

Development of Photopolymer-type Simple-Process CTP Systems, “PRO-V” and “PRO-VN”

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Abstract

We have newly developed unique environmentally friendly photopolymer-type simple-process CTP systems “PRO-V” and “PRO-VN”, which use a single solution/single-bath without requiring replenishment, along with a new CTP suitable for this process. These systems integrate the conventional four-step process into a single-step process and offer customers a variety of advantages, like reducing the running cost, reducing processor maintenance, saving the space and protecting environment.

1. Introduction

With the increasing concern of society about the global environment, the momentum towards ecologically friendly products is increasing in Japan’s printing industry, thanks to the industry’s various efforts. The Japan Federation of Printing Industries (JFPI) has established the green printing (GP) certification program. The Environment Pollution Prevention Printing Association (E3PA) has set up the environment pollution prevention printing mark (Clione Mark) certification system.

On the other hand, as printing is going digital, as a system for making printing plates, demand for CTP (computer to plate) is increasing. In CTP technology, an image on computer is output directly to a printing plate without requiring a photographic film. Although the current CTP systems enhance efficiency of the plate making process, save time and stabilize the quality, as for plate processing, the mainstream systems still require high-alkali developers. These systems require management of automatic processors and developers to maintain quality and disposal of waste solutions, which are a heavy burden in cost and labor.

Considering the above situation, we have developed next-generation CTP technology for two types of CTP systems in

order to simplify or eliminate the plate processing process and thereby reducing the environmental impact and cost. One is thermal CTP that uses infrared laser. The other is visible CTP that uses visible-light violet laser).

For thermal CTP, we developed processless thermal plate PRO-T (ET-S in Japan)¹⁾ and put it on the market in 2006. The PRO-T has been well received. It provides the same level of sensitivity (productivity) and printing capability as the conventional thermal plates using high-alkali developers. Still, the new plate requires no processing at all, which means no developers or waste solution.

For visible CTP, we have simplified the processing because of the aptitude for the safelight during printing process. And, we have come up with a simple-process photopolymer CTP system. We launched the system in 2008. The system for commercial printing comes with the plate PRO-V, the plate processing solution LC-V, and automatic processor FCF-85V or FCF-125V (Photo 1). The system for newspaper printing comes with the plate PRO-VN, the processing solution LC-VN and the automatic processor FCF-NEWS. This report mainly focuses on the newly developed technology on the high-alkali-free processing solutions for simplifying the process and CTP plate materials suitable for the solutions.



Photo 1 Plate: PRO-V, Treatment solution: LC-V, Processor: FCF-125V.

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2. Development Concept and Problems of the Simple-process Photopolymer CTP System

As shown in Fig. 1, the plate processing of the conventional photopolymer CTP system after the laser exposure and the preheating consists of the following four steps (four baths): pre-washing, developing, rinse and finishing. The developer is highly alkaline (pH = approx. 12 to 13). The developer is susceptible to fatigue due to repeated use for many plates or fatigue with age by carbon dioxide generated during operation/stand-by hours of the automatic processor. For stable processing, a replenishment system is required to counter the fatigue. This makes the automatic processor big and complicated, and the maintenance is difficult, and the machine takes up a lot of space. Moreover, the process uses a large amount of solutions, including a developer, finisher and rinse water. All the steps produce waste solutions, which are an impact on the environment and a strain on the costs.

To solve these problems and create benefits to customers, we have started technological development for simplifying the photopolymer CTP processing system.

<Benefits for customers by simplified processing>

- (1) Reduction in the running cost (reduction in processing solutions and waste solutions)
- (2) Reduction in maintenance loads of the automatic processor (reduction in workloads for solution management and cleaning)
- (3) Reduction in space required by the automatic processor
- (4) Reduction in the impact on the environment (in print production)

As shown in Fig. 1, simplifying process we have sought is integrating the four steps of the processing process into a single step process. Specifically, we need to remove the oxygen barrier layer (overcoat layer = OC layer), remove the unexposed part of the photosensitive layer and form the

hydrophilic protective layer in one process (one solution and one bath). In the conventional process, these are done in separate steps. We also need to configure a stable processing system using a high-alkali-free solution that does not require replenishment to reduce the impact on environment and the amount of processing solutions.

