

“AquaGreen” Photosensitive Water-Wash Flexo Plate to Meet the Environmental Needs of the Printing Industry

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The printing market is changing dramatically, and by the year 2020, it is estimated that it will have shrunk by about 3% annually. However the printing and printing related manufacturers are working on the expansion of their market and “Environmental friendly” is regarded as an important keyword. Until now, a large quantity of organic solvents has been used for conventional printing processes. In view of such situation, the Japan Federation of Printing Industries introduced in 2001, the “Green Standard” that compels the printing industry to work on the reduction of volatile organic compound (VOC) emissions.

Since 2009, Sumitomo Riko Company Limited has been selling the environmental friendly Water-Wash Flexo Plate that is suitable for solvent-free ink printing in Europe and the United States.

Afterwards, we began to improve high quality printing and started marketing “AquaGreen” as the “Water-Wash Flexo Plate and Waste Water Recycling System” for Japan. This Water-Wash system enables us to reduce VOC emissions during the whole process of printing.

Keywords: flexo printing, water-wash, dot, environmentally friendly, waste-water recycling system

1. Introduction

At the moment that Sumitomo Riko Company Limited started to develop the flexo plate in 2004, there was only a small market for flexo printing within the Japanese printing market. The reason that Sumitomo Riko decided to enter the flexo market under those conditions is that it was aware of the actual trouble involved in processing waste water and solvent odors for waste water from organic solvents. This was done during a time when it was becoming the mainstream in each industry to move towards being environmentally friendly on a global scale, and we, therefore, as a company, decided to bring about a change to these conditions.

Non-solvent inks including water-based ink and UV ink that can be used for the material characteristics of plates used in flexo-printing. The most popular plate making method was to only allow protruding sections on a surface for ink coating to cross-link and harden through UV exposure using photosensitive rubber and then immerse it in wash water combined with organic solvent during the plate-making process. Taking this process, Sumitomo Riko used a proprietary polymer compound and processing technology and started to develop the water-wash plates that can be washed out in a water-based solution, which we launched into the European and American markets in 2009. After this, we continued to make improvements in high quality printing and then we succeeded in developing AquaGreen. It performed high-definition images with no less image quality than offset printing and gravure printing. We also went on to develop in-house, a waste-water recycling system for the water-based wash water

used during the AquaGreen plate making process. A report is given below on AquaGreen and the waste-water recycling system.

2. Comparing Various Printing Methods

There are five types of printing methods: lithography (offset printing), intaglio printing (gravure printing), relief printing (flexo printing), stencil printing (screen printing) and electrographic printing. We will explain about offset, gravure and flexo printing, which are high-quality printing methods that print using ink (**Table 1**).

Using flexo plates as an example, we will now provide an easy explanation about the plate making process (**Figure 1**). A typical structure for the print plate consists of a negative film, a photosensitive layer and a substrate. The negative film is a black film with the characters or the image carved out in advance. During the first exposure process, the protrusions on the plate are hardened by using UV exposure from the negative film side. Next, the plate is immersed in wash water and then non-image portions that have not hardened are scraped off by brushing to form the protrusions and depressions in the “wash-out process.” Finally, any wash water adhering to the plate is dried to complete the print plate.

2-1 Offset printing

This is a typical printing method currently used for general printing. It is suitable for high-speed printing of large volumes of print items for commerce including books, newspapers, direct mail and advertising litera-

Table 1. List of printing methods

(Currently, any of the printing methods shown below has been progressing for environmental correspondence)

Printing method	Main Application	Plate Structure	Character / image Shaping			Printing
			Printing section	Non-printing section cleaned (removed)	Waste water	Ink type/ "Ink transfer method"
Offset	Newspapers Books	Negative film Photosensitive layer Substrate	UV hardening Non-image area hydrophilicity	Strong alkali solution Image area hydrophobicity	Strong alkali solution Plate material waste (requires waste water processing)	(requires waste water processing) Printed matter Solvent ink Dampening "Chemical: Water/oil repelling effect"
Gravure	Magazines Flexible packaging	Negative film Photosensitive layer Cylinder (Laser engraving)	UV hardening	Weak alkali solution Heavy metal solution Chrome plating	Weak alkali solution Heavy metal solution Plate material waste (requires waste water processing)	Printed matter Solvent ink "Physical: Depressions"
Flexo	Paper products	Negative film Photosensitive layer Substrate	UV hardening	Organic solvent	Organic solvent Plate material waste (requires waste water processing)	Printed matter Water-based ink UV ink Solvent ink
Water-Wash Flexo (Sumitomo Riko)	Packaging	Negative film Photosensitive layer Substrate	UV hardening	Tap water	Tap water Surfactant Plate material waste [Waste-water Treatment System] (our original system)	"Chemical + physical: Protrusions"

