Conventional inks for continuous forms printing

HBL speciality inks for laser printer forms

The introduction of laser printers confronted business forms printers with a new technology that required certain changes to 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. the printing inks and paper, and by the production conditions.

A study of the functional relationships between ink, print, the printing process and laser printers was particularly important for printing ink manufacturers. Laser imprinting on forms is a significant example of the extent to which print converting and later use 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 has formulated its 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 thermically. The toner powder is melted onto the paper between the burning-in roller 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.

Pressures of around 300 kN/m^2 may occur in the nip between the burning-in and counterpressure rollers.

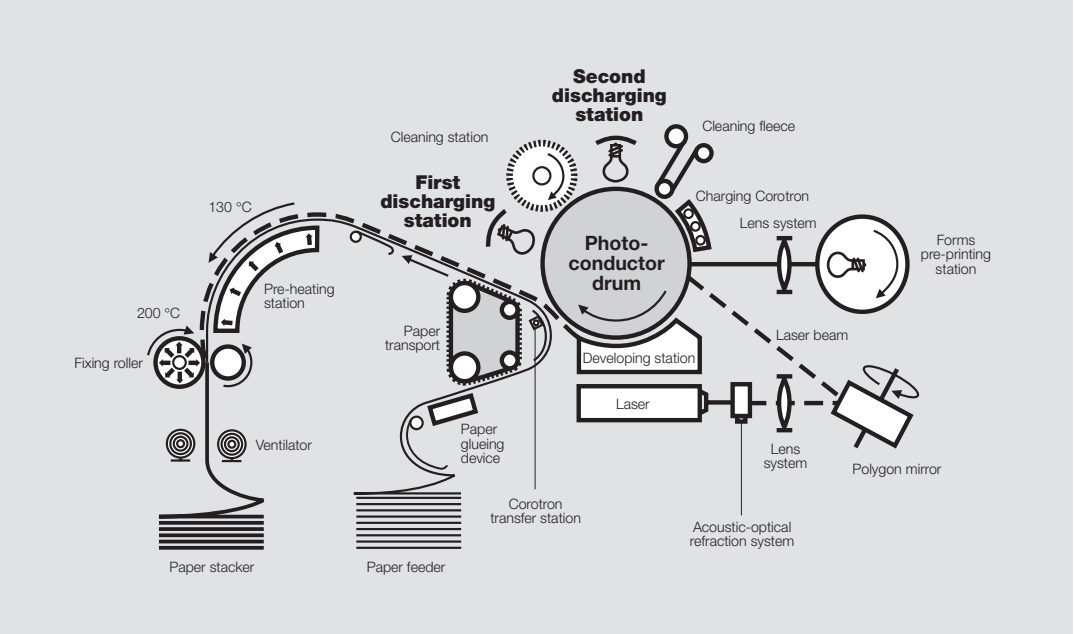


Fig. 1
Working principle of the Xerox laser printer

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 rate should not exceed the usual thickness of ink layer for forms printing of around 1.3 grams. Multi-colour commercial work (mail shots) must only be produced with inks for UV curing or hot air drying.
- The tension length and bending strength 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).
- The printing process, i.e. appropriate font solution for offset printing, minimum dampening, printing plates.
- The printing ink.

Laser printer troubles become apparent or occur nearly exclusively in the burning-in station. A comparatively large number of different forms of defect are encountered where one or more of the above parameters are either not complied with or are not adequately matched to each other.

- Build-up of printing ink particles on the preheating plate and on the burning-in or counterpressure rollers.
- 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 resulting from the evaporation or vapourisation of volatile 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.

Demands to be met by these inks:

- Good printability, particularly with images requiring little ink transfer.
- Comparatively high colour strength to make thin ink films possible.

- No piling in the printing unit, but quick drying on paper, with high density of the interlaced, oxidative-drying vehicle components.
- Ink components which are volatile under the conditions prevailing in the burning-in station and which are likely to condense or cause odour have to be avoided as far as possible.
- Ink components that cause swelling in elastomer-coated burning-in rollers must 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 the 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 must take this into account. If laser imprinting on pre-printed offset ink cannot be avoided, halftone screens with less than 50 % dot area should be used. Otherwise, toner will stick to the burning-in roller and this 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 vehicles with the required profile of characteristics.

