Factors to Influence Image Stability of Inkjet Prints

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Abstract

Image stability is one of the hot issues in inkjet industry. There are several factors known that can deteriorate a print image, like light, heat, humidity, O3, and so on.

In this study, inkjet prints are exposed to each and/or combination of these factors, and the influences of those factors are evaluated. Based on the results, possible mechanisms will be discussed.

Introduction

Image stability of inkjet prints is one of the broadly discussed issues in the industry.

For light fastness, several inkjet researchers have investigated about its improvement from both media and ink formulation points-of-view.[1,2] Also, how to quantify the lifetime of light-faded inkjet prints remains an issue and intensive discussion is ongoing.

For gas fastness, ozone is known to play a dominant role in fading.[3] Many of the reports sofar are mainly discussing the ozone fading in micro-porous media and not in swellable media, since the extent of ozone fading in micro-porous media is far bigger than that in swellable media if a dye-based inkset is applied.[4] In micro-porous media, it is known that the higher the humidity is during ozone exposure, the bigger is the extent of fading.[5]

Looking to the practical situation how inkjet prints are displayed in private houses or offices, there is seldom a situation where only a single environmental factor is applied, but it is more common that the prints are exposed to a combination of factors. There are few studies which discuss the combination of environmental factors, especially the combination of light, ozone, and humidity.

In this study, some preliminary results from this aspect will be discussed, including some "super additive" phenomena which were observed for the first time.

Experimental

The following test conditions were applied;

1) Ink/printer system: HP deskjet 5652, cartridges 57 and 58.
2) Media: 3 kinds of swellable media, hereafter referred to as SW-A, SW-B, SW-C, and 2 kinds of micro-porous media, hereafter referred to as MP-A, MP-B, all of which are available in the market.
3) Print image: Y/M/C/K patches with different densities including OD=0.6 and 1.0.
4) Pre-treatment: The prints were dried 2 weeks at 20C 47%RH.
5) Ozone exposure: Ozone Test Chamber OTC-1 (IN USA Inc.) was used.
6) Light source: Xe 30klux
7) Temperature during exposure: 21C
8) Humidity during exposure: varied by 20%RH, 47%RH, 60%RH.

Results and Discussion

Ozone Exposure at Varied Humidity

Figures 1-3 show an overview of the results. Behavior of pure magenta patches are shown as representative. On micro-porous media, there is indeed fading occurring as a function of ozone exposure time. Also, clear humidity dependency was observed where the higher the humidity is, the bigger is the fading extent. These are in line with the previous studies.[5]

On the swellable media, on the other hand, the following phenomena were observed;

a. Overall the extent of the fading is far less than that on the micro-porous media. A reasonable explanation for this is that one of the main binders in swellable media is known to be gelatine, which can reduce the chance of ozone reacting with the dyes incorporated in the media.
b. One of the swellable media showed relatively bigger humidity dependency than the other swellable media. Possibly, swellable media swell more and make ozone permeate more into the matrix at higher humidity than at lower humidity.

Ozone and Light Exposure

Figures 4 and 5 show the results of the combination of ozone exposure and light exposure at the same time for the media SW-A and SW-B at the humidity of 60%RH. The following phenomena were observed;

a. "Light exposure only" showed rather limited fading in this case, since the accumulation of light is equivalent to 1-2 years only.
b. Media SW-A showed a "super additive" fading phenomenon, where it seems that the combination of ozone and light exposure makes prints fade more than the sum of ozone fading and light fading. This, we think, is a phenomenon which was observed for the first time. It was also confirmed that the Xe exposure did not produce extra ozone by measuring ozone concentration with and without Xe exposure. Regarding the mechanism for this, we don't have a nice explanation yet, which remains an open item for future investigation.
c. On the other hand, Media SW-B didn't show such "super-additive" behavior.

