Tech
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Marabu

Auxiliaries for solvent-based Screen Printing Inks

Appropriate use of Marabu's Additives and Auxiliaries for Solvent-based Screen Inks

Screen
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It is well known that screen printing lives from the variety and almost unlimited possibilities for industrial as well as graphic applications. Today, Marabu offers numerous solvent-based ink systems. Each individual ink type has clearly defined properties and specific fields of use. These requirements are considered while development by selecting the right binder and additives. If different ink properties are required for special print jobs, alterations can be made by the careful use of our additives and auxiliaries. Please see below for a description of their properties and benefits.

List of contents

1. Viscosity

Viscosity describes how thin (low viscous) or thick (highly viscous) an ink system is or how it is adjusted. Before starting the print run, it is important to adjust the ink to the correct viscosity, as this will have an influence on ink levelling, print sharpness, mesh opening, drying behaviour, possible printing speed and ink adhesion in some cases. Owing to the variety of machines and requirements in the market, solvent-based inks are not press-ready. Before printing, the ink´s viscosity must be adjusted by adding solvents. Single exception is the 2-component "traffic sign ink" Mara® *Sign* TS.

Generally, the following 'rule of thumb' is applicable for solvent addition based on an ambient temperature of 20°C:

10-15%	full-area ink for hand printing and flat-bed machines, for 2 component inks 10% is sufficient due to the hardener addition
15-20%	full-area ink for cylinder printing machines
10%	4 colour process (4cp) ink for hand printing and flat-bed machines, for 2 component inks, 5% is mostly sufficient due to the hardener addition
15%	4cp ink for cylinder printing machines

Basic shades are always adjusted to a relatively similar viscosity range, with two exceptions:

- Due to high pigment levels in White, Opaque Whites, and high-opaque shades, the viscosity is always higher than all other shades
- 4-colour process inks feature a higher viscosity than the basic shades in order to ensure best dot definition

Different ink types usually have different working viscosities, depending upon the individual requirements.

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Thinners

The addition of thinner influences the viscosity, flow properties, mesh opening, drying speed, block resistance, solvent and dissolving power, and also to a large degree, the adhesion to the substrate. The two thinners UKV1 and UKV2 can be used for most ink series, for ink types based on other solvents there are other thinners available. Please refer to the ink´s Technical Data Sheet or the Table of inks and substrates for the recommended thinner.

Spray thinners

If the ink is applied with a spray gun, very fast evaporating spray thinners are available. Fast drying of the ink at the surface is important in order to avoid surface irregularities.

Retarders

Retarders are solvents with a significantly slower evaporation, resulting in an improved mesh opening while on the other hand reducing the drying speed as well as the block resistance. Retarders are normally added to the thinner for printing fine details and halftones, or if slow printing speeds are required. Retarders change the ink´s viscosity and are chosen for ink compatibility and adhesion to the substrate, always in combination with thinners.

Product overview and characteristics

Most products are a mixture of different solvents. The Speed of evaporation is an important characteristic.

Thinners

	Evaporation	Solvent power	Odour
GLV	slow	good	mild
LIGV	slow	good	mild
MGLV	average	good	mild
PLV	very fast	good	mild
PSV	very fast	low	mild
PUV	very fast	good	average
PV	slow	good	mild
QNV	slow	good	average
UKV 1	very fast	very good	strong
UKV 2	fast	good	mild
YV	slow	average	mild

Spray thinners

	Evaporation	Solvent power	Odour
PSV	fast	low	mild
7037	very fast	very good	strong

Retarders

	Evaporation	Solvent power	Odour
SV 1	average	good	mild
SV 3	slow	low	mild
SV 5	fast	very good	mild
SV 9	slow	low	mild
SV 10	average	good	mild
SV 11	average	good	mild
SV 12	slow	good	mild

Cleaners

	Evaporation	Solvent power	Odour
PLR	very fast	low	average
UR 3	fast	good	mild
UR 4	average	good	mild
UR 5	average	good	mild

Remarks

The evaporation data is based on proportional figures of the relevant solvents and theoretically calculated values without considering the interactions occurring through solvent mixtures and the influence of binders. In practice, one may not draw an automatic conclusion from the evaporation value to the direct quality of mesh opening.
The "evaporation" value is a guide only and must be always controlled in practice. The data in the "odour" column is subjective and may be judged differently from one person to another.

