OXEA

PROPYLS

DISCOVER THE SUPERIOR SOLVENT CONCEPT

PROPYLS


n-propyl acetate
n-propanol
PROPYLS
ester/
alcohol blends

INTRODUCTION

Do you want to be a part of the new movement in the printing industry? Let's talk about a superior solvent concept: Propyls.

Which role does Propyls play in the printing process? n-propanol and n-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. A study recently conducted at the Stuttgart Media University (HdM) in Stuttgart confirmed that results to that extent are feasible.

Learn more about the advantages and industry studies of OXEA in this brochure. You can also talk to an OXEA representative about a tailor-made solution for your printing environment. Because when it comes to making the change, our technical experts have several years of experience gained in industry trials with printers and converters all over the world. We are more than happy to accompany you and share our expertise while you experience the Propyls advantages for the first time.
Talk to us!

"Propyls" is a made-up word that is used to subsume n-propanol and n-propyl acetate mixtures or pure n-propyl acetate, whereas the term "Ethyls" is used to describe conventional solvents like ethanol and ethyl acetate or blends of such. Besides creating a more sustainable footprint, Propyls offer a variety of additional process-related advantages.

INK SAVINGS

Start saving ink immediately

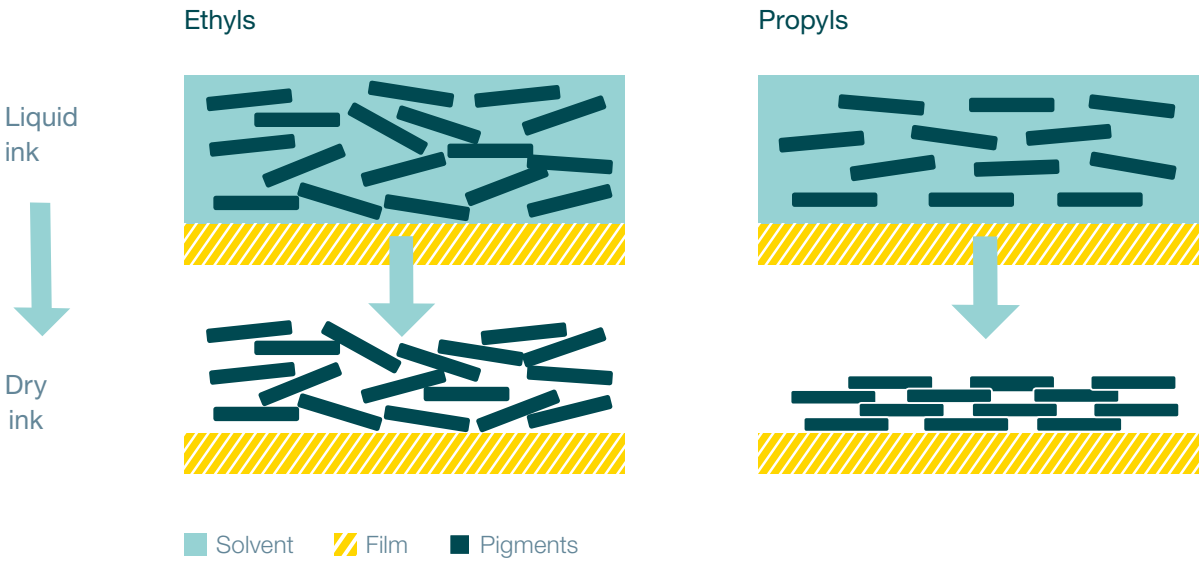
In numerous industry trials around the world an average saving of 20% of ink volume was achieved simply by exchanging Ethlys for Propyls. Find out more about the studies on page 18.

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 Ethlys solvent system (left side of the illustration) pigments do not distribute uniformly on the printing film while pigments build a homogenous layer due to their medium evaporation behavior (right side of the illustration).

Measurement of dried ink on a polymer film

Besides the ink savings measured at the printing presses, measurement 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 OXEA 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, retardants and extreme retardants.

