PROPYLS

DISCOVER THE SUPERIOR SOLVENT CONCEPT

DO YOU WANT TO BE A PART OF THE NEW MOVEMENT IN THE PRINTING INDUSTRY?

LET'S TALK ABOUT A SUPERIOR SOLVENT CONCEPT: PROPYLS.

CONTENTS

INTRODUCTION

Which role does Propyls play in the printing process? Propanol and Propyl Acetate can replace conventional solvents in rotogravure or flexographic printing processes without any further investment in the existing printing processes. Using Propyls will help to achieve significant savings in terms of solvent and ink consumption. Global industry trials showed that average savings of 20% ink and 30% of solvents are feasible.

Learn more about the advantages and industry studies of OQ in this brochure. You can also talk to an OQ representative about a tailor-made solution for your printing environment. When it comes to making the change, our technical experts have experience gained in trials with printers and converters all over the world.

> **“Propyls“ is a made-up word that is used to describe Propanol (n-Propanol) and Propyl Acetate (n-Propyl Acetate) mixtures or pure Propyl Acetate, whereas the term “Ethyls” is used to describe conventional solvents like Ethanol and Ethyl Acetate or blends of such.”**

1. QUALITY

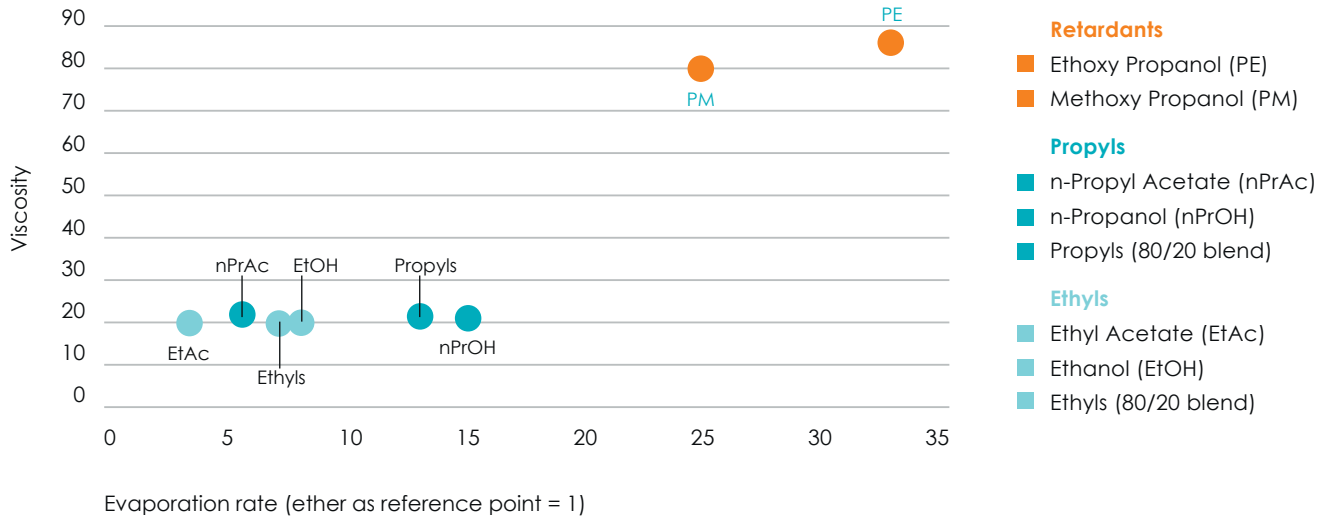
1.1 MORE STABLE PROCESS AND LESS NEED FOR ADJUSTMENTS

When using Ethyls the balance between evaporation rate and viscosity is a constant struggle of excessive retardant use and ink performance requirements. As the speed of printing presses becomes faster, the evaporation rate of ink solvent needs to remain slow and controlled. Historically this has been managed by the presence of retardants such as glycol ethers, which have a higher boiling point. The addition of retardants slows the ink evaporation rate, contributing to better brilliance and adhesion during the layer formation, but this significantly increases viscosity.

Using Propyls will help you to increase the overall process quality and stability of the printing operations. It will result in:

- **Increased viscosity stability**
- **Decreased solvent retention**
- **Increased photopolymer lifetime**
- **Decreased moisture absorption**
- **Reduced use of retardants**
- **Less manual input required to achieve stable print quality**

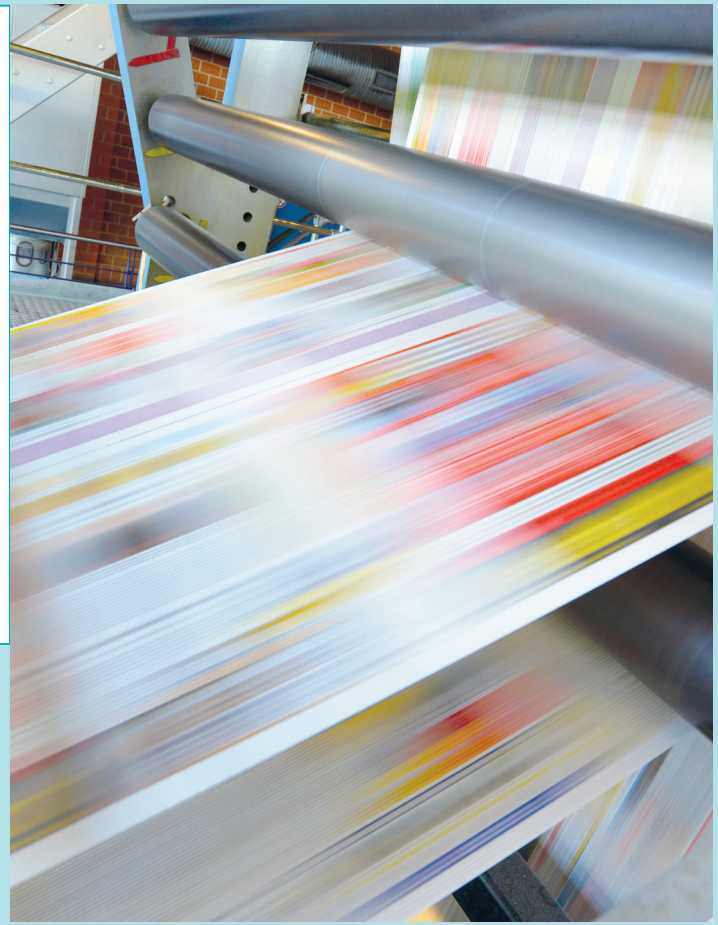
VISCOSITY AND RELATIVE EVAPORATION RATE OF SOLVENTS AND RETARDANTS



Retardants
- Ethoxy Propanol (PE)
- Methoxy Propanol (PM)

