INTRODUCTION

Fujifilm is offering a complete range of pressroom chemicals. By building up the perfect combination of pressroom products, we can provide the customer with a complete pressroom solution. Solving problems across the printing process implies that we have to think in terms of the whole process as they are often interlinked and not just located in one area.

By avoiding problems through the printing process, we manage not only to boost performance but also to reduce costs for our customer.

Our product range:

1. **Fountain solutions**
2. **Coatings**
3. **Glues**
4. **Washes**
5. **Silicone emulsions**
6. **Spray powders**
7. **Auxiliaries**

2. Coatings

2.1 Basic role of a coating

The basic role of a coating is quadruple. Coatings are used to ensure safe and fast processing while printing, and to protect the final print during subsequent finishing in the commercial or packaging printing industry. Secondly for esthetical reasons, they are used to achieve an almost endless variety of finishes: from super gloss, gloss, neutral, silk matt and matt to extra matt. They can also be used to support further finishing (such as foil lamination, UV coating on top of conventional ink). Finally also providing a specific property (such as slip, protective features like rub/wet block resistance or functional like blister) can be its role.

Where coatings in the past were an additional asset, nowadays they have become a part of the standard printing process, if only for the processing safety they offer!

2.2 Groups of coatings

Coatings are divided into product groups based on their composition, resulting in different drying and varying features:

- oil based coatings (by oxidative drying and penetration of oil)
- water-based coatings (by evaporation and penetration of water)
- UV coatings (by curing/polymerisation)

Fujifilm produces both water-based and UV coatings. Oil based coatings are not part of our product range.

Above mentioned product groups are afterwards classified according to their end purpose, as all require different demands to the coating:

- commercial printing, e.g. magazines and advertising prints
- packaging printing, e.g. folding boxes and labels
- food packaging printing

Finally, next to the previous classifications coatings are classified further according to the way they are applied:

- inline application “wet in wet”: roller coating unit or chamber type doctor blade unit
- offline application “wet on dry”: roller coating unit or chamber type doctor blade unit
- inline and offline application with ink duct unit application

One thing is essential to keep in mind: using a coating may have become standard to the printing process, the use of coating itself can never be a standardised process. Due to the many influences and varying demands, individualisation and adaptation to given circumstances remain a key factor for a successful application!

2.3 Oil based coatings

Oil based coatings can be thought of as ink with no pigment. Due to the slow drying, yellowing effect and odour of these products, they have become unpopular and are only used on presses having no inline coating unit.

2.4 Water-based coatings

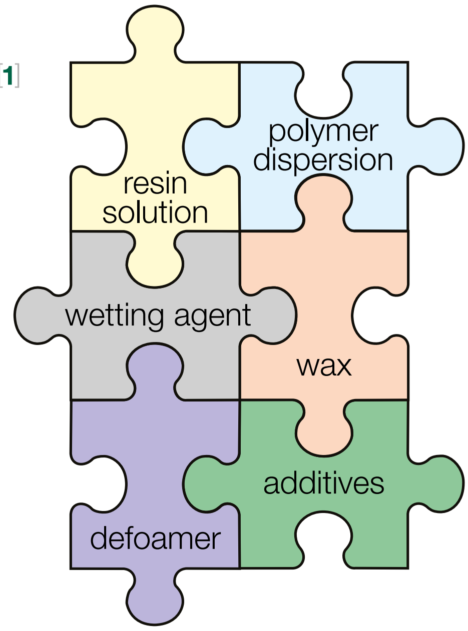
As said the drying of the water-based coatings happens by evaporation of water and does not give the side effects an oil based coating faces. Therefore this coating type has become more or less standard in today's printing environment.

This type of coating offers several advantages:
- fast drying for maximum print speed and full stacks
- immediate perfecting
- high gloss to matt finishing options
- good rub resistance
- defined adjustment of slip values
- production safety while printing and finishing

2.4.1 Composition of a water-based coating

A water-based coating is composed out of 6 major components: [1]
- resin solution
- polymer dispersion
- wax
- wetting agent
- defoamer
- additives

[1]



In Fujifilm coatings all these components are aligned to one another and chosen with great care, resulting in:
- fast drying
- no cracking
- outstanding rub resistance
- very good wetting
- low foaming
- stable and constant viscosity

2.4.1.1 Resin solution

In order to obtain a certain gloss level, resin is needed. These particles are dissolved in water with the lowest technically possible needed amount of ammonia (this causes the typical smell and the alkaline pH of 7,5 -8,5). The more resin present in the coating, the higher the gloss level will be. [2]

[2]

As an increase in the amount of resin can have a negative effect on the drying speed, wet block resistance and rub resistance, this amount needs to be carefully determined.

2.4.1.2 Polymer dispersion

Very fine polymer particles are emulsified in water. Polymer dispersion can have either hard or flexible properties. [3]

[3]

[left] hard dispersion
[right] soft dispersion

Hard formulas are economically priced, but sensitive to cracking. [4] This as the coating needs to dry immediately and the ink below still stays wet, a certain flexibility of the coating is needed to prevent stress cracks.

[4]

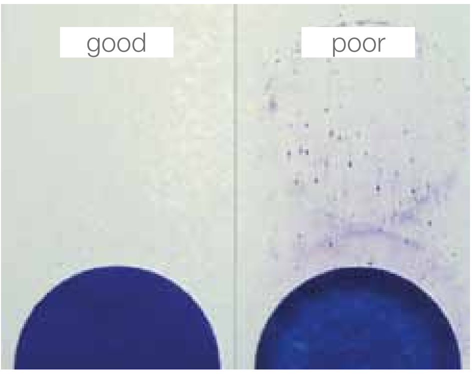
Flexible formulas prevent cracking and show a better performance, also on high ink load or non absorbing substrates, like e.g. cast coated or metalised substrates. With a combination of hard and flexible dispersion, price and performance of each coating can be managed individually.

