



Conventional inks for continuous forms printing

HBL special inks for laser printer forms

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HBL special inks for laser printer forms

The introduction of laser printers confronted business forms printers with a new technology requiring certain changes of the usual procedures.

The production of forms for use in laser printers poses certain demands which have to be met by the printer's materials, e.g. printing inks and paper, and by the manufacturing conditions.

The study of functional relationships between ink, print, printing process, and laser printers was particularly important for printing ink manufacturers. Laser imprinting on forms is a significant example for conditions of use which shape the profile of requirements to be met by printing inks.

In the case discussed here, the printing inks have to meet particularly demanding requirements. **huber**group formulated the HBL inks for this application.

HBL stands for "HitzeBeständig für Laserdrucker", that is heat resistant for laser printers.

Critical interactions in laser printers

The question of possible interactions between pre-printed business forms and laser printers requires a brief explanation of the laser printing principle.

Laser printers are composed of the following components:

- Data memory for at least one page of output.
- Laser station, modulator, and mirror system to convert the stored information into light pulses.
- Electro-photographic printing unit to produce latent charge images on a photoconductor drum.
- Developing station to apply toner and generate an electrostatic image on the latent charge image.
- Transfer station to transfer the electrostatic image onto paper. The paper with the toner adhering to it is carried over a preheating plate, heated to about 120 °C, to fix the image thermally. The toner powder is melted onto the paper between burning-in and counterpressure roller.

The burning-in roller is heated up to temperatures between 180 and 220 °C, depending on the type of laser printer. The melting temperatures of toner powders are located between 80 and 150 °C. That is the temperature which the paper has to reach to fix the image perfectly.

Pressure of around 300 kN/m² may occur in the nip between burning-in and counterpressure roller.

Trouble-free operation of the laser printer requires a perfect fit of all the components participating in the process. This concerns the following parameters:

- The layout of the form should avoid, if possible, overprinting of solid areas and laser imprinting on pre-printed solids. Wherever possible the inking adjustment should avoid exceeding the thickness of ink layer usual in forms printing, around 1.3 grams. Multi-colour commercial work (mailings) must only be produced with inks for uv curing or hot air drying.
- Tension length and bending stiffness of the paper have to conform to DIN 6721, and the paper has to belong to fibre class Z 100 according to DIN 827 (100% cellulose).

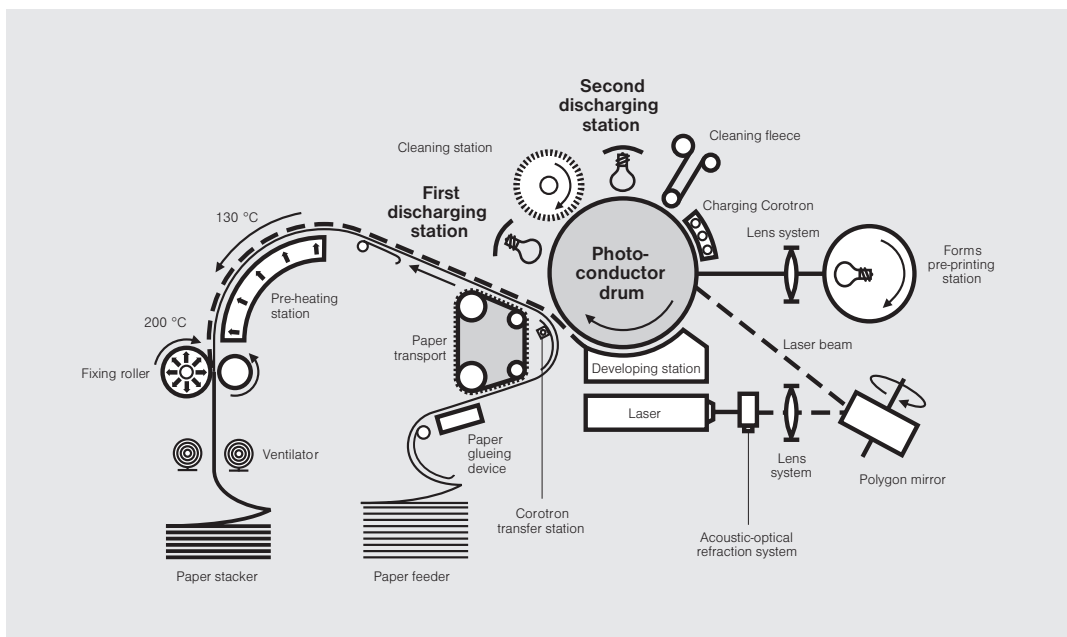


Fig. 1
Working principle of the Xerox laser printer

- Printing process, i.e. appropriate fount solution for offset printing, minimum fount application, printing plates.
- Printing ink.

