

LETTERS TO THE EDITOR

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NOTE ON A PARTICULAR TEST FOR
CONVERGENCE

If $\sum_{n=1}^{\infty} a_n$ is a series of positive terms, and if

$$\frac{a_n}{a_{n+1}} = 1 + \frac{f'(n)}{f(n)} + \frac{\rho_n}{f(n)}$$

where $f(x)$ is a continuous function such that $f''(x)$ tends to zero as x tends to infinity, then the series is convergent if $\lim \rho_n > 0$, and divergent if $\lim \rho_n < 0$.

In the proof of this result, Bromwich¹ works out and uses a peculiar form of the second mean value theorem, viz.,

$$f(n+1) = f(n) + f'(n) + \int_0^1 dx \int_0^x f''(n+t) dt.$$

But there is no need for this special form, and the proof will be rendered easier by using the familiar form, viz.,

$$f(n+1) = f(n) + f'(n) + \frac{1}{2} f''(n+\theta), 0 < \theta < 1.$$

V. S. ANANTHACHAR.

Mysore,
December 12, 1942.

1. Bromwich, *Infinite Series*, 1926, p. 39.

THE OPEN-ARC METHOD OF
EXCITING THE BALMER SERIES

WHEN a steady stream of hydrogen is passed into a copper arc the Balmer series of lines is excited. The series is also obtained if instead of hydrogen, a stream of coal-gas or steam is used. In fact, with steam more lines of the series appear and their intensity is even greater than with hydrogen. In all these

cases, however, the lines are very broad compared to what are obtained with an ordinary discharge tube. A series of experiments with different metallic arcs run at various current strengths brought out two significant facts: (i) The Balmer series is excited only with the copper arc and no trace of the series is to be observed with iron, zinc, aluminium or carbon arcs. (ii) Along with the hydrogen lines, the OH Bands ${}^2\Sigma \rightleftharpoons {}^2\Pi$ at $\lambda\lambda$ 3064 and 2811, also appear and as regards occurrence and intensity these bands and the Balmer series of lines go *pari passu*.

That the excitation of the hydrogen lines is not a pure temperature phenomenon becomes obvious. Two explanations suggest themselves. First, in the case of the arcs where the hydrogen lines are not excited, the hydrogen supplied is used up in reducing the oxides of the electrodes formed. With copper arc, copper being less easily oxidised, a free supply of hydrogen becomes available for excitation. Second, and what seems more plausible, the excitation of the hydrogen atom is due to some collision processes taking place in the copper arc.

In the case of copper it is well known that the electronic configuration $3d^{10} 4s$, gives the series of normal doublet levels, while the configuration $3d^9 4s^2$ gives a system of inverted doublet and quartet levels. Some of these latter levels lie in the continuum above the limit of the level $3d^{10} 1S_n$. If an excited copper atom in one of these levels makes an inelastic collision with a hydrogen atom and comes down to the level $1S_n$, the energy so liberated may be sufficient to raise the hydrogen atom from the second to the higher orbits thus giving rise to the Balmer series. Alternatively, a collision between a copper atom

in the $3d^9 4s$ level and a hydrogen atom may result in bringing the copper atom to the $3d^{10}$ level and exciting the hydrogen atom to higher levels.

It is also observed that the injection of steam or hydrogen greatly modifies the intensity of a number of copper lines, especially in the region below $\lambda 3000$. A detailed analysis of the lines which are so modified will give a clue to the nature of the collision processes involved in the arc.

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January 1, 1943.

GEL-FORMATION BY MUTUAL INTERACTION OF OPPOSITELY CHARGED SOLS

A STUDY of the literature reveals that most of the inorganic gels have been prepared by the following two methods:

(i) Metathetical reaction: In this method solutions of definite concentrations of substances which on reacting give rise to the gel-forming substance, are mixed in suitable proportions. The resultant mixture is clear in some cases (silicic acid)¹ while in others^{2,3} a precipitate is obtained which disappears on slight or vigorous shaking.