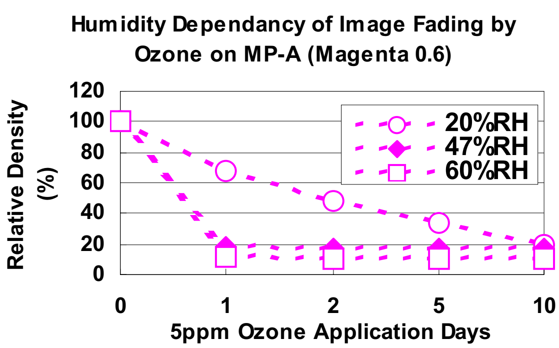

Figure 1. Humidity dependency of Ozone fading for MP-A

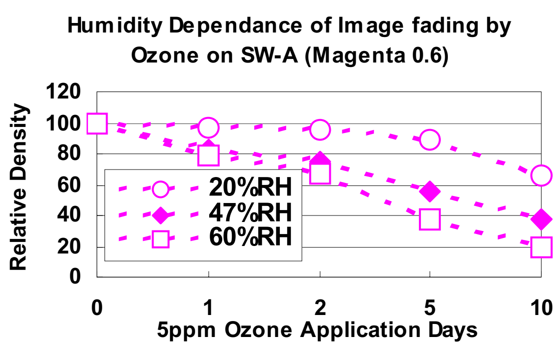

Figure 2. Humidity dependency of Ozone fading for SW-A

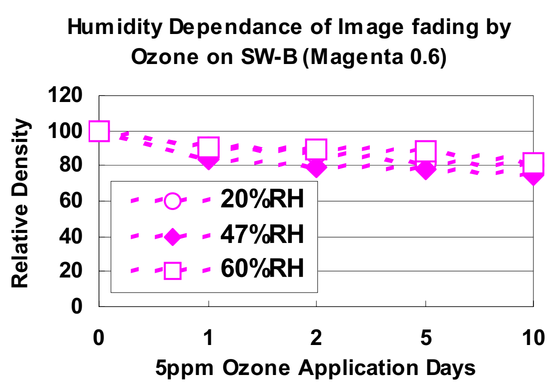

Figure 3. Humidity dependency of Ozone fading for SW-B

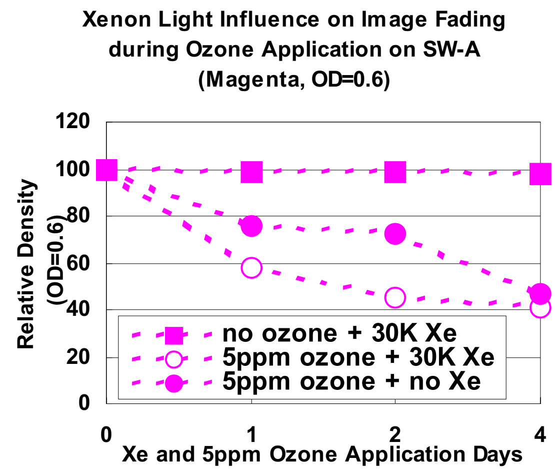

Figure 4. Combination effect of ozone and light exposure for SW-A

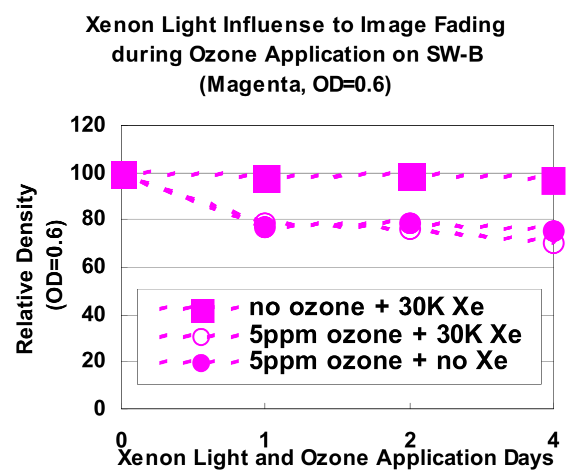

Figure 5. Combination effect of ozone and light exposure for SW-B

Conclusion

1. Influence of the combination of environmental factors, ozone, light, and humidity, was investigated in some swellable and micro-porous media.
2. Some swellable media showed a humidity dependency during ozone exposure.
3. Some swellable media showed a "super additive" phenomenon, where light exposure accelerates the ozone fading.
4. From the results above, it became clear that we have to take care, during the evaluation of the image stability of inkjet prints, not only of a single environmental factor, but also of a combination of factors. It will then surely benefit customers' satisfaction.

References

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Biography

Akira Kase received his master's degree in chemistry from University of Tokyo in 1987, when he joined Fuji Photo Film Co., Ltd. He is now working at Tilburg Research Laboratory, Fuji Photo Film B.V.