Propyls
- n-Propyl Acetate (nPrAc)
- n-Propanol (nPrOH)
- Propyls (80/20 blend)

Ethyls
- Ethyl Acetate (EtAc)
- Ethanol (EtOH)
- Ethyls (80/20 blend)



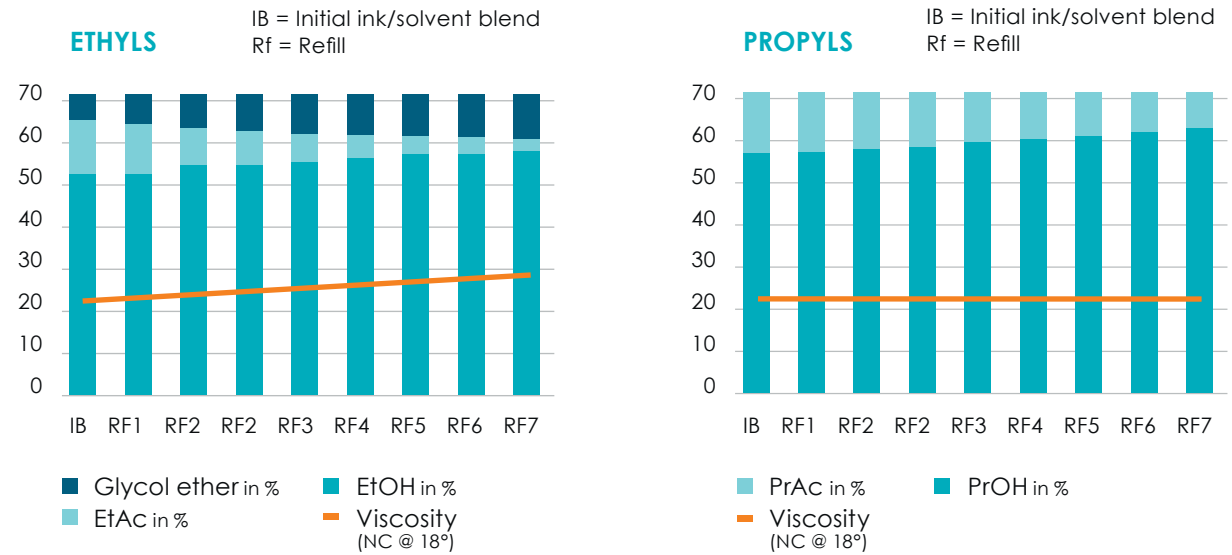
OQ Chemicals's Propyls display ideal evaporation rates at low viscosity, minimizing the need for slow evaporating glycol ether retardants which add unwanted viscosity to the ink.

1.2 INCREASED VISCOSITY STABILITY

SPEND LESS TIME ADJUSTING THE VISCOSITY

In the course of the printing process, retardants accumulate in the overall base ink due to their low evaporation rate. As the ink viscosity increases, past the acceptable specification limit, more solvent must be added. Continuous refills become necessary which leads to increasing instability of the ink in the sink.

Propyl blends can help to maintain a consistent viscosity over the printing process. The below evaporation-refill scenario illustrates how using Propyls allows for a better process and ink stability. Propyls require less retardants.



OPTIMIZED INK STABILITY

Refilling with alcohol-ester solvent blends in the course of printing shifts the composition towards lower ester content. Propyls facilitate a more consistent ink composition which has a positive impact on print quality.

When using Ethyls, the ink viscosity is negatively impacted due to its evaporation behavior. This calls for the addition of more Ethyls solvent which in turn decreases color density.

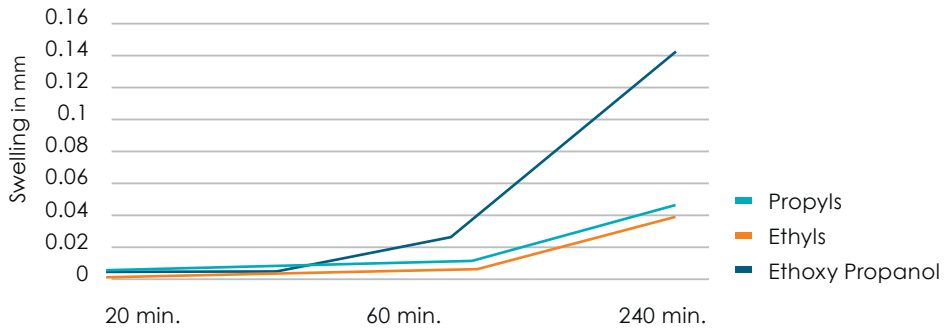
1.3 REDUCTION OF RETARDANTS IN THE REFILL

As retardants are an elementary component in the ink formulation provided by the ink manufacturer, additional retardants won't be necessary while preparing the base ink at the press using Propyls.

During the coatings, the evaporation of solvent takes place at the top surface of the flowing fluid. If the solvent evaporates too fast then this top dry surface could act as a diffusion barrier to prevent any further solvent evaporation.

PHOTOPOLYMER LIFETIME

Ethyls blends require more Glycol Ether than Propyls blends. As Glycol Ethers are more aggressive against the photopolymer than linear alcohols, the reduction of such leads to prolonged durability of the photopolymer.



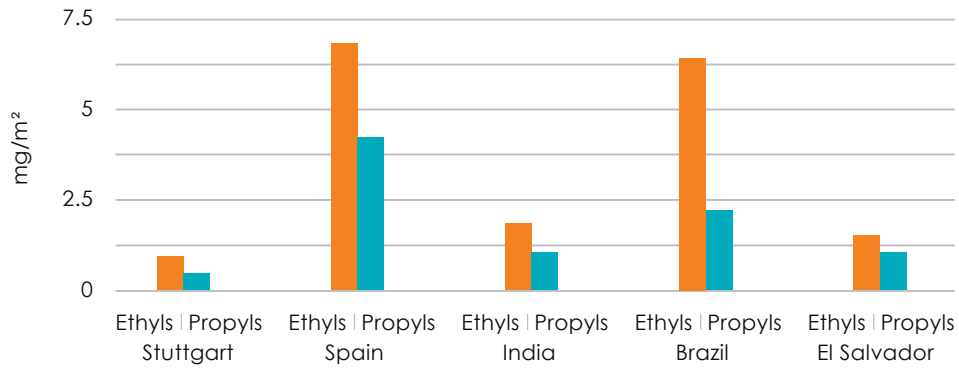
Damage of Photopolymer in Solvent.