<Problems for simplifying the process>

- (1) Processing with one solution
- (2) Developing with high-alkali-free solution
- (3) No replenishment

We have solved these problems and developed new high-alkali-free solutions and new CTP plates suitable for the solutions. The following sections provide the detailed descriptions about the main technologies we have developed for the solutions and plates.

3. Development Technology

3.1 Development of Processing Solutions

3.1.1 Dispersing Photosensitive Layer

In the conventional processing system, if some sludge is left on the plate, it will be fully removed during the rinse and finishing process subsequent to developing. In our new system, on the otherhand, there is no rinse or finishing process and processing is carried out in one process with one solution. The sludge may often remain on the plate. In order to solve the problem, the photosensitive components need to be dispersed completely in the processing solution.

Among the photosensitive components, pigments and polymerizable monomers are especially hard to disperse. Pigments released into a processing solution will not stably disperse and they are prone to remain as sludge. Monomers gradually hydrolyze and dissolve completely in a high-alkali developer. In our high-alkali-free solution, the hydrolysis is still slow, resulting in sludge with time. Dispersion of

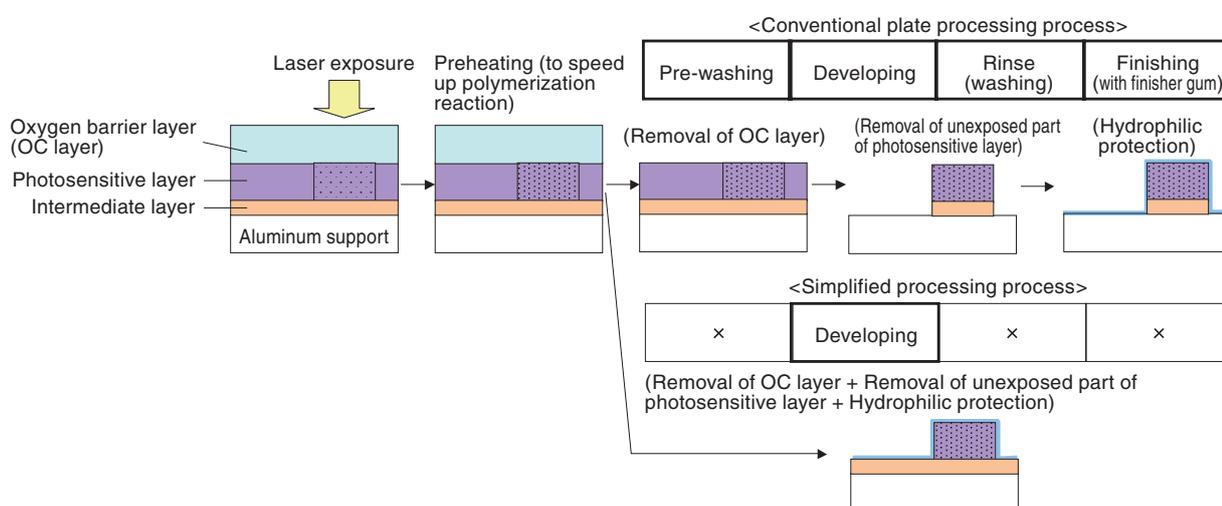


Fig. 1 Comparison between the conventional process and simplified process.

pigments and monomers is the key in processing with one solution without sludge of photosensitive components.

Considering the above situation, we have tried stabilizing the dispersion using a surfactant to disperse pigments and monomers uniformly. As shown in Fig. 2, we have found that several types of ampholytic surfactants increase the dispersion of pigments and monomers satisfactorily. These surfactants help disperse photosensitive components including pigments and monomers and stabilize the dispersion of photosensitive components.