Together with the resin, the polymer dispersion is the film building component of a water-based coating.

2.4.1.3 Wax

Finishing often subjects the printed sheet to mechanical stress such as cutting or folding, even on its way to the point of sales micro vibration during transport on the truck can damage the print. By adding a good quality wax in a right amount to the coating, a strong rub resistance is created and makes sure the coating offers optimum protection to the printed image. [5]

[5]



rub resistance tested with 600 double rubs, standard weight 610g

2.4.1.4 Wetting agent

For a good wetting and smooth levelling of the coating, a wetting agent is added to the coating. Next to the surface smoothness it mainly influences the runability of the coating. Not enough wetting agent can lead to a disturbed coating film with very small pin holes, with ink build up on the coating blanket and wash breaks as consequence. Needless to say, that all our coatings are well equipped to ensure convenient and reproducible processing.

2.4.1.5 Defoamer

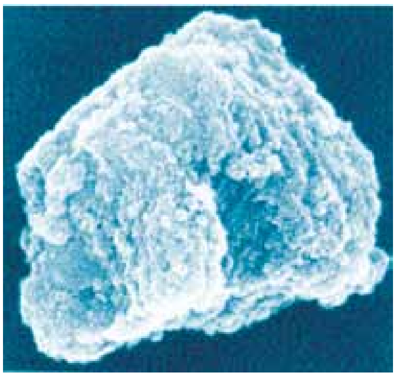
Foam can be caused during the process by the coating pump (membrane pump is more sensitive as peristaltic pump) resulting in inhomogeneous surface, increased viscosity or micro foam. Therefore defoamer is added to our coatings so they have a very low foaming tendency.

2.4.1.6 Additives

Additives are added to create specific properties for a certain coating. Such properties can be:

- maximise wet block resistance
- adjust to high or low slip
- matting agent [6]

[6]



2.4.2 Application systems

2.4.2.1 Inline coating unit

2.4.2.1.1 Inline application: roller coating unit

The roller coating unit was the first generation of inline coating units with the same working principle as a dampening unit, which was used in the starting phase of this technology. The benefit of a roller coating unit is that the amount of coating (film thickness) can be adjusted easily. The negative aspect is that matt coatings often tend to structure lines and inhomogeneous surface due to the roll motion. Therefore modern presses are equipped with chamber type doctor blade systems. [7]

2.4.2.1.2 Inline application: chamber type doctor blade

With this system the coating is transferred with an engraved anilox roller. The amount of coating (film thickness) can be adjusted only by changing to another anilox roller with a higher or lower transfer volume. Beneficial is a very constant film thickness all over the sheet and homogeneous print out even when applying a matt coating. Usually with a matt or protective gloss coating, a roller with theoretical transfer volume of 10g/m^2 is enough. To obtain good gloss or high gloss at least a theoretical transfer volume of 13g/m^2 is needed. [8]

2.4.2.2 Offline application

For water-based coatings, offline application is not used. More information can be found under the UV coating section.

2.4.2.3 Ink duct unit application

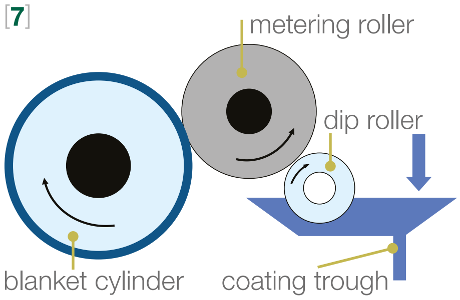
For each offset press which does not have an inline coating unit, water-based ink duct coatings are an alternative solution. Sometimes the print buyer insists in using a water-based coating, sometimes the printer just wants to get rid of oil based coatings and all negative implications. In the late 1980's many printers started testing ink duct coatings from the supplying industry. At that time, gloss and rub resistance were good already, but the runability and open time on the rollers have been critical. Today we can still find strongly prejudiced printers against this coating type. But our formulas could convince them and met their requirements such as improved open time on the rollers. This is key for convenient handling and trouble free processing. Please find more instructions and tips in our application leaflet.

2.4.3 Other materials as performance factors

The formation of the coating film is influenced by several other materials. Following parameters for sure have an effect on the final result [9] [10]:

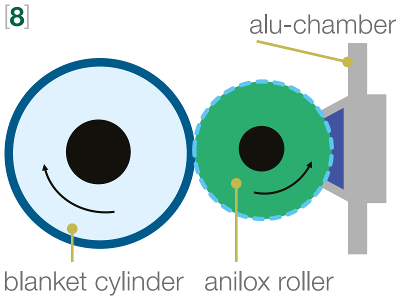
- substrate
- ink
- fount management
- coating transfer
- anilox roller
- coating cleaner
- spray powder
- drying and dryer settings

[7]



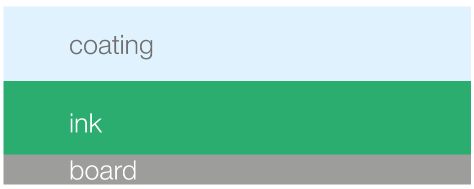
Adjustable rollers to apply more or less coating, effecting layer thickness and gloss

[8]

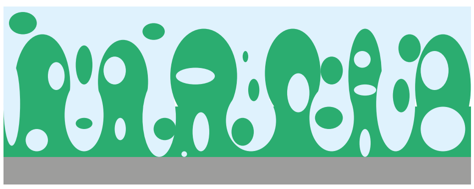


Anilox roller with different volume create different transfer and gloss

[9] what we would like to get



[10] … what we really get



Next to above mentioned materials, we have to mention that also temperature has a very determining effect on the coating, more specific on the viscosity of the coating. Important to realise is that the stated viscosity refers to the run out time of the DIN-cup 4mm, this at a coating temperature of 20°C. As viscosity depends on temperature, the warmer the coating, the lower is viscosity. 40-45 seconds is standard for most applications, 60 or 80 seconds are available in many cases for special needs. [11]

[11]

INFLUENCE OF TEMPERATURE TO VISCOSITY

24°C	36 seconds
22°C	38 seconds
20°C	40 seconds
18°C	42 seconds
16°C	44 seconds

slight deviations possible depending on formulation

The higher the viscosity, the higher the coating film thickness resulting in higher gloss and better rub resistance.

