

Good prospects from every perspective

Joncryl® FLX Line – water-based
technology for medium duty
film printing



 **BASF**
The Chemical Company

High quality – powered by water

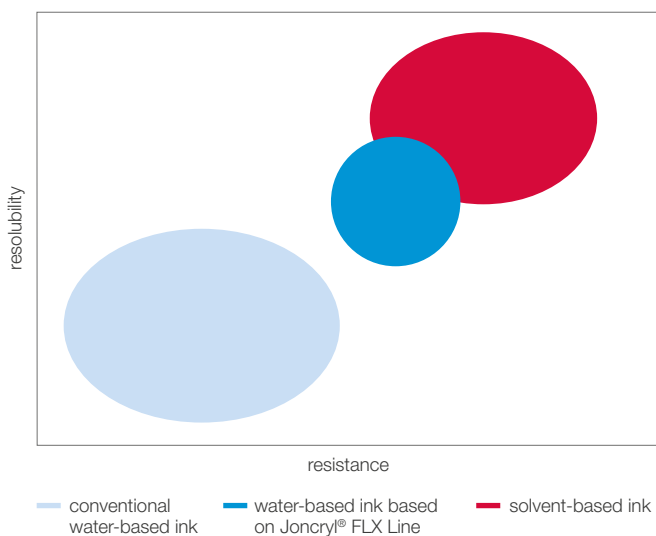
Joncryl® FLX Line

Come on in ... the water is great! Joncryl® FLX Line products are successfully used in water-based inks for film printing applications. Thanks to the Joncryl® FLX Line conversion from solvent- to water-based inks is a high quality, cost-saving and eco-efficient option for film printing.

BASF is the world's leading chemical company. With six Verbund sites and close to 385 production sites worldwide we serve customers and partners in almost all countries of the world. Through new technologies, intelligent system solutions and high-quality products in accordance with the principles of sustainable development we help our customers to be more successful.

In close cooperation with customers BASF's continuous development efforts have resulted in new products that make the next step in water-based film printing possible. High lamination bond strengths in film structures, also when it includes PET film, are now possible to achieve with water-based inks. Because printability and resolubility are key parameters in film printing, the Joncryl® FLX Line products are further optimized for these properties. Therefore the application opportunities for water-based inks have been further extended with the new products of the Joncryl® FLX Line in the ink formulation.

Balance between resistance and resolubility



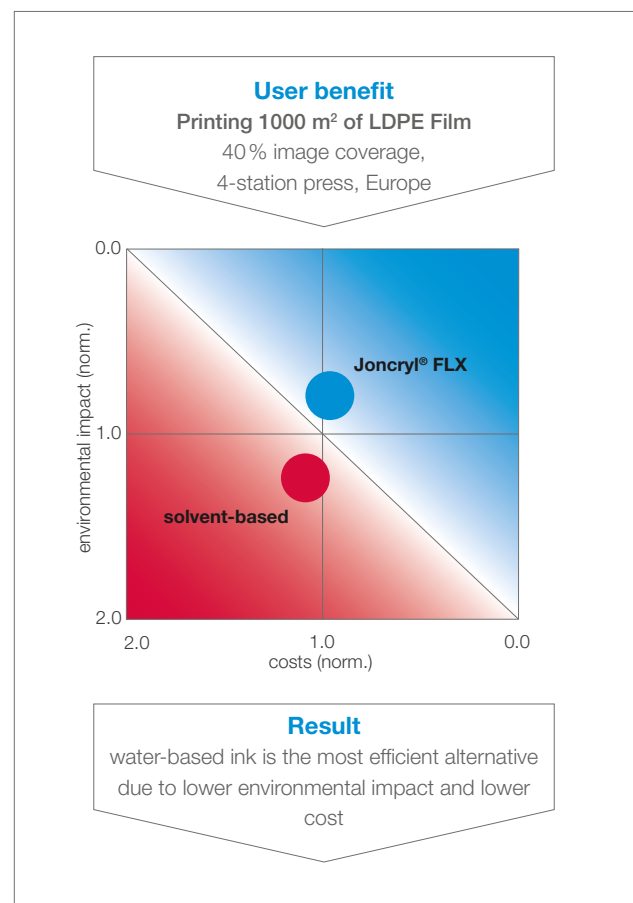
Water-based inks are a sustainable substitute for solvent-based inks which is proven in an Eco-Efficiency Analysis performed by the SUCCESS department of BASF. In the Eco-Efficiency Analysis solvent- and water-based ink technologies that are used for printing LDPE film were