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

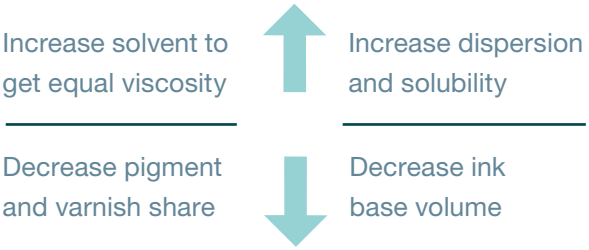
Viscosity changes related to a different solvent concept (cP 8% r½-s NC 25°C)

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 of 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

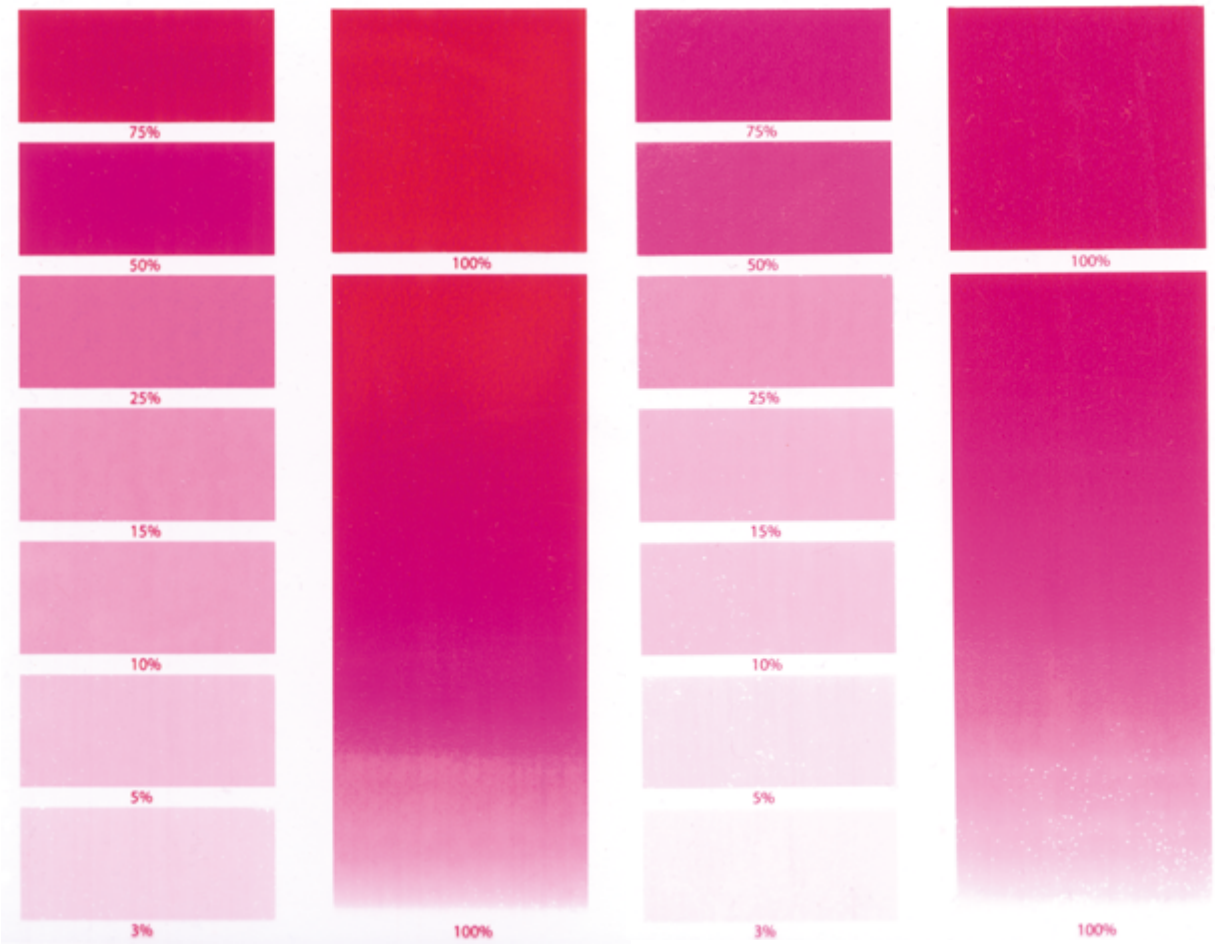


Decrease pigment and/or varnish share

Difference in color density

100% propyl acetate

100% ethyl acetate



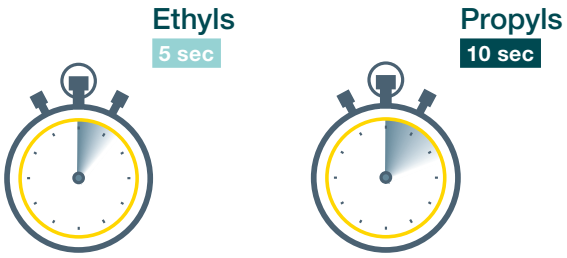
Acetate esters are active solvents that solubilize pigments and resins in inks. Adding n-propyl acetate to the concentrated ink results in a higher viscosity than adding the same amount of ethyl acetate. By comparing the same ink diluted with Ethyls with ink diluted with Propyls in a so-called draw-down experiment, Propyls-based ink shows significant higher color density.