Further general recommendations

- The surface of polystyrene is not solvent resistant and allows the solvents to migrate to the inside of the material very quickly. We recommend the fast and mild Thinner PSV for this application.
- Injection moulded plastic parts with a high tension within the material also require a very mild ink solvent to obtain good printing. We recommend the mild Thinner PSV here as well.

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Transparent base
Some ink systems offer a transparent base "409" in their range, with the following application purposes:

- to decrease the colour density of 4-colour-process shades
- to increase the ink´s viscosity for standard and 4-colour-process shades
- to reduce flow properties of standard shades when printing fine details, and negative printing

Transparent bases always include the original binder of the relevant ink type and are, therefore, always compatible. An addition of 5-20% to the shade reduces the flow ability while increasing the viscosity at the same time. The shade may show a slight tendency to smear. For a homogeneous mixture, we recommend adding thinner and/or retarder to the transparent base first and then mixing it with the colour shade.

Advantages of Transparent Base
- higher thixotropy, flow property will be reduced
- viscosity is increased
- best compatibility
- easy addition (manually)

Disadvantages of Transparent Base
- opacity and colour strength is reduced depending on quantity added
- degree of gloss is somewhat reduced
- moulding ability is probably reduced
- weather resistance is reduced
- homogeneous ink levelling is somewhat reduced

2. Opacity

Most screen printing ink series feature 17 standard shades according to System Maracolor. This ink system embraces a combination of opaque and transparent shades, allowing brilliant colour shades to be mixed. If a high opacity is required for printing onto dark substrates, the following options are available. Keep in mind, however, that an increase in opacity will likely lead to a slight reduction in brilliance.

High-opaque shades
Several Marabu screen printing inks have been complemented with additional high-opaque shades.

Opaquing Paste OP 170
The addition of Opaquing Paste OP 170 significantly increases the opacity of colour shades without substantially reducing the resistance to chemicals or dry abrasion. Max. addition amounts to 15 %. OP 170 is not suitable for use with white inks. Attention: OP 170 is not recommended for all ink series; further details see Technical Data Sheets.

The Marabu-ColorManager MCM includes optimized opaque and high-opaque colour match formulas, enabling good matches with colour references such as RAL, HKS, and PANTONE®.

3. Rheology

The generic term "rheology" describes the ink´s flow properties and depends on the binders used as well as on the solvents added.

Thixotropy is one of the rheological characteristics of an ink. It describes how an ink´s consistency is changed during shear action, e. g. becoming "more fluid" during the printing process.
We distinguish between a "short" ink having a high thixotropy (poor flow ability), this means that the ink tears very quickly when flowing down on a spatula (like ketchup drops from a spoon) and a "long" ink having a low viscosity (high flow ability), which holds the ink together for a longer time (as honey flows from a spoon).
This varying behaviour of the flow characteristic, amongst other parameters (e.g. solids content of the ink), has a central influence on ink transfer from the screen to the substrate, moulding behaviour, ink behaviour onto electrostatic charged materials, mesh opening, and contour definition of fine details, as well as 4-colour-process printing. The rheological adjustment of each ink system is optimised for the intended application; it can, however, be changed by adding suitable auxiliaries. The advantage of ink systems having a high toughness is the tendency towards higher chemical resistance, provided that suitable binders were selected.

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Thickening agent STM

Thickening agent STM is a thickener in powder form which significantly increases viscosity and thixotropy of a printing ink (reduced flow ability) if 1-2 % are added and mixed mechanically. This addition is useful for printing very fine details in positive and reverse printing, for haptic effects (thick ink film is desired), and when printing onto absorbent materials, e.g. uncoated papers.

Advantages of STM

- the inks do not smear
- viscosity is increased
- colour strength is not reduced
- universal use

Disadvantages of STM

- machine-stirring is obligatory
- moulding ability is considerably reduced
- reduced weather resistance
- reduced degree of gloss
- reduced surface flow of the ink

Retarder Paste VP

Retarder Paste VP is well suited for very fine printing motifs and for 4-colour-process printing. An addition of 10-15%, supplementary to thinner and/or retarder, keeps the viscosity high and improves the mesh opening at the same time. VP can be added to most of the solvent-based inks, see details in the Technical Data Sheets.

