Screen printing – Part 3

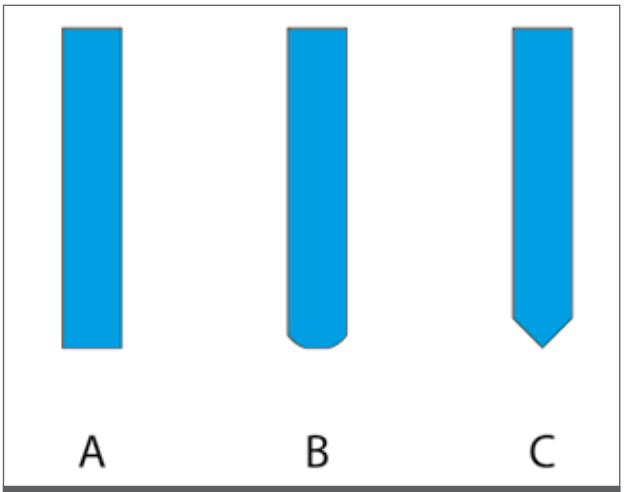
The screen printing production process is influenced by numerous factors. Besides the characteristics of the screen printing forme, the most influential factors are the blades or squeegees and the flood bars as well as their settings, the type of printing machine or printing table in manual printing, the off-contact and screen lift setting as well as the properties of the printing substrate and the printing ink used.

Depending on the application, the blades or squeegees used in screen printing differ as regards their shape and material. The specialists among these blades are the RKS squeegees and the roller squeegees. The RKS squeegees have a narrow blade made of glass fibre-enforced plastic with a plastic lip at the top. Roller squeegees are preferably used in large-format flat screen printing. They are cylindrical metal profiles which are guided during the printing process by means of a magnetic field. The most common shape in screen printing is, however, a blade made of rubber or polyurethane with a blade holder. During printing, the blades are in permanent contact with the inking systems and cleaning agents so that they feature high resistance to numerous chemicals. Nevertheless it can`t be ruled out that chemicals will penetrate and make the blade swell. Another aspect is the embrittlement of blades as a result of the constant contact with chemicals or the insufficient removal of ink residues. Embrittled blades often produce unclean prints. Damages on the surfaces manifest themselves in streaks in the printed image. Careful cleaning of the blades after printing, regular sharpening of the beveled edges of the blade and early replacement of used blades help to avoid these problems.

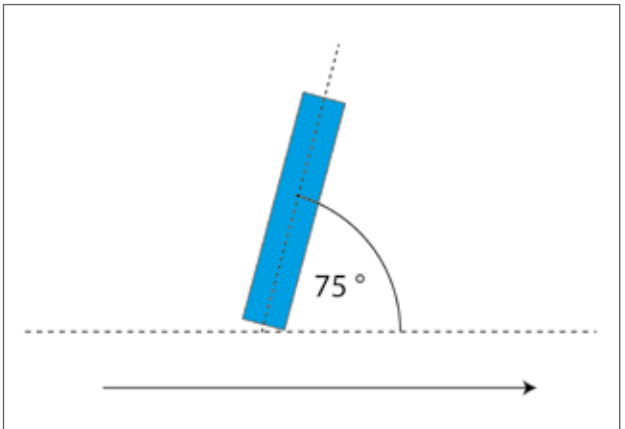
During the printing process, the squeegee or blade, respectively, changes its shape and thus adjusts to the surface of the screen in printing direction. Through the choice of different hardness degrees, different print results can be achieved. Soft blades ensure the transfer of a high amount of ink. The ink is swiped into the screen. As a consequence, the coloured areas are saturated and feature rather unsharp print edges. Therefore, details in the printed image may get lost or be flooded. High-quality raster printing inevitably requires a hard blade. It is less prone to losing its shape and cleanly shears surplus ink from the screen so that only the ink contained in the mesh is printed. The result is sharp printing edges. The hardness degree of blades is measured in Shore A, as is customary for elastic plastics. The usual Shore grades are in the range from 60° to 80° Shore A. The lower the Shore grade, the softer the blade.
With increasing printing width, it is recommendable to use hard blades in order to ensure clean blade guidance. It should always be kept in mind that the use of hard blades reduces the service life of the printing forme. As a result of the interaction with the necessary contact pressure it may easily occur that the copying layer or even the screen gets damaged. In practice, besides simple blades also combinations in the form of duplex or triplex blades have increasingly been used. In this case, rubber and/or plastics of different shore hardness are combined. Besides the Shore hardness, the characteristics of the blade edge have considerable influence on the transfer of ink and the details in the printed image.
The image on the right shows typical blade profiles.