Laserprinter troubles become apparent or occur nearly exclusively in the burning-in station. A comparatively large number of types of disturbance is known where one or several of the above parameters are inadequate, or are not sufficiently adjusted to each other.

- Build-up of printing ink particles on the preheating plate and on burning-in or counterpressure rollers.
- Mechanical damage of the burning-in roller, often coated with silicone resin, due to adhering print-ing ink and toner particles.
- Swelling of rollers, caused by volatile components of printing inks, e.g. mineral oils.
- Dirt on the burning-in roller marking in the printed image of forms.
- Smoke and odour caused by evaporating or volatilizing components of paper or printing inks.
- Insufficient adhesion or repelling of the toner powder on printed areas on the paper.

Demands to be met by the printing inks

Special inks have to be used in order to avoid ink-related disturbances.

In the text that follows we shall discuss only such types of offset inks which dry exclusively by striking in and oxidative interlacing reactions, unassisted, for instance, by radiation or heat.

Demands to be met by these inks:

- Good printability, particularly with images requiring little ink transfer.
- Comparatively high colour strength to make possible thin ink films.
- Non-drying in the printing unit, but quickly drying on paper, with high density of the interlaced, oxidatively dried binders.
- Ink components which are volatile under the conditions prevailing in the burning-in station, and which are likely to condensate or cause odour, have to be avoided as far as possible.
- Ink components causing swelling of elastomer-coated burning-in rollers have to be avoided.
- Under the conditions (pressure, temperature) prevailing in the burning-in station, the dried ink film must not become so sticky that ink particles will be transferred to the rollers. Dried ink films of low thermoplasticity are required.
- Components which increase the interfacial surface tension between “melting on” toner powder and ink film must not be used nor generated. “Burned-in” toner adheres less well to printed areas than to unprinted ones. The layout of the form has to take this into account. If laser imprinting on pre-printed offset ink cannot be avoided, halftone screens with less than 50 per cent dot area should be used. Otherwise, toner will stick to the burning-in roller which may damage the roller mechanically.

The list of demands shows that “normal” continuous forms inks are unable to meet the requirements.

HBL special inks from the hubergroup

All HKS®-E inks are HBL special inks containing binders with the required profile of characteristics.

Good printability was a major consideration when developing these systems. Stability and high tolerance for damping fluids, i.e. wide range between the scumming limit on one hand and the generation of wash marks on the other, help to lower the waste rate.

Most HBL inks contain only small amounts of volatile ingredients. Disturbances in the laser printer caused by volatilizing or evaporating ink ingredients, and swelling of the burning-in roller are thus avoided.

Ingredients	shares (per cent)
Modified colophonium resins	30
Special synthetic resins	15
Vegetable oils	35
Reactive thinner	15
Gelling agents	5