compared. Water-based inks based on Joncryl® FLX Line products are a more eco-efficient alternative due to its lower environmental impact and lower costs relative to the solvent-based alternative.¹

The Joncryl® FLX Line proves that it is possible to combine good resistance or high lamination bond strength with very good printability in water-based inks, making the conversion to water-based inks for medium-duty film applications a cost-effective and eco-efficient reality.

¹ Ecology meets Economy; Eco-Efficiency Analysis of water-based ink systems for PE film applications (EDC 0110 e)

Overall environmental impact and life cycle costs





Key properties of the Joncryl® FLX Line

- a water-based technology platform for surface and reverse film printing inks
- the cost-effective and eco-efficient substitute for solvent-based inks
- excellent resolubility and resistance properties
- excellent adhesion on non-absorbing substrates such as HDPE, LDPE, OPP and PET
- high lamination bond strength in different film structures incl. PET film
- ideal for printing flexible packaging like bread bags, frozen food, snack food, confectionery, baked goods, diaper packaging, tea and coffee packaging and heavy-duty bags

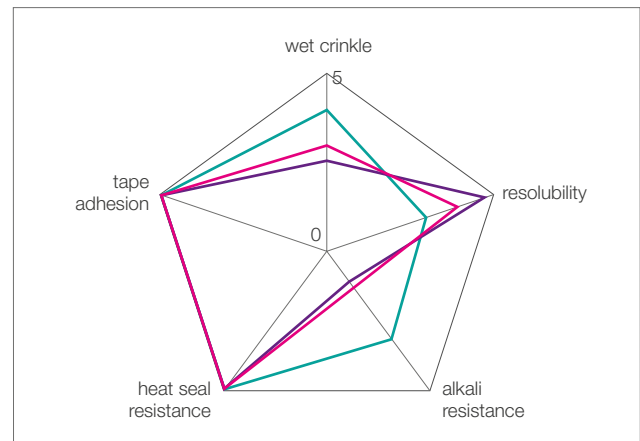
Quality you can see

Joncryl® FLX Line

The Joncryl® FLX Line is offering the ink formulator an opportunity to formulate water-based printing inks that fulfill many demands of the flexible packaging market. The different products all have its own benefits and together they cover a broad range of properties needed to print film for flexible packaging.

The common property of interest for an ink maker and a film printer of the Joncryl® FLX Line is an excellent resolubility / resistance balance. This balance is key for the success of the Joncryl® FLX Line products. Printers do recognize that water-based inks are a viable solution and can offer an answer to their issues with solvent related legislation and costs. Ink makers realize that more and more properties are reaching a similar level as solvent-based systems and that more developments are coming up to make further improvements of water-based inks possible. Our new product Joncryl® FLX 5002 enforces the Joncryl® FLX Line and enlarges the application possibilities and therefore increases the opportunities to convert from solvent- to water-based inks.

Surface print



— Joncryl® FLX 5000 — Joncryl® FLX 5002 — Joncryl® FLX 5020

Joncryl® FLX 5002 is an addition to our range of products for surface film printing. With its further improved resolubility and printability properties it fits perfectly in the Joncryl® FLX Line. Joncryl® FLX 5002 is introduced to fill the gap between standard soft emulsions and the existing Joncryl® FLX Line products. Joncryl® FLX 5002 is very suitable for low to medium duty surface printing. It provides an excellent printability and resolubility in combination with improved resistance properties over standard soft emulsions. Target segment of Joncryl® FLX 5002 is the low and medium-duty surface PE film printing segment that consists of shopping bags and standard PE packaging material. Another target segment is bioplastics and PE coated paper for applications like paper cups.

