OPTIMUM CONDITION FOR DEVELOPING SWR FILMS

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Synopsis

In order to find the optimum condition for development, the photographic films SWR are developed at various temperatures and in various concentrations and then the resolving power of the negatives are examined. The maximum resolving power is obtained at the temperature 20°C. when the concentration of the developer is reduced to one fifth of the original specification.

1. Introduction

Emulsions for the ultraviolet radiation contain only a small amount of gelatine to support AgBr because the gelatine absorbs strongly this radiation. Such kinds of emulsions now available are S.W.R. (Eastman Kodak Co. Ltd., U.S.A.), S.C. (Pathé Kodak, France) and others. But the development of these films requires several precautions.

S.W.R., perhaps the most widely used, is indicated to be developed at 20°C for five minutes with the original D-19 developer according to the specifications. However, it is well known from experience among the workers engaged in the ultraviolet researches that better results are obtained if the developer is diluted and cooled although the optimum condition has not yet been made clear.

In order to find the best condition the films are developed in various concentrations and at various temperatures and then the images on the films are carefully examined. The quality of the image is estimated by its granularity, resolving power, sharpness, recognition, definition, etc[1]. In this report, the resolving power is especially considered because it is the most important characteristic of emulsion.

2. Experiment

Koana's test chart† was used in the measurement of the resolving power. This chart is shown in Fig. 1. The spatial frequency and pitches of this chart is tabulated in Table 1.

This chart was photographed using S.W.R. with a contraction of 1/52.8. The developed image was examined through a microscope and the limit of resolution for spatial frequency is estimated by observing two adjacent lines which could be barely recognized as separated. D-19 was used as the developer. The magni-

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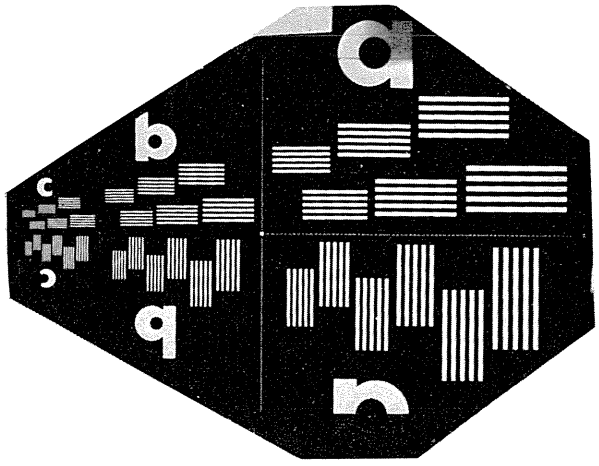

FIG. 1. The test chart.

TABLE 1. The spatial frequency and pitches of the test chart.

	Group **a**		Group **b**		Group **c**	
	Pitch (mm)	Spatial frequency (lines/mm)	Pitch (mm)	Spatial frequency (lines/mm)	Pitch (mm)	Spatial frequency (lines/mm)
1	1.99$\overset{\circ}{5}$	0.501	1.000	1.000	0.501	1.99$\overset{\circ}{5}$
2	1.778	0.562	0.891	1.122	0.447	2.239
3	1.58$\overset{\circ}{5}$	0.631	0.749	1.259	0.398	2.519
4	1.413	0.708	0.708	1.413	0.35$\overset{\circ}{5}$	2.818
5	1.259	0.794	0.631	1.58$\overset{\circ}{5}$	0.316	3.162
6	1.122	0.891	0.562	1.778	0.282	3.548

fication of the microscope was 15, and two mercury lamps were used to illuminate the test chart. Two filters, VY-43 and V-V 40 were placed in front of the camera lens to isolate the Hg λ 4358 line.

The aperture of the camera was reduced to F/16 to avoid the errors originating from the defocusing of the lens. As is well known, the resolving power of emulsion depens not only on the condition of development but also on the quality of the lens, its aperture, the contrast of the chart, time of exposure and the wavelength used[2]. The true resolving power of emulsion is defined as the maximum attainable value when all these factors are most favorable. In the present experiment, the factors except that for development were perhaps not the optimum, and hence the "true resolving power" of S.W.R. could not be determined. However, it is of course significant to compare the results among themselves because the difference of the values obtained arises from the difference of developing condition only.

The resolving power was measured under the following thirty conditions of development;

Temperature; 10°C, 15°C, 18°C, 20°C, 25°C.

Dilution; 1 : 0, 1:1, 1 : 2, 1 : 3, 1 : 4, 1 : 5.

Here dilution means the ratio of the original D-19 to added water.