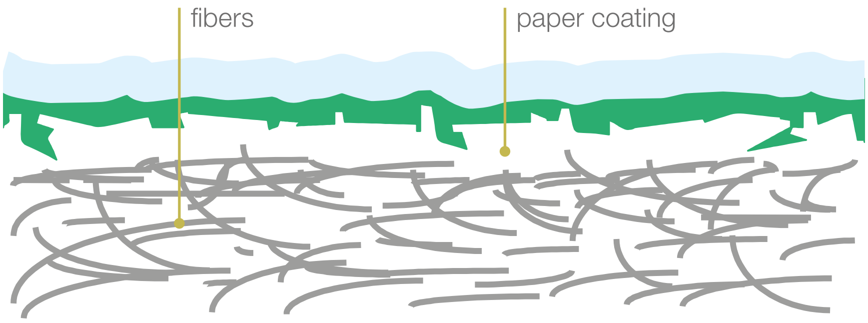
2.4.3.1 Substrate

The printing substrate is one of the very big influencing factors when it comes to the result of the gloss level. As coating is an optical intensifier of the surface properties of the substrate, the paper surface itself, with its individual structure and surface properties, is getting visible. Next to this, with high gloss or super gloss coatings, a gloss difference up to 10-15 gloss point is achievable only by using and comparing paper and board. [12]

[12]

PRINTING SUBSTRATE

- very big influence to gloss result
- coating is an optical intensifier of the surface properties of substrate
- compare different substrates in one job and see the difference!

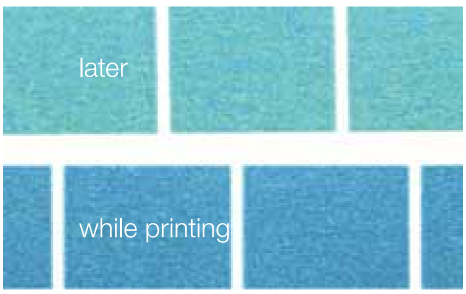


cardboard surface roughness up to 50µ | coating film in average 2µ

2.4.3.2 Ink

Following ISO 2836, ink must be alkali-, spirit- and solvent-resistant (only exception is magenta)! Otherwise delayed changes in the colour tone or bleeding are possible (even in the days following the print). [13] Problematical can be the use of Pantone qualities and metal ink.

[13] **COLOUR TONE CHANGE**

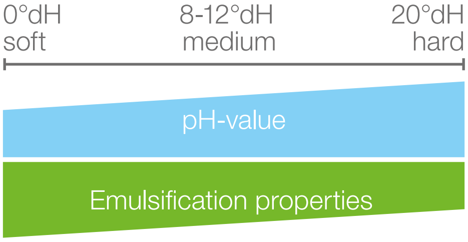


2.4.3.3 Fount management

In commercial printing, where thin paper is printed double sided, fount management is even more essential than in packaging printing where only one side is printed on thicker board.

If we look at fount management in its whole context, it has to start with monitoring the process water. The total hardness should be at approximately 10°dH, as this causes an ink-water balance with balanced emulsifying properties. (1°dH= 10mg calciumoxide/litre water) [14]

[14] **WATER MANAGEMENT - INFLUENCE OF TOTAL HARDNESS**



If water with a significantly lower total hardness is used (for instance by too low rehardening of osmosis water), ink is emulsifying too much. The ink is – simply said – too wet, which can lead to bad drying of the ink with a higher risk for delayed blocking of the printing sheets.

Also the correct dosage of the fountain solution additive is important. A too low or too high dosage means a deviation of the necessary active ingredients for the ink-water balance. Especially an over-dosage can lead to an overload of non-absorbing or non-evaporating components – these can migrate into the ink surface/coating film during the ink drying and soften it later or cause blocking. [15]

FOUNTCONTROL – a unique Fujifilm technology – offers a safe and reproducible drop test, by which the fountain solution dosage can be checked through colour change. Parallel, also the pH should be measured, by this has to be judged independent from the fountain solution dosage. Too sour pH-values lead to a delay of the oxidative ink drying, too high pH-value lead – similar to a too low total hardness – to an over emulsification.

2.4.3.4 Coating transfer
Old, offset-print blankets can have a surface which become "ink-friendly. This can lead to problems with coating transfer, wetting of the coating or reduced gloss results. For this reason we discourage the use of those, we do recommend to use at least new, non-printed blankets. Optimal would be to use a special coating blanket equipped with specific surface properties. In general printers need to make sure that the printing pressure is as low as possible to avoid squeezing while spot coating or splashing of the coating.

2.4.3.5 Anilox roller
In most presses anilox rollers with engraved hexagonally cells are used, this mainly for water-based coatings. Tri-helical rollers (line screening) are mainly used for UV coatings. [16]

The consumption of water-based coatings depends on the transfer volume of the anilox roller. Often the theoretical volume is mentioned, a general rule is that approximately 1/3 of this volume is applied on the substrate. All applied quantities refer to the wet coating, after evaporation of the water and drying, only half of the quantity remains on the coated sheet. [17] [18] [19]

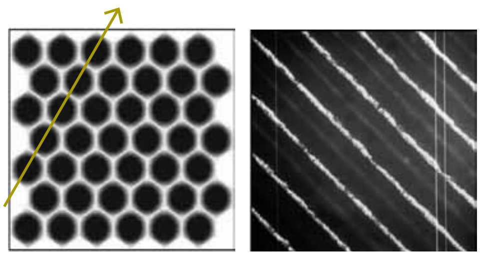
[19]

