The pad printing process

During the past forty years, the pad printing process has gone through a period of rapid development. An important factor in this development was the implementation of silicone rubber as the method for ink transfer. Silicone is used because it can be easily molded into a variety of shapes, and because it is resistant to colour absorption. The pad printing process is a direct marking process that provides a high-quality decoration or mark on any product.

Introduction

It is surely the colour of nature that has inspired man to add colour and decoration to their immediate environment. As a result, there is hardly a product currently manufactured that does not have some colour or embellishment to make it stand out in the market.

When considering decoration, manufacturers must not only find a process that will be effective in their marketing and advertising activities, but must also be cost-effective. Manufacturers, when choosing a marking process, must also consider if the process is flexible and reliable.

The process that incorporates all of these characteristics, cost effectiveness, flexibility, and reliability, is **the pad printing process**.

Pad printing

Origins of pad printing

The origins of the pad printing process are rooted in the Decalcier Process which was primarily used in the Swiss watch making industry. In this process, a gelatine pad was used to add ink to the watch face.

In the late 1960's, the implementation of several technological advancements such as the introduction of silicone pads and more efficient machinery and the development of new applications provided the perfect opportunity for the development of the pad printing process.

What is pad printing?

Pad printing is an indirect photogravure process. Depressions are etched into a flat plate or printing block, and then they are filled with ink. A smooth silicone pad is used to pick up the ink of the plate.

Silicone is used because it is ink repellent, and as a result will not absorb any of the ink.

Teca-Print was founded 1973 in Thayngen, Switzerland and belongs now to the worlds best pad printing machine manufacturers. Our company's philosophy focuses strongly on quality, reliability and dynamical further development of the products, which include next to a big number of pad printing machines, peripherals and accessories like inks and printing plates. Many well-known costumers all over the world are attended by a dense staff of field service and sales personnal. Points of special interests are our own subsidiaries in USA (Boston and Chicago), France (Paris), Germany (Baden-Württemberg and Nordrhein-Westfalen) and Hungary (Miskolc). Since 2002 Teca-Print AG is a self-dependent part of the Machines Dubuit SA enterprises, that works in the silk screen process worldwide.

The pad printing process

Fig. 1:
The pad printing machine TPE 150 is designed for plate sizes from 100 x 100 mm to 150 x 100 mm. Print capacity: 1800 cycles per hour.

What materials can be printed ?

Because of the wide variety of inks available, pad printing can be done on almost any material.

Advantages of pad printing?

There are many advantages that pad printing has over other methods of marking.

The first advantage is the use of silicone as the means of transferring the ink. Silicone is a very flexible substance and can be molded into a variety of shapes for any application.

This flexible quality enables the pad to print on uneven surfaces. Pad choice is dependent upon the shape of the product, the image size and its positioning. The use of height compensators, as shown in Figure 2, will allow for a simultaneous printing of an image at different heights.

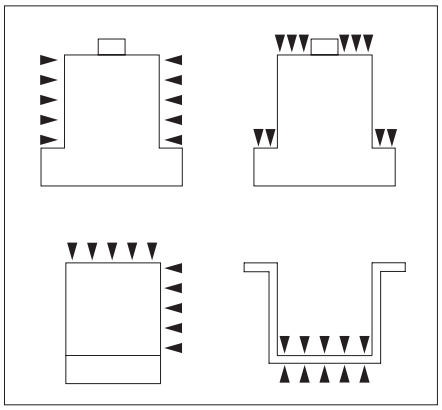

Fig. 2:
Pad printing makes it possible to simultaneously print on all sides of an object, at different heights or in cavities.

Ink transfert

Pad printing also allows for ink transfer to occur to a sloping or vertical surface. Tilt-head machines can be used for these fields of application.

Fig. 3 depicts the actual ink transfer process. When a printing cycle is triggered, the ink that is lying on the plate is drawn back into the ink reservoir by a doctor blade. The thinner that is in the ink evaporates causing the ink to become sticky. The pad is then lowered onto the plate's surface and the ink is transferred from the plate to the pad. The ink on the pad is then transferred to the component.