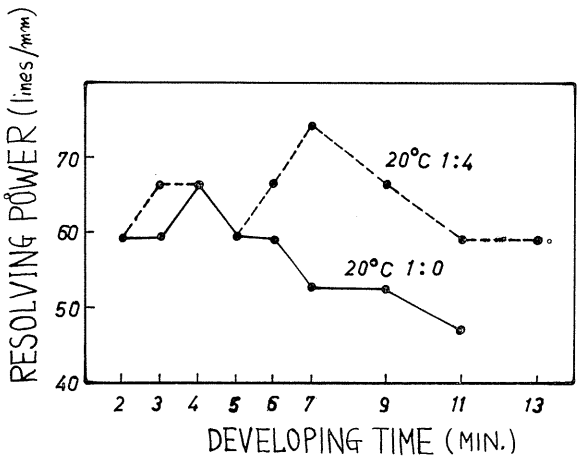

FIG. 2. The resolving power for various developing time.

Fresh developer was always used for each film to keep the similar condition of development, and in this experiment the maximum value was adopted when the time of development was changed. In Fig. 2 these relations are illustrated. It is concluded from the figure that 7 minutes and 4 minutes are the optimum developing time.

3. Results

The resloving power for each condition of development is shown in Fig. 3. The mean values of the resolving power are shown in Fig. 4.

It is concluded from these figures that

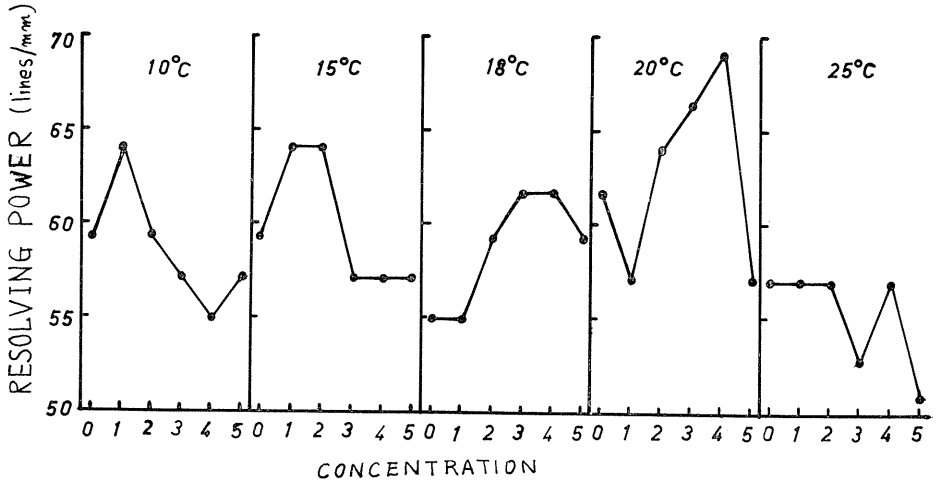

FIG. 3. The resolving power for each condition of development. (Abscissa designates the ratio of added water to original D-19.)

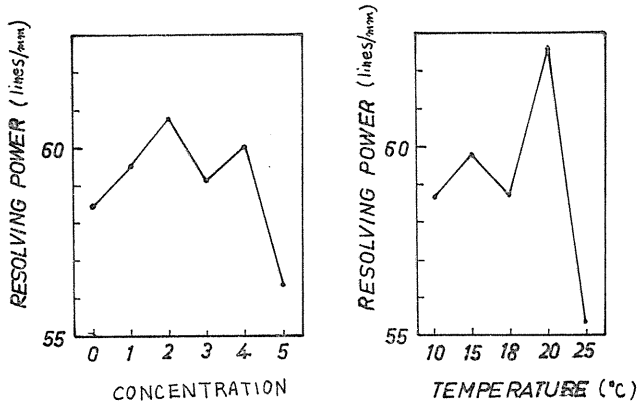

FIG. 4. The mean values of resolving power.

1) the maximum value of the resolving power is 69.22 lines/mm when the temperature is kept at 20°C and the concentration of the developer is 1/5 of the original;

2) when the temperature is raised the diluted developer gives the better results;

3) the specified condition (20°C, not diluted) is not at all the best.

4) The resolving power at 25°C is considerably lower than those at other lower temperatures. This means one must be careful that the temperature of the developer may not exceed 20°C to get good results.

4. Discussion

When the vacuum ultraviolet spectrum is taken with a spectrograph using S.W.R., the density and the contrast of the developed image are not uniform, because the intensity of the light source as well as the sensitivity of the film varies with wavelength. Accordingly, the proper developing time must be determined in advance in order to get the best resolving power in the wavelength region to be studied.

Acknowledgement

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References

1) Kikuchi, *et al.*, Kagakushashinbinran (II), Maruzen, pp. 433-471.
2) Kikuchi, *et al.*, Kagakushashinbinran (I), Maruzen, p. 485.