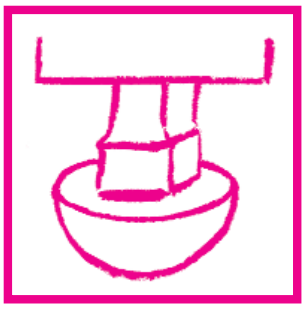
Pad Printing – Theory and Practice



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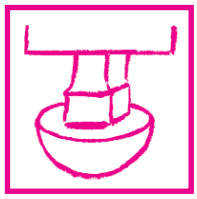
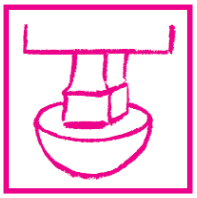
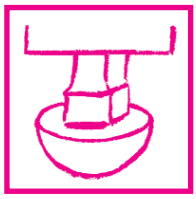
Contents



Appendix



1. Introduction



Pad printing opens up new possibilities which were not available with traditional printing processes, or which could be exploited only with great effort. To some extent, pad printing also replaces other decorating processes, such as screen printing, labeling and hot stamping.

The form used for pad printing is a plate of etched steel or washed out photopolymer. As with intaglio, the image printing elements are contained (etched) in the non-printing surface. During a printing operation, the plate is covered with ink, the excess is doctored from the surface of the plate, and the ink for the print remains in the depressions. A soft, elastic pad then transfers the ink from the depressions onto the substrate.

The areas of application are so extensive that dozens of pad printed articles are encountered every day in the form of commercial items, such as lighters, ball pens and toys, as well as housings, switches, keys, knobs and buttons in the automotive and electronics industries.

2. Pad

The pad receives the motif from the cliche, transfers the ink film to the substrate and deposits it there. The pad must be constructed so that it is pliable, but guarantees transfer of the motif without smudges or blurring.

Printing pads are made of silicone rubber and produced as stamps in a wide array of shapes, hardnesses and qualities.

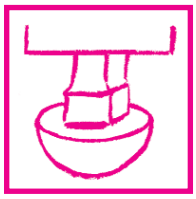
2.1 Shape

All standard pad shapes have one common characteristic: the printing surface is convex and angled from the sides to the print area in the center. This convexity is a factor influencing the ink transfer, whereby the lateral angles provide the stability necessary to obtain smudge free prints. A *semi-circular, tapered pad* is the ideal shape. It can be rolled to all sides equally well, thus preventing the formation of air bubbles. This rolling motion allows the ink to be easily transferred from the cliche to the piece to be printed. The above described shape, however, does not lend itself to all objects or print motifs. Square or rectangular pads are sometimes necessary. When square pads are used, it is still important for the central area to be tapered in order to insure that the pad rolls well. The results produced by rectangular (bar-shaped) pads are generally less desirable, as the pads themselves can only be rolled laterally in two directions.

2.2 Size

In order to guarantee sharp, smudge free print, the pad selected should be as large as possible. The less the pad is deformed, the sharper the printed motif. The

pad must be larger than the actual motif to be printed, particularly with "problem prints" , where corners are to be reproduced at an exact angle. The disadvantage of the large pad volume is that a very large pad requires a large press, and, such a large pad is more subject to the vibration caused by the movement of the press than is one of smaller mass. Besides this, the price is considerably higher, as the main factor in pricing pads is the weight of the material.



2.3 Hardness

Pads are generally available in varying grades of hardness ranging from 2 to 18 Shore A. However, special grades of hardness from 0 Shore A to over 40 Shore A can be utilized. Here, the rule is: the higher the number, the harder the pad.

The hardness has a major influence on the quality of the printed motif and the life expectancy. A hard pad can reproduce print well, and has a greater life expectancy due to its physical stability. In many cases, this hardness cannot be exploited, as the pad would damage the material to be printed. In the same way, softer pads must be used for very curved surfaces, as they can adapt to such surfaces better than very hard pads. Selection of the grade of hardness does, of course, depend on the force of the press which is utilized. Many presses are, accordingly, pushed to their limits by large, hard pads.

2.4 Quality

In the case of silicone rubber, there are basically two different systems: *crosslinking by polycondensation and crosslinking by polyaddition*.

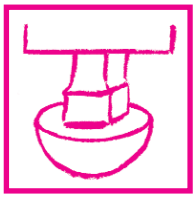
Physical properties, such as tear resistance or resistance to swelling in contact with solvents, are better in polyaddition crosslinking materials than in polycondensation systems. Obtaining the raw material is more expensive, however. The smoothness of the surface is a decisive factor in the quality of the print. The smallest impurities or air bubbles caused by defects in manufacturing result in unclear print. In the beginning, new pads tend not to pick the ink up from the cliche as well. This problem can be solved by making a few prints on paper or by a short cleaning operation using alcohol. If cleaned with aggressive agents, such as thinner, the pad immediately takes the ink from the cliche, but does not transfer it to the piece to be printed quite as well. Once a pad is "broken in", it is recommendable to dab its surface with adhesive tape to remove any dust particles.

2.5 Life Expectancy

Approximately 50,000 to 100,000 prints can normally be produced with one pad. This, however, depends on the quality of print required and the type of inks used. The life expectancy is longer using single-component inks and shorter using two-component inks. The size, shape and hardness of the pad as well as the shape of the material printed also has an influence on the life expectancy. In the case of

very sharp corners or extreme curvatures on an object to be printed, the pad can be physically damaged after as few as 1,000 to 5,000 prints.

The life expectancy of a pad can be extended considerably by careful cleaning and treatment with silicone oil.



3. Cliche

The cliche is the carrier of the print motif. Varying types of cliches are used depending on the desired print quality and quantity.

The motif is recessed, etched into or washed out of the cliche. In order to assure smooth fitting and printing, the motif should be at a distance of at least 25 mm (1 inch) from the outer edge, and centered on the plate. In the case of long or fine lines, the motif must be at an angle of approx. 5° to 15° to the blade track in order for the doctor blade not to dip too low and scoop out too much ink. Numerous trials have shown that an etching depth of 25 µm is optimal for pad printing. Since the pad can only transfer a limited quantity of ink, a greater depth is pointless. At an etching depth of 25 µm, the pad only picks up an ink film of 12 µm. The rest remains in the depressions of the cliche. Because the ink film consists of approx. 40 % to 60 % thinner, which evaporates during the transfer and drying, the actual thickness of the ink film left on the substrate comes to around 5 µm - 8 µm, in some cases, as little as 2 µm. As an exception to the above statement, very fine fonts are etched at approx. 15 µm, and very large motifs, at approx. 30 µm. For very large surfaces, the dip of the doctor blade can be avoided by additionally copying a fine screen into the motif.

3.1 Steel Strip Cliche

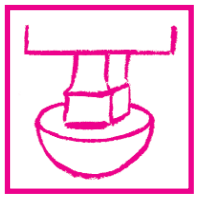
This is a strip of spring steel, 0.5 mm (0.02 in.) in thickness, with a very fine surface, and a hardness ranging between approx. 48 and 54 Rockwell. In the press, the steel strip is held in the ink well by a metal plate.