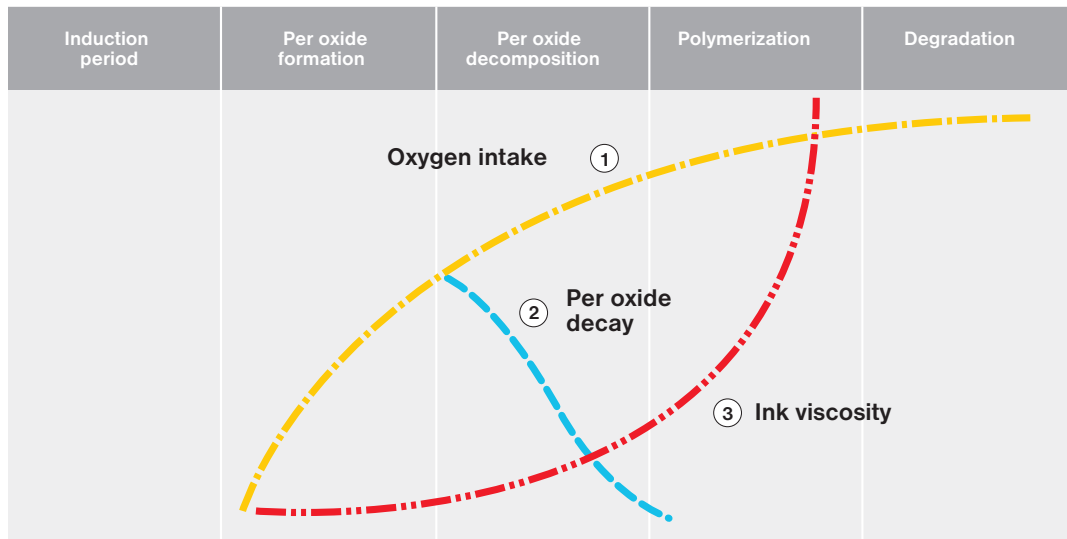
Binder formula

The fluid components such as vegetable oils and reactive thinner are capable of interlacing oxidatively, and they are completely incorporated in the ink film. Oxidative drying causes a phase change from fluid to solid.

Ingredients	shares (per cent)
Pigments	15 – 30
Fillers	0 – 10
Binders	84 – 52
Auxiliaries	0 – 5
Driers	1 – 3

Ink formula

The driers, based on organically combined metals, catalyse the oxidative interlacing reaction, taking place under the influence of the oxygen contained in the air, between suitable vegetable oils and reactive thinner according to the following diagram:



Contrary to inks based exclusively on binders containing only mineral oils, the striking in capability of HBL inks is lower, i.e. they need more time to strike in.

Ink	time required for striking
standard continuous forms ink	240 s
HBL ink	360 s

Striking in test on coated paper

Striking in was tested on coated paper because on that stock differences show more clearly than on uncoated paper such as used in business forms printing (without hot-air drying or radiation curing).

The fact that HBL inks need more time not only for striking in but also for drying requires a sufficient time interval between printing and use in the laser printer. At least three to five days are necessary, depending on the number of colours and ink coverage.

Otherwise ink may stick to the burning-in roller of the laser printer, causing ghosting of the printed image. Inks for uv curing should be used where overprinting is necessary.

The following problems may occur when using HBL inks on self-duplicating papers:

- Contact yellowing
- Neutralizing which, however, does not have effects because there is no copying onto solid areas in the printed image.

The commercially available types of SD papers are not of identical quality. Differences of interaction with printing inks are therefore possible. Before running the job, tests for contact yellowing and neutralization are recommended. Special inks from the **hubergroup** should be used if the problems occur during the test.

Additives

Only special additives must be used with HBL inks:

Printing oil 10 T 1405

It matches the binder system of the inks and may be used to reduce the tack of the inks if stock

of low wet picking resistance has to be printed on. Picking and piling on blankets can thus be avoided.

Grafo Drier 10 T 5001

Emulsified fount solution may retard drying if the image requires low inking. The problem can normally be eliminated with Grafo Drier.

Transparent white 30 IL 1000

This is the only admissible product to brighten colour shades, because it is based on the same binders as those used in HBL inks.

Technical information and Safety Data Sheets for all these products are available.

Printing on self-duplicating papers

The demand of the business forms market has been concentrating on SD systems with good printability and copying capacity. SD papers are excellent aids for organizing business, provided they are pre-printed. Offset is best suited to print solids, type, and halftones on both sides of the sheet. The printing pressure required by the process is much lower than that necessary in letterpress printing.

Some of the requirements which SD papers have to meet:

- Good copying capability.
- Good readability.
- Durability of copies.
- Copies which resist wiping and smearing.
- Hygienic and physiological safety.
- Forging-proof.

Printing process and printing inks must not have detrimental effects with regard to the above properties of sets of forms.

The following producers of SD papers are known to us:

USA	Europe	Japan
WTA (Wiggings Teape Appleton)	Aero-Celje	Fuji
Mead	Ahlström	Jujo
3 M	Arjo-Wiggins	Kanzaki
Moore	Binda	Mitsubishi
Nashua	SAPPI	
	Feldmühle	
	Köhler	
	Sarrio	
	WTA	
	Zanders	

Structure and functions of SD papers

Chemical SD papers produce copies, mostly of blue or black colour, by a colour reaction of two components. A simple set of forms made of reaction-type SD paper is composed of an upper sheet, also called CB sheet (CB = coated back), carrying a microcapsule coating on the reverse.