	STM	**VP**
Form, Addition	Powder, 1-2%	Paste, 10-15%
Viscosity	↑	→
Thixotropy	↑	↗
Opacity	→	↓
Ink levelling	↓	→
Degree of gloss	↓	↘
Remark	Must be stirred mechanically	improves mesh opening

↑ = increase, ↗ = slight increase, → = unchanged, ↓ = decrease, ↘ = slight decrease

4. Matting

The degree of gloss of a solvent-based ink can be reduced by adding auxiliaries.

Matting paste ABM

With an addition of 10-30% matting paste to the ink, the degree of gloss is reduced, according to the percentage used. As a result of this, a roughening of the ink surface is created which reduces the reflection of the incident light and thus leads to a matt appearance. Depending on the quantity of ABM added, opacity and abrasion resistance will be reduced. As the degree of gloss of White/ Opaque White shades is generally lower, the quantity to be added must be reduced (10-20%). If Matting Paste ABM is not suited for an ink series, the universal Matting Powder MP can be used.

Matting Powder MP

If a printing ink should have a matt surface, without reducing the opacity, this can be achieved by adding the universal Matting Powder MP. An addition of 1-4%, for White/Opaque White max. 2%, is recommended. The MP Powder must be stirred mechanically into the ink. MP can be used universally for all ink types, specifically for all 2C-inks.

5. Plasticizer resistance

Soft vinyl (PVC) is heavily loaded with plasticizers that are chemically not bound within the material (10-40%), which allows them to possibly migrate into the printed ink film after the printing process. Ink series that are specifically developed for printing onto soft vinyl have the ability to incorporate the plasticizer into the ink film, with good adhesion on the substrate and block resistance. To improve this process furthermore, 10-30% of matting paste or matting powder MP can be added to the printing ink. Both possibilities achieve a roughening of the ink surface and the emergence of small hollow spaces so the ink film can absorb the plasticizer. The addition of matting paste or matting powder reduces the degree of gloss which leads to a reduced abrasive resistance of the ink film at the same time.

6. Block resistance

If matting paste or matting powder is added to a screen printing ink the block resistance of the printed sheets in the stack will be increased. However, the degree of gloss and the abrasion resistance of the printed ink film is also reduced. It is also important to

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control the thinners and retarders used. For a good block resistance, do not use auxiliaries with low evaporation rates.

7. Elasticity

Thermal loads, e. g. during the drying process, may lead to tensions in the printed sheets due to different expansion coefficients of ink film and substrate. This can be vital when it comes to very thin substrates like self-adhesive films, particularly if post-processing steps like cutting or die-cutting are involved. This risk can be minimized:

Plasticizer WM1

1-5% of Plasticizer WM1 can be added to 1C-ink systems (except for Mara® *Prop* PP) to "de-stress and to flexibilize" the printed ink film. This minimizes the risk of "edge curling" or material shrinkage of printed self-adhesive films. Plasticizers are extremely low-volatile substances which reduce the rigidity of ink films.
When printing several ink layers onto a thin film (e.g. for double-sided stickers), a plasticizer must be evenly added in all layers (3-5 %). One should bear in mind that any addition of plasticizer will reduce drying speed and, as a consequence, block resistance in the stack.

Control of solvent residues

The following facts should be considered for post-processing steps like cutting or die-cutting of printed adhesives: the flexibility of the binder used, the addition of a plasticizer, and the content of the solvent residues in the printed ink film. If the percentage of residual solvents is too high, the substrate and the ink film are still soft, and shrinkage of the foil or "edge curling" after cutting or die-cutting will be the result. To avoid this we strongly recommend minimizing the quantity of retarder used, sufficient drying in a rack or warm air tunnel, or the longest possible drying time of the printed sheets before processing.

8. Ink levelling

Basic formulations of inks already contain levelling agents to prevent air bubbles in the ink as a result of squeegee movement or stirring.

If the ink´s viscosity is too high, insufficient levelling may be the result. It can often be resolved by simply adding more thinner. If this does not lead to an improvement, the following auxiliaries are available:

Printing Modifier ES

The silicone-based auxiliary ES reduces the surface tension of the ink and has a defoaming effect. The quantity added must not exceed 1% (please use a scale!), as otherwise adhesion or overprintability may be affected.

Levelling Agents VM1 and VM2

Both levelling agents are silicone-free and are only recommended for silicone-free inks.

9. Abrasion resistance

Surface Additive SA-1

The addition of this auxiliary can increase the resistance against abrasion and other mechanical stress in many screen printing inks.
Recommended addition: 3-5% (max. 10%).

