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Color Characteristics of Certain Acid-Base Indicators

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It was found that students have difficulty in observing end points when titrating with methyl red and methyl orange as indicators, because of the comparatively large volume of solution necessary to cause a definite color change. Methyl orange-xylene cyanole was purchased from Eastman Kodak Company to overcome this difficulty. However, it was found that the color change of this mixed indicator was not completely satisfactory.

A study has been made to obtain an indicator which presented the best possible color characteristics combined with the lowest pH interval for the titration of strong acids and bases. Four indicators were studied. They were methyl red, methyl red-xylene cyanole, methyl red plus methyl orange-xylene cyanole, and methyl orange-xylene cyanole.

The mixing of indicators is critical to obtain the desired changes in color. The methods for preparation of the indicators used in these experiments are listed below.

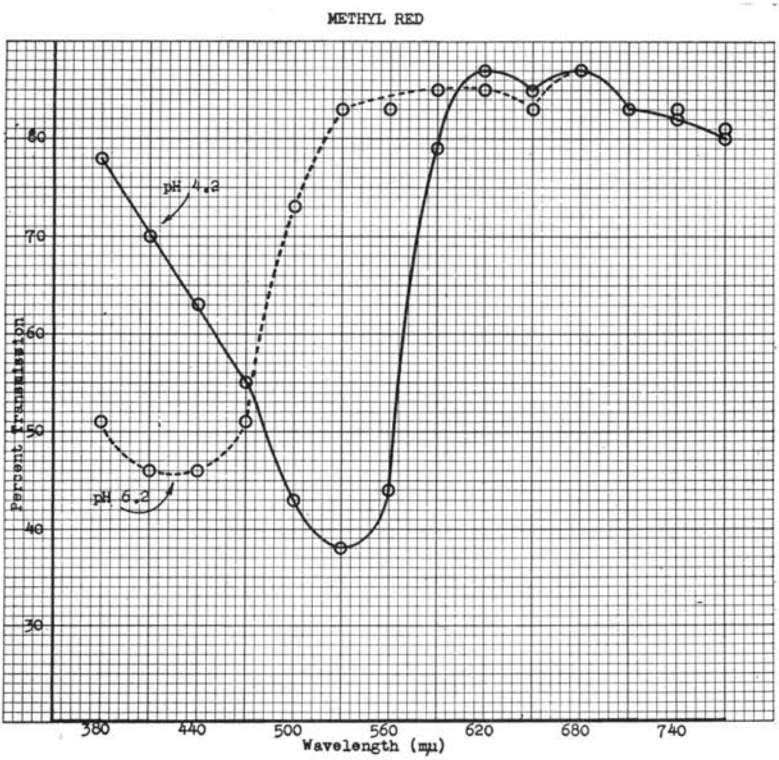

Figure 1

The methyl orange-xylene cyanole solution was purchased from the Eastman Kodak Company.

The methyl red indicator was prepared by grinding 0.1.g. of methyl red with 3 ml. of 0.1 N NaOH in an agate mortar and diluting to 100 ml, with distilled water.

The methyl red-xylene cyanole indicator solution was prepared by adding 0.05 g. of xylene cyanole FF to 100 ml. of the previously prepared methyl red solution.

The methyl red plus methyl orange-xylene cyanole solution was prepared by mixing three parts of the methyl red solution with one part of the methyl orange-xylene cyanole solution.

The color change intervals of the four indicators were determined with a Fisher Titrimeter, showing the following results. In each case two drops of indicator per 50 ml. of solution were used.

It was found that methyl red changes completely from red to yellow in an interval of pH 4.2 to 6.2.

Methyl orange-xylene cyanole changes from purple at pH 3.55 to green at pH 4.6.

Methyl red plus methyl orange-xylene cyanole changed from red to green over a pH range of 4.9 to 6.0.