Next comes a middle or CFB sheet (CFB = coated front and back), carrying a developer coating on the front and a coating with microcapsules on the reverse.

Then there is the under or CF sheet (CF = coated front) with a developer coating on the front side.

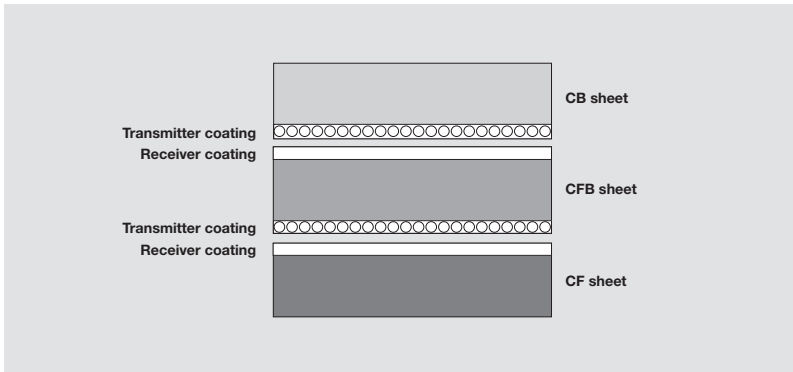


Fig. 3
Structure of a set of forms

The developer coating (receiver coating) is composed of activated anorganic pigments, e.g.

- bleaching earth, clay (about 7 g/m²)
- silica gel
- sodium aluminium silicates.

These, together with binders such as polymer dispersions, are coated and fixed on the paper substrate. Acid phenolic resins or salicylic acid salts may replace the anorganic components as developers, a formula used in most US and Japanese SD papers.

The microcapsule coating (transmitter coating) of the upper (CB) sheet contains about 5 g/m² capsules of 5 to 10 µm diameter.

Depending on manufacturer and process, the capsule walls are composed of gelatine, acrylate polymer, or polyurethane.

The microcapsules contain, in the majority of commercially available papers, a combination of two colour generators which, on the adsorbent of the receiver coating, develop within seconds a colour, for instance blue. The colour generators are dissolved in hydrocarbons (polyphenyle derivate, alki-naphtalenes such as diisopropylnaphtalene = KMC or alkylbenzolene) with comparatively high boiling points.

Distance buffers are incorporated in the coating to protect the capsules against premature bursting when the paper web is wound up. Cellulose powder or, for instance, interlaced starch act as mechanical "buffers".

The pressure of writing or typing causes the microcapsules in the back coating to burst and, in contact with the developer coating of following sheet, to generate a discolouring which has to meet the above stated requirements. Black copies can be achieved by combining suitable colour generators, e.g. a combination of blue, red, and yellow, or of a greenish blue and red colour.

To generate the colour, the lactone ring of the colour generator is opened on the solid, activated surface of the adsorbent (e.g. Clay), the leuco forme serving as electron giver, the components of the receiver coating as electron receivers.

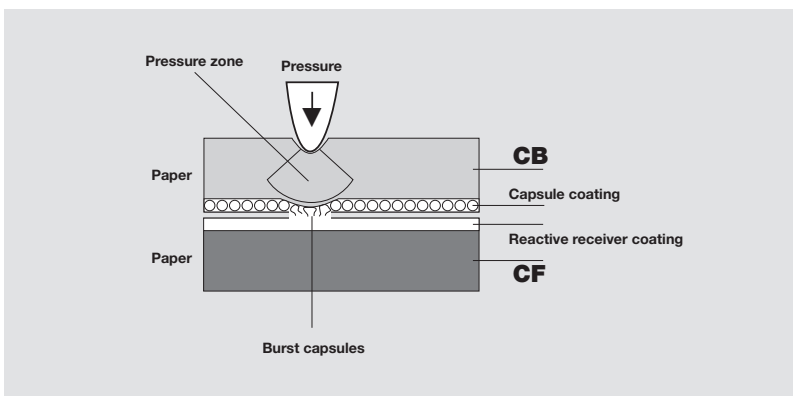


Fig. 4
The principle of colour generation

Interactions with printing inks

All SD papers are pressure sensitive. In spite of this they can be printed on without destroying a significant share of the capsules, using, for instance, the offset process (with compressible blankets). Solid and halftone areas are used when designing business forms to assist organization and to create visual impact.