The advantage of steel strip cliches over photopolymer ones is that within one cliche, sections of a motif can be screened while other sections are not. As well, etching can be done in stages, i.e., certain portions of a motif can be etched more or less deeply than others. The quantity of prints which can be made depends on the type of press used and the settings, as a steel strip cliche is somewhat softer than a doctor blade. In practice, the serviceability allows between 20,000 and 100,000 printing runs.

3.2 Steel Cliche

This classic cliche is produced from special high-grade, abrasion-proof steel. Its area of application is found primarily in the industrial sector. Steel cliches are especially suited to high quantity printing runs and closed ink systems. The qual-

ity of these cliches is unequaled. This is evident from their absolute sharpness of contour, multi-stage etching, utilization of screens of all types, very fine surface, low susceptibility to physical damage and consistency in high quantity printing runs. The number of prints which can be achieved using this cliche comes to at least 1,000,000 doctoring operations.



3.3 Chrome Cliche

A chrome cliche is made up of a brass film with an upper layer of durochrome which is photo-coated. In a printing press, a chrome cliche can only be used with a vacuum plate or double-stick tape. Production of such cliches is relatively expensive, and results in the formation of substances which must later be disposed of. The advantages of the chrome cliche lie in its capability to produce large numbers of prints at approx. 100,000 doctoring operations, and its multi-stage etching.

3.4 Photopolymer (Plastic) Cliche

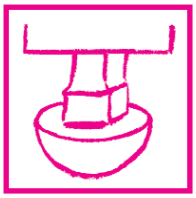
Photopolymer cliches consist of a UV light sensitive layer of plastic which, if necessary, is bonded to a metal carrier by an adhesive coating. Single as well as double-layer materials are used for photopolymer cliches. With the latter, the upper layer of approx. 25 µm is generally carried off during the developing process. These cliches are unsuited to screened motifs. The thickness of the single-layer material is up to 400 µm, and the etching depth is controlled by the exposure and the use of a screen.
The number of prints which can be obtained using this cliches lies in the range of some 10.000 doctoring operations. Under optimal conditions runs up to 100.000 prints are attainable.
Areas of use for this type of cliche include (progressive) proofs, pre-series runs and smaller jobs.

3.5 Other Cliche Types

Two further types of cliche are used for pad printing. For rotary presses, *steel rollers* are necessary. Since the printing may sometimes be done in a scope of 360°, the film montage and production of the rollers is very expensive. Special etching equipment is also required.

In many areas of industrial production, transitional codes are to be printed, such as the date of production, batch number, model number, etc. In order to avoid the constant production and changeover of new cliches, it is advisable to work with *encoding cliches* or encoding rods. These cliches are the same thickness as steel cliches, but are polished on the two long sides. Thereby, the rods lie very close together and can be pushed against each other in the ink well. This shift permits any combination of digits and letters to be printed without the necessity of interrupting the production process.

4. Pad Printing Inks



To achieve optimal print quality, special pad printing inks must be used. These inks display very highly concentrated pigmentation, as only very small quantities of ink are transferred in the pad printing process. The properties of the ink should, as far as possible, include:

- easy workability
- long pot life in wells/cups
- non-hazardousness to health
- absence of environmental risks
- ease of cleaning
- best possible adhesion to all objects and material without need of pre-treatment or subsequent treatment
- capability to serve as a universal ink system for all substrates

Depending on the area of use, the requirements placed upon an ink vary greatly. For simple marking or labeling, the demands are low, for decoration, very high.

4.1 Composition

Inks consist of binders, pigments, solvents and additives. These ingredients give the individual ink systems their particular properties.

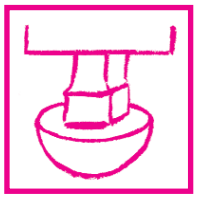
The **binder** of a pad printing ink is composed of one or more resins. Since the resins are, in most cases, obtained in the form of granulates or powders, they must be dissolved in suitable solvents or solvent mixtures. The selection and combination of the resins determine the ink's later area of utilization and the resulting properties, such as adhesion to various substrates, grade of gloss and resistance to chemicals.

Solvents differ, above all, in their evaporation speeds and solvent strengths. The solvent content of a pad printing ink is the deciding factor for its drying behavior and thereby, printing speed on and adhesion to moderately soluble substrates.

Solvents are broken down into thinners and retarders. **Retarders** have almost no significance in pad printing, as the output of the prints is usually very fast. Retarders are merely necessary when printing slowly and when using very fast drying ink systems like KS-U. A retarder which evaporates too slowly can have a negative influence on the prints. **Thinners** consist of solvents as contained in the corresponding ink systems. Mixing them with the ink in the correct proportion provides the desired viscosity, which is prerequisite to the ink transfer. For the pad to transfer the ink, part of the thinner must have already evaporated during the transfer process, leaving a tacky ink film on the pad.

Pigments provide the color tone of the ink and determine its hiding power. A distinction is made between organic and inorganic pigments. Pigments containing heavy metals are no longer utilized.

Additives are substances normally used in small quantities. Their function is to fine tune the ink properties, such as flow, viscosity, or characteristics of the surface. Additives include, for example, leveling agents, thickeners, or waxes.



4.2 Properties

The most varied requirements are placed upon the finished print, regardless of the substrate:

- the motif is to be matte, satin, glossy, or high gloss
- the ink is to be resistant to chemicals, dishwasher safe, resistant to UV light, scratchproof, or resistant to saltwater, saliva, or perspiration
- the print is to cover (hide) the surface or be transparent

The variety of partially contradictory properties demonstrates that a wide range of inks is absolutely necessary.

4.3 Ink Systems

Pad printing inks are broken down into different categories based on their drying behavior:

- physically drying inks (one-component inks)
- chemically curing inks (two-component inks)
- heat curing inks
- UV curing inks

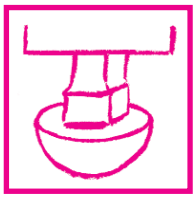
4.4 Solvent Based Inks

Single-component inks are given the desired viscosity by using thinners. Their drying is induced by the physical evaporation process of the solvents they contain. At the same time, substrates of thermoplastic compounds, such as polystyrene, polycarbonate, or PVC are partially dissolved. This “slight dissolution” of the printing surface results in a direct bond between the ink and the substrate. A high degree of scratch proofing and good adhesion of the ink usually pose no problem in this case.

Two-component inks display very high resistance to chemicals along with good bonding and scratch proofing properties, especially when used on problematic substrates. A hardener which reacts chemically with the binder must be added to the ink. Here, it is of critical importance for the hardener to be added in the correct proportion. It should not be added until shortly before the printing run, as the ink is only workable for a short time thereafter. The complete drying and bonding of this ink system is dependent on the ambient temperature; at room temperature (approx. 20 °C / 68 °F), this takes several days. In this case, the mistake is often made of undertaking bonding and scratchproofing tests much too soon. Reading Pröll`s related Technical Information is a must.

Heat curing inks display the same properties as two-component inks. The chemical reaction of this ink system is a cross-linking of the binder which does not take place at room temperature, but only under the influence of high temperatures.

Oxidizing inks dry/cure as a result of their reaction with atmospheric oxygen. This is a relatively slow process, whereby the final state is reached in one to two days at room temperature.