SOLVENT SAVINGS

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 (Ethoxy) can be reduced or avoided completely. This process has been proven by industry trials, which show an average solvent savings of 30% (more information on page 18).

Evaporation rate



Ethyls evaporate about two-times faster than Propyls

Evaporation rate of solvent blends

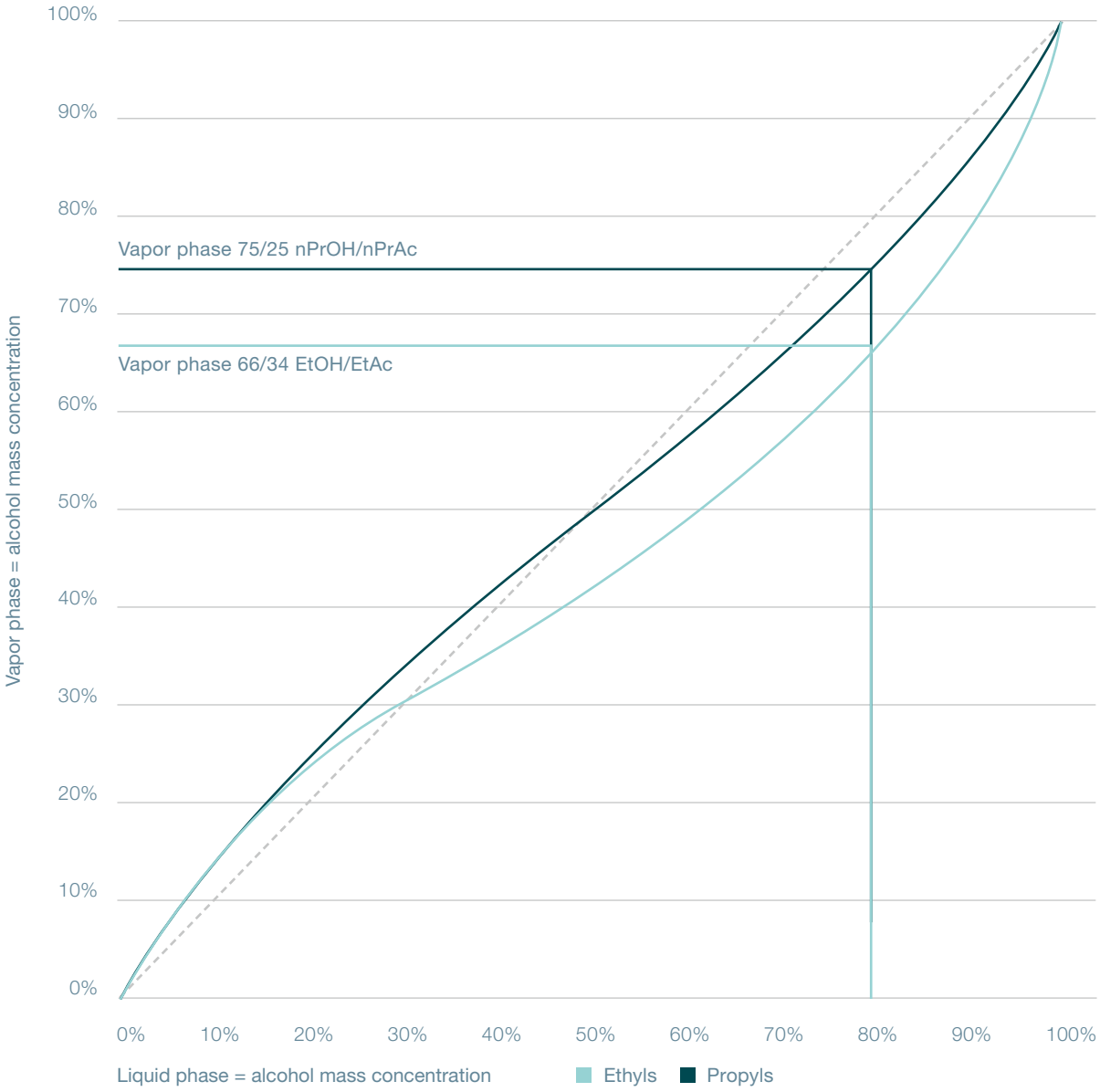
	alcohol : ester ratio (w% : w%)	DIN (ether = 1)	ASTM (nBuAc = 1)
Gravure solvents	pure ethyl acetate	3.20	3.91
	ethanol : ethyl acetate blend 10 : 90	3.68	3.40
	ethanol : ethyl acetate blend 20 : 80	4.16	3.22
	ethanol : ethyl acetate blend 30 : 70	4.64	3.18
	ethanol : ethyl acetate blend 50 : 50	5.61	2.48
	pure n-propyl acetate	5.50	2.27
	n-propanol : n-propyl acetate blend 10 : 90	6.45	2.28
	n-propanol : n-propyl acetate blend 20 : 80	7.39	2.18
Flexo solvents	pure ethanol	8.02	1.56
	isopropanol (IPA)	8.67	1.44
	pure n-propanol	14.97	0.84
	ethoxy propanol	27.50	0.45

