Eco-Friendly Fountain Solution for Offset Printing

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Abstract

The basic nature of offset printing is repulsion between oil (ink) and water (fountain solution). Regarding the fountain solution, its key function is said to depend on its low dynamic surface tension and high viscosity, which come from VOC compounds in it. And it is well known that when replacing VOC by other compounds, it is very difficult to achieve the same value of surface tension and viscosity.

However, we found that surface tension and viscosity is not actually essential for the fountain solution and thus we were able to create a novel formula composed of only non-VOC components.

1. Introduction

The worldwide concern over the global environment has been growing in recent years. In Japan, too, to reduce CO_2 and volatile organic compounds (VOCs), there have been various promotion activities including legal restrictions, the introduction of information disclosure system in which eco-friendly products could be evaluated, the addition of economic incentives (such as environmental tax) and the encouragement of voluntary efforts.

In the offset printing industry, too, especially regarding the type of ink, printed materials using soybean oil or non-VOC inks have been increasing. This time, the paper reports our attempt to replace the conventional VOCs by non-VOCs to make fountain solution more eco-friendly.

It has been many years since the continuous water supply system became the main stream in the supply of fountain solution for printing. To produce a sufficiently high printing performance with this water supply system, isopropyl alcohol (IPA) has been commonly used as is generally known. However, this IPA is categorized in the Organic Substances specified in Ordinance on Prevention of Organic Solvent Poisoning (1989) under the Industrial Safety and Health Law and the reduction of its use has been demanded internationally. Today, the fountain solutions used commonly in the market are composed of alkyl ether solvents of ethylene glycol or propylene glycol that can perform the function of IPA. However, as these solvents are VOCs, it is hoped to develop some eco-friendly technology capable of replacing them.

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2. Function of Fountain Solution

The functions of fountain solution are the supply of sufficient amount of water to printing plate, protection of aluminum surface as printing plate, addition of wettability and the physical property control when mixed with ink. In addition, in some printing-plate material, the function to add the ink filling property is included. Among these functions, the supply of sufficient amount of water to printing plate is essential for forming ink images on the printing plate. Today, in the mainstream printing machines, water is supplied in the state of uniform thin water layer through more than one roller that rotate at high speed. The reason that the addition of IPA to fountain solution was effective has been considered to be due to the following two functions: (1) Increased wettability of rollers and printing plate due to decreased surface tension and (2) Increase in the passing amount through rollers by increased viscosity. [1), 2), 3)] In fact, it can be noticed that if IPA is added to water, the physical properties of the water change as shown in Fig. 1.

In aiming to achieve non-use of VOCs for fountain solution, it was a big study theme how to secure this printing-plate water.

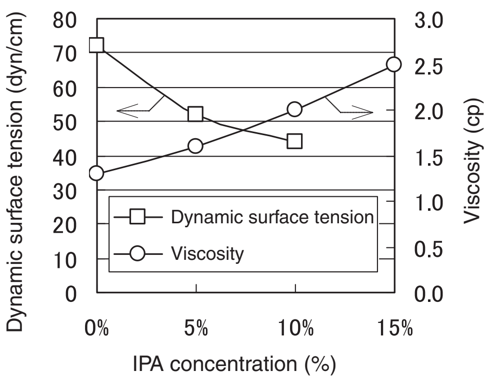


Fig. 1 Surface tension and viscosity.

3. Design of Non-VOC Fountain Solution

In an attempt to design a non-VOC eco-friendly fountain solution, there is a fundamental difficulty to overcome from the viewpoint of dynamic surface tension and viscosity.

3.1 Dynamic Surface Tension

Fig. 2 shows a static/dynamic surface tension map for water, 10% IPA aqueous solution and 2% diluted commercial fountain solutions. To maintain the wettability on a printing machine rotating at high speed, a design to lower the dynamic surface tension is being introduced. As a material to lower the static surface tension, it is possible to use a surfactant besides water-soluble organic solvents (commonly VOCs). Meanwhile, to lower the dynamic surface tension, the use of only surfactant is not sufficient in many cases. The molecules of surfactant can lower the surface tension of solution through their orientation in the gas-liquid interface. However, in a dynamic state where new interfaces are continuously formed, the speed of their orientation to the surface is not high enough. Therefore, to lower the dynamic surface tension, the use of organic solvents with a low molecular weight and a high orientation speed is effective. In Fig. 2, those showing lower levels of dynamic surface tension tend to have higher solvent concentrations. Accordingly, from the viewpoint of lowering dynamic surface tension it can be said that the design of non-VOC fountain solution is not easy.