1.4 DECREASED SOLVENT RETENTION

Starting from the same ink base, the printed film with Ethyls shows more solvent retention due to the dry early skin layer formation, which impacts proper solvent evaporation. Evaporation of the volatile constituents occurs from the top surface of the ink. For Propyls this means less retained solvents and no objectionable odor in the dried ink film. In addition, Propyls are less polar molecules than Ethyls and therefore molecular interactions with resins are weaker, thus accelerating the release of solvent from the drying film.

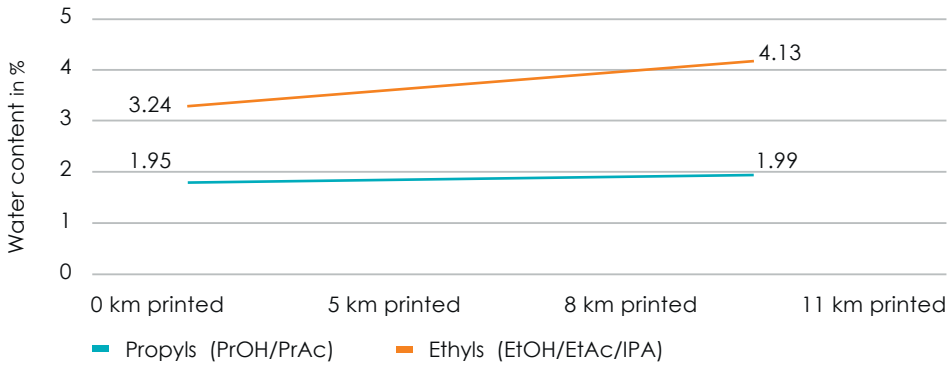
RETAINED SOLVENT

GC measurements in industrial scale trials clearly indicate the trend of less retained solvent when exchanging Ethyls for Propyls. This trend applies for both Flexo and Gravure.

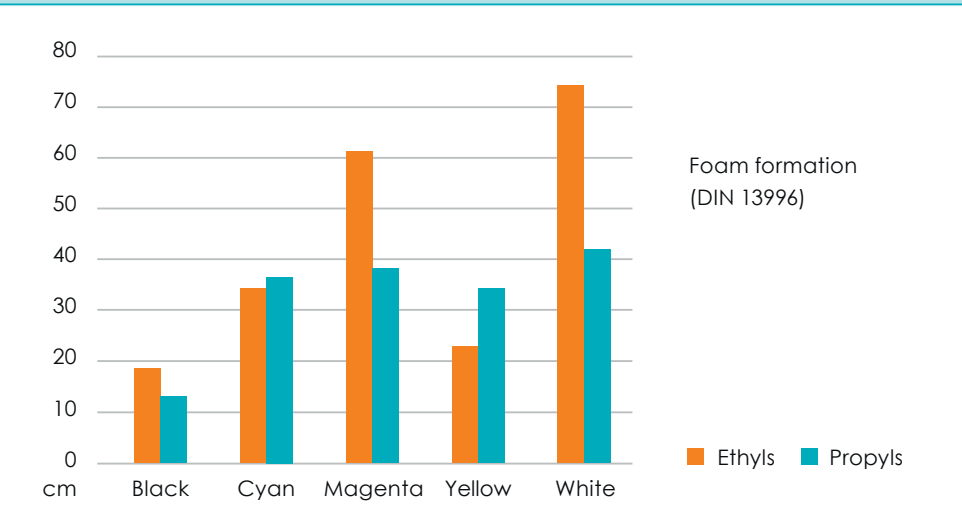


1.5 DECREASED MOISTURE ABSORPTION

Higher water content causes printing problems such as blush or milky obsolescence in addition to foam formation. The use of Propyls lowers water spoilage and quality issues in the printing ink. Propanol has a longer hydrophobic alkyl-tail so the molecule is less hygroscopic than Ethanol and isopropanol. It minimises the use of retardants like glycol ethers, which are hygroscopic and can lead to increased moisture absorption.



WATER CONTENT IN THE COURSE OF PRINTING
This graph shows how the ink with Propyls has lower moisture absorption tendency than ink with Ethyls at the beginning and the end of the run.



Reduction of foam formation by more than 22.4% on average.