slower

faster

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

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.

QUALITY

More stable process and less need of adjustments

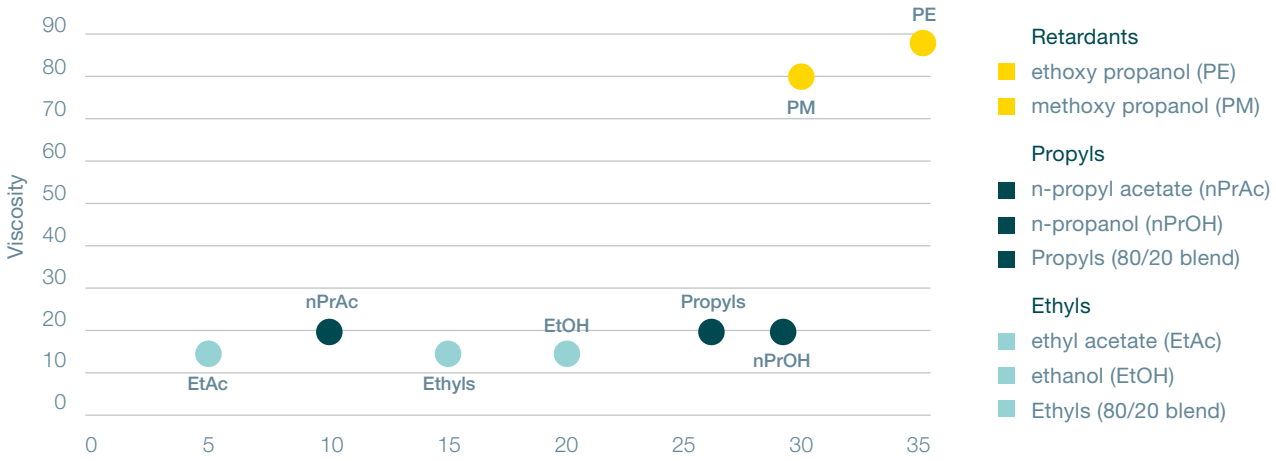
Using Propyls will help you to increase the overall process quality and stability of your printing operations. One of the prerequisites for a stable printing process is maintaining a constant printing viscosity. To maintain the required viscosity and evaporation rate, a careful balance between retardants and solvents in the ink composition becomes necessary. While stabilizing the process, less manual inputs are required to continuously achieve the same printing quality.

The balance between evaporation rate and viscosity is a constant struggle between excessive retardant use and ink performance aspects. As the speed of printing presses becomes faster, the evaporation rate of ink solvent needs to be slow and controlled.

Usually this has been controlled by the presence of retardants such as glycol ethers. These solvent retardants typically have a higher boiling point. This condition helps to reduce the ink evaporation rate, contributes to better brilliance, and adhesion during the layer formation but increases the viscosity significantly. The use of Propyls will result in:

- increasing viscosity stability
- decreasing solvent retention
- increasing photopolymer lifetime
- decreasing moisture absorption

Viscosity and relative evaporation rate of solvents and retardants



Evaporation rate (ether as reference point = 1)