Where screen printing machines are used, careful setting of the blade as regards its parallel position to the screen, the contact pressure and the angle is of major importance. The screen will quickly get damaged when the contact pressure is too high or parallelism is not ensured. The normal blade angle in relation to the screen surface is approx. 75°. During the printing process, the blade can slightly retract to the rear and evenly press the ink through the screen. If a flatter screen angle is selected, the blade can easily yield so that it only wipes over the surface of the screen. In this case, a high amount of ink is transferred, and it may happen that ink creeps under the screen. The printed image is not clean and starts to become slurred. Frequent interruptions of the printing process and cleaning of the screen are inevitable.

A typical misprint: Streaks in the printed image



The different blade pofiles: A= standard profile; B = V-shaped profile with flat tip; C = V-shaped profile with sharp tip

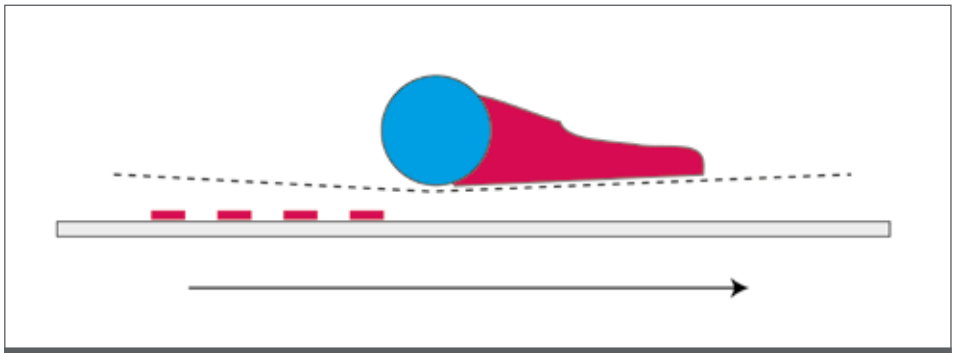


The squeegee / blade angle is the angle formed between the face of the squeegee / blade and the plane of the screen.

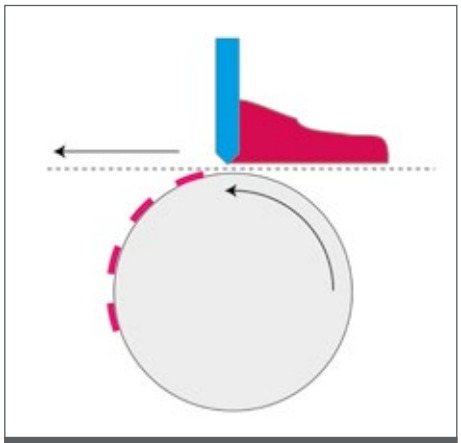
When a steeper blade angle is selected, the blade gets stiff and yields during the printing process to a lesser extent. The blade pressure is directly transferred to the printing line at the blade top and the screen surface is squeegeed cleanly. Ink transfer is reduced to a minimum. In this case, the screen is mechanically stressed to a large extent. Furthermore, the screen is strongly stretched in the printing process, which may result in register differences in printing direction. In the end, the perfect interaction of blade angle and blade pressure are decisive for the quality of the printed image. With a correct blade profile and angle, only low blade pressure is needed in order to dissolve the ink from the screen cleanly. The blade pressure should in general be reduced to a minimum.