Joncryl® FLX 5000 is generally well accepted in the market and appreciated for its good resolubility and printability while still having a good resistance level. Joncryl® FLX 5000 finds its way in water-based inks for medium duty surface film printing (LDPE and OPP substrates) applications like shopping bags and boutique bags and dry food packaging.

Joncryl® FLX 5020 is the FLX product with the highest water- and alkali-resistance making it suitable for usage in water-based inks for heavy-duty print applications such as deep-freeze and fertilizer bags. The improved resistance is best visible in halftone printed areas where the layer thickness of the ink is low.

Joncryl® FLX 5030 is suitable for use in water-based inks for medium-duty lamination jobs. Reverse printed on OPP and laminated with solvent free adhesives it results in laminates suitable for the low to medium-duty laminate segment with general demands like confectionery and snack foods packaging. A white ink based on Joncryl® FLX 5030 shows very good leveling and lay. We do not recommend using Joncryl® FLX 5030 in surface printing inks because the resistance level is lower than the other FLX Line products.

Properties you can rely on

Joncryl® FLX Line

Property overview

| Product | Surface printing | Reverse printing and lamination | Resistance | Resolubility | Lamination bond strength |
|-------------------|------------------|---------------------------------|------------|--------------|--------------------------|
| Joncryl® FLX 5000 | ■■■■ | | □ | □□ | - |
| Joncryl® FLX 5002 | ■■■■ | | □ | □□□ | - |
| Joncryl® FLX 5020 | ■■ | | □□ | □ | - |
| Joncryl® FLX 5030 | | ■■ | - | □ | □□ |

■■■■ recommended ■■■ suitable □□□ excellent □□ very good □ good - not suitable

Recommended usage of the Joncryl® FLX Line products

| Product | Print job | Film | Application examples |
|-------------------|-----------------------------------|------------------------------------------|----------------------------------------------------------------------|
| Joncryl® FLX 5000 | medium duty surface print | HDPE, LDPE, OPP, PE coated paper | boutique and shopping bags, dry-food packaging, PE coated paper cups |
| Joncryl® FLX 5002 | low to medium duty surface print | HDPE, LDPE, PE coated paper, bioplastics | shopping bags, PE coated paper cups |
| Joncryl® FLX 5020 | heavy duty surface print | LDPE, OPP | deep-freeze and fertilizer bags |
| Joncryl® FLX 5030 | low duty reverse print lamination | OPP | bakery, confectionery, snack foods packaging |



Resolubility is crucial for obtaining clean and sharp images over a long print run. The printability properties in combination with its high gloss give prints produced with inks based on Joncryl® FLX a high quality appearance.

To benefit most from the performance of the Joncryl® FLX Line products the additive package should be carefully screened. The Joncryl® FLX Line was developed with the aim to get the optimum balance between resistance and resolubility. Since this balance is built into the product, it is not recommended to add extra resin solution or retarders (such as glycol ethers, glycerine or amines) in order to obtain a good resolubility. Doing so will negatively influence the end resistance properties.