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

Components	shares %
Modified colophonium resins	30
Special synthetic resins	15
Vegetable oils	35
Reactive thinner	15
Gelling agents	5

Vehicle formula

HBL inks usually contain vehicles and auxiliaries that prevent the vehicle from softening again on the laser printer’s burning-in roller.

Otherwise ink may stick to the burning-in roller of the laser printer causing ghosting of the printed image.

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

- Contact yellowing
- Neutralising which, however, does not have any 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 neutralisation are recommended. Speciality inks from the **huber**group should be used if the problems described above occur during the tests.

Printing on self-duplicating papers

Demand in the business forms market has been concentrating on SD systems with good printability and copying capacity. SD papers are an excellent organisational aid provided they are preprinted. 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
- Forgery-proof.

The 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 in blue or black, by means of 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 the 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.

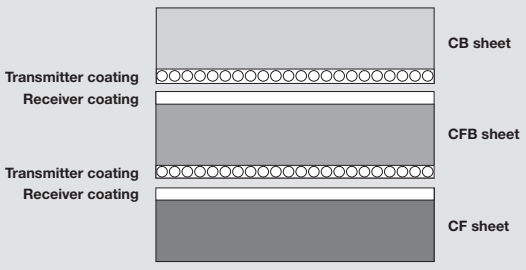


Fig. 2
Structure of a set of forms

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

- bleaching earth, clay (about 7 g/m^2)
- silica gel
- sodium aluminium silicates.

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

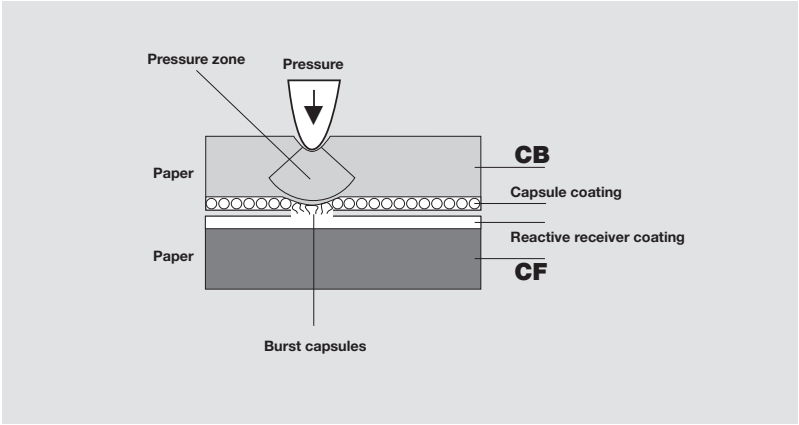
The microcapsule coating (transmitter coating) of the upper (CB) sheet contains about 5 g/m^2 capsules of 5 to 10 µm diameter. Depending on the manufacturer and manufacturing process, the capsule walls are composed of gelatine, acrylate polymer or polyurethane.

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, alkinaphtalenes 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 the 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.



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 organisation and to create a 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 % 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 blankets with quick-release properties are a must.
- The fount solution should not contain more than 10 % isopropanol in order to avoid detrimental effects on the capsules.
- Printing plates which store little fount solution are of advantage. The scumming threshold will be reached earlier.
- Slightly higher dampening should be used to minimise 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 the rollers or to high dot gain. The adjustment of dampening 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 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 burst 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 vehicles.
- Neutralising effects caused by inks that dry chiefly through oxidation.
- Insufficient fastness properties in connection with neutralising 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:

- Relatively low tack to avoid picking of coating components and piling on blankets.
- Rapid striking-in to avoid the transfer of fresh ink (setoff) when rewinding (printing reel to reel).
- Comparatively high colour strength to reduce the ink films as much as possible (avoiding setoff).
- Black inks must not contain toners which are soluble in the capsule solvent (core solvent). 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 the core solvent (see table below).
- 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 characteristics, e.g. HBL inks, may, due to vehicle components and decomposition products generated by oxidative drying, have a “neutralising” effect and cause yellowing.
- Soap-fast inks have to be used where printing inks and neutralising inks come 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 from Hostmann-Steinberg's HKS®-E colour guide and the PANTONE® system must not be used:

HKS® E guide	PANTONE®	
HKS 27	Rhodamine Red	and the mixed colours produced from these inks
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 neutralising effect.

Auxiliaries

Should it become necessary, under exceptional circumstances, to adapt the process inks to special printing conditions, those auxiliaries available from the **huber**group companies that are compatible with the highly sophisticated vehicle system should be used.