

PHOTOVOLTAIC EFFECTS IN DYE SOLUTIONS

CONTINUING former work¹ on aqueous solutions of Erythrosin and Chrysoidine, three new dyes, whose absorption extends well into the red have been investigated—Methylene blue, Methyl green and Malachite green. These dye solutions give rise to two absorption maxima and it should be interesting to note if the photo-potential also exhibits similar maxima. With reference to their photo-sensitising action it may be mentioned that when dyed on the phototropic substance, HS.Hg.CNS, a second maximum of darkening is noticed in the orange-red, the first in all cases practically coinciding with, or extending on either side by a short region of that due to the substance itself. These investigations yielded results similar in every way to those recorded before and confirmed the conclusions then arrived at, as will be shown presently. Further a far-reaching parallelism between the development of photo-potential and optical sensitisation may be traced which forms the subject of another communication.

A description of the apparatus will appear elsewhere in a fuller account of the work. It is however necessary to add that a vacuum type of mercury arc served as the source of illumination and potentials were measured with a vacuum tube volt-meter, in which the lighted electrode was connected directly to the grid and the dark electrode was biased from the negative end of the filament to the potential of the free (floating) grid. Under these conditions the grid current being actually zero at the start and negligibly small at the end of a run, polarisation of the cell does not occur and the zero of the instrument does not drift.

The rise and fall of potential on insolation and cutting off the light, its variation with the concentration of the dye and intensity of illumination, do exhibit complete similarity to the dyes already examined. In the composite light of the mercury arc, Methylene blue develops a potential of 12 m.v. at a concentration of 0.0009 mg. per ml., Methyl green 10 m.v. at

0.0024 mg., and Malachite green 11 m.v. at 0.0015 mg. per ml. Of interest however is the variation of the photo-potential with the wave-length of the exciting radiation. The accompanying table gives these values corrected for the transmission factors of the spectral filters employed and the energy distribution of the mercury arc. It is particularly noteworthy that all the dyes develop maxima of photo-potential corresponding to their absorption maxima in the different regions of the spectrum and shifted therefrom by a few wave-lengths to the red.

Calculated photo-potential and wave-length

	Methyl green	Malachite green	Methylene blue
	m.v.	m.v.	m.v.
Composite light ..	10,0	11,0	12,0
436 $\mu\mu$..	7,0	4,0	7,5
546 ..	2,0	6,0	6,0
577-9 ..	8,0	7,0	14,0
615 ..	11,0	12,5	10,0
690 ..	9,0	7,0	8,0
700 ..	3,5	4,0	5,0

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¹ *J. Phys. Chem.*, 1934, **38**, 693.

VERIFICATION OF KAUFMANN CONDITION, FOR ARC DISCHARGE IN MERCURY

KAUFMANN¹ derived the condition for the stability in glow discharge. He showed that the *limiting point* on the falling characteristic of voltage against current in a glow discharge which will give the *smallest current* under which the glow could be maintained depends on the external resistance W in the circuit. His condition can be expressed as $W = -\tan \beta$

where β is the angle which the tangent to the characteristic at the point makes with the current axis.

In this note we wish to show that this condition holds and can be verified in the case of arc discharge in mercury.

The mercury arc characteristic as obtained with a mercury lamp of the high vacuum type is a straight one, in which the voltage across the arc rises with increase of current flowing through, i.e., it is a rising characteristic as shown by Henri² as well as Daniels and Heidt.³ Therefore there is no question of the Kaufmann condition being fulfilled here, at all, as $\tan \beta$ is positive and no falling part in the characteristic of mercury was known.

All efforts by us to get a falling part in the characteristic proved futile in highly evacuated arc lamps of mercury. If however a small amount of air is introduced, so that the air pressure in the arc space is about 0.5 mm. or more, then it is possible to get the falling part. It becomes more and more prominent as the pressure is increased.⁴ The development of the negative characteristic can be brought about also by cooling the arc for example by blowing currents of air from different distances, with an electric table fan, provided the pressure

(inside air pressure) is not lower than about 0.5 mm. of mercury. From such curves we can obtain the tangents at different points.

The figure above shows the values of the tangents as ordinates obtained for the limiting points when an arc is maintained in a mercury arc lamp made out of soft glass, and cooled by the fan to different amounts. The abscissae show the actual values of the resistance in the external circuit. The tangents obtained with coolings at distances of fan of 1, 2, 3, 4 and 5 metres, and also without any cooling by fan are shown in the figure. The deviations in the values of the tangents under a particular condition are indicated by arrows. The points fall on a straight line inclined at 45° to the axes, showing that the tangent condition is strictly fulfilled. These points show that their value increases with decrease of cooling, i.e., by removing the fan farther and farther away. We also verified this condition with two different mercury lamps.

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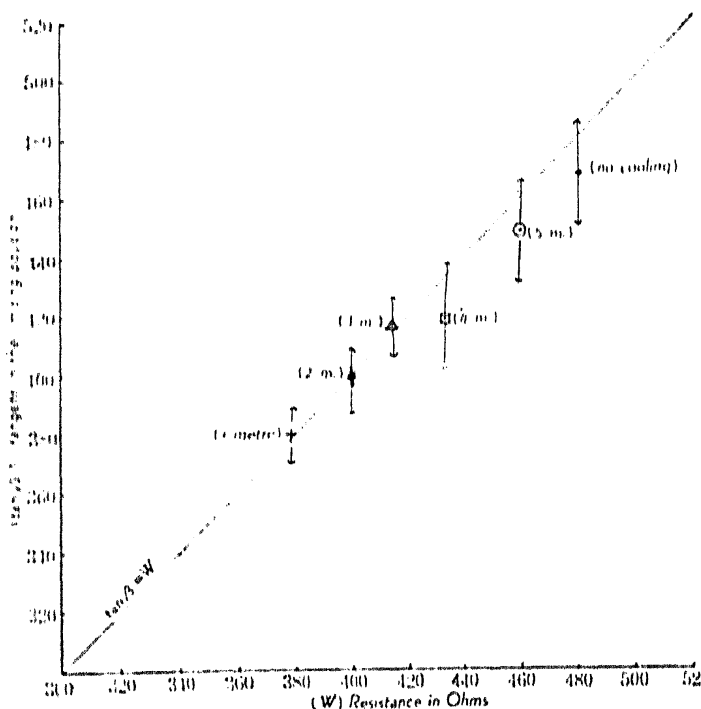


FIG. 1

Verification of Kaufmann condition

¹ W. Kaufmann, *Ann. d. Phys.*, 1900, 2, 158.

² Henri, *Comptes Rendus*, 1911, 153, 426, quoted in the paper by Lewis Reeve; *J. Phys. Chem.*, 1925, 29, 30.

³ F. Daniels and L. G. Heidt, *J. Am. Chem. Soc.*, 1932, 54, 2381.

⁴ See B. Dasannacharya and C. Dakshinamurti, *Curr. Sci.*, 1941, 10, 166.

MODIFIED EQUATIONS FOR ADSORPTION AND BASE-EXCHANGE IN SOILS*

WHEN a calcium soil is treated with a solution of Na_2CO_3 the following base-exchange reaction takes place:



This equation however does not express all the significant factors connected with the reaction.

*[This work is being done under the auspices of the Irrigation Department (Research Section) of the U P. Government.]