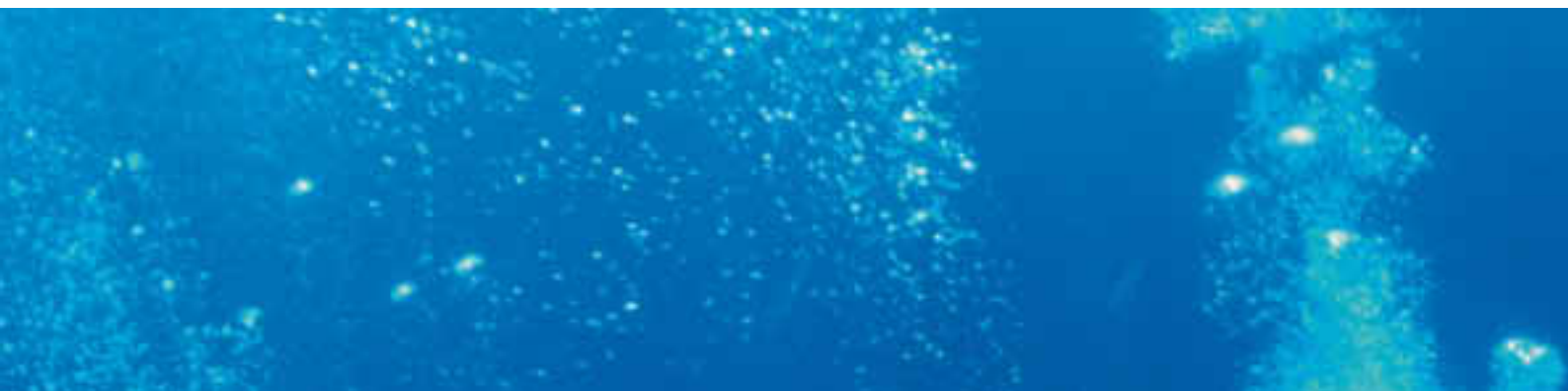
When testing Joncryl® FLX Line products, we recommend to follow our guideline formulations as listed in the tables.

Please contact our technical service department for more help on formulating with products from the Joncryl® FLX Line.

Guideline formulation Joncryl® FLX Line

| | Surface print ink | | Surface print heavy duty ink | | Lamination ink |
|----------------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------|
| Joncryl® FLX 5000 or 5002 | 56.2 | Joncryl® FLX 5020 | 56.0 | Joncryl® FLX 5030 | 56.0 |
| color pigment concentrate* | 37.5 | color pigment concentrate* | 37.5 | pigment concentrate | 40.0 |
| Joncryl® Wax 4 | 1.0 | Joncryl® Wax 35 | 4.0 | DSX®4 2000 | 0.5 |
| BYK®1 094 | 0.6 | Tego®2 Foamex 1488 | 0.5 | Tego®2 Wet 500 | 1.0 |
| BYK®1 024 | 0.2 | Tego®2 Glide 482 | 0.6 | Tego®2 Foamex 1488 | 0.5 |
| Tego®2 Glide 482 | 0.5 | Tego®2 Wet 500 | 1.0 | Joncryl® Wax 35 | 2.0 |
| Tego®2 Wet 500 | 1.0 | Nopco® DSX 2000 | 0.4 | Total | 100.0 |
| DOW CORNING®3 84 | 3.0 | Total | 100.0 | | |
| Total | 100.0 | | | | |

* color pigment concentrate / 35 - 45 % pigment dispersed in Joncryl® HPD 96-E



Make the high quality, cost-effective choice

Joncryl® FLX Line

Inks based on the products of the Joncryl® FLX Line are a cost-effective and eco-efficient alternative to solvent-based inks and eliminate the printer's need to worry about European solvent-related legislations. Three important European directives are affecting flexographic printers using solvent-based printing inks. The Solvent Emissions Directive (SED, in force since October 2007) forces every printing plant using over 15 tons of solvent per year to either invest in incineration equipment or substitute approximately 75 % of its solvent-based inks with solvent-free or low-solvent alternatives.

From June 2006, every flexographic plant using solvent-based inks needs to draw up an explosion protection document, take adequate protection measures and provide adequately safe equipment. This is described in the ATEX directive for the protection of workers from explosive atmospheres.

Furthermore, the "Integrated Pollution Prevention and Control Directive" (IPPC, in force since October 2007) describes the need for all flexographic printing plants with a consumption of more than 200 tons of solvent per year to have a comprehensive environmental permit and to apply "Best Available Techniques" (BAT).

Plants that continue to use solvent-based inks incur tremendous cost to comply with this legislation. These cost increases can be fully prevented by the application of water-based inks. Applying 75 to 80 % water-based inks and other solvent-free products is sufficient to benefit from this advantage in most EU member states.



Make the right choice – incinerate or substitute

Joncryl® FLX Line

Total ink-related costs

| | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|--------------------------------|-------------------------------|-----------------------------|
| ink | 437.4 | 480.3 |
| solvent | 80.0 | 6.4 |
| total ink-related costs | 517.4 | 486.7 |

BASF has developed a digital cost calculation model summarizing printing-related expenses for flexible packaging converters in cooperation with Paul Verspoor of Sitmae Consultancy.