The papers may be printed on both sides with the offset process.

Solid areas should be printed only where copying is not required. Halftone areas should have a maximum dot area of 30 per cent to avoid losses of intensity of the copies.

The following rules apply to the impression on the reverse:

- light typefaces,
- little ink transfer,
- transparent, bright inks (show through).

The impression on the front side (receiver coating) has to meet the following requirements:

The colour shades should contrast as strongly as possible with the colour of the copy.

Some experiences regarding disturbances during the offset run:

- Compressible blanket with quick release properties are a must.
- The fountain solution should not contain more than 10 per cent of isopropanol in order to avoid detrimental effects on the capsules.
- Printing plates which store little fountain solution are of advantage. The scumming limit will be reached earlier.
- Slightly higher volume of fountain solution should be used to minimize piling of coating components on blankets. On the other hand, and particularly with images requiring low inking, this leads to piling of the inks on rollers, respectively to high dot gain.

The adjustment of fountain solution transfer therefore has to compromise between piling and good contrast. Printing units with small cylinder diameters are more prone to piling, due to the larger opening angle. In most cases, the degree of piling is similar with conventional inks and with inks for UV curing.

Various unpleasant interactions are possible between printing inks and the components of receiver and transmitter coatings.

The following unfavourable interactions are known:

- Unsuitable pigments (triarylcarbonium types) may be dissolved by core solvents of destroyed capsules on the back of the sheet when printing on the front of CB paper with such inks. The pigments migrate through the sheet and appear on the reverse of the sheet.
- Destruction (dissolution) of capsule walls caused by unsuitable mineral oils in printing ink binders.
- Neutralizing effects caused by inks drying by strong oxidation.
- Insufficient fastnesses in connection with neutralizing pastes.
- Chemical reactions between leuco bases and unsuitable pigments which are dissolved in core solvents. This creates colour changes.

The above mentioned interactions have to be taken into account when formulating printing inks for SD papers.

The offset inks have to meet the following requirements:

- Low tack to avoid picking of coating components and piling on blankets.
- Rapid striking in to avoid the transfer of fresh ink (setting off) when rewinding (printing reel to reel).
- Comparatively high colour strength to reduce the ink films as much as possible (avoiding set off).
- Black inks must not contain toners which are soluble in the capsule solvents (core solvents). Otherwise bleeding or a chemical reaction with the leuco base cannot be avoided.
- Some types of pigments and toners must not be used in inks for printing on SD papers. Otherwise, again, chemical reactions and changes of colour may occur. The colouring agents generally have to be insoluble in core solvents (cf. the following tabular survey).
- The printing inks must not contain mineral oils which may migrate through the capsule walls, causing these to burst by a slight dissolving effect or by an increase of the inner pressure due to osmotic effects.
- Inks with strongly oxidative drying characteristic, e.g. HBL inks, may, due to binder components and fission products generated by oxidative drying, have a "neutralizing" effect and cause yellowing.
- Soap-fast inks have to be used where printing inks and neutralizing inks get into contact with each other in the set of forms.
- Wrong handling of the paper in the printing process may destroy many microcapsules. This may retard drying considerably because the inks will be thinned by escaping capsule fluid.

The following basic colours of the HKS®-E fan and of the PANTONE®-system must not be used:

HKS® E fan	PANTONE®
HKS 27	Rhodamine Red
HKS 33	Purple
HKS 43	Reflex Blue
	Violet
	Blue 072

Alternative formulations with suitable pigments will not be identical in colour, and their colours will be less pure.

The types of paper available on the market are not of identical quality. They may therefore cause different interactions with printing inks. Consequently, tests should be run prior to printing with regard to yellowing and neutralizing effect.

Additives

To avoid trouble, printing inks for SD papers have to be mixed only with special additives.

Printing oil 10 T 1405

This additive has to be used where the tack of inks has to be reduced because the wet picking resistance of the stock is low.

Mixing white 50 0625

Only this product must be used to brighten colour shades, because it matches the binder basis of the inks for SD papers.

Technical information and Safety Data Sheets of all the above mentioned products are available.

Contact addresses for advice and further information: www.hubergroup.de

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