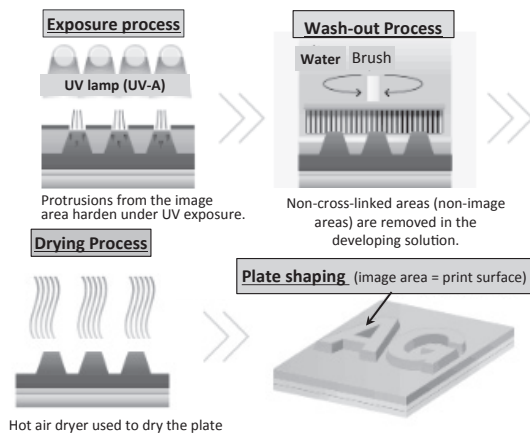


Fig. 1. Plate making process for water-wash flexo plate

ture. The plate consists of a negative film on top of an aluminum substrate coated with a photosensitive resin layer. The resin is hardened during the exposure process of the plate making process to form a hydrophobic portion.*1 Next, during the wash-out process, a strong alkali solution is used to wash-out and form hydrophilic portions*2 that are slightly depressed on the plate. For the printing method, the plate is loaded onto a plate cylinder (roller), and then the non-image portion is saturated with water by coating the plate with a dampening solution*3 first. After that, the plate is coated with oil-based solvent ink and then the solvent ink is placed on the image portion. In terms of environmental concern, this method creates industrial waste that

requires processing according to disposal laws because it generates liquid containing a mixture of waste from the non-hardened photosensitive layer and a strong alkali solution as waste water produced while washing-out. Furthermore, the dampening solution used during printing is collected together with the remaining ink and must be processed as industrial waste in the same fashion. In addition, solvent ink is used for this method.

2-2 Gravure printing

This is a printing method suitable for high quality printing. Its features are that the amount of ink can be easily adjusted using an intaglio plate and high-definition photographic images can be printed reliably. Large-item printing and endless printing can be performed using a seamless plate because plate making uses a cylinder roller in order to print large volumes of print items in the form of magazines and catalogs, etc. For plate making, portions exposed to an ultraviolet laser become the non-image portions while a weak alkali solution is used during the developing process to remove the non-exposed photosensitive layer to reveal the copper cylinder surface underneath. Next, etching is used on the naked copper cylinder surface to form depressions that will become the image portion and then the chrome plating processing is used to complete it. For the printing method, ink is inserted into the depressions formed on the cylinder roller, and then the plate is pressed against the print item to perform printing for this method. In terms of environmental safety, this method generates waste water containing a mixture of plate material waste, heavy metal solution and the weak alkali solution when making the plate so the liquid must be processed as industrial waste. In

addition, solvent ink is used for this method.

2-3 Flexo printing/solvent-wash

This method allows printing on a wide range of print items using flexible relief plates. A wide range of print items are supported from flexible package printing that demand high quality such as printing on packaging popular in Europe and America to printing on mainstream paper products, etc., in Japan. For the plate, a flexible photosensitive layer and negative film are laminated onto a resin substrate such as PET. This method uses a wash-out solution combined with organic solvent during the wash-out process. For the printing process, ink is placed on the protrusions, and then the plate is pushed against the print item. A feature of this method is that the printing pressure is low in comparison to other printing methods and is termed “kiss-touch.” In terms of environmental safety, this method generates waste water containing a mixture of plate material waste and organic solvent when making the plate, and the liquid must be processed as industrial waste. The kiss-touch method uses less ink compared to other printing methods, which reduces the drying time and allows water-based ink useable. Recently, it has become apparent that UV ink is also being used for this method. Solvent ink can also be used, but this may cause restrictions on the print quality because the size of the protrusions on the plate will change when solvent is extracted from the prescribed material of the photosensitive layer.