VOLUME AND REAL TRANSFER — BASIC RULE FOR EVALUATION:
the applied coating quantity is 1/3 of the theoretic volume
12 cm^3/m^2 = 4 g wet = 2 g dry

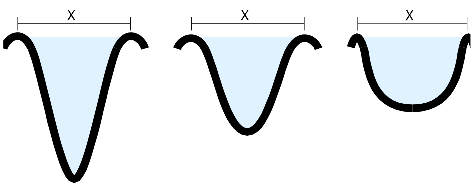
[15] **WATER MANAGEMENT - DOSAGE OF FOUNTAIN SOLUTION**

4,0 %	overdosage: non evaporating chemicals can separate from ink film, possibly soften the coating film
3,0 % – 2,0 %	optimum dosage
1,0 %	underdosage

[16] **HEXAGONALLY CELLS** **LINE SCREENING**

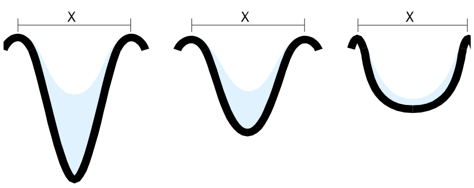


[17]



- 3 different cell forms but
- all have the same volume

[18]



- and show different emptying!

2.4.3.6 Coating cleaner
As solvent based roller and blanket washes effect the wetting of the coating to the blanket and may possibly cause ink build up on the coating blanket, these should never be used. Fujifilm offers save to use products to clean these machine parts.

A first product is our VARNISH REMOVER. This is a water-based special cleaner, which does not cause swelling of polymer plates, plastic parts or the fittings of the chamber type doctor blade. Dilution is possible with water up to 1:1. Even for the daily cleaning of the anilox roller this product is suited. For weekly deep cleaning we recommend our ANILOX CLEANING GEL. Moreover both products meet the requirements of Fujifilm's Green Policy.

2.4.3.7 Spray powder
Best is to use a spray powder based on vegetable starch (round grain), finished with a hydrophobic additive, a so-called coated powder. This makes it resistant against humidity, causes better flow ability in the spray system, is non-abrasive and easy to remove from the coated sheet due to its surface properties. Also when not using a coating, it has the same positive effect on a wet ink film. We advise against sugar based and calcium based spray powder!

2.4.3.8 Drying and dryer settings
Water-based coatings contain about 60% water. As most of it is already part of the different raw materials, only a small amount of water is added while producing. The coating dries by absorption of the water into the substrate and by evaporation. During the evaporation the polymer particles "melt" together with the resin and wax. This process is called film formation. During the delivery most of water has already disappeared and the coating is touch dry.

As for the dryer settings, it is important to observe the optimal use of IR-dryers and hot air (air knife).

For the adjustment of the IR-dryer, which can vary depending on the used dryer, the general rule is following: „as much as necessary, as little as possible". On the one hand, IR-radiation has positive influence on the ink drying. This as the oil particles are being absorbed, which gives an obvious change in viscosity and the ink already seems to be drier.

On the other hand, IR-radiation stimulates the oxidative ink drying which causes some negative effects. As side effect of the oxidative drying, warmth arises and more powerful IR-radiation accelerates the oxidative ink drying, with excessive increase of temperature in the stack as result. This excessive and delayed increase of temperature in the stack can lead to blocking. Due to the wet ink and the influence of temperature, the coating film tends from 35°C on to plastification, which means softening of the ink. That is why the air knife is important here, it can realise a gentle drying with a temperature controlled air jet.

We recommend to control all mentioned parameters and if needed to write them down for a period of time.

2.4.4 Demands linked to the end purpose of the coating

As different end purposes of the coatings set different demands to the performance, we differentiate them in 3 major groups:

- commercial printing
- packaging printing
- food packaging printing

At first sight packaging and food packaging belong in the same group, but due to the complexity, large differences in demands and growing importance of everything in relation to food packaging, we have chosen to split them up.

Further we also have one group of coatings, used in the 3 above mentioned groups, namely the primers. They require some specific demands and have a three-folded purpose:

- to create a good adhesion of subsequently applied UV coatings or foil lamination
- to improve the surface quality of the UV coating (surface and brilliance)
- in subsequent digital overprinting or encoding, where a special matt primer is available

Primer coatings can only provide maximum adhesion or bridging to the printed materials when – during the application in the printing zone – penetration through the ink film and into the printed substrate (fibre layer) is possible. Therefore the use of special components and effective agents are necessary. More technical instructions can be found in our leaflet for the processing of primer coatings.

2.4.4.1 Commercial printing

Commercial printing e.g. magazines and flyers is mainly driven from technical/functional aspects. Next to good runability of the coating on the press, safe print processing, reduced processing time, coating features like rub resistance and wet block resistance do matter. In contrast, properties like good slip values are hardly not demanded.

2.4.4.2 Packaging printing

In packaging printing, next to above mentioned properties which were important for a commercial printer, slip specification like glide angle or coefficient of friction (COF static and dynamic) is of great importance. This parameter is used to determine the surface and glide features of the coated print. This is necessary to meet the requirements of the box gluing machine and subsequent filling lines.

2.4.4.3 Food packaging printing

On top of all above mentioned properties required to meet demands in commercial and regular packaging printing, food packaging, needs to ensure low migration properties in order to meet all requirements linked to food compliance. [20] [21]

For a better understanding, some key topics need to be explained:

- regulation 1935/2004/EC
- GMP
- migration

[20]

[21]

2.4.4.3.1 Regulation 1935/2004/EC

Framework regulation 1935/2004/EC is the European guideline approved on 27 October 2004. It involves all materials and articles intended to come into contact with food.

Basically it contains rules for all kinds of food contact materials – the printed packaging is only a sub-group next to many others like e. g. beverage bottles, tins or the sealing of preserving jars.
Its purpose is to prevent interactions between packaging and foodstuff to avoid endangering the health of the consumer. As substances can migrate coming from any individual packaging component, it is essential to know the relevant information regarding the individual packaging components.