4.5 UV Curing Inks

In pad printing, the transfer of ink is usually dependent on the evaporation of the solvents. This evaporation induces a tackiness on the surface of the ink film which modifies the adhesive behavior of the ink. The ink must be transferred as a film to achieve optimal results with respect to hiding power and sharpness. This transfer is contradictory to UV technology. Due to the absence of a solvent in UV inks, the surface of the ink film is not altered. The transfer takes place in a “wet state”, which makes it more difficult.

The primary area of application for **UV curing inks** is found in high-output industrial pad printing.

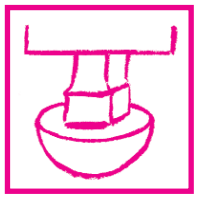
The advantages of UV inks are:
- no drying out on/in cliche
- guaranteed reliability in production with uniform grade of quality
- far less wear and tear on cliche and doctoring mechanism
- immediate drying on contact with UV light -> no time lag in further processing
- no emissions from solvents.

On the other hand, the disadvantages are:
- restricted hiding power and dependency on performance of available UV curing unit
- partial transfer of shadows of doctor blade by pad
- restricted possibility to clean pads with tape, as ink on pads does not develop tackiness as do conventional inks
- precision of transfer for the high demands placed on printed motif does not attain quality level of solvent inks.

4.6 Water Based Inks

The use of water based inks has not established itself in pad printing. This is due to the very slow rate of output. The necessary properties of quick drying, tackiness and adhesion cannot be attained using water as a solvent, as the evaporation speed of water is considerably slower than that of the usual solvents.

4.7 Processing



The ink is made ready for printing by adding thinners and, the need arising, hardeners. Because the difference of only a few grams in the small quantities required to fill the cups or wells can lead to a considerable deviation, the individual components must be weighed carefully.

However, even after the ink has been prepared, further steps may be necessary to make the printing process possible at all. This is due to the fact that some substrates, e. g., certain plastics, can only be printed after *pre-treating*, or they require a *subsequent treatment* to guarantee the adhesion of the ink.

Substrates which are soiled with an oil film or with silicone cannot be printed without *pre-cleaning*. Some materials are so sensitive that even perspiration from the fingers can impair the final results or the adhesion of the ink. The simplest method to clean a substrate is to wipe it with alcohol.

Plastics such as polypropylene or polyethylene can be pre-treated using *corona (electrical) discharge* or *flaming*. Corona discharge units operate with a high frequency / high tension discharge in the neighborhood of 20,000 volts. Flaming units produce an open flame over the substrate. The intensity and duration of the flame are adjustable. Both units function the same way; the surface tension is increased to anchor the ink in the substrate. Another option to achieve better adhesion is treatment with primers. For polypropylene, ink systems which make pre-treatment unnecessary are available.

With some plastics, there is an occurrence of very strong static electric charges which result in the appearance of dust inclusions or spiderwebs on the edges of the printed motif. These manifestations can, for the most part, be avoided by using an *ionizing* unit.

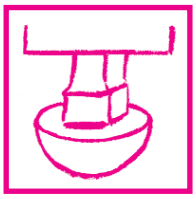
At an accelerated cycle time, for multi color prints, for materials which do not readily pick up the ink and for slow drying inks, *cold* or *hot air* blowers provide good support to speed up the drying process. The pad can be ventilated on its way to the front and in the forward position. Alternatively, the parts or material can be ventilated so that the ink film dries more quickly. Care must be taken, however, not to mount the blower directly above the ink well, as this will cause the thinner to evaporate too quickly and more will have to be added very frequently. Subsequent treatment of hard to print materials with hot air can improve the adhesion of the ink. Subsequent treatment with hot air or flame drying is the only way to achieve durable print on some materials. The temperature and duration of these treatments can be found in Pröll`s Technical Information.

5. Pad Printers (Presses)

Pad presses are available in a great variety of sizes, versions and with different drives. The printing pad, cliche and ink system are the elements common to all types. Differences are seen in the physical structure and layout of the compo-

nents, as well as the movement patterns. In practice, the following requirements are placed upon the machines:

- capacity to produce one-color and up to five-color prints
- capacity ranging from manual printing to fully automated systems with prior or - subsequent processing
- hand, table, upright and built-in units
- high performance (high speed) units
- customized and standard all purpose units
- capacity to produce flat, semi-circular and circumferential (wraparound) prints
- open-well and sealed cup systems



5.1 Types

All the various requirements can only be met by different types of presses.

5.1.1 Table Models

These models are the most widely used, as they lend themselves to the greatest number of applications. They consist of a complete press which is suitable for small to middle sized prints and products. Table models can be set up on work benches, installed into assembly lines, or utilized in transitional work stations.

5.1.2 Upright Models

Upright models consist of a complete press with integrated or add-on pedestal. The press then becomes a self-contained unit or self-contained work station. To accommodate larger products, this type of machine can normally be combined with a large compound cross table which is adjustable in height.

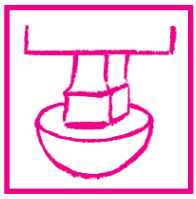
5.1.3 Built-In Models

These are often very small, compact units, designed for integration into an assembly line. As a rule, they are operated by remote control. The machine must be aligned according to the product in such a way that the unit itself can be set up on a cross table and that the complete assembly can be brought into the correct position. Many of these machines are also equipped with a tiltable head attachment. Further, this type of unit must be totally adaptable to the speed of the conveyor belt. This makes a very large number of printing speeds necessary.

5.1.4 All Purpose Models

This type of unit is suited to the broadest range of applications. Differences can be observed in the technical design of the individual components, such as stationary

(pad moves up/down and backwards/forwards) or movable ink wells (pad moves up/down, ink well moves backwards/forwards).



5.1.5 Tiltable-Head Models

After takeup of the ink, the pad is rotated 90°, or to any other angle, in such a way that the printing is not done in a vertical, descending motion, but at an angle in a horizontal, forward motion.

5.1.6 Circumferential (Wraparound) Printing

For some objects, print around the entire outer surface (circumference) is desired. This is achieved either by standard table models, or upright units, which have rectangular pads and which take the motif from a conventional, flat cliche. The pad remains stationary underneath in the forward position, while the piece to be printed rolls on a special adjustable table under the pad.

The advantage of these units lies in the favorable price, which results from the fact that a standard table model only needs to be equipped with one attachment. The disadvantage of this system is its unsuitability for small diameters and automated processes. As well, circumferential printing is not economical for high output requirements.

5.1.7 Rotary Pad Printers

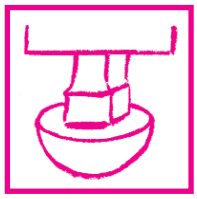
In rotary pad printing models, both the pad and the cliche are cylindrical. The steel cliche roller rotates in the ink well and is doctored by a stationary unit. The silicone pad roller, rotating in the opposite direction, picks up the ink and transfers it to the object to be printed.

Here, the advantages are the high operating speed and the capacity to print onto flat objects as well. Besides this, multi color printing can be done in one step. The disadvantages are the high investment required along with the restricted area of application.