2-4 Flexo printing/water-wash

We will only describe the part of this method that is different to the solvent wash-out plate. The greatest difference lies in the wash-out process where tap water is used instead of organic solvent. A more detailed explanation is that tap water is used at a temperature of 40 to 50°C with approximately 1% of surfactant added as the wash-out solution used when physically removing any of the non-hardened portions of the photosensitive layer during the wash-out process. This achieves a volatile organic compound (VOC) free environment in the plate making process and can also improve problems with solvent odors in the workplace. Furthermore, this method provides a highly environmental friendly process through the use of water-based ink and UV ink when printing.

3. Developing AquaGreen and the Waste-Water Recycling System

3-1 Photosensitive water-wash flexo plate

There are two types of wash-out methods, which differ depending on the composition and processing technology of the photosensitive layer for the material design surface: solvent-wash and water-wash. Solvent-wash is designed to dissolve the non-hardened portion of the photosensitive layer using solvent after exposure to the layer and then scrape it off by brushing. On the other hand, water-wash (water washing-out) uses either a flexible elastic rubber, from which its name “flexo” is derived, or a resin (hydrophobic polymer) with a UV hardening type material and hydrophilic polymer

combination for the photosensitive layer arrangement design. The water absorption of the combined hydrophilic polymer is a key point for the mechanism that allows the wash-out solution to be water-based. This means that during the wash-out process, when submerging the plate in the water-based wash-out solution, the wash-out solution penetrates into the non-hardened photosensitive layer portion through the hydrophilic polymer. This allows the non-hardened portions to be removed by the effect of the surfactant in the wash-out solution and by the brushing.

3-2 Features of AquaGreen

This section explains about the features of AquaGreen divided into aspects of its functionality and productivity.

(1) Support for high quality images

Sumitomo Riko has achieved an ultra-fine shape (**Figure 2**) for plate protrusions to be printed as dots*4 for a high-definition image and especially for highlighted image portions (bright portions) to meet the demand for high quality images in the flexo printing market. Furthermore, we have made it possible to reliably print high quality images by improving the gradation and have increased the ability to control the amount of ink by achieving a flat-top-dot shape for the tip of the ultra-fine plate protrusion.

For the specific shape and quality of the highlighted halftone portions, we have achieved the print industry term of “175 lpi/1% reproduction”*5 and also a flat-top-dot with a 16 micron diameter at the tip (**Figure 3**). This

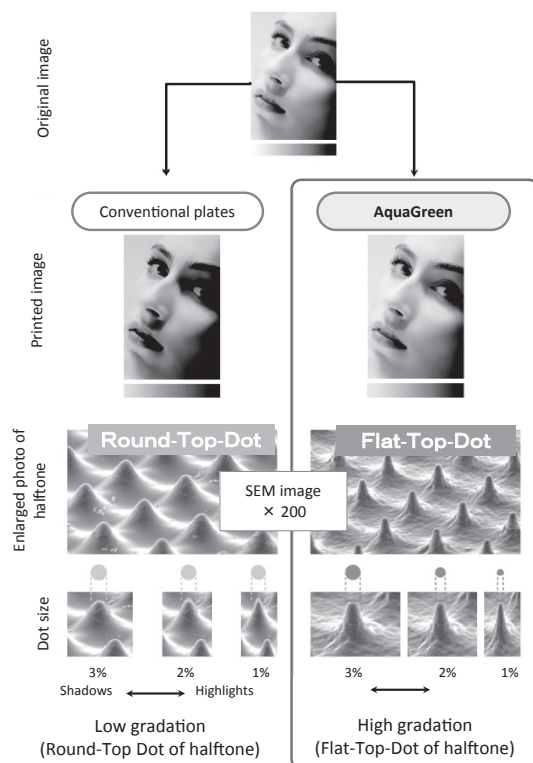


Fig. 2. AquaGreen supports for high quality images

ultra-fine dot shape is formed during the exposure process. Generally, UV exposure (hardening) is understood to be due to oxygen inhibition. The fine shape formed portion is adversely affected due to the effects of this oxygen inhibition. Flexo plates, in comparison to other printing plates, require their protruding shapes to be properly formed, and it is said that this is a key point in making distinctions for material design. For Sumitomo Riko, high dispersion processing technology for compound materials has become important, in addition to our proprietary mix design, as a key point for designing our plates with regards to oxygen inhibition.