Silicone Pad as the Transfer Mechanism
(Fig. 4)

The printing pads Teca-Print use are made of silicone and are available in a variety of shapes and degrees of hardness. The pad that is selected for any application must be chosen so that it can conform to the component's shape without causing any distortion in the image during transfer.

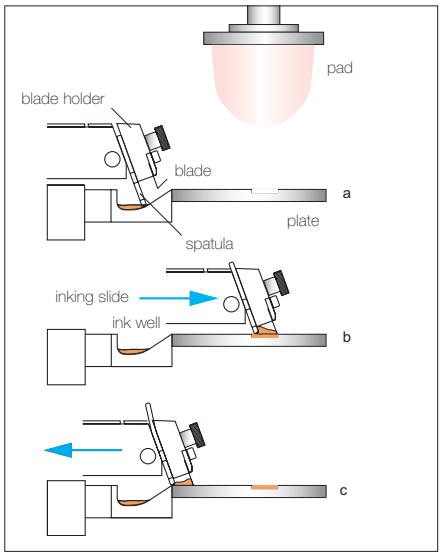

Fig. 3:
a) The starting position of the ink slide before the plate is flooded with ink
b) The plate is flooded with ink before the printing cycle has begun
c) The doctor blade draws the ink back into the reservoir

The pad, regardless of size or hardness, is cone shaped; that is the base of the pad is wider than its point.
This shape is necessary because during the print cycle, the pad uses a rolling motion to eliminate the air that is between the surface of the plate and the ink. Eliminating the air between the pad and the plate guarantees proper image pick-up.

The only area of the pad that has direct contact with the ink is the area where the image is placed on the pad. All other areas of the pad remain free from ink (Figure 4).

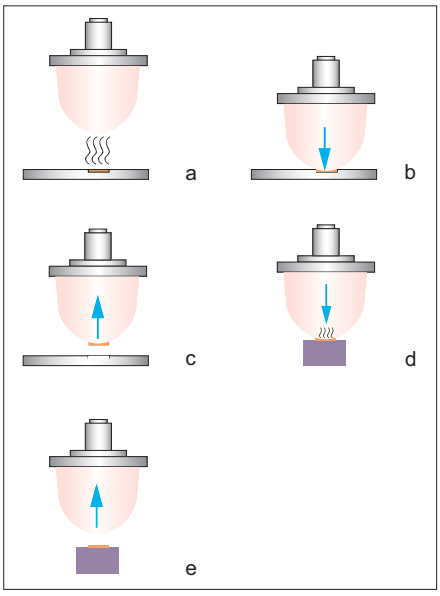

Fig. 4:
Ink transfert process:

a) The thinner evaporates from the surface of the ink in the plate and the ink becomes sticky.
b) The pad sinks down on the surface of the plate and the ink sticks to the pad.
c) The pad is then lifted up from the plate. The ink layer is detached from the plate.
d) The ink is carried by the pad to the surface of the component. The thinner evaporates from the ink on the pad. The ink becomes sticky. The ink is applied to the component's surface and remains on the objekt.
e) The pad is lifted off from the component and the ink layer detaches from the pad and stays on the component.

Pad quality

The quality of image printed on the product is dependent upon the pad's surface texture. When using a pad for the first time, the silicone oil must be washed off the pad's surface. This can be accomplished by using ink thinners.

The actual surface of the pad that will be used for printing must also be cleaned, but therefore only cleaning tape is recommended. It is also important to understand that the pad surface should never be rubbed dry as this damages the pad's surface and its ability to transfer the ink.
The actual print life of a standard printing pad – under ideal conditions – would be between 20,000 and 500,000 printing cycles. The printing life is dependent on a number of factors including:
– the type of ink used
– pad shape, size and hardness
– the shape of the printed part
– the type of object surface

The printing quality of the pad deteriorates over time because the printing surface (which needs to be smooth for undistorted ink transfer) is in contact with the ink and thinner that causes the pad's surface to become rough.

Ink layer thickness

The actual thickness of the ink that is transferred from the pad to the component is approximately four microns. The ink's thickness is dependent on the type of ink that is used, ink viscosity, the etch depth of the plate, and atmospheric conditions such as heat, air temperature, and humidity.