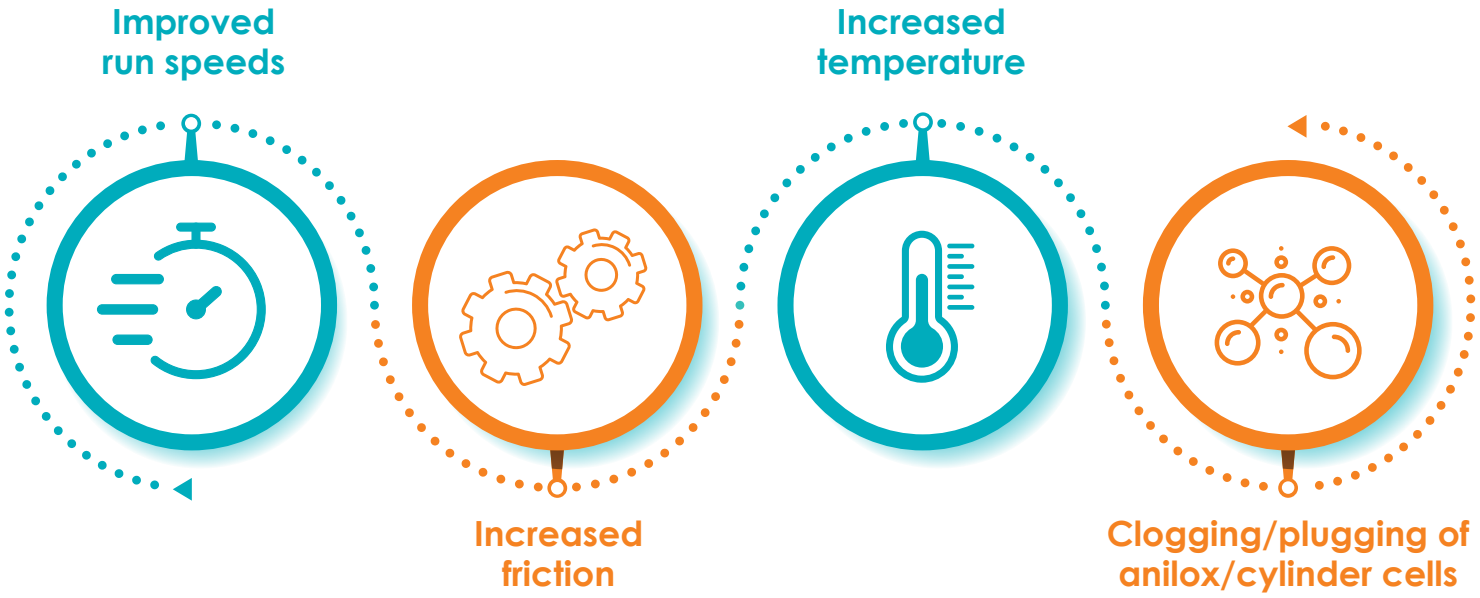
FOAMING OF INKS IN FLEXOGRAPHIC PRINTING (TRIAL AT HDM/DFTA)
During one of the Flexo trial studies conducted at the University of Media Studies in Stuttgart, the foam formation behavior in an Ethyls and Propyls environment was investigated.

In a 10 km print run with five colors and a printing speed of 220 m/min, foam formation could be reduced by 22.4% (average of all colors) by using a Propyls blend of 5% PrAc and 95% PrOH (Ethyls blend used for comparison: 5% EtAc, 85% EtOH, 10% PE).

1.6 FASTER SPEEDS, LESS DOWNTIME

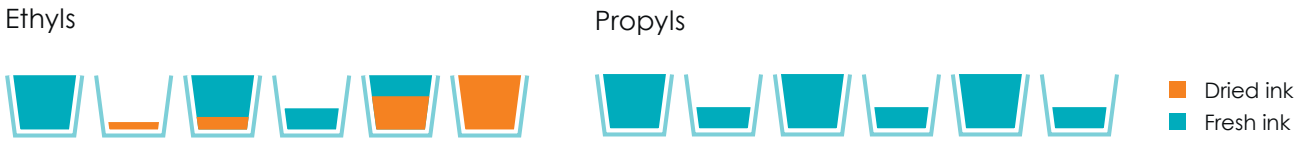
High speeds change cylinder dynamics in the press and can be a major challenge. At accelerated speed, the ink release of a press decreases which creates dry ink problems for faster evaporating solvents.

Propyls are medium evaporation rate solvents, capable of drying on the web film but not in the anilox or engraved cells. This enables increased speed for the printing process and subsequently improved productivity.



How increased printing speed leads to clogging/plugging. Propyls allow to work at high speeds without clogging/plugging.

DEVELOPMENT OF PLUGGING IN CELLS



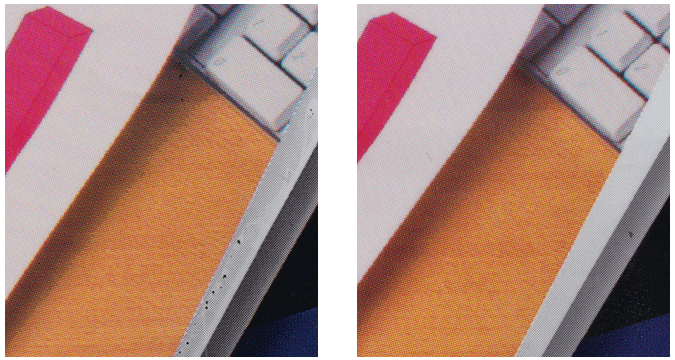
Clogging/plugging potential of Ethyls and Propyls in comparison. Picture represents the magnified view of anilox or gravure cylinder cells.

Anilox or engraved cells using Propyls transfer the full amount of ink, leading to a higher print quality and a reduced need to stop the press to clean the anilox or gravure cylinder. Using Propyls removes dry ink accumulation inside cells, resulting in more accurate filling/emptying throughout the entire printing process. The formulation stability and evaporation rate of Propyls prevents plugging due to dry ink and reduces cleaning time.

1.7 IMAGE QUALITY

Faster evaporating solvents typically used at slower speeds will not be able to work at high speeds. Different rates of evaporation between fast and slow solvents (retardants) affect ink solubility. Esters as the active solvent play a key role in terms of solubility but they are the first to vaporize. A balanced solvent blend, containing slower-evaporating n-Propyl Acetate, improves the ink resolubility and helps to redissolve the dry ink. The benefit for the converter or printer is obvious: more efficient ink transfer, less scrap as a result of fewer press stops, as well as less solvent needed for cleaning purposes.

HIGHER PRINT QUALITY WHILE USING PROPYLS



Ethyls Propyls

Increased performance of ink transfer / less “dirty print”

1.8 PREPARE FOR ADVANCED TECHNOLOGIES

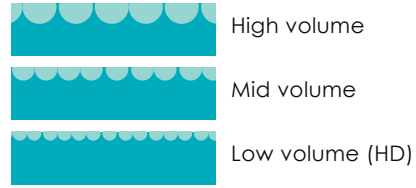
EXPANDED COLOR GAMUT

Utilizing a fixed palette of colors offers improved efficiency to the packaging printing process. It reduces downtime and extra hours for operators by eliminating the need to exchange spot colors between different print jobs. But this approach also requires greater ink-stability and longer ink stay in the running machine. This is where the benefits of using Propyls for ink refilling and viscosity control come into play. Propyls offer favorable evaporation behavior without the use of poorly evaporating retardant, ensuring ink composition remains consistent. Propyl alcohol-ester blends evaporate in a composition that closely resembles the refill solvent. This prevents an imbalance of active solvent in the ink, which can result in quality issues. Therefore, the combination of Expanded Gamut Printing and Propyls provides a synergistic effect in the pressroom while meeting the higher quality requirements of the products.