Regulation 1935/2004/EC dictates that any material or article intended to come in contact – directly or indirectly – with food must be sufficiently inert to prevent substances from being transferred to food in quantities large enough to:

- endanger human health
- cause an unacceptable change in the composition of the food
- or change its organoleptic properties

The distributor of the end product bears the legal responsibility that the food packaging is suitable for its intended purpose and has acquired an assessment of this within the framework of the applicable laws, carried out from an accredited institution. As a logical consequence, the printer as producer of the whole packaging or at least part of it, needs to ensure a summary of all used components and the individual processing of the product he is supplying.

Regulation 1935/2004/EC also enforces individual measures for 17 groups of food contact materials as evidence. There are three groups of concrete guidelines already examined: ceramics, regenerated cellulose and plastics.

The groups of printing ink and lacquer/coatings required by the printing industry are not regulated by any individual guideline yet.

For this reason for example the plastics guideline 2002/72/EC and regulation 10/2011/EC is consulted to define migration limits for raw materials and additives.

2.4.4.3.2 Good Manufacturing Practise (GMP)

Regulation 2023/2006/EC is mandatory for the food packaging printer, as part of 1935/2004/EC. It describes the good manufacturing practice for materials and objects that are intended to come into contact with food and therefore represent a binding system of rules for the manufacturer and converter of food contact materials.
The GMP regulations apply to the packaging manufacturer or distributor of the end product and to all areas and all levels of production, processing and distribution of materials and objects, which are intended for food contact. It requires a consistent, traceable quality assurance, control system and adequate documentation which has to be made available to the authorities upon request.
This means the entire production chain must be documented accordingly – from purchase of consumables (such as specifications) to the effective production (such as manufacturing procedures, procedural parameters, …) to the eventual end product – all contributing to the necessary conformity and safety of the end product.

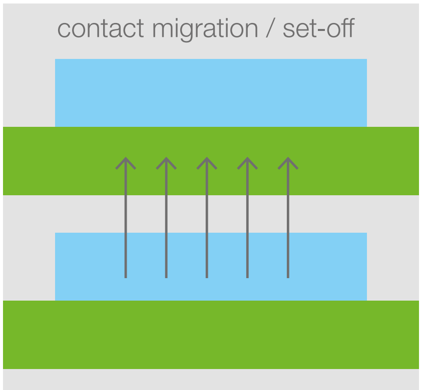
2.4.4.3.3 Migration

a) General

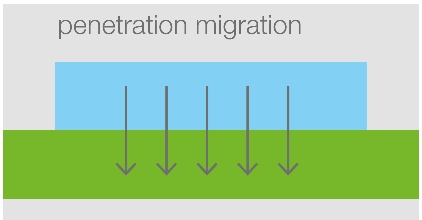
In principle migration is a transfer of chemical substances from the packaging into the food. For print production two forms of migration are important:

- **penetration migration:** this is migration coming from the printed side (ink + coating) through the substrate onto the unprinted side. Be aware, conventional cardboard without any plastic coating does not have any barrier function! [22]
- **contact migration (set-off):** this is migration coming from the printed side (ink + coating) to the unprinted side through contact in the stack or roll [23]

[23] **MIGRATION PRINT PRODUCTION**



[22] **MIGRATION PRINT PRODUCTION**



In general we can say that migration is a dynamic process depending on:

- initial concentration of migrating substance
- mobility and speed of the migrating substance
- permeability of the printed substrate and build up of the packaging
- absorption capacity of foodstuff
- contact time/storage time
- ratio between packaging size/volume of the food

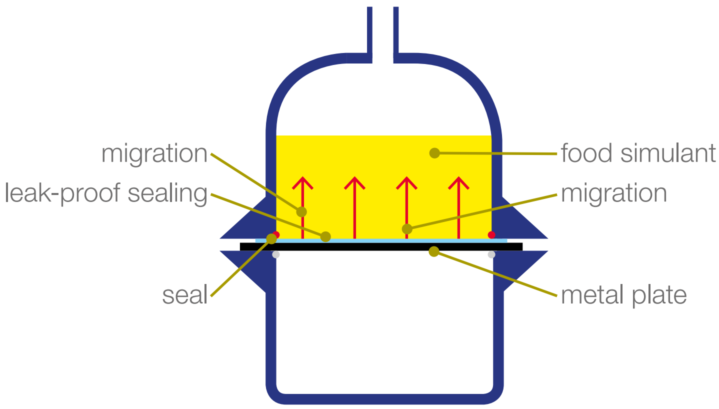
b) Migration tests

To test migration a simulant is used. [24]

[24]

BUILD UP MIGRATION CELL —FOOD SIMULANT

- application on non-printed reverse side
- defined contact time to react
- defined temperature
- migration test with food simulant (global or specific migration)



[25]

	FOOD SIMULANT	FOOD STUFF
A	10% ethanol	aqueous food stuff (ph ≥ 4.5)
B	3% acetic acid	acidic food stuff (ph ≤ 4.5)
C	20% Ethanol	Alcoholic foodstuff
D1	50% Ethanol	Milk products
D2	Olive oil	Fatty food stuff
E	Tenax	Dry food stuff

This is important to obtain reproducible results (this would never be possible with the actual filling like chocolate or cheese). To set these reproducible standards, all food is classified in different groups of food simulant. [25]
Migration tests are in a first phase done in a so called migration cell. This allows direct contact with the liquid food simulant and the unprinted/uncoated reverse side of the sample print during a pre-defined contact/reacting time, e.g. 10 days at a defined temperature of 40°C or even more demanding at 60°C, following the needs of regulation 10/2011/EC. At the end of this procedure, the food simulant can be treated either with global or specific migration. [24]

c) Global migration vs specific migration

Global migration:
Global migration determines the total amount of all substances, moving during contact time into the foodstuff. As there is no toxicological relevance behind, global migration assumes that only harmless components are used. Therefore global migration can be described as an indication about the inertness of included chemical substances.
For this global migration, the migration limit is set at 10mg/dm^2. This value results from the plastic regulation we spoke about earlier, used because of the lack of a regulation for coatings so far. To make this more practical, the so called "EU-Cube" is used as a reference model for packaging. As a cube has six sides, migration limit is 60mg per kg food (6 x (10/dm^2)).
To test this in practice, the liquid food simulant is evaporated. Afterwards all possible remains (even the smallest ones) are being weighed.
Important to remember is that global migration is measured by evaporation residues only, the substances are not known and not traceable by using this method. [26]