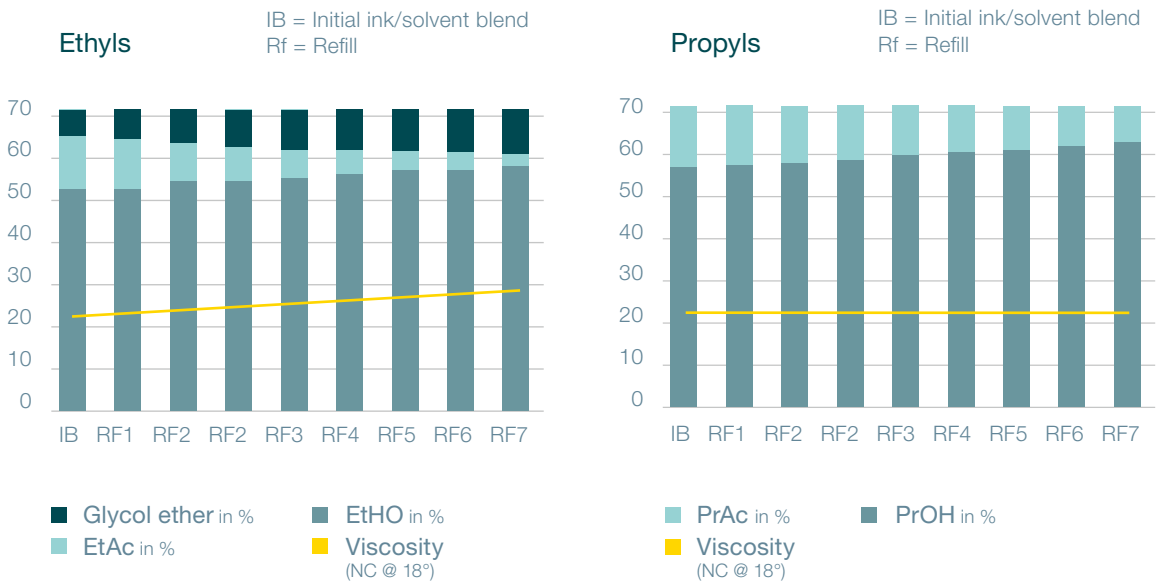
OXEA's Propyls display ideal evaporation rates at low viscosity while slow evaporating glycol ether retardants add unwanted viscosity to the ink.

Increase viscosity stability

Spend less time adjusting the viscosity
In the course of the printing process, retardants accumulate in the overall base ink, and increase due to their low evaporation rate. As a result, the ink viscosity increases past the acceptable specification limit and then more solvent must be added. More refills become necessary which leads to an increasing instability in the ink sink. Propyls blends can help to better maintain a consistent viscosity over the printing process.

Refilling the ink sink with the standard solvent blend is a common practice automatically executed by presses. However, when using Ethlys, the viscosity is negatively impacted with each refill interval because of the need to use retardants. The above evaporation-refill scenario illustrates how using Propyls allows for a better process and ink stability.

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 direct positive impact on print quality. When using Ethyls thinners, the viscosity is negatively impacted due to its evaporation behavior. This calls for the addition of more thinner which in turn decreases color density.

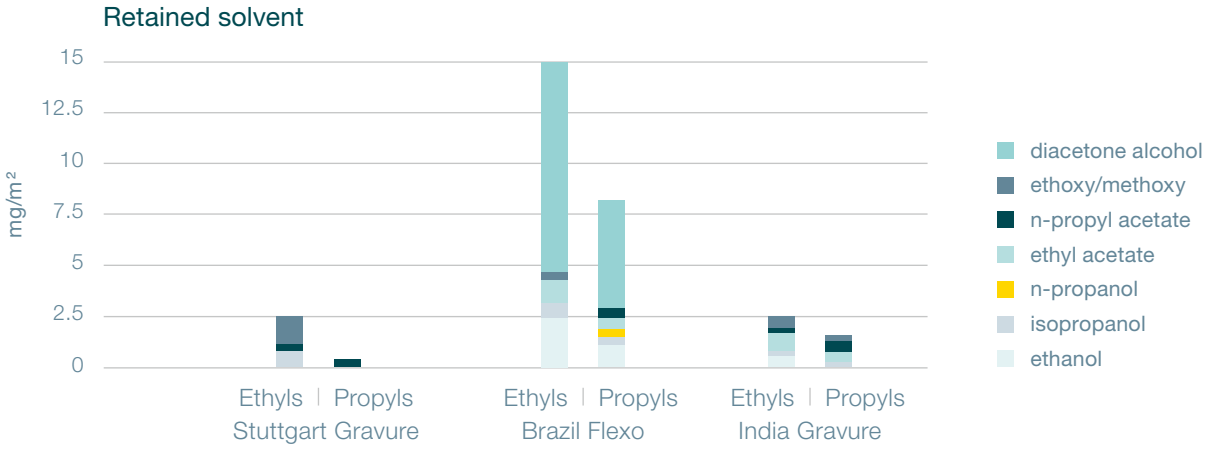
Propyls enables reduction of retardants in the refill

As retardants are an elementary component in the ink formulation provided by the ink manufacturer, adding retardants won't be necessary while preparing the base ink at the press. During the coating process, 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.