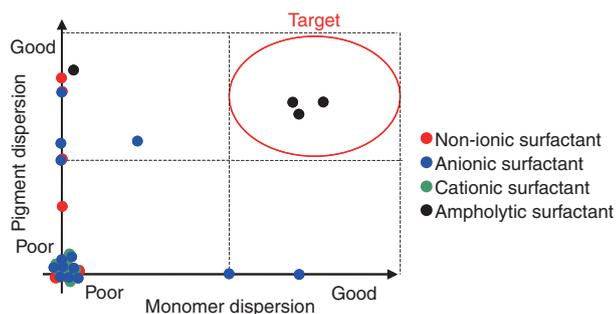


Fig. 2 Dispersion ability of monomer and pigment.

In the first place, a processing solution needs the developing function, that is, removal of the non-imaged area of the photosensitive layer. In the conventional system, the developing function is provided mostly by the high alkaline property of a developer. High-alkali free solutions will not have an adequate developing function. However, as described above, our system employs a surfactant excellent in dispersion of photosensitive components and the surfactant helps remove the photosensitive layer sufficiently and stably. That makes possible a processing solution free of strong alkali.

3.1.2 Stabilizing Processing Solution

In order to realize the stable processing, it is essential to stabilize the pH of the processing solution. The conventional high-alkali developer is liable to fatigue resulting from consumption of the alkali. The alkali is consumed by carbon dioxide in the atmosphere and by the photosensitive components during their processing. To solve this problem, the conventional systems make up for the consumption by adding a high-pH alkali.

In general, the higher the pH of an alkaline solution is the more it takes in carbon dioxide, which reduces the pH. Compared with the conventional high-alkali developers, the high-alkali-free solutions are insusceptible to carbon dioxide and fall in the pH is small. But, the pH needs to be more stable to eliminate the need of replenishment. We have added a buffer function to the processing solutions. We tried several types of buffer agents that work between neutral and low alkaline (pH10 or less). Finally, we have decided on a carbonate buffer for the pH stability and impact on the

environment. By adding a buffer function, we have succeeded in stabilizing the pH of processing solutions reducing the effects of the fatigue without replenishment (Fig. 3).

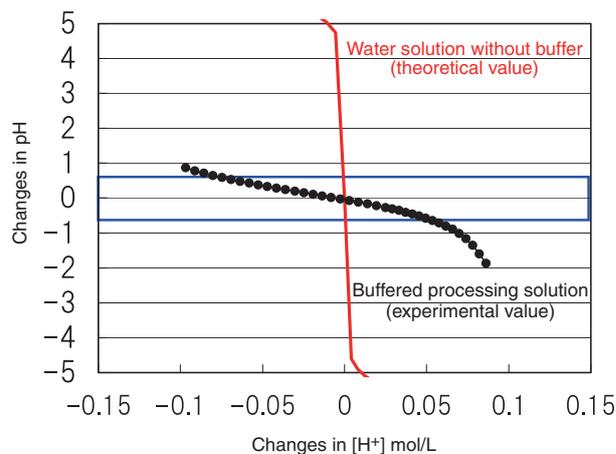


Fig. 3 pH stability range of sodium carbonate.