Multi-colour printing

Because of the rapid conditioning of the ink, it is also possible to use pad printing for multi-coloured applications.

The accessories available for such applications include:
– The two-colour pad sliding device
– Rotary tables
– Displacement tables
– Transfer carrousels
– Linear indexing devices.

Pad printing must be viewed as a separate and distinct method of printing, not just as a "refinement" of other printing processes, specifically screen printing and relief printing.

Fig. 5:
Pad printing machine TPX 301 for multi-colour printing.

Although pad printing does have its limitations, it is no different than other printing processes. Relief printing, for example, is able to provide excellent colour transfer because the ink substrate is welded film. This process is very expensive and most manufacturers are unable to use this process profitably.

Screen printing can be used to mark large images, but it is not a flexible method and the squeegee cannot adapt itself to the shape of the object.

Plates

Steel plates *(Fig. 6)*

For fields of application that require precision printing and are printed in large series, steel plates are used.
Steel plates can be manufactured using several methods. The first method for steel plate production is light exposure. This method involves several steps.

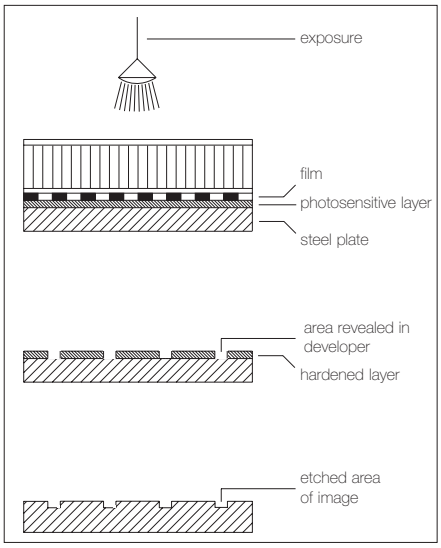

Fig. 6:
Steel plate production.

The surface of the steel plate is initially coated with a light-sensitive material. Before exposing the plate to light, a film containing the desired image design is placed face down on the plate. The film and plate are then exposed to light. The light hardens the area of the plate not covered by the film. The areas that were covered by the film remain soft. The soft area of the plate is then removed from the plate by soaking the plate in a developer bath. The area containing the image leaves an impression that will be etched in a bath consisting of nitric acid, chlorine (III), iron, or other similar chemicals.
The actual etch depths for a steel plate vary depending on its intended use. In general, the etch depths are 16 microns for fine scripts, and 22 microns for standard scripts.

Film quality and choice

The quality of the finished etched image is dependent on the type of film used during plate exposure. Teca-Print uses high-quality film materials for exposing plates.

Screening Steel Plates *(Fig. 7)*

Screen dotting is used because it eliminates the problem of having the doctor blade sag into the etched image, which causes an uneven distribution of ink. When screen dotting is used, small cones remain in the image's area, which result in the following advantages:

– The doctor blade is supported by the small crests, which prevents the doctor blade from sagging.
– The screen dots retain the ink's even distribution of the entire image area.
– The pad is supported by the crests which enables ink pickup to remain uniform.

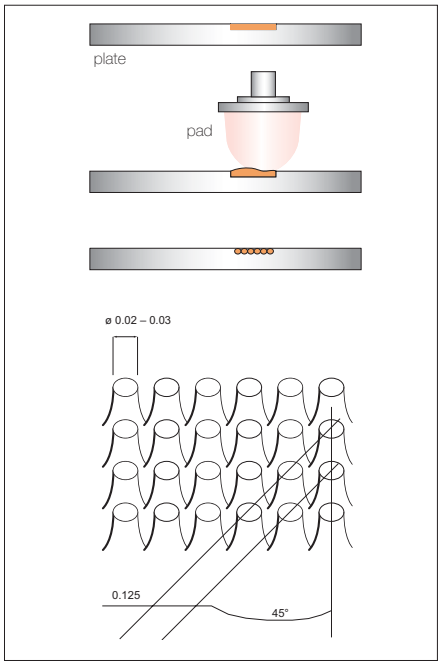

Fig. 7:
For large images, the doctor blade can sag, scrape the plate and remove too much ink. Screen-dotting the image after exposure eliminates this problem

Plastic Plates

For small production series, Nylo plates can be used. These plates, if handled properly, will have a production life of several thousand prints. Alcohol wash plates are metal-based plates that are coated with a light-sensitive material that becomes hard when exposed to light.