[26]

EU cube

Evaporation residue (weight)

Specific migration (10ppb-screening)
Specific migration on the other hand determines the amount of single specified substances moving during contact time into the food. Here toxicological relevant substances have individually defined migration limits (e.g. benzophenon 0,6mg/kg foodstuff), non relevant substances have a general migration limit of 10 ppb (0,01mg per kg food).
With his testing method the liquid simulant is used for chemical analysis which is carried out by a gas-phase chromatograph.

For lot of brand owners and therefore also for the printers, today's market is driven by global migration, obviously supporting their coating choice or used for the migration test of the print product, e.g. folding box.
But with regulations becoming more binding, the importance of specific migration is growing each day. Every packaging printer needs to be aware, that in worst case scenarios, with a food compliance issue of the packaging, a court case will demand specific migration as binding evidence (f.ex. the regulation 10/2011/EC which implies that all multi layer materials – which coated card board belongs to – demand the evidence of 10ppb-screening).
To be responsible to such a great extent, the packaging manufacturer or distributor (printer) must perform regular checks of the end product to confirm the use of currently defined and valid limits based on migration tests by an accredited institute.

2.4.4.3.4 Influencing factors in the printing process
In order to fulfil the prescriptions of the framework regulation 1935/2004/EC, a number of additional factors must be taken into consideration on top of the careful selection of substrate, printing ink, fountain solution and coatings (as well as washes, glues and auxiliaries).

The following factors can have an influence on the possible migration and thus on the conformity of the end packaging:

- printing substrate (recycled or fresh fibre)
- ink load and penetration properties
- properties of plastic foil (functional barrier properties?)
- print speed
- applied coating quantity
- processing viscosity through temperature influence
- anilox roller: theoretical volumes and real transfer quantities
- dryer settings and pile temperature
- water-based coating: IR and Hot Air
- UV Coating: emitter performance (lamp power)
- invisible setting off

We must stress that this list only represents some factors and does not guarantee the totality of the influencers. In every case, the relevant amount of influence must be determined and considered accordingly.

2.4.5 Summary

Using the correct water-based coating gives you several advantages: cost reduction, increased productivity, environmental advantages and troubleshooting.

2.4.5.1 Cost reduction
Fujifilm's philosophy starts from the fact that we believe the printer should not need auxiliaries with our coatings. Therefore they are formulated in such a way that they do not exhibit foaming and offer a stable viscosity during the run resulting in saving costs and time. However, for extreme situations, we do offer defoamer which is effective and compatible with our coatings. Also thanks to the wide application range of our coatings, stock can be reduced.

Our “Super gloss” water-based coatings have outstanding gloss properties and an appearance which compares favorably to UV coatings. They also have excellent drying properties, which enables high film thickness, full print speed or high stacks. So it offers cost reduction for the printer as well as for the print buyer.

2.4.5.2 Increased productivity
Thanks to the fast drying properties of our water-based coatings, we can assure that no blocking occurs (sticking together of the sheets) which is especially important at high machine speeds resulting in increased productivity.

2.4.5.3 Environmental advantages
The low-odour coatings we offer, improve both working environment as the appearance of the finished product. Also the “Super gloss” water-based product range, offers an environmental friendly alternative for UV coatings.

2.4.5.4 Trouble free process
Fujifilm coatings ensure a trouble-free process for the printer. Once the settings of the coating unit are entered, they will remain in place, enabling high machine speeds.

2.5 UV coatings

This group of coatings is not physically dried but chemically cured. The curing takes place as polymerisation through a chemical reaction initiated by UV light. The final result is, simply said, a hardened plastic film.

UV curable inks and coatings especially designed for application in offset printing presses were introduced during the 1960´s and had epoch-making features and advantages like:

- an increased potential range of synthetic substrates next to paper and board
- elimination of spray powder
- workable dry sheets in the delivery
- outstanding gloss results

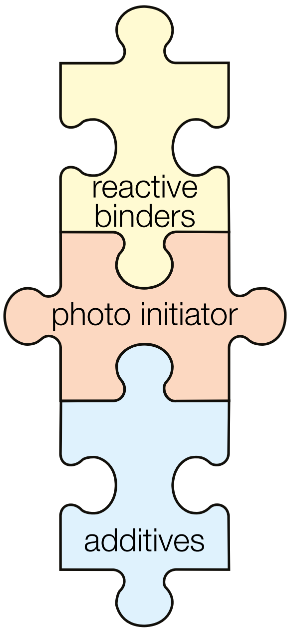
Of course these are an appreciated outcome of this new technology.

Nowadays, UV coatings offer several advantages and through these increasingly gain acceptance/market share:

- highest achievable gloss level (due to the thickness of the cured film)
- highest chemical resistance
- very high rub and scuff resistance
- weather proof
- enable brilliant effect in spot coating
- economical finishing of foil substrates

2.5.1 Composition of a UV coating

[27]



A UV coating is composed of 3 major components: [27]

- reactive binders
- reactive starting system (photo initiator)
- non reactive components (additives)

2.5.1.1 Reactive binders

The reactive binders are composed of two substances:

- oligomers (bigger amount)
- monomers (smaller amount)

2.5.1.1.1 Oligomers

Oligomers have an effect on the basic properties of the coating. They adjust:

- chemical and mechanical resistance
- hardness of the coating
- adherence of the coating
- gloss level

Oligomers are composed of bigger molecules which results in a high viscosity.