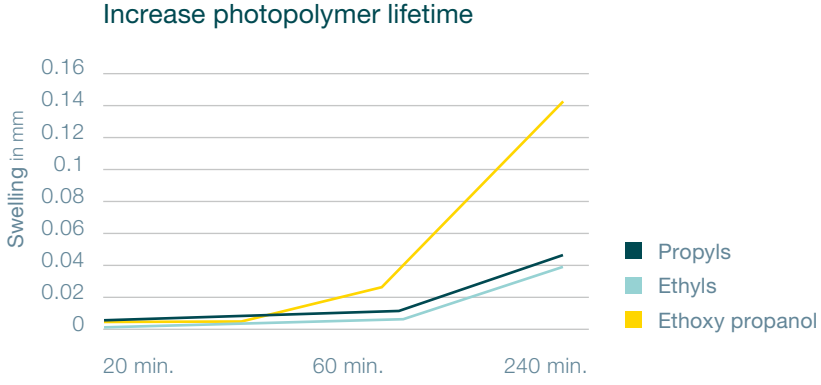
Propyls-based inks dry more homogeneously, preventing an early skin-layer formation on the top surface that would prevent the remaining solvent from evaporation. This would result in less solvent retained in dried film. Propyls are less polar molecules like Ethyls therefore molecular interactions with nitrocellulose or polyurethane resins are weaker, thus accelerating the release of solvent residues from the drying film.

Decreasing solvent retention

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



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

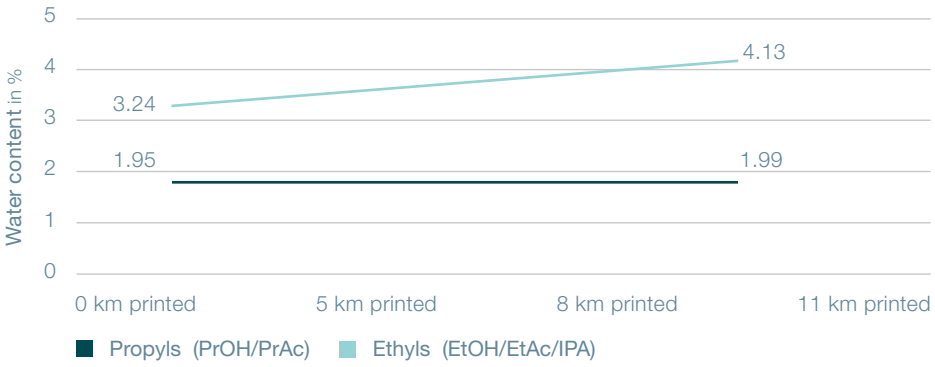


Ethyls blends require more Glycol Ether than Propyls blends. As Glycol Ethers are more aggressive against the photopolymer than linear alcohols, the reduction of such leads to a prolonged durability of the photopolymer.

Decrease moisture absorption

Use of Propyls lowers water spoilage and quality issues of the ink. n-propanol has a longer hydrophobic alkyl-tail so the molecule is less hygroscopic than ethanol and isopropanol. Retardants like glycol ethers are also hygroscopic which leads to increase moisture absorption. Higher water content causes printing problems such as blush or milky obsolescence in addition to foam formation.

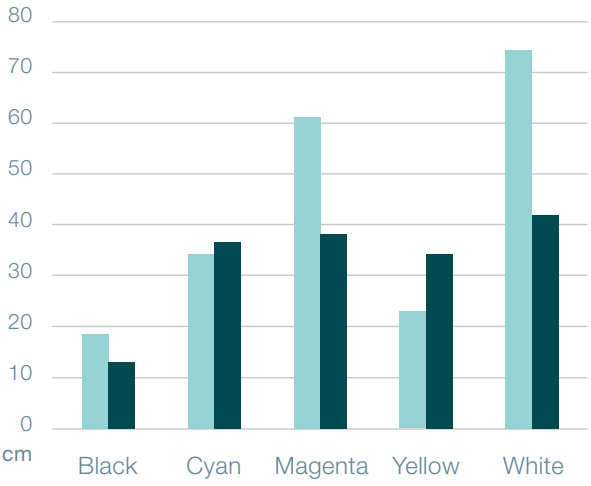
Water content in the course of printing



This graph shows how the ink with Propyls has lower tendency moisture absorption than ink with Ethyls at the beginning and the end of the run.

