV inks. UV inks may also be processed with fabrics of 100 threads/cm, however only if ink can still be sufficiently cured.



Layer thickness in relation to screen fabric

Printed traffic signs (right) are an example for extemely long-term applications. Printed on long-lasting materials, with high quality inks and higher layer thickness they still show signs of weathering. Depending on location (geographic direction, duration of light influence etc.) they will fade sooner or later.

Above: without chalking
Below: traffic sign weathering

PROTECTION (?)

You could protect the printed ink layer with varnishes containing UV protection additives. However, a notable effect of absorption of UV-radiation will not take place unless you apply the protective coating with a layer thickness between 50µ and 100µ.

On the other hand, depending on the ink type used, a protective coating may also have undesired side-effects such as cloudiness of the varnish layer. However, in some individual cases protective coating may be suitable to shield the ink layer from mechanical damage and mainly dirt.

LIGHT AND WEATHER RESISTANCE TEST

To get the necessary information about properties of substrates, ink types and colours, test prints are usually subjected to open air or accelerated weathering.

In an open air test sample prints are subjected to natural light and weather conditions for a period of several years, therefore reliable test results take quite a long time.
At the same time accelerated weathering testers are used. In this equipment test prints are subjected to UV-A light and condensation humidity 24h/day.

Due to this agressive mixture the material will quicky age so that about 1 month accelerated weathering corresponds to approx. 7 – 8 months outdoors.

QUV - Accelerated Weathering Tester