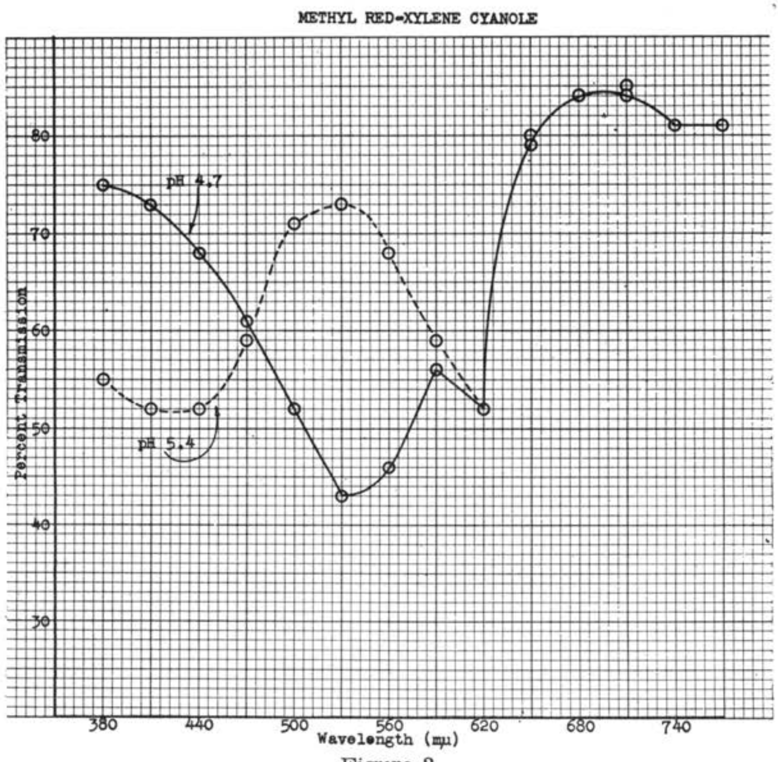

Figure 2

Methyl red-xylene cyanole showed a color change from deep red to green in going from a pH of 4.7 to a pH of 5.4.

It is believed that the color change-pH intervals found are accurate, as the interval found for methyl red coincides with that listed in the literature, and the same methods of determination were used for all of the indicators.

A comparison of the acid and base color transmissions over the range of the sensitivity of the human eye was made using a Coleman Spectrophotometer. The results are shown on the accompanying graphs.

The human eye is capable of seeing color in a range from 400 mμ to 750 mμ, with a maximum sensitivity at 555 mμ. It can be observed from the graphs, that the acid and base colors of three indicators showed their maximum difference in transmission at 530 mμ, while methyl orange-xylene cyanole exhibited a maximum difference at 410 mμ. It is because of these differences in transmission that a color change is observable. However, the indicator which exhibited the greatest difference in transmission between its acid and base color should be the one in which the color change would be the most apparent.