Foaming of inks in flexographic printing (trial at HdM/DFTA)

Foam formation (DIN 13996)



During one of the Flexo trial studies conducted at the University of Media Studies in Stuttgart (please also refer to page 18) the foam formation behavior in a Ethyls and Propyls environment was observed.

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

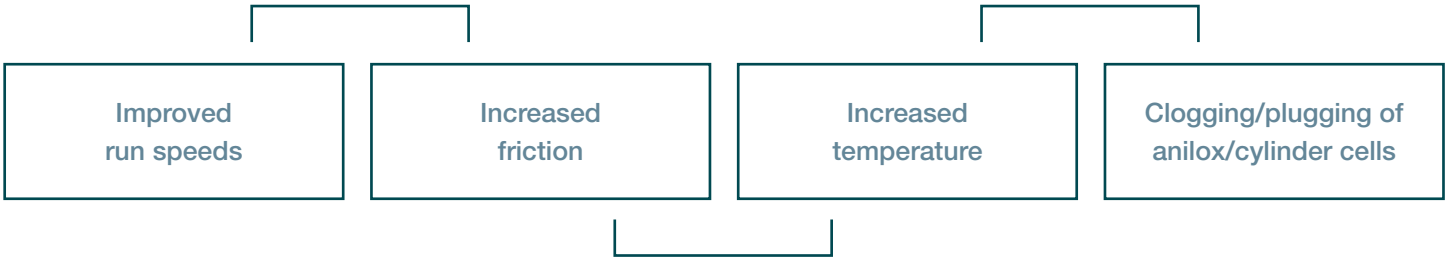
Ethyls Propyls

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

Print more in the same time

Propyls are medium evaporation rate solvents and they are capable of drying on the web film but not in the anilox or Gravure cylinder cell. This enables increasing the speed of the printing process and subsequently increases productivity. A major challenge: high speeds change cylinder dynamics in the press. At accelerated speed, the ink release of a press decreases which creates dry ink problems.

Causal chain improved printing speed



How increased printing speed leads to clogging/plugging

Development of plugging in cells

Ethyls

Propyls

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

dried ink
fresh ink

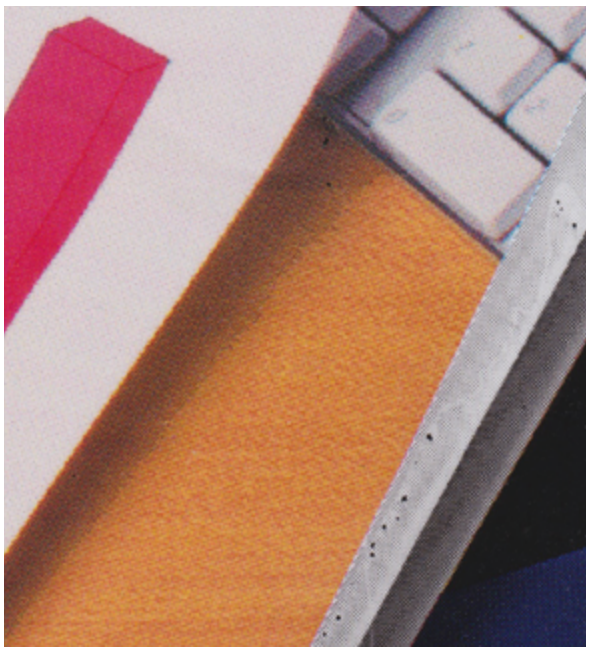
Anilox cells transfer the full amount of ink and lead to a higher print quality and less need to stop the press to clean the anilox or Gravure cylinder. Using Propyls removes dry ink accumulation inside cells resulting in more accurate filling/emptying throughout the entire printing process. The formulation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

Image quality

Faster solvents used for slower speeds will not be able to work at high speeds. The solubility is affected due to a different range of evaporation rate between faster and slow solvents (retardants). 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”

SUSTAINABILITY

Less ink, scrap and solvent – more sustainable printing

Sustainability – the movement towards conscious consumption and more sustainability 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 conserved and emissions of volatile organic compounds (VOCs) are reduced due to an overall condensed 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

Implications in terms of sustainability for different solvent concepts

✔ = positive impact
✘ = negative impact
○ = neutral

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 in the inside air of the pressroom together with reduced emissions of VOC into the atmosphere. Thus, workers are exposed to lower inside-air concentration.