HIGH DEFINITION FLEXO PRINTING

High definition (HD) printing has transitioned from being a mere trend to becoming a standard practice in pressrooms. This technique utilizes a higher line density in the Anilox process, resulting in significantly improved image resolution that meets the packaging industry's demand for enhanced visual appeal. However, HD printing comes with the challenge of reduced ink volume transfer due to smaller cells. This poses a greater risk of cell clogging or plugging caused by dry ink. Fortunately, Propyls offer a solution to this issue. With their higher re-solubility potential and slower evaporation rate, Propyls enable HD printing without compromising on print quality.

Anilox cells for ink transfer



Propyls evaporate more slowly, allowing the use of higher line screen Anilox. Illustration shows anilox ink volume.

Printability

Propyls improve printability due to better re-solubility and a more balanced ink composition.

Tonal value

HD printing calls for minimum tonal values. Propyls allow to reduce the ink volume.

2. SUSTAINABILITY

2.1 LESS INK, SCRAP AND SOLVENT – MORE SUSTAINABLE PRINTING

Sustainability – the movement towards reduced consumption and more sustainable practices has arrived in the printing area. What can Propyls achieve? With Propyls, printers and converters use less ink and less solvent while also producing a lower percentage of scrap. As a result, resources are preserved and emissions of volatile organic compounds (VOCs) are reduced due to an overall decrease in the volume of solvent being used.

OVERVIEW OF SUSTAINABILITY-RELATED IMPACTS

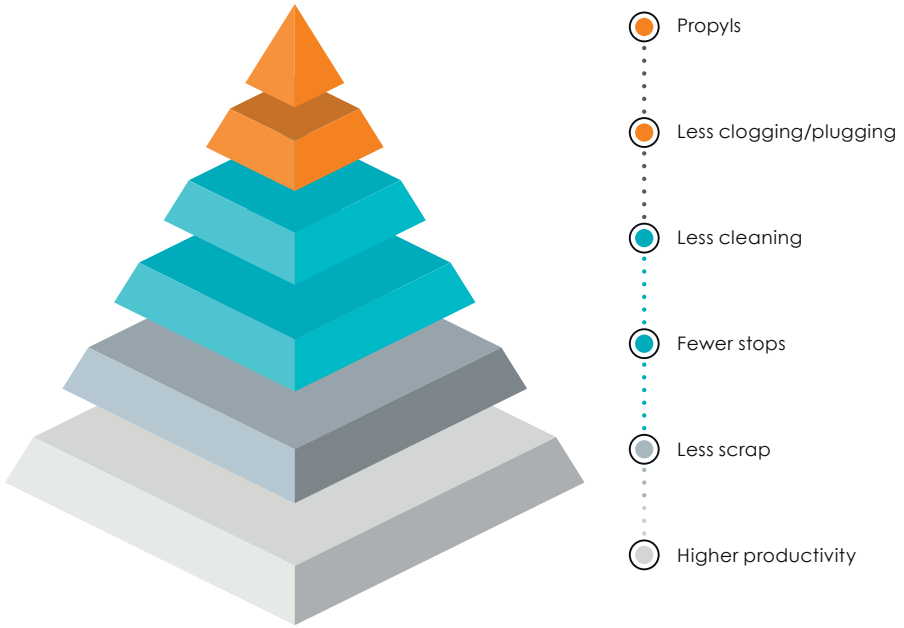
	Solvent savings	Avoidance of toxic solvent vapor to protect workers	Lower VOC concentration in the pressroom	Less energy demand for solvent recovery	Avoidance of scrap production (mainly film)	Lowering retained solvent in product
Propyls (n-Propanol / n-Propyl Acetate blends)	✓	✓	✓	✓	✓	✓
Ethyls (Ethanol / Ethyl Acetate blends)	✗	○	✗	○	✗	○
Toluene-ketone blends (Toluene/Ethyl Acetate or MIBK/MEK as active solvents)	○	✗	✗	○	No results so far	No results so far

✓ = positive impact
✗ = negative impact
○ = neutral

Implications in terms of sustainability for different solvent concepts

Solvent savings of 30% on average lead to a more sustainable and environmentally friendly process. The overall slower evaporation behavior of Propyls helps to reduce vapor concentration throughout the air of the pressroom. This reduction combined with reduced emissions of VOC into the atmosphere expose workers to lower inside-air-concentrations.

PRODUCTIVITY CAUSAL CHAIN



Less volume evaporated and recycled directly translates to less energy spend for condensation and distillation, which is essential for solvent recovery. When directly comparing n-Propyl Acetate with Ethyl Acetate, the Propyls blend is superior due to its chemical characteristics combined with a lower enthalpy of vaporization. Propyls enable a more stable process as fewer stops are necessary for cleaning purposes, due to a lower tendency of foaming and reduced occurrence of clogging. Fewer stops directly translate into less film waste, that in turn saves costs for purchasing, recycling, or disposal. In addition, less solvent is needed for cleaning the printing equipment.

Retained solvent is a key specification for the end consumer who does not accept any residues or smell, especially in food packaging. As confirmed in many industrial trials, Propyls display a much better performance over Ethyls in this regard.

Due to the medium evaporation rate of Propyls the clogging potential of dried ink in the gravure cylinder cells or the anilox is reduced significantly. This, in turn, reduces the amount of stops required for cleaning purposes. As a consequence the press creates less scrap due to fewer recurring starts of the printing press. These effects result in an overall higher productivity, which enables the printer to produce more prints in the same period of time. Furthermore, less solvent is used for cleaning the clogged anilox or gravure cylinder cells.