2.5.1.1.2 Monomers

Monomers are reactive diluents which are in fact small molecules. The monomers in the coating make it possible to adjust the high viscosity caused by the oligomers to an individual application viscosity.

2.5.1.2 Reactive starting system
UV curable coatings require an ultra violet light source in order to initiate the curing process. So when we speak about the reactive starting system, we speak about the photo initiators in the coating. These appear as powder or crystals but must be dissolved to be effective. Photo initiators react with the UV light: they change the molecular structure and produce free radicals. Those initiate the three dimensional polymerisation of the reactive components, which is the conversion from liquid to solid.

2.5.1.3 Non reactive components
The non reactive components are the additives which are added to the coating. Just like with the water-based coatings, these make sure that specific properties can be added:

- wetting
- levelling (silicone)
- slip
- matt degree
- rub resistance (wax)

2.5.2 Application systems
UV curable coatings can be applied by inline-coating units at the end of offset printing presses, with inking units, with dedicated offline coaters or with screen (screen coatings are not available from Fujifilm Belgium NV).

2.5.2.1 Inline application: on UV-ink
In this type of application no water-based primer is used. The curing of the UV ink happens due to the inter unit dryers. Those are movable UV dryer units to be put in or switched on individually. Most presses are equipped with one or two of them. The curing of the UV coating is done by the end dryer, which mainly consists of three UV lamps to be adjusted individually. By using this type of application a very high gloss level of the UV coating can be obtained.

2.5.2.2 Inline application: in double coater
Here conventional ink and a special water-based primer are used in combination with the UV coating. The water-based primer functions as a “link” between the ink and the UV coating. In the dryer units the water-based primer is dried while the curing of the UV coating happens in the end dryer.

This application requires more attention to the configuration as draw back effect can be possible.

2.5.2.2.1 Draw back effect
Draw back effect means that there can be a gloss reduction after 10 minutes to a few hours. This because the double coater system is more sensitive to the interaction between substrate, ink, primer and UV coating. As a consequence special attention has to be given to the emulsification of the ink and the adjustment of the dryer configuration to avoid this problem. Also the primer coating has a key role as it is a flexible link between the ink and the UV coating, resulting in a homogeneous gloss on the different ink placements. Please pay attention to our leaflet “Processing information for UV inline double coating”.

2.5.2.3 UV offline coater (subsequent finishing of offset prints)

As many printers do not possess the printing press required for UV coating application, an offline coater opens the market to almost any printer demanding an UV finish. These units are supplied in several print format/size from the known press manufacturers. Also here a combination of conventional ink, primer coating and UV coating is used. In this type of application a very high gloss level of the UV coating can be obtained. Moreover good levelling is possible due to the technical settings of the offline coater:

- warming up of the UV coating
- infrared for best possible flow
- long distance between application and curing

2.5.3 Other materials and parameters as performance factors

The formation of the coating film is influenced by several other materials and parameters. Following parameters for sure have an effect on the final result:

- substrate (paper, board and foil substrates)
- ink
- fount management
- coating transfer
- anilox roller
- curing and dryer settings
- heat management

Next to above mentioned materials and parameters, also here we have to mention that temperature has a very determining effect on the viscosity of the coating. We stress again that the stated viscosity refers to the run out time of the DIN-cup 4 mm, this at a coating temperature of 20 °C. [28]

The use of too much or a too cold coating can cause:

- disturbed flow [29]
- orange peel

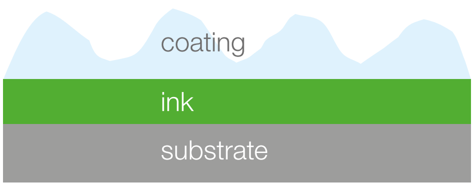
[28]

INFLUENCE OF TEMPERATURE TO VISCOSITY

24°C	36 seconds
20°C	50 seconds
16°C	62 seconds

slight deviations possible depending on formulation

[29]



2.5.3.1 Substrate

A wide range of paper, board and foil substrates is suitable for finishing with UV coating. However, differences regarding gloss level, surface smoothness, adhesion and scratch resistance may be given. Therefore a pre-test with the substrates is recommended when applying a UV finish for the first time.

2.5.3.2 Ink

With conventional ink please ensure with your supplier, that the ink meets the requirements of the application, like low content of wax or anti-oxidative agents.

2.5.3.3 Fount management

For printing with UV ink as well as conventional ink (UV inline application in double coater), water management is not only essential in order to get a stable and convenient ink water balance, but also to obtain a stable base for a good performance of the UV coating on top of the ink.
If we look at fount management in its whole context, it has to start by monitoring the process water. The total hardness should be at prox. 10°dH, as this causes an ink-water balance with balanced emulsifying properties. (1°dH= 10mg calciumoxide/litre water).

If water with a significantly lower total hardness is used (for instance by too low rehardening of osmosis water), the ink is emulsifying too much. The ink is – simply said – too wet, which can lead to bad drying of the ink with a higher risk for delayed blocking of the printing sheets.

Also the correct dosage of the fountain solution additive is important. A too low or too high dosage means a deviation of the necessary active ingredients for the ink-water balance. Especially an over-dosage can lead to an overload of non-absorbing or non-evaporating components.

FOUNTCONTROL – a unique Fujifilm technology – offers a safe and reproducible drop test, by which the fountain solution dosage can be checked through colour change. Parallel, also the pH should be measured and has to be judged independent from the fountain solution dosage. Too sour pH-values lead to a delay of the oxidative ink drying, too high pH-value lead – similar to a too low total hardness – to an over emulsification.

2.5.3.4 Coating transfer
In general printers need to make sure that the printing pressure is as low as possible to avoid squeezing while spot coating or splashing of the coating.