Less volume evaporated and recycled directly translates to less energy expenditure for condensation and distillation that are essential for solvent recovery. Propyls are superior because of their chemical characteristics combined with a lower enthalpy of vaporization directly comparing n-propyl acetate with ethyl acetate. Propyls enable a more stable process as fewer stops are necessary for cleaning purposes due to less foaming and clogging tendency. 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 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 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 (more information on page 14).

This, in turn, reduces the amount of stops required for cleaning purposes. As a consequence the press creates less scrap caused by fewer recurring starts of the printing press. All of this results 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 of the clogged anilox or Gravure cylinder cells.

Sustainability causal chain

Achieving a higher productivity in a sustainable and environmentally friendly way.

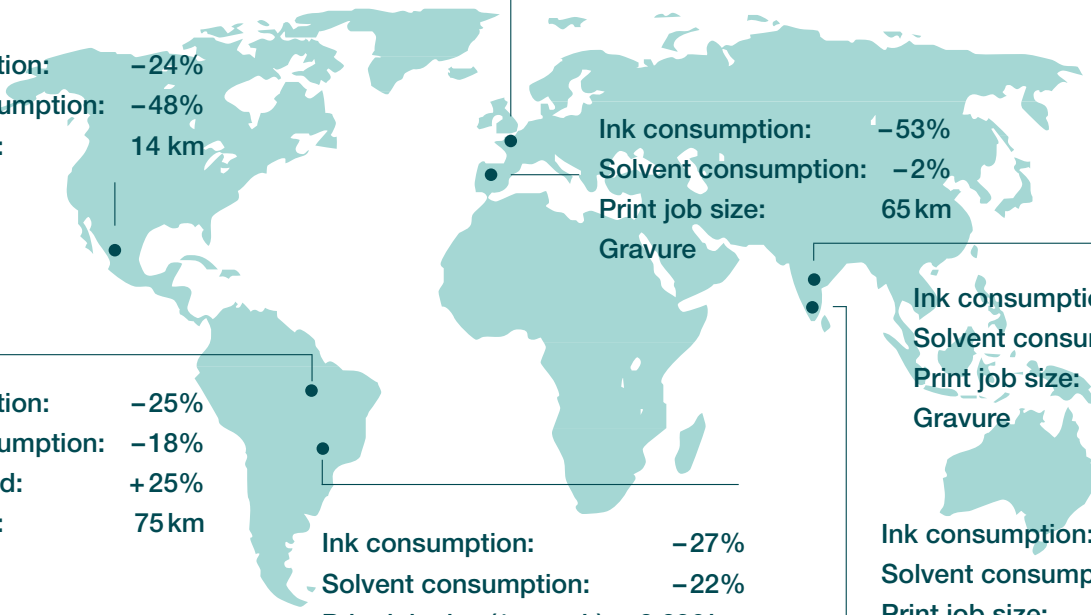
INDUSTRY TRIALS

Trials overview

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

Ink consumption: −12%
Solvent consumption: −26%
Print job size: 10 km
Gravure

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

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

Ink consumption: −25%
Solvent consumption: −18%
Printing speed: +25%
Print job size: 75 km
Flexo

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 OXEA 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 very well known in North America for decades. By continuous optimization of production capacities OXEA also improved the supply situation globally. Global trials were operated in both Flexo and Gravure printing and showed overwhelming results. The savings and performance improvements were achieved by 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 at the end of 2017 compared blends including Ethoxy as retardant in the Ethyls blend vs. a Propyls blend without additional retardant. The 2018 trial was performed without Ethoxy 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 OXEA 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.

Disclaimer: Please note that the details in the table of trials might differ from test to test, basically as the facilities of the print shops did not have the same possibilities of analysis.

Propyls@oxea-chemicals.com

Please send any inquiry to the Propyls e-mail address and an OXEA representative responsible for your region will contact you shortly.

Imprint/Legal Notes

Editor

OXEA GmbH
Rheinpromenade 4a
40789 Monheim am Rhein
Germany

Tel +49 2173 9993-0
info@oxea-chemicals.com

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Editorial staff

Lucia Paniuagua
Sebastian Anton
Dr. Jens Klabunde
Patrick Neumann
Friederike Schneider

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OXEA

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