3.2 Development of Plates

3.2.1 High-solubility Overcoat Layer

Photopolymer plates use polymerization reaction to form an image. They need an oxygen barrier layer as an overcoat layer to prevent oxygen, which hinders polymerization reaction, from entering into the photosensitive layer. For the conventional overcoat layer, it was common that the polyvinyl alcohol is used as a hydrophilic polymer to reduce oxygen permeability. In the conventional plate processing process, the overcoat layer is removed in the pre-washing process before the unexposed part of the photosensitive layer is dissolved and removed with a high-alkali developer in the developing process. However, our system does not have the pre-washing process and the overcoat layer material, not only the components of the photosensitive layer, is dissolved into the processing solution. The overcoat layer material, i.e., polyvinyl alcohol, dissolved into the processing solution affects the printing capability. It increases the viscosity of the solution, hinders the dissolution of the photosensitive layer, and causes sludge due to gelation. Moreover, it increases loads on washing by the automatic processor. Therefore, for one-solution processing, it is necessary to reduce the loads of the overcoat layer material on the processing solution. On this account, we have sought ways of enhancing the solubility of polyvinyl alcohol and reducing the thickness of the overcoat layer. To enhance the solubility of polyvinyl alcohol, the acid-denatured polyvinyl alcohol using sulfonate group have been employed by us. The flat particles high in aspect ratio have been added in order to reduce the thickness of the overcoat layer. Adding the particles increases the length of the oxygen permeation pathway in the overcoat layer and that makes it possible to reduce the thickness of the layer without reducing the

oxygen barrier property (Fig. 4).

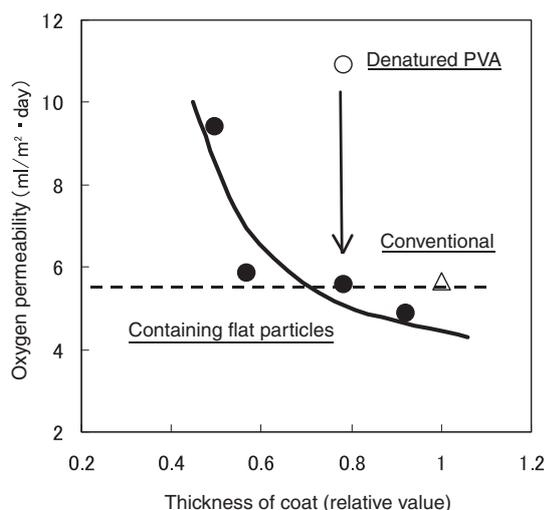


Fig. 4 Control for oxygen permeation of overcoat layer.

3.2.2 Control of the Interface Adhesion

Between the photosensitive layer and the support, an intermediate layer is placed to ensure adhesion of the image area and hydrophilicity of the non-image area. In the conventional high-alkali developing CTP, the intermediate layer material is hydrophobic and soluble in the high-alkali developers. In our system using a high-alkali-free solution, it is difficult to remove the hydrophobic intermediate layer. We need a hydrophilic intermediate layer that ensures adhesion of the image area and hydrophilicity of the non-image area. We have decided to leave the intermediate layer and started development of a hydrophilic intermediate layer that can control the adhesion of the interface with the photosensitive layer. The adhesion of the image area is achieved by adding to the intermediate layer a functional group that electrostatically interacts with the polar functional group of the photosensitive layer components. The hydrophilicity of the non-image area is achieved by reversing the electrostatic interaction

in the processing solution, which ensures the solubility of the photosensitive layer and the hydrophilicity of the intermediate layer (Fig. 5).

4. Features of the System

4.1 System Specifications

Table 1 shows the specifications of the new system. The system has practically the same level of capabilities as those of the conventional violet laser CTP systems using high-alkali developers (FUJIFILM “Brillia LP-NV” and “Brillia LP-NNW”). That means that the light exposure settings are also the same. And, the present violet CTP setter can be used with the new system. The high productivity of photopolymer CTP will be maintained. The plates made by this system will cause as little toning in printing as the conventional CTP plates. In printing, they can be handled exactly the same way as the conventional plates.

Table 1 Specifications of “PRO-V” and “PRO-VN”.