5.1.8 Carousel Models

This is a self-contained unit. The pads are mounted onto a circular fixture (carousel) which turns above the individual cliche plates. These are arranged in a circular formation. When the entire set of pads is moved downwards, one pad picks up the ink from the cliche, a second passes the ink film to the substrate, and a third pad is cleaned with tape. Carousel units are suited to small or middle range jobs.

5.2 Types of Drive



Various types of drives, such as pneumatic, electromechanical, hydraulic, as well as servo-pneumatic are available for printing presses.

Pneumatic drive is the most widely used for the following reasons:

- the sequence of movement is pre-programmed for operation with cylinders (up/down, forward/backwards).
- the clear layout of its construction makes it easy to monitor and maintain.
- production is economical, since existing standard components (cylinders) can be used.

Electromechanical drive is available primarily in small and middle sized units. The distinguishing feature is its particularly quiet operation. Due to the relatively sophisticated technology involved, they are more expensive and less user friendly than pneumatic drives.

Hydraulic drive is only found in a few very large models, since the great pressure which is necessary can only be achieved using this type of drive. These models are more expensive than the pneumatic or electromechanical types.

A more recent concept couples traditional technology with **servo-pneumatic** drive for the movement of the pads. This concept permits high speed printing and, at the same time, high precision. Servo-pneumatic units are controlled electronically and may be programmed as desired. Up to now, they have only been utilized for multi color printing, as they make it possible to print each color as often as needed within a given printing cycle. These units entail extremely high investment costs.

5.3 Auxiliary Equipment

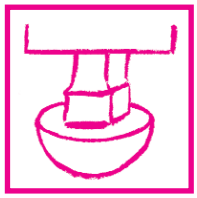
Most of the above described models can be used with auxiliary equipment, for instance rotary indexing tables, carree and adjustable tables, or linear belts. The majority of these additional elements can be equipped with automatic feed and ejection stations. Objects can also be printed on more than one side, as turning units can be installed between the individual stations.

5.4 Open-Well and Sealed Cup Systems

In the details of the basic components necessary for all machines, there is a broad spectrum of solutions to problems, such as fastening the cliche plate and ink containers.

In the case of **open wells**, the cliche lies in a depression in the ink well and is secured with screws on four sides. Thereby, only cliches whose size corresponds

to that of the ink container can be used. The cliches should also be uniform in height in order to avoid the necessity of adjusting the doctor blade, brushes or spatula. Since the ink is also distributed around the sides of the cliche, a great quantity of ink is required to fill the well. The advantage is that nearly the entire surface of the cliche can be used for the print. Photopolymer or steel strip cliches do not work well in this configuration.



In open-well systems using a **clamp container**, the cliche is inserted, either from the front or the side, into the ink well, then pressed from underneath against two terminal strips. The ink is filled into the rear. The advantage of the clamp container over a stationary system lies in its lower ink consumption, for example, as well as greater speed in changing the cliche and greater ease in cleaning. Photopolymer or steel strip cliches can be clamped in very simply with an adapter or magnetic plate. In the case of wells with a lateral opening, longer cliches with several motifs can also be pushed through. This makes it possible to change motifs very quickly. This type of container also allows the use of encoding rods. The effort required to set up a multi color unit is also reduced considerably, since only one cliche with all colors is pushed through.

Sealed cup systems with an ink pot hold the ink in a container which also performs the doctoring function. A trough does not constitute part of the system. The cliche, however, must be somewhat larger, as the ink/doctor well requires a resting (idling) position. The advantages of the sealed cup system include, for instance, the elimination of unpleasant odors from solvents and, besides this, a long range reliability of almost 100% in production, as the ink cannot dry out. The quality of print is good after short or long idle periods. The disadvantage is the higher price of the ink wells as opposed to that of doctor blades.

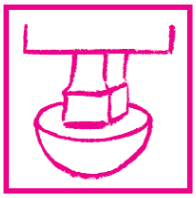
Besides the differences in cliche and container types, there are also several varieties of doctor blades (steel or ceramic) and ink dispensing systems, such as brushes, spatulas, and rollers as well as pumps. The adjustment of the head stroke of the pad as well as speed, ventilation, hot air, corona (electronic) and flaming units, along with ionizing and suction units open up new avenues of opportunity in equipping the machine and expand the areas of application.

5.5 Setup

Proper selection of film, cliche, pad and ink are prerequisite to a good printing result. If compromises have to be made regarding the shape or hardness of the pad, the suitable ink or the right thinner, no optimal result is possible. All these points apply, regardless of what type of unit is used. The printing result is also influenced by factors such as ambient temperature and humidity.

There are several tricks to facilitate the setup of a pad printer.

5.5.1 Pad



To select a suitable pad, the positive film can be pressed onto the pad using a stable glass plate. This is a simple method to show how strongly the pad must be squeezed. To prepare the pad in the press for the motif, it is recommendable to breathe shortly onto the cliche or clean it with alcohol in order for the impression left on it by the pad to be seen. In this way, the position of the pad can also be corrected at the same time.

Should the pad be too large, it can be cut to size with a sharp knife. This saves having to produce an expensive, custom made pad. When cutting, care must be taken to maintain the approximate lateral angles of inclination in order not to reduce the stability and, thereby, the print quality too greatly.

If a number of different, physically separated motifs are printed, several pads can be mounted onto one single wooden panel. A better result can be achieved in this way than by using one very large pad.

The position of the pad can cause considerable smudging of the image on very curved parts. This can be decreased or eliminated by several X-Y shifts of the pad in the machine.

Here, it is also important for the pad to be pressed onto the cliche and the substrate with only minimal stroke force. Pressing too hard can lead to smudging, greater wear and tear as well as poor ink transfer.

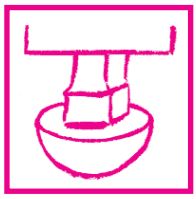
5.5.2 Cliche

Before use, every cliche should be examined with a magnifying glass for visible deficiencies. Should there be a defect in the area where the pad touches down, it will inevitably be transferred to the object which is printed. In such a case, the cliche should be replaced.

5.5.3 Ink

The entire quantity of ink needed for one day should be mixed in a sealable vessel. The normally small amounts should never be poured directly from the can into the mixing container, as too much can easily flow out. Using ink spatulas is the best method to remove the desired quantity to be weighed from the original package. The necessary percentage (proportion) of thinner to be added varies from ink system to ink system, and may also differ from color (shade) to color (shade). It is of critical importance for the mixture to be stirred well before being placed in the cup or ink well. Otherwise, separation of the ink and thinner in the container is possible. The container is filled to approximately 80 % of its capacity to avoid any ink build-up in the front area and to prevent any ink from running over the edge of the container onto the motif after the doctoring operation.

5.5.4 Printing Press



An X-Y (double axis) cross table is very helpful, as the object to be printed can be quickly and precisely fitted into place on it. The position can be most quickly corrected using a transparent film, which is laid over the object. Adjustable ink containers are also helpful when the motif on the cliche is to be positioned at an angle.