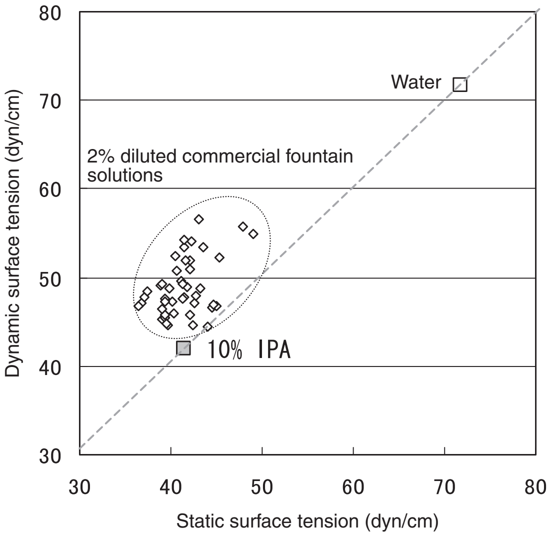
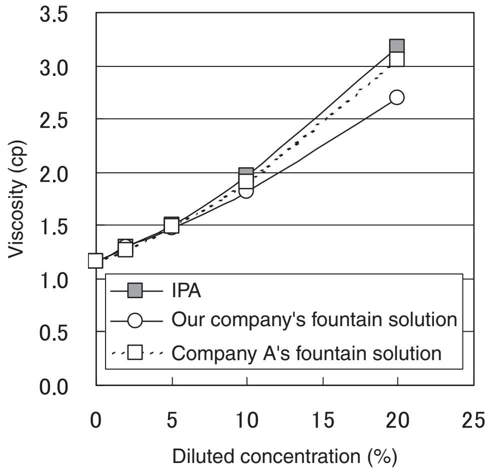


Fig. 2 Static/Dynamic surface tension map.

3.2 Viscosity

It is said that the passing amount of fluid through pressurized rollers increases with increasing viscosity (EHL theory). However, as a diluted fountain solution of about 2 percent is generally used in Japan, it is not possible to keep a sufficiently high viscosity at the concentration of actual fountain solution even if a viscosity improver is used. Fig. 3 shows the viscosity of our company's fountain solution and that of Company A's fountain solution of which stock solution viscosity is the highest in Japan (35 cp). At a concentration of 2 percent, there is little difference in viscosity between those two.

In the design of non-VOC fountain solution, it was aimed to obtain the same level of performance at a diluted concentration of about 2 percent as in the case of the existing fountain solution. On the other hand, IPA is used at a concentration of about 5 percent and used together with the fountain-solution's stock solution of about 2 percent. Its viscosity is set at higher levels. To achieve the same viscosity level as this only with 2% non-VOC fountain solution, it is necessary to design the viscosity of stock solution to have an extremely high value.



<Elastohydrodynamic lubrication model (EHL theory)>

$$h_0 = k \times (\eta^3 U^3 R^3 / W E^2)^{0.2}$$

h_0 : Nip passing amount
k : Constant
η : Viscosity
U : Circumferential velocity of roller
R : Radius of roller
W : Nip line pressure
E : Equivalent elastic coefficient

Fig. 3 Dosage and viscosity.

Fig. 4 shows the effect of fountain-solution viscosity on the amount of water on the printing plate that was actually measured on a printing machine. The amount of water was measured by installing infrared sensors in the printing machine, measuring the absorbance of reflection and expressing the measured values in g/m^2 using a calibration curve. The individual sensor measures the same area on the printing plate once per rotation of the plate cylinder. The individual point in the figure indicates the mean value of approximately 100 measuring points.

When the viscosity of fountain solution was increased using a viscosity improver, the amount of water on the printing plate decreased unexpectedly, indicating that the design concept of increasing the viscosity is not necessarily effective.