	PRO-V system for commercial printing	PRO-VN system for newspaper printing
Plate	Polymerized photopolymer (negative)	Polymerized photopolymer (negative)
Exposed Light source	Violet laser (wavelength: 405 nm)	Violet laser (wavelength: 405 nm)
Plate/processing solution (name)	PRO-V/LC-V	PRO-VN/LC-VN
Automatic processor (name)	FCF-85V, FCF-125V	FCF-NEWS
Processing time	19 seconds (28 °C)	21 seconds (25 °C)
Sensitivity (standard)	65 $\mu\text{J}/\text{cm}^2$	30 $\mu\text{J}/\text{cm}^2$
Resolution	2-98% (200 lpi)	2-98% (100 lpi)
Runlength	200,000 prints (depending on printing conditions)	200,000 prints (depending on printing conditions)
Capability of processing	20m ² /L	20m ² /L

As the process is simplified, the automatic processor of the new system is reduced in size. It is approximately 35% smaller than the automatic processors for the conventional CTP

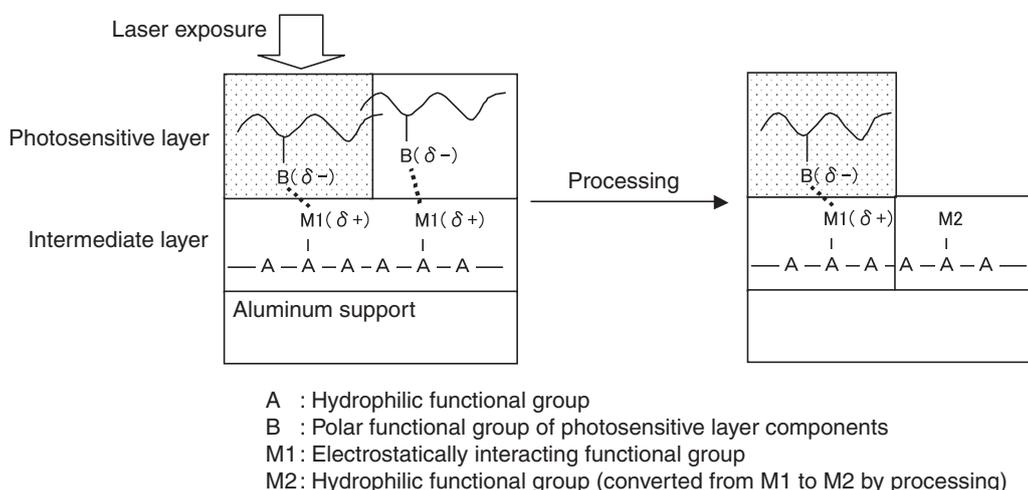


Fig. 5 Control mechanism of interface between photosensitive layer and intermediate layer.

systems (Fig. 6). The system provides stable processing without replenishment of a processing solution. The consumption of processing chemicals is reduced about 75% compared with the conventional CTP systems, assuming 1000 m² of plates are processed per month for 8 hours a day for 20 days a month (Fig. 7).

4.2 Quality

4.2.1 Tone Reproduction

Fig. 8 shows the tone reproducibility of a plate exposed for imaging with the Luxel plate setter Vx9600 and made with the PRO-V system (plate: PRO-V, processing solution: LC-V and automatic processor: FCF-125V). Fig. 9 shows enlarged photographs of the dots on the plates exposed and made in the same way as above with AM screening (200 lpi, 2438 dpi) and FM screening (20 μm, 2438 dpi). The

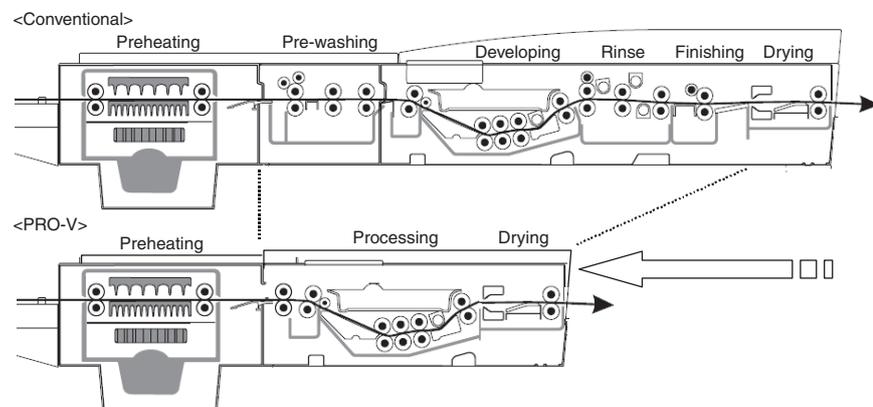


Fig. 6 Comparison between the conventional type and PRO-V type processors.