6. Advantages and Unique Features of Pad Printing

The following list demonstrates the strengths and unique features of pad printing in comparison with other printing processes:

Advantages of pad printing in comparison with other printing technologies:

- Variety of substrates
- Printing of firm, hollow objects
- As indirect intaglio process, capacity to print fine subjects
- High resistance properties of inks
- Easy handling with little maintenance
- Multi color wet-on-wet prints
- Short change-over times, especially suited to small jobs
- Low up-front costs for printing run
- Relatively small space requirement
- Low drying costs
- High speed in rotational systems
- Integration into complex systems: online in assembly and production lines
- Less attention required for ink in sealed systems, e.g., consistency of viscosity
- Use of variety of printing media, e.g., lacquers, adhesives, pastes, inks
- Precise adjustment of tones

Unique features of pad printing in comparison with other printing technologies:

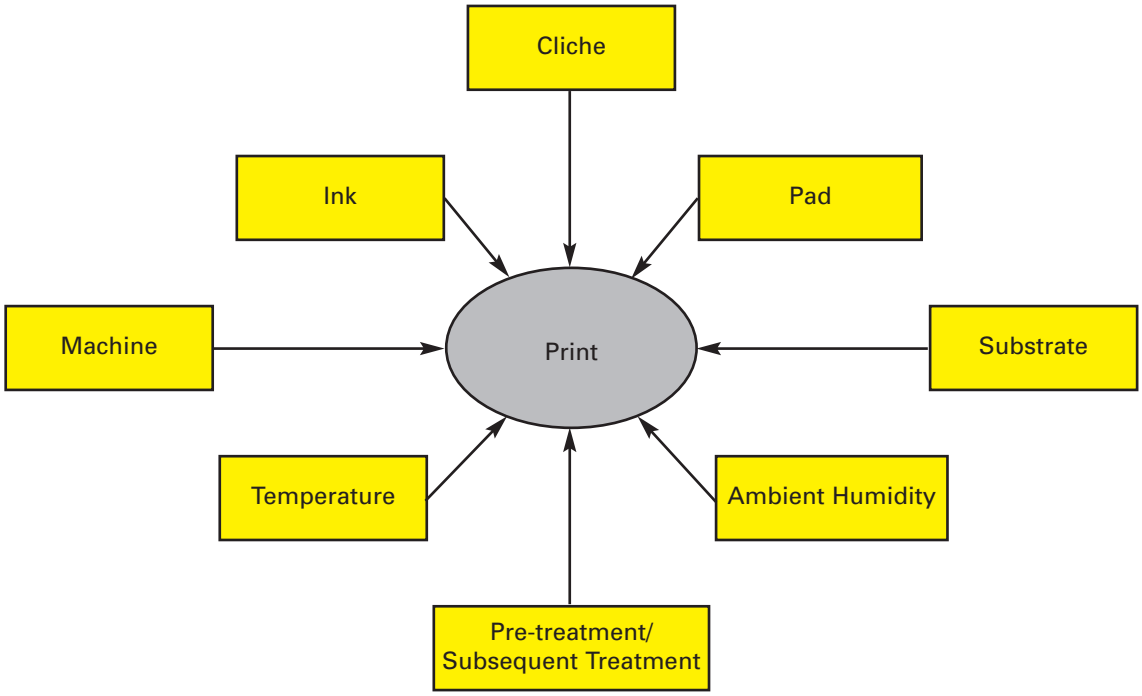
- Printing with almost no dependency on shape, e.g., concave, convex, curved objects
- Printing of varied surface types, e.g., grained or structured areas
- Possibility to print into depressions
- Physically sensitive products can be printed

7. Problems in Printing

From the facts mentioned so far, it becomes evident that the result of printing is influenced by a multitude of factors (see diagram below). Experience shows that the root cause of a faulty print is virtually never to be found in the mechanics of the printing press. Defects in the press itself are nearly always obvious, clearly definable and can be remedied by the technicians of the manufacturer. Hence, this issue can be ignored. To eliminate problems connected with printing, it is of greatest importance to describe deficiencies in as detailed a way as possible. Any application technician has difficulties on the telephone when a customer makes state-

ments which are only general in nature. Not even the best technician can be of assistance when simply told “the press won’t print” or “the quality of the print is poor.”

Factors influencing print:



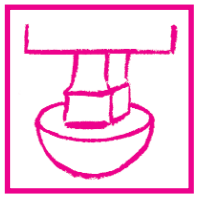
7.1 Sources of Deficiency

Deficiencies most commonly found in printed material:

- no opacity
- misregister
- motif distorted
- blurring
- poor leveling of ink
- problematic overprintability in multi color prints
- color does not correspond with artwork
- spiderweb effect on contours
- screen dots are visible/are not visible
- fine lines run together
- large areas not completely covered
- small bubbles (pinholes) visible
- motif smudged
- ink does not adhere to substrate
- desired grade of gloss cannot be achieved

During printing operation:

- pad does not pick up ink
- no deposit or only partial deposit of ink by pad



A number of additional problems arise, which are, however, very particular to the individual areas:

***Pre-operational* deficiencies, e.g.:**

- inadequate pre-treatment
- no or only partial deposit of ink on substrate

***Post-operational* deficiencies, e.g.:**

- ink/color turns after some time
- ink cannot be lacquered
- ink does not adhere to substrate

7.2 Containment of Deficiencies

In order for any problems which arise to be contained quickly, the individual components (e.g., substrate, pad, cliche and ink) should be systematically changed or replaced. The settings of the press and the ambient conditions (humidity!) should be checked. Making individual sample prints at a higher or lower printing speed or blowing on the pad can also be helpful.

A number of deficiencies, their causes and suggested remedies are listed in the appendix (pages 19 – 37).

8. Conclusion

Pad printing has, in recent years, become more dynamic and reliable in production due to the development of sealed ink systems and automatic pad cleaners. In the coming years, it will undoubtedly achieve even greater importance in comparison with existing decorating processes. In addition, this gain in significance will be promoted by the increasingly elaborate decoration of articles for daily use, as well as by the switch from other printing processes. Further, the trend in industry to label an ever increasing number of components with ID numbers, date of manufacture, etc., can be clearly observed. Besides this, the typical advantages of pad printing, such as reproduction of even the smallest fonts, printing on uneven objects, as well as the relatively high printing speed, and, last but not least, cost efficiency must be taken into account.

Pad Printing Inks – Which Ink for which Substrate

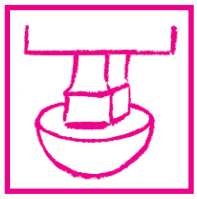
	KS-U	Norifin® PP N	Norilit® CS	Norilit® U-SG	NoriProp N	NoriPUR®	Sorte P	Tampo-Jet® ECO	Tampo-Jet® GMI	Thermo-Jet®
One-component ink	✔	✔	✔	✔	✔	✔	✔	✔		✔
Two-component ink						✔			✔	
Substrates										
Acrylic glass (PMMA)	■	▲				■	■	■		■
Glass									■	
Coated substrates	▲	▲	▲	▲	▲	▲	▲			▲
Thermosets	▲	▲	▲	▲		▲	▲			
Wood, plywood	■	■	■	■		■	■			■
Leather						▲				▲
Metal / non-ferrous metal	▲			■		▲			■	
Polyamide	▲					▲				
Polycarbonate	■			■		■	■	■		■
Polyester pre-treated				■		■				■
Polyester untreated				■						
Polyethylene pre-treated	▲	■		■	■	■	■			
Polypropylene pre-treated	▲	■		■	■	■	■			
Polypropylene untreated		■			■					
Polystyrene, ABS, SAN	■					▲	■	▲		▲
Polyurethane						▲				
PVC rigid	■	▲		■		■	■	■		■
PVC plasticized, self-adhesive films				■		▲				■
Properties										
Drying										
physical	✔	✔	✔	✔	✔	✔	✔	✔		✔
physically reactive						✔			✔	
Grade of gloss										
high gloss	✔									
glossy					✔	✔	✔			✔
satin gloss		✔	✔	✔				✔	✔	
Auxiliaries										
Thinner / Percentage (%)	25	20	20	30–35	20–25	30–40	30–35	30	30	30–35
Hardener	030	002	002	002	002	002	002		Adhesion Promoter 101	002