The table “Total ink related costs” shows that water-based inks are a cost effective alternative to solvent-based inks. In the cost calculation example, ink costs were calculated with a price for water-based ink 30 % higher than for solvent-based ink. However, despite a higher unit price, the calculation model shows that water-based inks offer up to 20 % cost savings in the total printing process because no additional solvents are needed for dilution.

Total environmental costs

| | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|------------------------------------|-------------------------------|-----------------------------|
| incinerator; capital | 128.0 | 0.0 |
| incinerator; operational | 40.2 | 0.0 |
| ink waste disposal (k€) | 1.7 | 4.8 |
| waste water treatment; capital | 1.6 | 6.4 |
| waste water treatment; operational | 1.3 | 5.2 |
| total environmental costs | 172.9 | 16.4 |

Switching to water-based inks eliminates the need for large investments in solvent recovery or abatement equipment such as incinerators. Also safety measures for explosion prevention are not needed. The table “Total environmental costs” shows that the expenses for waste water treatment and the disposal of water-based ink waste are much lower than the costs involved with incineration or recycling.

Total other costs

| | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|---------------------------|-------------------------------|-----------------------------|
| anilox (for 5 years) | 0.0 | 22.8 |
| tests (for 5 years) | 0.0 | 1.6 |
| legislation related costs | 23.0 | 3.4 |
| total other costs | 23.0 | 27.7 |

Total costs

| | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|---------------------------|-------------------------------|-----------------------------|
| total ink-related costs | 517.4 | 486.7 |
| total environmental costs | 172.9 | 16.4 |
| total other costs | 23.0 | 27.7 |
| total costs | 713.3 | 530.8 |

Because of the generally higher pigment loading of water-based inks, less ink needs to be applied. Using aniloxes with a lower cell volume will reduce the volume of ink needed and improve print quality and production speed. The table "Total other costs" shows that the investment in new aniloxes is relatively small and the return on investment is immediate.

Many flexible-packaging plants are equipped with inline corona treatment in order to raise the surface tension level of the plastic films to acceptable values for printing. Water-based inks show better wettability on freshly treated films with higher surface tension levels. It is therefore recommended to have inline corona treatment equipment when water-based inks are used. The investment of an inline corona treatment is a small one taking into account the benefits it will bring to the flexible packaging converter.

This cost comparison clearly shows that water-based inks are a cost-effective alternative to solvent-based inks. Besides lowering ink costs, switching to water-based inks eliminates the need for substantial investments in solvent recovery or abatement equipment such as incinerators, and investments to eliminate explosive hazards.

When economical benefits meet ecological benefits, it's because at BASF, we create chemistry.

Contact worldwide

Asia

BASF South East Asia Pte. Ltd.
Block 213, Henderson Road,
#04-11, Henderson Industrial Park
Singapore 159553
Tel.: +65-62722338
Fax: +65-62717956

Europe

BASF Nederland B.V.
Resins & Additives
Innovatielaan 1
8466 SN Nijehaske
P.O. Box 390
8440 AJ Heerenveen
The Netherlands
Tel.: +31 51 3619-570
Fax: +31 51 3619-555
resins@basf.com

Eastern Europe, Africa, West Asia

BASF SE
Business Management
Dispersions & Pigments
EUM/SD – Europe House
67056 Ludwigshafen
Germany
Tel.: +49 621 60-76246
Fax: +49 621 60-76115

North America

BASF Corporation
1609 Biddle Avenue
Wyandotte, MI 48192
USA
Tel.: +1 800 231-7868
Fax: +1 800 437-3266
americas@basf.com

South America

BASF S.A.
Av. Faria Lima 3600 – 10º andar
Itaim Bibi – São Paulo – SP
04538-132
Brazil
Tel.: +55 11 3043-3680
Fax: +55 11 3043-3134

BASF SE

67056 Ludwigshafen
Germany
www.basf.com/resins

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