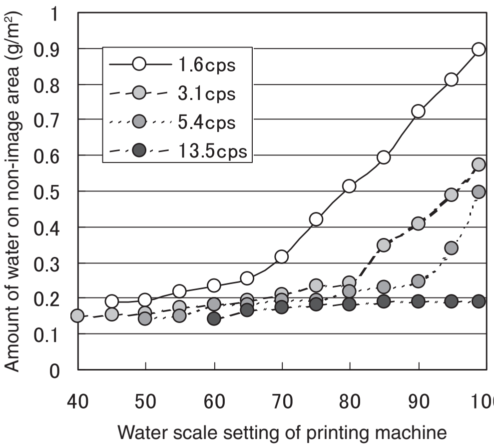


Fig. 4 Amount of water on the plate and viscosity.
{Measured by DMS (grapho metronic)}

For the reasons stated above, it can be said that those two parameters are not useful for the design of non-VOC fountain solution from the viewpoint of dynamic surface tension and viscosity that are controllable by IPA and have been considered the basic factors in the design of fountain solution.

4. Eco-friendly Fountain Solution "Non-VOC Ecolity"

A non-VOC fountain solution (non VOC Ecolity) we have developed solved this difficult problem. Instead of physical properties such as surface tension or viscosity, we took notice of the structural factors of components and designed its formulation from the viewpoint of materials. As shown in Fig. 5, for example, we have found a non-solvent substance with which the amount of water on the printing plate can be increased simply by increasing the concentration of components. However, as shown in Table 1, at the concentration of fountain solution actually used for printing (2%), the non VOC Ecolity is higher in dynamic surface tension and not that higher in viscosity compared with those of the representative product using our company's solvent (VOC).

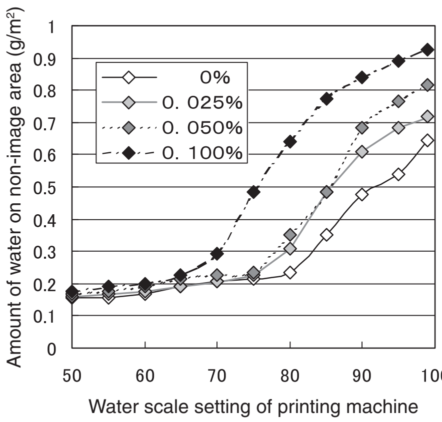


Fig. 5 Amount of water on the printing plate and substance concentration.
{Measured by DMS (grapho metronic)}

Table 1 Physical Properties of Fountain Solution

	non VOC Ecolity 2% dilution	Product using VOC 2% dilution	IPA 10%
Dynamic surface tension (dyn/cm)	60.2	49.0	41.4
Static surface tension (dyn/cm)	45.8	33.4	41.9
Viscosity (cp)	1.29	1.25	1.97

Fig. 6 shows the measured amount of water on the printing plate on a printing machine using "non VOC Ecolity". In the figure, it is apparent that the amount of water on the printing plate when non VOC Ecolity is used is equal to that of our company's fountain-solution product containing VOC components. In addition, in the comparison of water-scale lower-limit values where the ink scumming and on printed paper and the entangled soiling of halftone dots occur, it has the same level of performance.

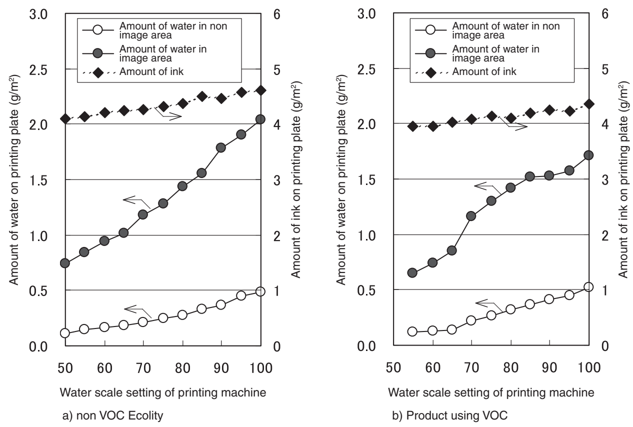


Fig. 6 Amount of water and ink on the printing plate.
{Measured by DMS (grapho metronic). Not only the amount of water on the non-image area, but the amount of water and ink on the image area was also measured.}

5. Conclusion

In this study, the design of fountain solution has been carried out not from the viewpoint of dynamic surface tension and viscosity that have been considered important but by taking notice of the molecular-structural factors of materials. In the future, we will study this topic by expanding our perspective from the molecular structure to micro and macro physical properties.

References

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