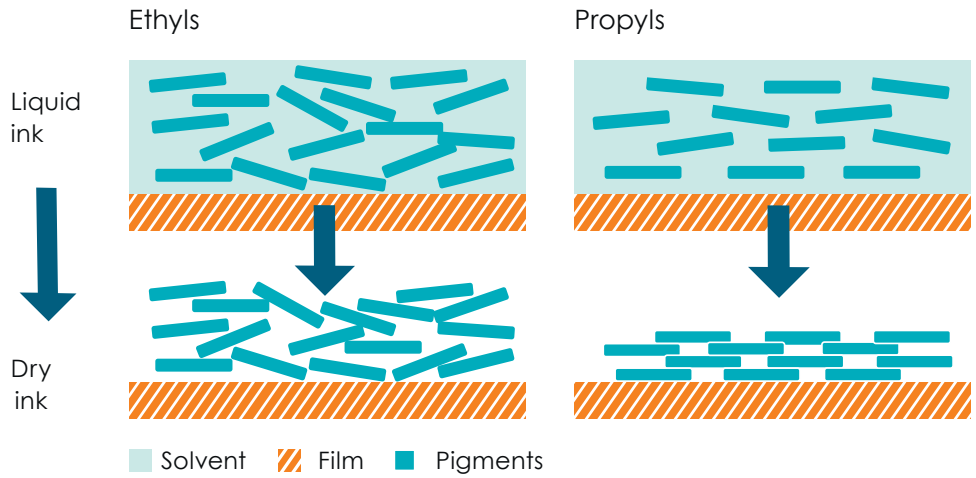
3. INK SAVINGS

3.1 START SAVING INK IMMEDIATELY

In numerous industry trials around the world an average saving of 20% of ink volume was achieved simply by exchanging Ethlys for Propyls. Find out more about the studies on page 21.

3.2 HOW DOES IT WORK?

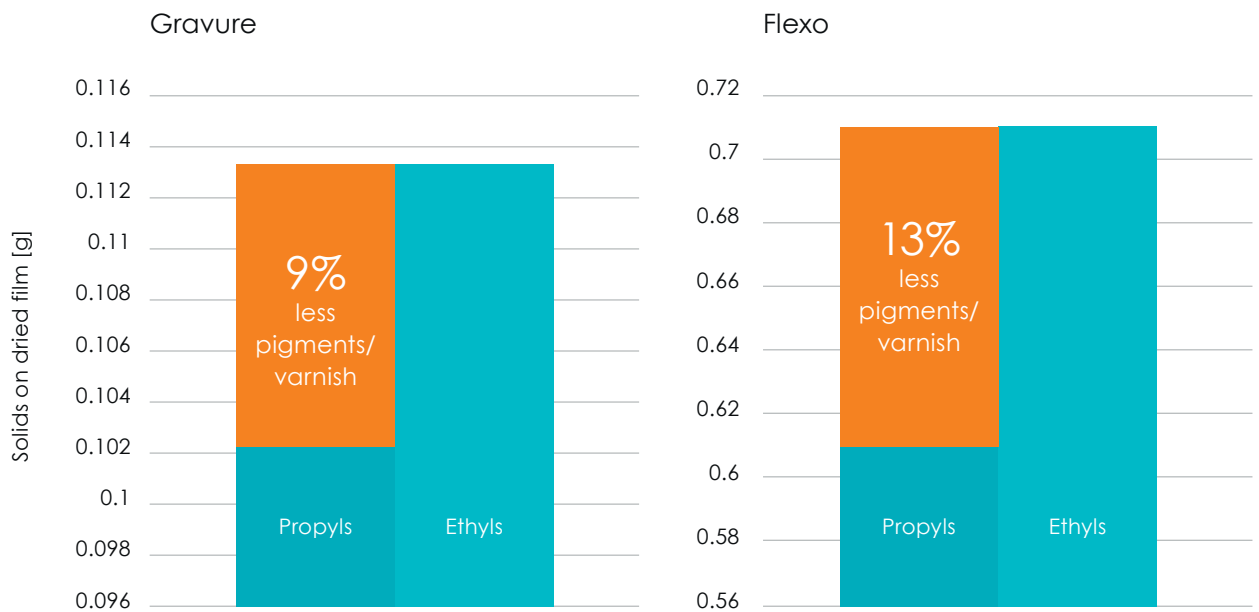
The slightly longer drying period required in a Propyls solvent system gives the printing ink pigments more time to distribute uniformly when they are applied to the film. This results in a higher color density for the same quantity of pigment. Accordingly, the same printing quality can be achieved with less pigment, which in turn leads to a lower consumption of concentrated ink. Due to the more homogeneous layer formation the final print comes along with improved optical effects such as a favorable light refraction and more brightness.



COMPARISON OF THE DRYING BEHAVIOR OF PRINTING INK ON FILM
In the Ethyls solvent system (left side of the illustration) pigments do not distribute uniformly on the printing film while in a Propyls solvent system pigments build a homogenous layer due to their medium evaporation behavior (right side of the illustration).

3.3 MEASUREMENT OF DRIED INK ON A POLYMER FILM

Besides the ink savings measured at the printing presses, analysis of the dried ink layer under laboratory conditions, clearly showed the significant difference in ink consumption when using Ethyls or Propyls. Thus the results previously shown at the printing press were confirmed. Samples from Flexo and Gravure trials have been examined for their content of solids on the surface of dried film in OQ laboratories by rinsing with n-Propyl Acetate.



QUANTIFICATION OF SOLIDS

Solids refer to the sum of pigments and varnish without any other volatile components such as solvents and retardants.

3.4 GET THE SAME COLOR DENSITY WITH LESS INK

It is easy to make the switch – just swap the conventional solvent with a Propyls blend. The result of substituting Ethyl Acetate with the same amount of n-Propyl Acetate is a thicker ink that has a higher color density. In order to get the color density back to the expected level, the printer needs to amend the amount of solvent used. By adding more solvent and extender, the initial viscosity can be achieved, if necessary. This adjustment will produce more liquid ink which, in turn, leads to a higher amount of film printed.

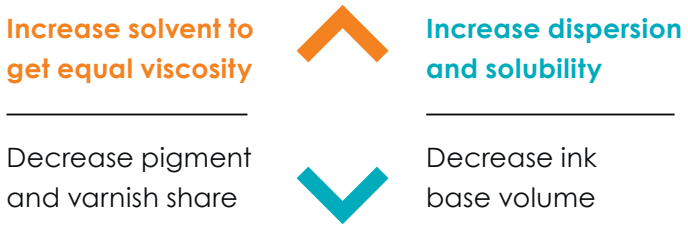
VISCOSITY AT A GLANCE

Viscosity changes related to a different solvent concept (cP 8% r½-sec NC 25°C)

3.5 LESS INK BASE VOLUME, MORE FILM PRINTED

A replacement of Ethyls by Propyls will always lead to a change of the ink composition. By keeping the ink unchanged and just switching the solvent, the printer will experience an increase in the viscosity (ink will thicken). The amount of solvent needs to be increased in order to get equal viscosity, finally resulting in a direct increase of dispersion and solubility. That in turn leads to a decrease of the pigment and varnish share which is equal to less ink base volume.