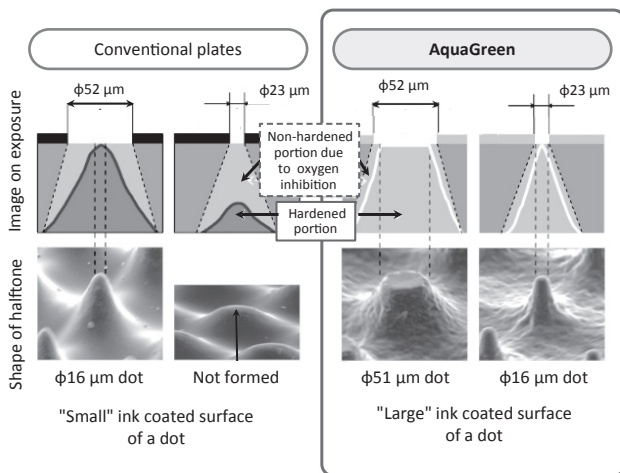


Fig. 3. AquaGreen achieving flat-top-dot

(2) High productivity

For productivity, we will compare the plate making process for our water-wash flexo plates and for mainstream solvent washing-out flexo plates on the flexo market. The significant difference for both of the plates is the material properties of the wash water, which occurs with a large difference in drying time after brushing (Figure 4).

During the drying process, the wash-out solution into which the plate is immersed is dried, and the drying time is affected by the compatibility of the wash-out

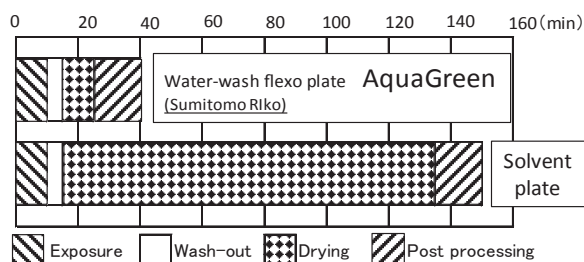


Fig. 4. Time distribution during a plate making process

solution and the polymer combined in the photosensitive layer. Both of the flexo plates have high compatibility with the solvent solution because these are included with the elastic rubber or the resin. Therefore, organic solvent permeates into the photosensitive layer of the hardened protrusions on the plate during brushing in the wash-out process for solvent washing-out. Solvent permeates deeply into the photosensitive layer particularly when forming fine dots because the brushing pressure is lowered to prevent damage to the fine protrusions on the plate, and a lot of time is taken to clean it. There are various designs for the wash-out solution mixture but an organic solvent mixture with a boiling point of roughly 150°C or more is common. It is desirable to heat the solvent above its boiling point to quickly dry the organic solvent that has permeated inside the photosensitive layer. However, in reality, drying is performed at or below 100°C over a long period of time to prevent any deterioration to the physical properties of each layer of the plate.

In comparison, when using water-wash flexo plates, tap water used for the wash-out solution does not permeate the photosensitive layer because the combined rubber or resin are hydrophobic. The compound material hydrophilic polymer is also distributed throughout the formed portion of the protrusions on the plate, but the hardened hydrophobic photosensitive layer blocks the wash-out solution from entering inside the portion. This achieves an overwhelmingly faster drying time in comparison to solvent wash-out.

3-3 Waste-water recycling system

Sumitomo Riko launched the waste water recycling system as one of the water-wash flexo plate making systems at the same time it announced the launch of AquaGreen (Figure 5).

In the printing industry the VOC reduction is the main theme; therefore there has been a lot of approaches for reducing solvents in the ink composition and for solvent-less at the plate making process.