✔ = applicable; ■ = basically suited; ▲ = can be suited

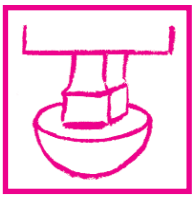
Important: Printing results, to a large extent, depend on the substrate as well as the conditions of use. We recommend checking your substrate under your printing conditions before performing any production runs. Materials that are supposed to be identical may vary from manufacturer to manufacturer and even from batch to batch. Some substrates may have been treated with sliding agents, antistatic or other additives which can impair the adhesion of inks.

The above table shows the most important pad printing inks manufactured by Pröll. With these inks a multitude of substrates can be printed. Beyond this scope further ink systems for specific applications as well as custom made special products are available.

Important: The result depends strongly upon the substrate and ambient conditions. It is expressly recommended to test the substrate under the respective conditions of application before the printing run. Materials assumed to be the same can vary from supplier to supplier or even from batch to batch. Certain substrates may have been treated with lubricants, anti-static or other additives which could impair the adhesive quality of the ink even long after the printing, e.g., from diffusion of plasitcizers (softeners).



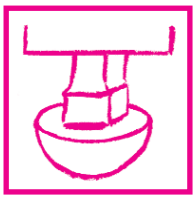
Spots of poor ink pickup by pad



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Dried out. 3. Wrong thinner.	1. Insufficient etching depth. 2. Wrong screen ruling. 3. Surface physically damaged.	1. Too flat. 2. Surface roughened. 3. Pad swollen. 4. Surface too oily.		1. Pad is pushed onto cliche too strongly.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Add thinner. 2. Clean cliche with thinner. 3. Use slower thinner or one suited to ink system.	1. Produce new cliche with greater etching depth. 2. Test new cliche with different fineness of halftone screen. 3. Use new cliche.	1. Use more tapered pad shape. 2. Replace pad. 3. Blow air on pad. 4. Clean pad (several times) or replace.		1. Decrease head stroke of pad.

If ink pulls on pad fibers during pickup, it is too thick and needs thinning.

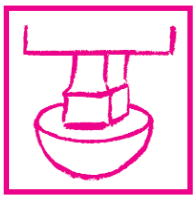
Poor (spotty) release of ink by pad



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Dried out on pad. 2. Too wet on pad, not tacky.	1. Insufficient etching depth. 2. Etched too deeply. 3. Wrong screen ruling.	1. Wrong shape pad. 2. Surface roughened.	1. Soiled surface (grease, oil, perspiration, mold release agents..). 2. Surface insufficiently pre-treated (polyolefines).	1. Print speed setting too slow. 2. High ambient (room) temperature.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use slower thinner. 2. Use faster thinner.	1. Produce new cliche with greater etching depth. 2. Produce new cliche with shallower etching depth. 3. Use new cliche with different fineness of halftone screen.	1. Use more tapered pad shape. 2. Replace pad.	1. Pre-clean objects. 2. Check pre-treatment, repeat as required.	1. Maintain uniform cycle time. 2. Optimal room temperature is 20 °C - 22 °C or 68 °F - 72 °F.

Incomplete or spotty deposit of ink by pad is referred to as “splitting.” It plays a minor role in a continuously running process. The problem only arises when cycle times fluctuate or after short breaks. The pad deposits the dried ink all at one time, producing an inconsistent image. Using fast thinners will decrease ink build-up and improve ink deposition.

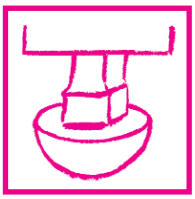
Insufficient opacity



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thin. 2. Transparent ink. 3. Wrong ink system. 4. Scanty ink transfer.	1. Insufficient etching depth. 2. Areas not screened. 3. Areas not slanted. 4. Wrong cliche type. 5. Wrong screen ruling.	1. Too flat. 2. Porous surface. 3. Too soft.	1. Soiled surface. 2. Dark substrate color. 3. Surface too rough. 4. Stress cracks (esp. on injection molded parts).	1. Soiling from greasy residues on accessories (auxiliaries). 2. Doctor blade sags.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Reduce amount of thinner. 2. Use opaque color shade. 3. Use pad printing ink . 4. Locate defect in cliche or pad.	1. Use new cliche with greater etching depth. 2. Screen area. 3. Slant areas. 4. Use cliche which allows screen to be etched with it. 5. Test new cliche with different fineness of halftone screen.	1. Use more tapered pad shape. 2. Replace pad. 3. Use harder pad.	1. Clean surface with alcohol. 2. Double print. 3. Use harder, more tapered pad. 4. Use milder ink/thinner system or quick drying ink/thinner to avoid any dissolution of substrate.	1. Clean cliche, doctor blade, etc. before installing. 2. Use harder or thicker doctor blade (or see cliche points 2 and 3).

This problem very often occurs in pad printing, and cannot always be solved satisfactorily. Due to the low degree of ink transfer in pad printing, 100 % opacity cannot be achieved on many objects with only a single printing, especially in the case of dark substrates. Increased hiding power can be attained by double or triple printing or preprinting with white.

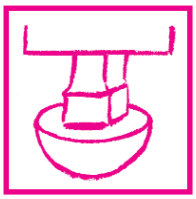
Misregister in multi color prints



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
	1. Individual motifs not correctly aligned.	1. Pads mounted off center. 2. Pads not same shape. 3. Pads not of same hardness. 4. Head stroke not same over cliche and substrate material.	1. Material is pliable.	1. Jig not perfect. 2. Carre, adjustable, or rotary indexing table inaccurate. 3. Mounting screws not tight.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
	1. If motifs are all on one cliche, film must be corrected and new cliche must be produced.	1. Readjust pad. 2. Replace pads with ones of correct shape. 3. All pads should be of same Shore hardness. 4. Adjust head stroke.	1. Switch to different material.	1. Check for play in jig, refabricate as needed. 2. Check indexing. 3. Screws not properly tightened during initial setup; they become loose during printing operation. Tighten screws.

The simplest way to contain these deficiencies is to produce a new cliche with precisely registered film.