MEASURES TO CHANGE THE SOLVENT CONCEPT

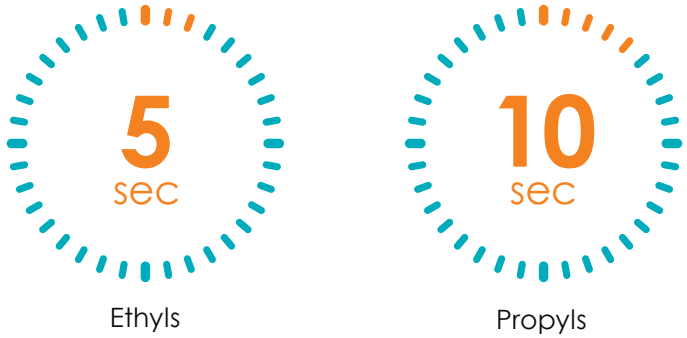


4. SOLVENT SAVINGS

4.1 SAVE BY USING A MEDIUM EVAPORATING SOLVENT

Conventional solvents evaporate quickly and require retardants to reduce their evaporation rate, whereas Propyls show a medium evaporation rate which leads to significant savings in solvents used during the printing process. Accordingly, the use of retardants such as Ethoxy Propanol (PE) can be reduced or avoided completely. This process has been proven by industry trials, which show an average solvent savings of 30%.

EVAPORATION RATE



Ethyls evaporate about two-times faster than Propyls

4.2 EVAPORATION RATE OF SOLVENT BLENDS

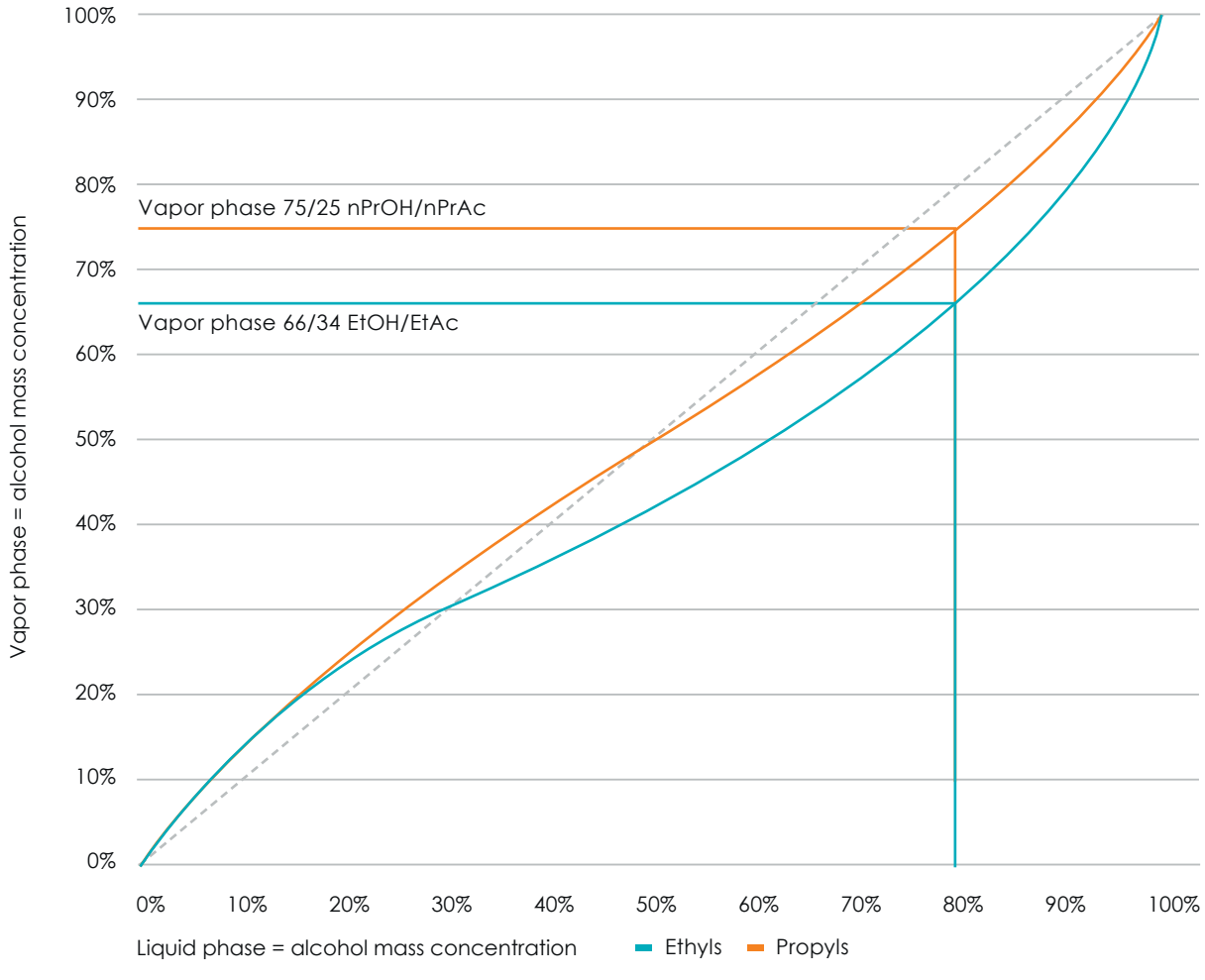
	alcohol : ester ratio (w% : w%)	DIN (ether = 1)	ASTM (nBuAc = 1)
Roto Gravure	pure Ethyl Acetate	3.20	3.91
	Ethanol : Ethyl Acetate blend 20:80	4.16	3.22
	Ethanol : Ethyl Acetate blend 50:50	5.61	2.48
	pure n-Propyl Acetate	5.50	2.27
Flexo	Ethanol : Ethyl Acetate blend 80:20	7.05	1.77
	pure Ethanol	8.02	1.56
	pure Isopropanol (IPA)	8.67	1.44
	n-Propanol : n-Propyl Acetate blend 70:30	12.13	1.03
	n-Propanol : n-Propyl Acetate blend 80:20	13,08	0.96
	n-Propanol : n-Propyl Acetate blend 90:10	14.02	0.89
	pure n-Propanol	14.97	0.84
	Methoxy Propanol	25	0.66
	Ethoxy Propanol	33	0.45
	Propyleneglycol Monobutylether (PnB)	151	0.11

slower

faster

Table compares evaporation rates according to DIN and ASTM standards used in different regions in the world.

