(3) The special conductivity K_s substituted by Briggs[1] in the classical equation in place of the bulk liquid conductivity is justified.

(4) Possibly (*a*) flocculation and (*b*) dispersion may be explained on this basis.

(5) The observations of Casagrande[2] on the pressure effects arising from electro-osmosis can be explained.

(6) Deviations from Darcy's law observed by various workers can also be explained on this basis.

Acceptance of the model also leads to the conclusion that the term 'zeta potential' has no rigid meaning; and analytical treatment of streaming potential along the lines followed by Elton[3] requires reconsideration.

A full account of the work will be published elsewhere.

HORACE E. ROSE
G. MOSS

Mechanical Engineering Department,
King's College (University of London),
Strand, London, W.C.2.
June 26.

[1] Briggs, D. R., *J. Phys. Chem.*, **32**, 641 (1928).
[2] Casagrande, L., *Geotechnique*, **1**, 3 (1949).
[3] Elton, G. A. H., *Proc. Roy. Soc.*, A, **198**, 581 (1949).

Mechanism of Electro-osmosis

As indicated above, the Rose and Moss model of ionic distribution for steady streaming potential conditions suggests a similar mechanism for electro-osmotic flow.

The application of an electrical potential gradient along the length of the capillary will disturb the ionic distribution of the diffuse double-layer, at rest, resulting in a thinning down of the layer towards the inlet end of the capillary. The double-layer will be partly restored by ions of the same sign contained in the incoming liquid, and when steady flow conditions are reached, the radial distribution of ions will vary along the length of the tube. The ions of the removed double-layer are discharged at the down-stream electrode while the ions in the incoming water of opposite sign to the diffuse double-layer are discharged at the other electrode, these two ionic streams composing the current concerned in electro-osmosis as distinct from the ordinary galvanic current in the capillary. The ionic force available in the double-layer for overcoming the viscous shear resistance of the double-layer in electro-osmotic flow is proportional to the ionic concentration of the double layer. In the suggested mechanism, the variation of ionic concentration along the length of the capillary means that the ionic tractive force will also vary along the capillary, being a minimum at the inlet end.

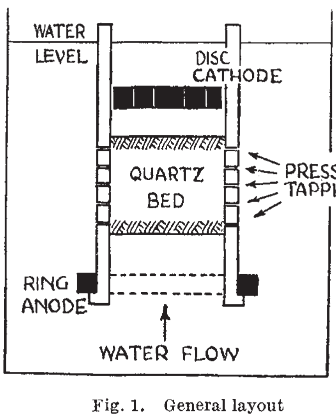

Fig. 1. General layout

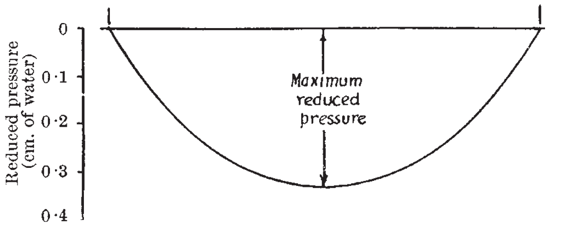

Fig. 2. Distribution of reduced pressures within the bed

From considerations of flow continuity, the rate of liquid flow will be dependent on the mean force available in the capillary. At any point along the tube the tractive force available will differ from the mean ionic tractive force by a certain amount, and a compensating pressure gradient will be induced at that point, the size and direction of which will depend on this difference.

In streaming potential there is no removal of charge from the system, and the solid – liquid system remains electrically neutral, whereas in electro-osmosis it would be expected that the solid – liquid system should contain a deficiency of the ions of the kind forming the double-layer.

Experimental work. Experimental work has been carried out on electro-osmotic flow of distilled water through a bed of quartz powder of size ranging from 50 μ to 140 μ subject to potential gradients of up to 40 volts/cm. Measurements of electro-osmotic discharge of water and of pore-water pressures within the bed were made with no external hydraulic pressure gradient across the bed. The general layout is shown in Fig. 1.

Pressures below that of the free water at either end of the sample were measured in the bed, the distribution of these reduced pressures being of the form shown in Fig. 2, with the greatest pressure reduction occurring near the centre of the length of the bed.

A typical result was that a maximum pressure reduction was obtained near the centre of the bed of 0·33 cm. of water in a quartz bed of 4·67 cm. length under a potential gradient of 21·7 volts/cm., giving a discharge of $1 \cdot 95 \times 10^{-3}$ c.c. of water per sec. per sq. cm. of bed.

The observed distribution of pressure within the bed agrees with the suggested theory, as the tractive force would be a minimum at the inlet end of the bed (the anode end for a quartz-distilled water system) and therefore less than the mean force governing the rate of flow. A supporting or assisting pressure gradient would consequently be expected towards the inlet end of the bed, reaching a maximum value at that end of the bed, which is indeed observed in the tests. Similarly, the negative or resisting pressure gradient measured towards the outlet end of the bed would be predicted from the theory.

K. L. NASH
N. W. LISTER

Civil Engineering Department,
King's College (University of London),
Strand, London, W.C.2.
June 26.