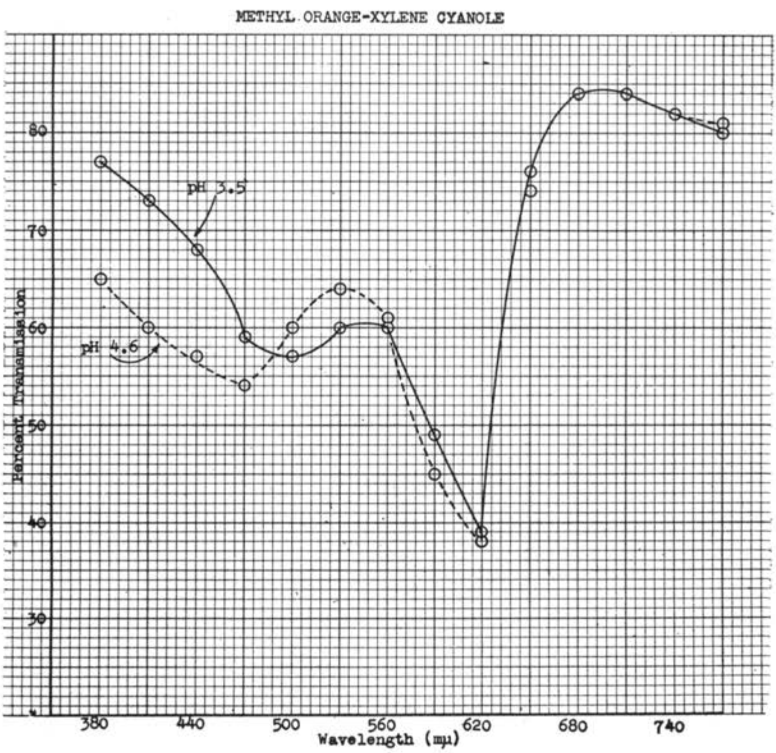

Figure 3

Methyl red should exhibit the most apparent color change observable, since at 530 mμ it transmits 83% of the light at a pH of 6.2, while at a pH of 4.2 it transmits only 38%. However, methyl red has a large color change interval, which indicates that the color change from red to yellow would proceed slowly with dilute solutions.

The two mixed indicators, prepared in the laboratory, exhibited excellent characteristics in terms of color change and pH range. Methyl red-xylene cyanole was the better, since it exhibited a difference of 30% in transmission between its acid and base colors at 530 mμ, and the pH range of the color change was only 0.7 pH units. Methyl orange-xylene cyanole plus methyl red showed a difference of 31% in transmission between the acid and base colors at 530 mμ and over a range of 1.1 pH units.

Methyl orange-xylene cyanole exhibited the poorest color change, as it had only 4% difference in transmission between its acid and base colors at 530 mμ. Undoubtedly, this is the cause of the difficulties which students have in observing the end point, when titrating with methyl orange-xylene cyanole as an indicator. Nevertheless, the pH range of the color change is good since it is 1.25 pH units.

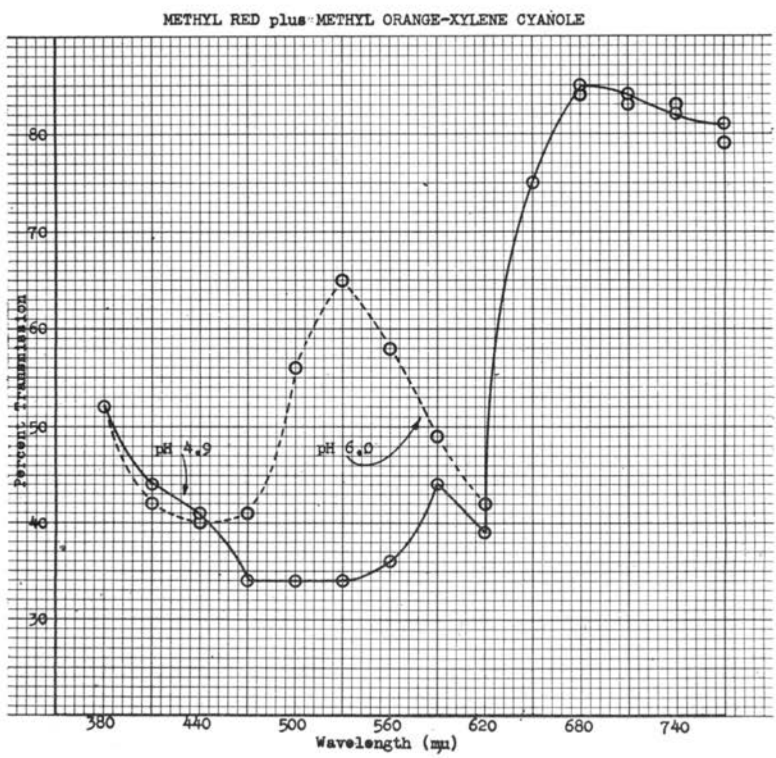

Figure 4

Differences in transmission in the violet and blue portions of the spectrum, also, have some influence over the observation of the color change by the analyst; but this cannot be as important as the differences in the portion of the spectrum where the eye is the most sensitive. Even in this range, the results show that methyl red-xylene cyanole is the best of the indicators investigated, with reference to color change and pH range.

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BIBLIOGRAPHY

Kolthoff, I. M. & Rosenblum, C.—*Acid-Base Indicators,* Macmillan, 1937.

Brode, W. R.—*Chemical Spectroscopy* PP. 278-289, 2nd Ed., John Wiley & Sons, 1943.