4.3 LIQUID-VAPOR EQUILIBRIUM PROPYLS VS. ETHYLS IN %



Propyls and Ethyls display azeotropic behavior – vapor phase composition is impacted by the ratio of the components in the liquid phase.

When comparing two representative 80:20 blends, the chart shows a favorable composition for Propyls to Ethyls (75% alcohol content versus 66%) that is closer to the composition in the liquid phase.

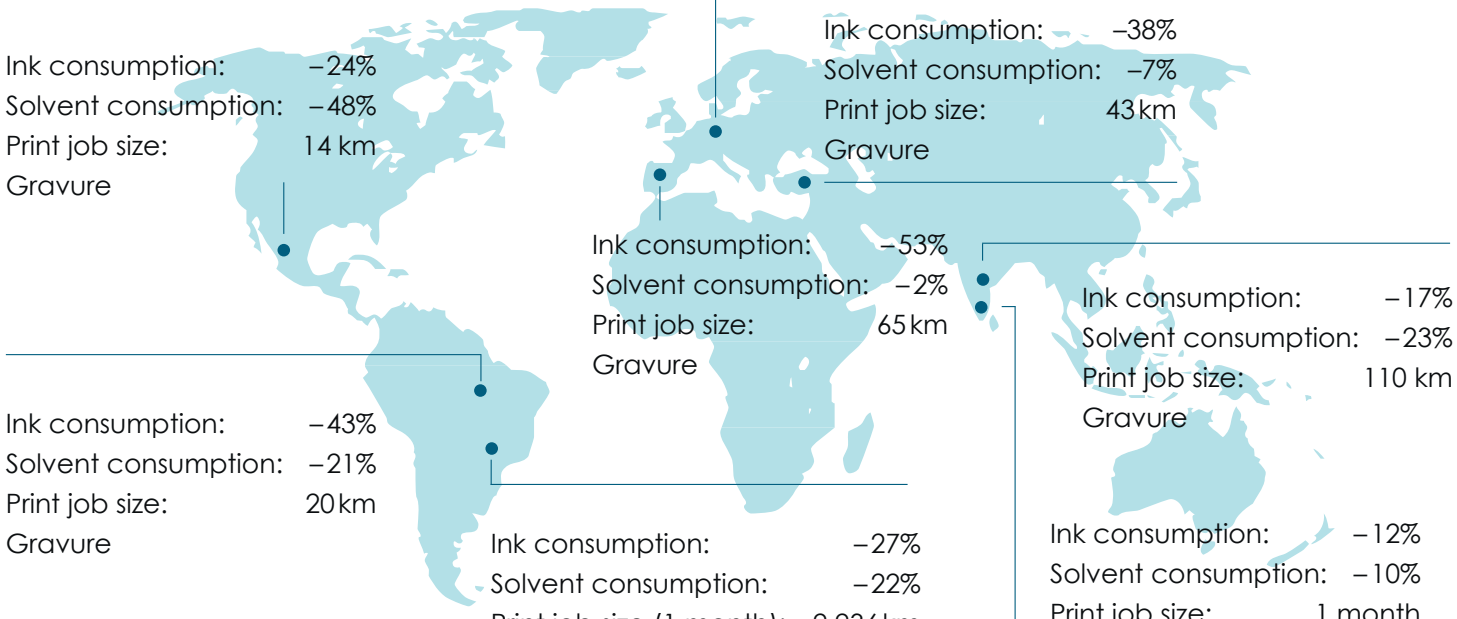
5. INDUSTRY TRIALS

5.1 TRIALS OVERVIEW

Ink consumption: –18%
Solvent consumption: –55%
Print job size: 10 km
Gravure

Ink consumption: –26%
Solvent consumption: –10%
Print job size: 65 km
Flexo

Ink consumption: –12%
Solvent consumption: –28%
Print job size: 17 km
Flexo



Ink consumption: –24%
Solvent consumption: –48%
Print job size: 14 km
Gravure

Ink consumption: –38%
Solvent consumption: –7%
Print job size: 43 km
Gravure

Ink consumption: –53%
Solvent consumption: –2%
Print job size: 65 km
Gravure

Ink consumption: –17%
Solvent consumption: –23%
Print job size: 110 km
Gravure

Ink consumption: –43%
Solvent consumption: –21%
Print job size: 20 km
Gravure

Ink consumption: –27%
Solvent consumption: –22%
Print job size (1 month): 2,236 km
Flexo

Ink consumption: –12%
Solvent consumption: –10%
Print job size: 1 month
Gravure

Extract of trials conducted by converters accompanied by OQ solvent experts

There are numerous studies about the effects and experiences with Propyls. Mainly driven by sufficient product availability, the advantages of Propyls have been well known in North America for decades. With continuous expansion of production capacities, OQ has improved its ability to supply customers globally.

Global trials were operated in both Flexo and Gravure printing and showed overwhelmingly favorable results. The savings and performance improvements were achieved in comparison to several different blends of solvents, which consequently demonstrates that Propyls do not only offer benefits for one specific application or type of blend used in the industry. At the HdM in Stuttgart the results from the previous trials at converters and printers were confirmed and showed an overall advantage when using Propyls instead of Ethyls in both Flexo and Gravure.

The first trials in Stuttgart Germany, compared blends including Ethoxy Propanol as retardant in the Ethyls blend vs. a Propyls blend without additional retardant. The second trial was performed without Ethoxy Propanol retardant in the Ethyls blend in order to have a better comparison between Ethyls and Propyls. The results of the first trials showed that the Propyls blend without additional retardant already offers superior performance compared to the Ethlys blend including additional retardant. The results are remarkable and OQ is ready to share a wide and profound expertise to achieve similar results with converters and ink manufacturers who are not yet enjoying the advantages of Propyls.


CMY
CMYK
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chemicals.oq.com

OQ Chemicals GmbH
Rheinpromenade 4a
40789 Monheim
Germany

Phone: +49 2173 9993-2000
sc.info@oq.com