It must be maintained stable for every order. Any change during the print run will result in deviations in the deposition of ink and thus differences in the print result. When a printing order consists of several screens, the blade pressure of the different screens should always be kept at the same level in order to avoid register differences due to changes of the print length of the screens. The necessary blade pressure is linear to the blade width. With increasing blade width, the pressure must also be increased accordingly.

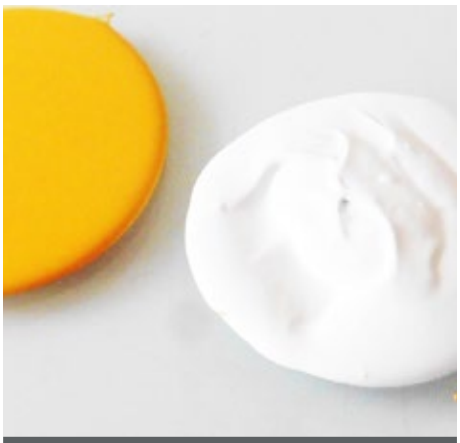
In order to guarantee clean and sharp edges in screen printing, the setting of the off-contact must be correct. Without off-contact, the screen would be permanently in contact with the substrate in flat screen printing. The printing ink could inevitably not be prevented from creeping under the screen and slurring. The off-contact is a very small distance between the screen and the substrate which must be overcome by the blade pressure and the elongation of the screen. The resulting contact zone between the substrate and the blade tip is reduced to a minimum and clean dissolution of the ink from the screen is made possible. The size of the off-contact depends of the screen size and the substrate. Normally, 2-3 mm are enough. When the off-contact is too high, there will be strong dimensional changes of the screen in printing direction, and furthermore the printed image will be distorted and there will be register differences in multi-colour printing. As an extra, many screen printing machines support maintenance of a constant level of the off-contact by means of a lifting movement of the screen. For that, the screen is minimally lifted with the running blade movement. Off-contact and screen lifting correspond with each other. The higher the screen is lifted, the lower can the off-contact be kept.



Schematic of a roller squeegee



Schematic of three-dimensional printing



Ink and its consistency

For special applications of screen printing, e.g. in large-format textile printing with roller squeegees as well as three-dimensional printing and in rotary screen printing with a blade in a fixed position, the parameters and settings described above are only partly applicable. As far as the roller squeegees are concerned, it is not possible to change the blade angle. The deposit of ink can be influenced by using roller squeegees with different diameters. The necessary blade pressure can be adjusted by means of the strength of the magnetic field. In three-dimensional and rotary screen printing with a fixed blade, there is no off-contact. Curving of the substrate and/or screen ensures a low contact zone between the screen and the substrate.

Regarding the substrate and the printing inks that can be used, only few generally applicable statements can be made. The fields of application are simply too manifold. In general it can be said that there is hardly any substrate which cannot be decorated in a screen printing process. As a result, all commonly used inking systems are applied in screen printing as well. Of key importance in products with especially high demands are 2-component inks. These inks consist of a basic ink and a hardener. Once the hardener has been added, there is a defined processing time that must be kept. After that time, the ink can no longer be used. The deposited ink film is interlinked by polymerisation similar to UV inks and thus very resistant.

Screen printing inks are often described as rather high-viscous. In practical use, the viscosity of the screen printing inks may, however, vary from high-viscous to low-viscous. The actually required viscosity primarily depends of the screen mesh used. The rougher the mesh, the more rigid the ink consistency. With very fine meshes from 120 threads per cm, a thick ink may rapidly block the screen. Therefore, the screen printer is required to set the optimal viscosity and to prevent early drying in the screen by adding additives. Ink that is optimally set should keep the screen free in the flooded condition and permit printing interruptions of several minutes without drying.

Ronald Weidel (azp Chemnitz)