The Influence of Air Pollution on the Discoloration of Dyestuff. III.¹⁾ Discoloration of Dyestuff by Nitrogen Dioxide²⁾

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The influence on the discoloration of two dyed clothes by nitrogen dioxide was measured. The apparatus of constant nitrogen dioxide generation was made in order to see the influence of nitrogen dioxide on the discoloration of dyed cloth. The nitrogen dioxide concentration is measured by NO₂ auto analyser. The dyed cloth is exposed to the nitrogen dioxide for a certain time in reaction chamber. For the detection of what extent the discoloration is occurred, the spectrophotance (400—800nm) was used. In the dry air, the remarkable color fading and change of the materials did not happen. In the wet air (relative humidity 60 %), the color of the silk cloth dyed with Acid blue 127 was only faded slightly and the color of the acetate rayon cloth dyed with Diacelliton fast brilliant blue B was faded and changed markedly.

For several years, the field test have been performed to investigate the influence of air pollutants upon the discoloration of dyed clothes.^{1,4)} In the field, however, are contained many air pollutants such as nitrogen dioxide, sulfur dioxide, various hydrocarbons and hydrogen sulfide, and it was difficult to decide which gas was the most effective to the discoloration. In this paper nitrogen dioxide, the environmental problem of which is serious in Japan, is taken to investigate the influence on the discoloration of dyed clothes.

Experimental

1. **Materials**—As described in the previous paper,^{1,4)} blue dyestuff was easily affected by air pollution, therefore, Acid blue 127 and Diacelliton fast brilliant blue B, the most popular blue dyes for silk and for rayon, were chosen as the experimental dyestuffs.

Material A : Silk cloth dyed with Acid blue 127⁵⁾
10g of silk cloth was immersed in 500 ml of the solution containing of dyestuff (Acid blue 127 0.02 g) and ammonium acetate (0.5 g), and heated at 100° for 30 min. After cooling, the dyed cloth was washed with water and dried.

- 1) The previous paper : F. Fujikawa, K. Hirai, T. Hirayama, M. Fujii, J. Takimoto, H. Yamada, H. Kawaguchi and M. Sawatari, *J. Hyg. Chem. (Japan)*, **17**, 112 (1971).
- 2) The 93rd Annual Meeting of Pharmaceutical Society of Japan, Tokyo, Apr. 1973.
- 3) Location : 5, Nakauchi-cho, Yamashina-Misasagi, Higashiyama-ku, Kyoto, 607, Japan.
- 4) F. Fujikawa, K. Hirai, T. Hirayama, M. Fujii, Y. Tsujide, M. Shibata, H. Toyoshima, K. Suzuki, N. Tsuda, H. Yamada, M. Sawatari, J. Takimoto, H. Kawaguchi, Y. Matsuyama, J. Ueda, T. Hatsutori, M. Kadoma, K. Okasaki, H. Nakamura, Y. Mantani and N. Takeda, *J. Hyg. Chem. (Japan)*, **16**, 96 (1970).
- 5) Acid blue 127.

Material B : Acetate rayon cloth dyed with Diacelliton fast brilliant blue B.⁶⁾ 10 g of acetate rayon was immersed in 500 ml of the solution containing of dyestuff (Diacelliton fast brilliant blue B 0.02 g) and dispersing agent (0.5 g) and heated at 85° for 1 hr. After cooling, the dyed cloth was washed with water then Marcel soapy water and dried.

2. Apparatus—Fig. 1 shows the outline sketch of apparatus. In order to generate the nitrogen dioxide constantly, the temperature of water bath was controlled at the constant level by coolnics circulator and magnetic-set thermo-regulator. In this water bath, there were a spiral glass pipe and a cylindrical glass pipe in which a permeation tube containing of liquid nitrogen dioxide was set. The reaction chamber in which the dyed cloth was exposed to nitrogen dioxide was surrounded with temperature-controlled water. In the reaction chamber, there were an autographic hygrometer, a thermometer and

a stirrer. Dyed cloth was hung on the point A. The humidity in the reaction chamber was controlled by water vapor generator.

The experimental conditions were as follows.

- 1) The air flow speed : 2.0 liter/min
- 2) Water bath temperature : 5.0°
- 3) Gas concentration : 0.36 ppm
- 4) Relative humidity : 27 and 60 %
- 5) Exposure time : 1/2, 1, 2, 7 and 14 days

3. Exposure and Measurement—Each dyed cloth was hung on the point A of Fig. 1. The dyed cloth was exposed to gas under the condition mentioned above. The discoloration extent of dyed cloth was determined by measuring the spectroreflectance before and after exposure respectively.

Results

The spectroreflectance spectra of Material A before and after exposure are shown in

Fig. 1. The Apparatus of Constant Gas Generation

A. dyed cloth B. hygrometer C. experiment room D. water vapor generator
 E1-2. buffer F. activated charcoal G1-10. cock H1-2. U glass pipe I1-2. flowmeter
 J1-2. gas generating pipe and control pipe K. drain L1-2. coolnics circulator
 M. humidity adjustment apparatus N. glass filter O1-2. magnetic-set thermo-regulator
 P1-3. air pump Q1-2. water bath R. gas auto analyser

6) Diacelliton fast brilliant blue B.

Fig. 2.

In dry condition (relative humidity 27 %), 0.36 ppm nitrogen dioxide concentration resulted in neither color fading nor color change. On the contrary, in wet condition (relative humidity 60 %), it resulted a little color fading of the dyed silk cloth.

Fig. 2. Spectra of Material A

A : before exposure (—)
B : after exposure (.....) (relative humidity 27%)
C : after exposure (---) (relative humidity 60%)

Fig. 3. Spectra of Material B

A : before exposure (—)
B : after exposure (.....) (relative humidity 27%)
C : after exposure (---) (relative humidity 60%)

The spectrophotance spectra of Material B before and after exposure are shown in Fig. 3.

In dry condition (relative humidity 27 %), 0.36 ppm nitrogen dioxide concentration gave a little color fading but never color change. On the other hand, under the condition that relative humidity was 60 %, the color of the dyed acetate rayon cloth faded and changed gradually throughout 14 days, and the reflectance at 642 nm increased markedly as shown in Fig. 3 and Table I.

TABLE I. The Change of Reflectances of Material B

Exposure time (hour)	Reflectances		Change of reflectance (B - A)
	Before exposure (%) A	After exposure (%) B	
12	28.7	28.7	0.0
24	28.7	29.0	0.3
48	28.3	29.7	1.4
7×24	28.0	38.5	10.5
14×24	28.4	64.7	36.3

Conclusion

Color fading and color change of dyed cloth by nitrogen dioxide were investigated, and the conclusion were as follows :

1) In the dry air, the remarkable color fading and change of the both materials did not happen.

2) In the wet air (relative humidity 60 %), the color of the silk cloth dyed with Acid blue 127 (material A) was only faded slightly and the color of the acetate rayon cloth dyed with Diacelliton fast brilliant blue B (material B) was faded and changed markedly.

3) From these results, it was suggested that the nitrogen dioxide would have a bad effect upon the protection of culture properties.