2.5.3.5 Anilox roller
The choice of roller can also be an influence of the final result of the print. We recommend using a tri-helical anilox roller for gloss UV coatings as it offers several advantages in comparison with nap gravure [30]:

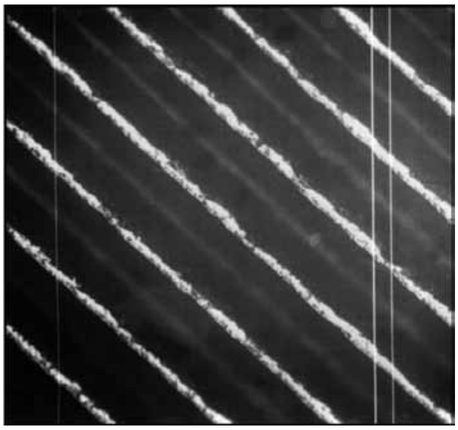
- good coating transfer
- good levelling and homogeneous surface
- good cleaning

For matt UV coatings on the other hand, we recommend anilox rollers with engraved hexagonally cells in order to get homogeneous and structure free print out. [31]

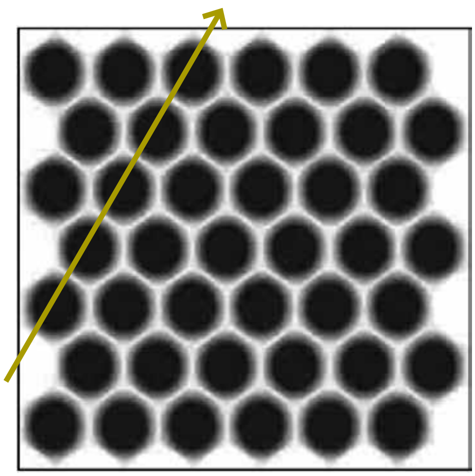
The consumption of UV coatings depends on the transfer volume of the anilox roller. Often the theoretical volume is mentioned, a general rule is that approximately 1/2 of this volume is applied on the substrate.
Moreover UV coating is solvent free and can be described as a “100% system”. This because the applied coating is solvent free it cures completely and nothing evaporates. Compared to water-based coatings (which is a “40% system), no significant reduction of film thickness takes place.

2.5.3.6 Curing and dryer settings
When a printed sheet enters the stack, it should feel completely dry. If it is still greasy or wet, curing needs to be checked and adjusted. In principle, the UV coating will continue to post cure for approx. 12 hours after printing, during this time adhesion will increase and the gloss level may drop down slightly.

[30] LINE SCREENING

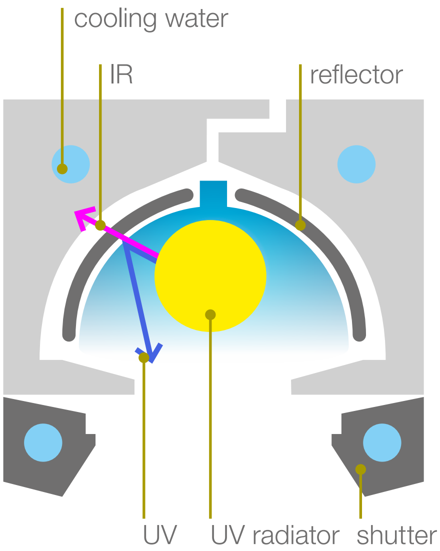


[31] HEXAGONALLY CELLS

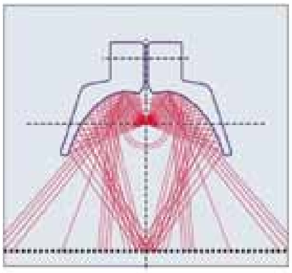


60°

[32] **PROFILE OF THE UV DRYER**



UV RADIATION ONTO THE PRINT



source: IST-Metz

A good monitoring of the UV dryer is important as 50 % of all UV problems are simply caused by defect lamps or dirty reflectors. To obtain a good curing we have to pay attention to the dosage of the UV radiation and the contact time of UV radiation (press speed) as too less power/UV radiation can cause incomplete curing with the risk of:

- a coating which feels sticky and may possibly lead to blocking
- bad smell
- bad adherence on ink or substrate
- lower gloss/brilliance

2.5.3.7 Heat management

Especially in commercial printing, with double sided UV application on paper, it is important to find a good balance between having the best possible levelling at the lowest possible energy input. This as:

- warming of the stack is possible (caused by UV dryer and IR dryer) [32]
- risk of softening/blocking especially with a low grammage

In order to avoid this, stack temperature has to be kept as low as possible (≤ 45 °C). This can be achieved by:

- drying of the primer with hot air and lowest possible IR (in the double coater)
- never overdose UV radiation, this can lead to cracking or poor adhesion of UV

2.5.4 Summary

Using the correct UV coating gives you several advantages: cost reduction, increased productivity, environmental advantages and troubleshooting.

2.5.4.1 Cost reduction

Fujifilm's philosophy starts from the fact that we believe the printer should not need auxiliaries with our coatings. Therefore they are formulated so that they do not exhibit foaming and offer a stable viscosity during the run resulting in cost and time saving. Also by the wide application range of our coatings, stock can be reduced.

2.5.4.2 Increased productivity

By the fast curing properties of our UV coatings, we can assure that no blocking occurs (sticking together of the sheets) which is especially important at high machine speeds resulting in increased productivity.

2.5.4.3 Environmental advantages

The Fujifilm product range includes low-odour coatings which improve both the working environment as the appearance of the finished product.

2.5.4.4 Trouble free process

Fujifilm coatings ensure a trouble-free process for the printer. Once the settings of the coating unit are entered, they will remain in place, enabling high machine speeds.

We recommend to document following parameters, in case of trouble this will help detecting the problem:

- stack temperature while printing verso and after x-hours
- parameters like anilox roller, substrate, ink, …
- UV-dryer – hour of operation (check with readings of the manufacturer)
- radiator power with volt-ampere meter.