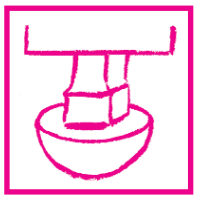
Distortion of motif



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
	1. Motif not aligned with cliche.	1. Wrong pad shape (pad too small). 2. Too soft or too hard. 3. Stroke force too great. 4. Stroke force on cliche and substrate not equal. 5. Touch down at wrong point.	1. Very soft/pliable. 2. Material allows distortion. 3. Very deep recesses/depressions. 4. Edges in proximity to motif.	1. Unsuitable jig. 2. Work piece mounted at wrong angle. 3. Jig too unstable.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
	1. Hold film over finished print and compare; correct and produce new cliche as needed.	1. Test different pad shape. 2. Test other hardnesses. 3. Decrease the head stroke. 4. Correct the head stroke. 5. Align pad to correct contact area.	1. Cool objects before printing to harden material; inflate hollow body. 2. Switch to different material. 3. and 4. Use pad assemblies or jigs which compensate for depressed areas; produce special pad as needed.	1. Modify jig so that substrate is supported in all print/contact areas. 2. Test correct angle using adjustable wedge. 3. Produce new jig.

Distortion means that a printed rectangle, for example, does not show any right-angled corners, and has more the shape of a cushion. Distortion occurs primarily in very curved motifs or in motifs which are in proximity to an edge of the area to be printed or of the substrate. It is often impossible to achieve a 100 % correction. It is possible to make a wraparound print, but improvements with this method are also limited.

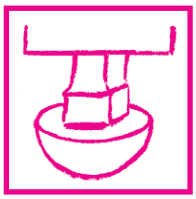
Blurring



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Too thin. 3. Too slow.	1. Poor etching. 2. Etching too deep. 3. Wrong cliche type. 4. Wrong screen ruling.	1. Too soft. 2. Wrong shape.	1. Soiled surface. 2. Not free of distortion. 3. Great differences in height. 4. Printing in proximity to edges. 5. Very structured surface.	1. Jig unstable. 2. Fast cycle time with bulky pad.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Add thinner. 2. Use new ink. 3. Use faster thinner.	1. Examine cliche with magnifying glass, produce new cliche as needed. 2. Produce new cliche with shallower etching depth. 3. Replace with correct cliche. 4. Test new cliche with different fineness of halftone screen.	1. Use harder pad. 2. Test different shape.	1. Pre-clean with alcohol. 2. Switch to different material. 3. Use pad assembly or special pad. 4. Jig should support substrate adjacent to edges, to prevent pad from extending over edge. 5. Use hard, pointed pad.	1. Refabricate jig. 2. Reduce speed, adjust setting to delayed cycle in front position to prevent pad from wobbling during print stroke.

Blurred print is understood as the indistinct, hazy reproduction of lines or letters. This deficiency is often confused with distortion.

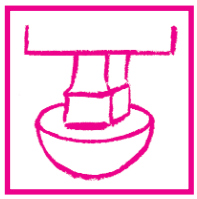
Poor leveling of ink/poor wetting



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Too thin. 3. Ink mixed insufficiently.	1. Wrong etching depth. 2. Wrong screen ruling.	1. Surface too rough. 2. Wrong shape. 3. Oily surface.	1. Soiled surface.	1. Ink contaminated by grease, oil, silicone, etc.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Add thinner. 2. Remix ink. 3. Mix ink well before pouring into ink trough.	1. Check etching depth, produce new cliche as needed. 2. Test new cliche with different fineness of halftone screen.	1. Replace pad. 2. Test different shape. 3. Clean with alcohol or replace pad.	1. Pre-clean with alcohol.	1. Use new ink and keep accessories free of contaminants, or clean before use.

Poor wetting can also be corrected by adding 0.2 % - 0.5 % additive 9011 or 2 % - 5 % Norilon 5.

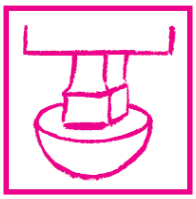
Overprintability in multi color prints



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Too slow.	1. Too deep. 2. Wrong screen ruling.	1. Rough surface.	1. Very slick, dense material structure.	1. Insufficient pre-treatment or subsequent treatment.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use new ink. 2. Use faster thinner.	1. Produce new cliche with shallower etching depth. 2. Test new cliche with different fineness of halftone screen.	1. Replace pad.	1. Substrates where surfaces cannot be dissolved by thinner are esp. problematic (e.g., glass).	1. Heat objects before printing, or ventilate them for thinner to evaporate faster.

During high speed printing operations, the last ink printed may be removed by next pad. This occurs particularly on larger surfaces, where material cannot be dissolved by thinner, or with slower inks in connection with carree or rotary indexing tables and linear belts. The problem hardly ever arises when adjustable tables are used. The best solution is to pre-heat objects or dry them with cold or hot air at intervals during the printing run.

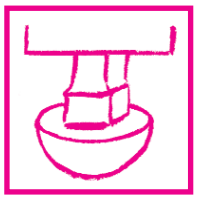
Color of ink does not match artwork



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thin. 2. Wrong ink system. 3. Wrong color match (in custom colors). 4.Transparent ink. 5. Shade cannot be mixed.	1. Wrong etching depth. 2. Wrong screen ruling. 3. Wrong type of cliche.	1. Wrong pad shape. 2. Surface too rough.	1. Dark substrate color. 2. Changing material types.	1. Only printed once.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use new ink. 2. Use pad printing inks. 3. Check proportions or re-mix as needed. 4. Use more opaque ink. 5. In this case no solution possible. Test another ink system.	1. Check etching depth or produce new cliche as needed. 2. Test new cliche with different fineness of half tone screen. 3. Replace cliche.	1. Use hard, pointed pad. 2. Replace pad.	1. Try to attain thicker ink deposit by double printing. 2. See below.	1. Test double or triple printing.

This problem occurs frequently in pad printing. It is, however, often impossible to achieve the original shade, as it cannot be mixed from the colors available in pad printing. To lessen the influence of the substrate color, the options are to: pre-print using white, double print, or triple print to increase the opacity. Each method does, however, have its drawbacks, and should be tested beforehand.

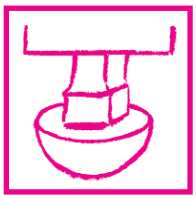
Splotches or spiderweb effect on contours



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Ink build-up on pad.	1. Etching too deep. 2. Wrong screen ruling.	1. Wrong pad shape. 2. Surface too rough.	1. Surface becomes charged with static electricity.	1. Humidity too low. 2. Cycle time too fast. 3. Intermittent operation of machine.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Add thinner. 2. Use faster thinner.	1. Produce new cliche with shallower etching depth. 2. Produce new cliche with fine half-tone screen.	1. Use more tapered pad form. 2. Replace pad.	1. Install ionizing unit on printing press.	1. Raise humidity to approx. 55 to 60 % (at a temperature of 20 to 22 °C / 68 to 72 °F) 2. Reduce printing speed. 3. Regulate to constant cycle times.

Improvement can be achieved by grounding press. Splotches or spiderwebs most often occur with materials such as polystyrene, polycarbonate, or acrylics.