When a film is placed on the plate and exposed to light, the image zones that were covered by the film remain soft. The plate is again exposed, but this time with a screen-dotted film. The "dots" on the plate remain hard, and, after washing the plate with the appropriate developing agent, small flat cones remains on the plate.

The screen-dotted process for plate development must always be used to when working with Nylo plates.

Water Wash Polymer Plates

Another more recent development in plate technology is the use of water wash polymer plates. Instead of a chemical, lukewarm water is used as a developer. The exposure process for these plates is the same as for alcohol wash plates. By air-drying the plates, and then exposing them to UV light, the plastic plate's production life is increased significantly.

Inks

The selection of the proper ink series and type for a particular application depends on the demands of the application. For example, ink type depends on whether or not a glossy or dull finish is required, whether or not thinners or other chemicals will be used in the production process, and on the type of adhesion test the ink must pass.

Ink Composition

All of the inks that are used in pad printing have been specifically developed and conditioned for a rapid cycle time. The transfer substance and binders in the inks are resins of either an epoxy or a polyester base with pigments kneaded into the mixture.

One Component Inks

In many applications single-component inks can be used. These inks have a longer pot life and are easier to process than two-component inks. These inks are very resistant to harmful solvents. They may also be cured either by drying by the air or by a heat source.

Two Component Inks

Two-component inks are used for applications that need to have high mechanical resistance. These inks are used for example for radio dials, computer parts and typewriter key pads. These inks chemically bond with the material on which they are printed after the thinner in the ink evaporates. It takes around six days on average for the ink to cure completely.

Colour mixing systems

In addition to our standard pad printing inks, we are also able to provide mixing inks that, when combined, can reproduce all Pantone or RAL colours. This inexpensive and easily used kit comes with the twelve basic colour tones and is available in one- and two-component inks.

UV Inks

In addition to the standard one-component ink, we have UV-curable one-component inks. These inks are cureed by ultra-violet radiation, this process changes inks' molecular structure by forming macro-molecules.

UV inks have several advantages over the standard inks such as reduced cureing time, reduced solvent emissions, and a constant ink viscosity.

However, because these inks use UV radiation to increase cureing time, special precautions must be followed when using the inks. For example, the radiation source must be enclosed and direct contact with the cureing source must be avoided. Also, because such precautions are necessary, and because of environmental concerns (ozone is created during the drying process, therefore the dryer must be in a ventilated area), the process is expensive.

Proper Ink Conditioning

Teca-Print pad printing inks are ready to use. However, the ink must be conditioned to reach proper viscosity levels.

Viscospatula

To enable our customers to make sure that proper ink viscosity is reached, Teca-Print AG has developed the Viscospatula (Figure 9).

When mixing the ink the following steps must be observed to assure proper viscosity:

- Ink hardener, when added to two-component inks, must be thoroughly mixed before ink viscosity testing
- Thinners and retarders used to condition ink viscosity must be added drop by drop into the ink. The ink must also be stirred continuously.
- If this is not done correctly, pigment shock occurs. This means that the ink pigments are separated from the resin base substance and the ink can not be used.

Ink viscosity cannot be tested using the above process if they have thixotropic properties.

Fig. 8:
Ink mixing and viscosity testing with the viscospatula

Ink adhesion

We have already mentioned several key issues, including proper pad and ink choice ad the etch depth of the plate.
However, perhaps the most important issue that is related to ink adhesion, is the composition of the part (or substrate) that will be printed. Depending on the type of substrate used, additional processing of component may be needed to guarantee proper adhesion.