10. Primer

Polyolefins such as polypropylene and polyethylene must be pre-treated before printing, usually by Corona-treatment or flame treatment. When printing onto polypropylene there is an additional pre-treatment possible by applying a primer.

Primer P 2

This special "solvent" is manually applied to the entire surface with a cloth or a spray gun before printing. It is then possible to print onto polypropylene with a 1C- or 2C-ink. The effect of this pre-treatment is limited in time, so it should be applied max. 1-2 days before printing.

11. Pre-cleaning

Many materials such as plasticized PVC or powder coated or wet painted substrates are invisibly contaminated by additives or plasticizers. This contamination may act as a separation layer and, therefore, may lead to adhesion problems due to a lack of contact between substrate and print.

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Tarpaulin Cleaner PLR
Using this mild alcohol-based cleaner, residues can be removed with a cloth soaked in PLR, often resulting in better ink adhesion. Please change the cloth from time to time.

12. Hardeners

There are ink systems which can be optionally used as single or 2 component ink systems. In these cases, the addition of hardener can increase adhesion to difficult substrates as well as the chemical and mechanical resistance. For 2-component inks, hardener must be added.

It should be noted, however, that the addition of hardener will reduce pot life to 8-16 hours (except with Hardener HT 1), depending on the ink type.
The following hardeners are available for the Marabu ink systems:

Hardener H 1
Hardener H 1 is non-yellowing and is, therefore, suitable for outdoor applications. Other characteristics: long pot-life relatively flexible ink film, which results in slow drying.

Hardener H 2
Hardener H 2 is not suitable for outdoor applications because it yellows when exposed to UV-radiation, which will be visible especially with varnishes or whites, and light-coloured shades mixed with white. Other characteristics: rigid ink film, shorter pot-life, quick drying.

Hardener H 3
Hardener H 3 has the same properties as Hardener H 1, its chemical base, however, is different and therefore only suited for certain ink series.

Hardener H 4
Hardener H 4 is non-yellowing and is, therefore, suitable for outdoor applications. Other characteristics: significantly increased resistance to water and humidity.

Hardener H 5
Hardener H 5 is non-yellowing and is, therefore, suitable for outdoor applications. Other characteristics: Very flexible (for applications with further processing by forming), which results in slow drying.

Hardener HT 1
HT 1 is a heat-reactive hardener which only reacts with the ink if force-dried at 150°C for 30 min. HT 1 can be used instead of H1 or H2, provided the same quantity of hardener is added, and has the big advantage of a prolonged pot-life of up to 6 months!

General information on hardeners
All hardeners are sensitive to humidity. Therefore, the drying process must take place at the lowest possible ambient humidity in the first 24 hours, otherwise parts of the hardener will react with the water instead of the ink. During storage of the hardener any contact with humidity must also be strictly avoided (containers must always be completely closed after use!).

Furthermore, the degree of cross-linking of hardener and ink, subsequently the chemical and mechanical resistance of the printed 2-component ink, is highly dependent on the temperature. By a forced drying of the ink at 140°C-150°C for 20-30 min. directly after printing, best possible cross-linking and thus the highest resistances will be achieved. 2-component ink systems can also be dried at room temperature; the complete cross-linking will, however, take up to 7 days and may have a reduced resistance. On difficult substrates such as glass, some metals, thermosetting plastics, and for high requirements, (e.g. dishwasher-resistance), forced drying of the ink in the oven may be essential.

Hardeners GLH, MGLH and YH9
These hardeners are exclusively designed for one single type of ink and cannot be used universally in other ink systems. GLH is the appropriate hardener for Glass Ink GL, MGLH for Mara® *Glass* MGL and Tampa® *Glass* TPGL. The Hardener YH9 is available for the use with Mara® *Poxy* Y. For further details please refer to the Technical Data Sheets of the respective ink series.

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13. Remark

Besides the regular addition of thinner or hardener, further modification of the ink with auxiliaries should be well-considered.

Auxiliaries show their positive effect only if added in the adequate quantity. Please refer to the Technical Data Sheets for quantity indications. The quantities are based on percentage by weight and not by volume. Overdosing will in most cases adversely affect the printing results and will lead to difficulties such as levelling problems or loss of adhesion, especially for multicolour prints. For these reasons, a scale and accurate working are a necessity.
Any addition of an auxiliary will change the characteristics of the respective ink system. Preliminary trials are always essential.

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