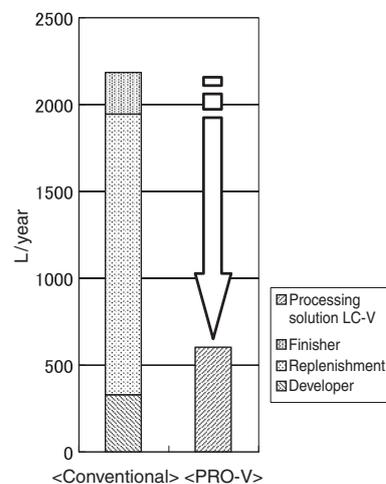


Fig. 7 Comparison of treatment solution consumption between the conventional type and PRO-V type.

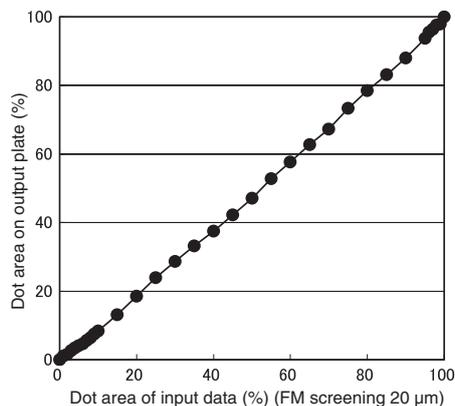


Fig. 8 Tone reproduction curve.

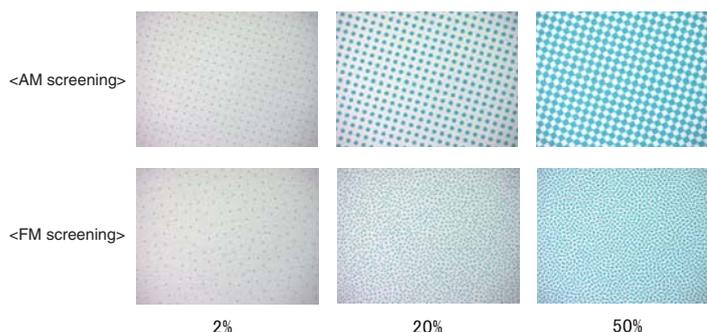


Fig. 9 Dot quality on plate.

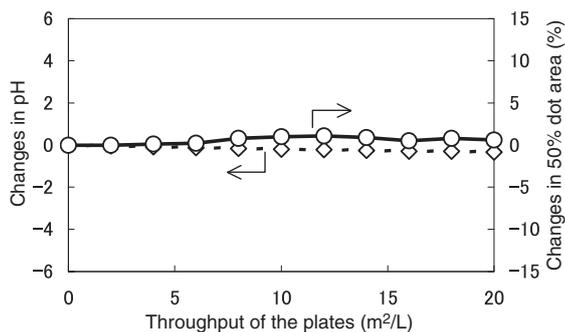


Fig. 10 Fluctuation of solution pH and dot area reproduction in running treatment.

5. Conclusion

The simple-process photopolymer CTP system, PRO-V/PRO-VN, is the product of the high-sensitivity polymer technology and the processless thermal plate technology Fujifilm has developed for CTP. It is an environmentally friendly system that has the same level of capabilities as the conventional photopolymer CTP. We are launching this system in Europe. The new system is very well received for its ease of maintenance, processing stability and low effluents. As people are getting more and more ecologically aware, we hope that this system, which provides above-mentioned benefits to customers, will spread in the market and contribute to printing solutions.

References

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