(ii) Addition of an electrolyte to a sol: In this case certain electrolytes of suitable concentration are added to a fairly concentrated sol of the gel-forming substance, dialysed to a certain extent.⁴

However, other methods, such as the action of α -, β - and X-rays on a sol (Fernau and Pauli),⁵ addition of non-electrolytes to a sol (Freundlich),⁶ dilution of a true solution of a gel-forming substance (Prasad and Desai),³ have been used in particular cases.

The authors have discovered that transparent or translucent gels are formed when oppositely charged sols of suitable concentrations, dialysed and undialysed, are mixed together in proper proportions. So far as the authors are aware it has always been observed that mutual coagulation takes place when oppositely charged sols are mixed together in proper proportions. The formation of gels by mixing oppositely charged sols seems to be a new observation. The first observations were made on mixing the sol of nickel hydroxide (negatively charged) with sols of ferric and aluminium hydroxide (positively charged). The nickel hydroxide sol was prepared by shaking with distilled water the gel obtained by the addition of NaOH solution to a saturated solution of nickel hydroxide in tartaric acid and its colloidal content corresponded to 3.01 g. of nickel per litre of the sol. The ferric and aluminium hydroxide sols were prepared by the hydrolysis of ferric chloride and aluminium acetate, respectively, and their colloidal contents were found to correspond to 3.05 g. of Fe_2O_3 and 2.34 g. of Al_2O_3 , respectively, per litre of the sols. Gels were obtained when 5 c.c. of the nickel hydroxide sol were mixed with the

following volumes of the ferric hydroxide sol dialysed to different extent.

TABLE I

Days of dialysis	Volume limits
0	1.30-1.55 c.c.
1	1.70-2.40 "
2	2.35-3.05 "
3	3.50-4.20 "
4	5.30-5.80 "
5	5.25-6.75 "

Gels have now been obtained on mixing (i) the sol of aluminium hydroxide (+ve) with sols of manganese dioxide (-ve), antimony sulphide (-ve) and silicic acid (-ve), and (ii) the sols of ferric hydroxide (-ve) and silicic acid (+ve).

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Bombay,
December 29, 1942.

1. Prasad and Hattiangadi, *J. Indian Chem. Soc.*, 1929, **6**, 653.
2. Prakash and Dhar, *Ibid.*, 1929, **6**, 587; 1930, **7**, 367.
3. Prasad and Desai, *J. Univ. Bom.*, 1933, **7**, 132.
4. Freundlich and Leonhardt, *Koll. Beih.*, 1915, **7**, 195; Weiser, *J. Phys. Chem.*, 1922, **26**, 418, 681; Schleck and Szegvari, *Koll. Z.*, 1932, **60**, 1847; Prakash, *Koll. Z.*, 1932, **60**, 184; *J. Indian Chem. Soc.* 1932, **9**, 193.
5. Fernau and Pauli, *Koll. Z.*, 1917, **20**, 20.
6. Freundlich, *Ibid.*, 1928, **45**, 348.

PARACHORS AND MOLECULAR DIAMETERS

THE mean value of $\frac{[P]}{V_0}$ is 2.873,¹ where [P] is the parachor and V_0 is the zero volume at absolute zero. At absolute zero, parachor can be written as

$$[P] = \frac{M}{D_0 - d_0} \gamma_0^{1/4} = V_0 \gamma_0^{1/4},$$

all the terms involved having their usual significance.

So, $\frac{[P]}{V_0} = \gamma_0^{1/4} = 2.873$. Hence, $\gamma_0 = 68.2$ for a majority of substances. However, it has been observed that γ_0 varies between 60 and 80 for many organic substances.² But, for purposes to be described below, the value of γ_0 may be taken as a constant for all normal substances.

The following equation³ gives a relation between density and temperature;

$$D_0 = \frac{D - d}{(1 - Tr)^{3/10}}$$

$$\text{Since } V_0 = \frac{[P]}{2.873} = \frac{M}{D_0}, D_0 = \frac{M \cdot 2.873}{[P]}$$