However, plate material waste contaminates the wash-out solution used during the wash-out process in the workplace and generates muddy waste water

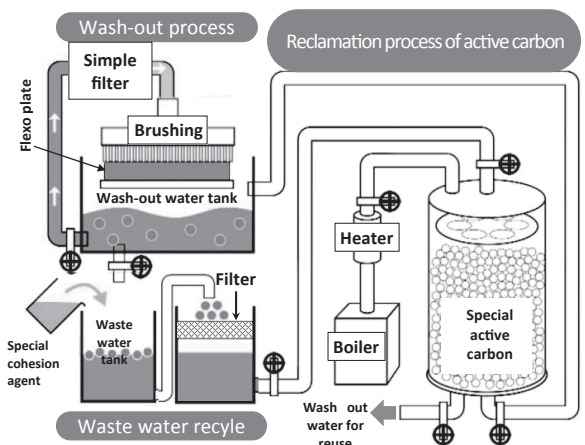


Fig. 5. Sumitomo Riko waste-water recycling system

(sludge), and high processing costs are required to process and dispose of this waste. Even if after introducing a water-wash plate making system, it is a fact that a large volume of industrial liquid waste will be produced after making plates.

To overcome the above mentioned waste processing problem, we have started to develop a waste-water recycling system at Sumitomo Riko. The concepts of this system are to separate and reuse the wash-out water. **Fig. 5** explains the specifications for this.

The wash-out water is used while being circulated between a simple filter and a wash-out water tank equipped with a brush when washing-out during plate making. At the moment when the wash-out water becomes muddy (sludge-like) due to the accumulation of plate material waste, the used wash-out water is sent to a waste water tank. A proprietary cohesion agent is then added to the used wash-out water sent in a sludge-like condition, which causes the plate material waste to cohere completely. After this, the wash-out water is filtered through a nonwoven fabric filter (or something similar) to completely separate the plate material waste from the used wash-out water. The used wash-out water separated at this process is still contaminated with extract from each constituent layer of the flexo plate. The solution appears transparent and looks clean, but it cannot be reused as wash-out water yet. Next, the separated water is sent to the reuse process, and impurities are removed by filtering within a special active carbon tank, which allows the wash-out water to be collected for reuse.

We have also achieved a maintenance-free setup for the special active carbon in the wash-out water reuse process by passing water vapor heated to over 300°C using the attached boiler and heater through the active carbon to clean it and allow it to continue functioning.

This system allows us to separate the industrial liquid waste in the form of sludge into reusable wash-out water and plate material waste only. Plate material waste can be thermal recycled because it is made from a material that has a low environmental burden.

4. Conclusion

The developed photosensitive water-wash flexo plate AquaGreen will contribute to VOC reduction and the improvement for workspace environment. Achievement of “creating 175 lpi/1%” aiming for high quality image by flexo printing means that the flexo printing method has attained the same printing level to offset printing and gravure printing. Based on the actual opinions from people working at plate making factories, we have successfully established a waste water recycling system. This recycling system will improve the flexo printing system to be more “Environmentally friendly.”

- AquaGreen is a trademark or a registered trademark of Sumitomo Riko Company Limited.

Technical Terms

- *1 Hydrophobic: A property that makes it difficult to mix with water.
- *2 Hydrophilic: A property that makes it easy to mix with water.
- *3 Dampening solution: Water applied to non-image portions of a plate for lithography in order to dampen it. This is done to prevent print blots in the non-image portion by dampening the portion prior to coating the image portion with oil-based solvent ink.
- *4 Dots: Enlarging an image portion of a print item using a magnifying glass or similar tool. This allows you to see that the print is a collection of fine points that appear as dots. The size and number of these dots express the contrasting density of the image.
- *5 175 lpi/1% reproduction: 175 lpi: Creating dots at each point of an intersection of 175 main lines drawn on a 1-inch square.
lpi: An abbreviation for “Lines per inch”
1%: The tip diameter of a fine shape protruding from a plate created at the intersections of 175 lines drawn on a 1-inch square.
“1-inch area × 1 %” = “175 pieces × tip diameter area” Therefore, the larger the lpi number and the smaller the percentage, the finer the diameter becomes.

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