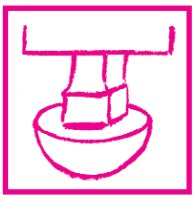
Screen dots are (not) visible



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick. 2. Too thin.	1. Etching too deep. 2. Wrong screen ruling. 3. Wrong cliche type.	1. Surface too rough. 2. Wrong pad shape.	1. Surface too coarse/ very structured.	1. Poor quality of artwork.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Thick ink with fast thinner produces visible screen dots. 2. Thin ink with slow thinner (retarder) causes invisible screen dots.	1. Produce new cliche with shallower etching depth. 2. Depending on results desired, use finer screen for invisible screen dots or coarser screen for visible screen dots. 3. Use cliche type suited to screen type.	1. Replace pad. 2. Depending on results desired, use more tapered pad for visible screen dots or flatter pad for invisible screen dots.	1. In this case, not the screen dots are visible, but the surface structure.	1. Check screen dot pattern on film or expose in new screen.

Screen dots are desirable for some prints, but not for others. Some photopolymer cliches cannot be produced without a screen, or only with a certain type of screen. With steel cliches, the screen is only exposed in for support of the doctor blade, to allow printing of larger motifs over an entire surface.

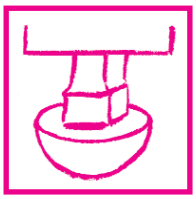
Fine lines converge



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thin. 2. Too slow; ink smears.	1. Etching too deep. 2. No graduated etching in fine motif. 3. Wrong cliche type.	1. Surface too rough. 2. Wrong pad shape.		1. Head stroke set too deep.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use new ink. 2. Use faster thinner and/or blow on pad.	1. Produce new cliche with shallower etching depth. 2. Only possible with strip steel/steel cliches. 3. Use different cliche type.	1. Replace pad. 2. Use more acute (more pointed) shape.		1. Causes crushing; adjust head stroke.

This problem occurs with cliches having both a large surface and fine lines in one motif, because the surfaces should be etched deeper and with screen, but the lines are to be etched flat and without screen.

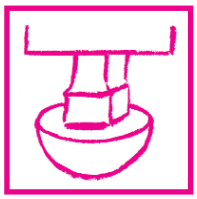
Surfaces appear patchy



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thin. 2. Wrong ink system. 3. Transparent ink.	1. Etching too shallow. 2. Wrong cliche type. 3. Wrong screen ruling. 4. Motif not slanted. 5. Different etching depth.	1. Wrong shape. 2. Too soft. 3. Surface too rough.	1. Surface structure too irregular. 2. Soiled surface.	1. Doctor blade sags. 2. Only printed once.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use new ink. 2. Use another pad printing ink. 3. Use opaque ink.	1. Produce new cliche with greater etching depth. 2. Use different cliche type. 3. Test new cliche with different fineness of halftone screen. 4. Slant motif. 5. Produce new cliche with constant etching depth.	1. Use more tapered pad shape. 2. Use harder pad. 3. Replace pad.	1. Use hard, pointed pad shape. 2. Pre-clean objects, e.g., with alcohol.	1. Use stronger doctor blade, or screen areas or slant lines. 2. Double print or preprint opaque ink.

This deficiency is easily observed in prints where peripheral areas are acceptable, but coverage (hiding) worsens progressively toward center. See also “Insufficient Opacity.”

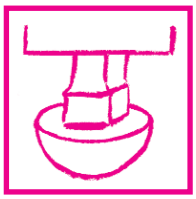
Small air bubbles (pinholes) visible



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thick.	1. Poor etching.	1. Surface damaged. 2. Wrong shape. 3. Too soft.	1. Statically charged. 2. Contaminated with dust particles.	1. Soiled artwork. 2. Dust present when films are copied. 3. Unclean environment, dust circulating in surrounding air.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Add thinner.	1. Examine cliche with magnifying glass; produce new cliche as needed.	1. Replace pad. 2. Use more tapered pad shape. 3. Use harder pad.	1. Install ionizing unit. 2. Pre-clean. objects, if necessary, using air hose (air jet).	1. Checks films. 2. Produce new cliche. 3. Dust particles, which appear to be air bubbles, can be transferred by pad from substrate to ink.

This deficiency can be contained easily. If bubbles always appear in same place, problem will be found in cliche or pad. If position of bubbles shifts, problem is caused by dust particles or electrostatic charges.

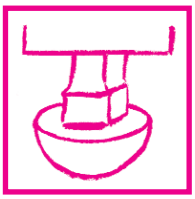
Motif smeared (smudged)



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Too thin. 2. Too slow.	1. Etching too deep. 2. Wrong screen ruling. 3. Wrong cliche type.	1. Too soft. 2. Too little volume. 3. Prints over edges. 4. Stroke force on cliche and substrate not equal.	1. Very irregular surface. 2. Surface not sufficiently pre-cleaned. 3. Material not smudge free.	1. Jig not fastened tightly enough. 2. Jig unstable. 3. Jig not precisely made, object has too much play. 4. Cliche not doctored cleanly.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use new ink. 2. Use faster thinner.	1. Produce new cliche with shallower etching depth. 2. Test new cliche with different fineness of halftone screen. 3. Use different cliche type.	1. Use harder pad. 2. Use larger pad. 3. Correct head stroke. 4. Correct head stroke.	1. Use pad assembly or special pad. 2. Pre-clean surface. 3. Switch to different material.	1. Tighten fixture. 2./3. Produce new jig. 4. Sharpen or change doctor blade.

This deficiency often occurs when thinner is added during printing run, where ink and thinner are not properly mixed.

Ink peels/flakes off substrate

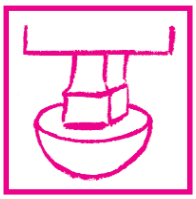


Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Wrong ink system. 2. Wrong or no hardener. 3. Wrong/imprecise mixing proportions.		1. Oily pad surface.	1. Soiled surface (grease, oil, perspiration, mold release agents).	1. Surface insufficiently or not at all pre-treated. 2. Curing (drying) time not observed. 3. Subsequent treatment of surface insufficient or lacking.
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Only use ink system suited to substrate according to technical bulletin. 2. Corresponding hardener must be added to two-component inks. 3. Weigh proportion of ink to hardener exactly.		1. Clean new pads with alcohol before use.	1. Pre-clean substrate with alcohol.	1. Check pre-treatment, repeat as needed. 2. Observe curing time as per technical bulletin. 3. Check subsequent treatment.

This problem frequently occurs because the type of plastic material is unknown, or unsuitable ink systems are used. The requirements for adhesion and scratch proofing are very different due to the respective demands placed on the finished products.

It is expressly recommended that the printing material be checked under the respective conditions of use before printing any production run.

Desired grade of gloss not attainable



Ink	Cliche	Pad	Substrate	Other
Problem	**Problem**	**Problem**	**Problem**	**Problem**
1. Wrong ink system. 2. Insufficient ink transfer.	1. Etching depth too shallow. 2. Wrong screen ruling. 3. Wrong cliche type.	1. Surface too rough. 2. Wrong shape.	1. Structure of material unsuitable. 2. Material unsuitable.	
Solution	**Solution**	**Solution**	**Solution**	**Solution**
1. Use glossy ink. 2. Double print.	1. Produce new cliche with greater etching depth. 2. Test new cliche with different fineness of halftone screen. 3. Use different cliche type.	1. Replace pad. 2. Use more tapered pad shape.	1. Structure of substrate influences result. 2. Ink looks matte due to stress cracks.	

Due to the thin layers of ink inherent in pad printing, it is generally not possible to attain as high a grade of gloss as with screen printing.