Pre-Treatment Processes

Components made of polyolefine, polyethylene, and polypropylene must undergo a pre-treatment process to ensure proper adhesion because their surface tension is too low. The surface tension for a component can be tested with a pen, and if it is below 38 dyne / cm, the component must be pre-treated using one of the following processes.

Flaming

The printing surface requiring treatment is passed under a pure flame. This causes scarification of the substrate, and the result is increased surface tension. Flame intensity is controlled by the operator, and the actual lenght of time necessary for the flaming process to be complete is substrate-specific.
Flaming does, however, remove the gloss of the component's surface area. This must be taken into account if a glossy effect is desired for the application.

Corona treatment

The pre-treatment process can also be accomplished by using electric corona equipment.
In the corona pre-treatment process, the substrate's printing surface is bombarded with ions and electrons that cause the static charge of the uppermost layer of molecules to change. This also results in increased surface tension.
Corona pre-treatment is based on a high-voltage spark with the voltage ranging form 5 and 15 kV at frequencies between 15 and 30 kHz.
This process is preferred over the flame pre-treatment process because it is less hazardous, that is, there are no concerns regarding an open flame.

Bonding agents

A third pre-treatment process is the use of a bonding agent. This is a chemical process which requires the component's surface to be coated with the agent. The surface is chemically etched and is ready for processing.
The use of the bonding agent as a pre-treatment process is limited to small series runs. This process also requires accesses to a well-ventilated room.

Ionization

Many plastic components build up an electrical charge as the result of static electricity while processed. Static electricity has an adverse effect on the printing process because the image "picks up" the charge during transfer and the print becomes distorted.
Using de-ionizing equipment on the components not only eliminates static electricity build-up, but it also removes dust particles and dirt that have accumulated on the components.

Post-treatment

The main purpose for treating components after the printing process is to reduce the curing time needed for the components.
Post-treatment, or curing, is usually used in applications where the components will undergo additional processing within a relatively short time. The methods by which the images are cured include flame treatment, hot air treatment, or passing through an infrared dryer.
It is important to note that with two-component inks, even when they undergo a post-treatment process, full curing (that is, molecular bonding) does not take place for six days.

Pad and printing

Pad printing errors

The most common error that occurs in any printing process is poor image transfer. Pad printing is no different, and in some cases the image that is transferred onto the component may not be clear and unblemished. However, unlike other processes where the error is usually process-related, the errors that occur most often are the result of not following the pad printing process guidlines.

Errors, such as poor image transfer, can be easily resolved by reviewing the process used. For example, if dots appear in the final image after transfer, it is almost certain that the problem in the process occurs during image transfer from the plate to the pad.

The reason the dots appear on the finished image is that too much thinner has been applied to the ink. As a result, the pad no longer has direct contact with the ink on the plate's surface.
To resolve this problem simply reduce the amount of thinner added to the ink, use a harder pad, more angular pad, and reduce the cycle speed on the printer, so that the air has more time, to escape when the pad picks up the image from the plate.

Fields of application

The pad printing process that has its origins in the Swiss watch making industry has expanded to many other types of industries including, but not limited to, the:
– electronic industry
– semiconductor industry
– automotive component industry
– sporting goods industry
– medical component industry
– plastic component industry
– compact disc industry

These industries represent only a fraction of the industries that use pad printing as a method of decoration.
The only limitation to the use of pad printing, at this point, is the image size. Pad printing can even be used to print images on a cylinder shape up to a circumference of 120°. Pad printing is a very versatile and economical method for marking components.

Teca-Print AG and its agents located throughout the world are committed to providing the market with reliable marking equipment and supplies.

CONCLUSION

Pad printing is very versatile and flexible. Many objects can be printed on without much preparation needed. This requires some basic knowledge, unskilled workers can be used for operating the printing machines.

Teca-Print printing machines are very user-friendly, even untrained personnel can operate them after very little preparation

Teca-Print will be glad to help you with complex and innovative printing projects.

We hope this brochure helped to extend and deepen your knowledge of the pad printing process.

Further information on our company and our range of products – from standard machines to complex printing systems – can be found on our web page:

www.padprinting.biz
www.tampographie.biz
www.tampondruck.biz
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