

SURFACE CONDUCTANCE AND THIXOTROPY*

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It has been shown by Street (1956) that the surface conductance of a suspended material is given by

$$\lambda_s = (F'K - K_1) \frac{\phi}{S_w},$$

where λ_s , surface conductance (ohm^{-1}),

F' , $[(x+1) - \phi]/x\phi$,‡

K_1 , conductivity of filtrate ($\text{ohm}^{-1} \text{ cm}^{-1}$),

K , conductivity of suspension ($\text{ohm}^{-1} \text{ cm}^{-1}$),

ϕ , fluid fraction of suspension,

S_w , surface area of particles/ cm^3 of suspension.

Since this measured surface conductance is equal to that calculated from the measured ζ -potentials (Street 1956), it should be possible to use measurements of surface conductance to calculate the ζ -potential of more concentrated suspensions than is possible by the microelectrophoretic method.

Application

The application of this method to some existing results indicates the desirability of considering the existence of surface conductance phenomena in the interpretation of suspension conductivities.

Schofield and Dakshinamurti (1948) give results for the relative conductivities of bentonite suspensions in potassium bromide solutions of different concentrations, and find that, at concentrations less than N/40, there is an increase in conductivity of about 3 per cent. on addition of the bentonite. However, if the concentration of potassium bromide is greater than N/40 the addition of bentonite to the solution causes a decrease in conductivity. It is also noted that the bentonite is deflocculated in solutions *less* concentrated than N/40 whilst a thixotropic gel is formed in N/10 potassium bromide solution.

These facts were interpreted on the basis of the decrease in conductivity being caused by obstruction by a thixotropic gel network.

The results can be used to calculate the surface conductance of the bentonite in suspension if K_1 is calculated assuming normal conductivity for the electrolyte concentrations given by Schofield and Dakshinamurti (*loc. cit.*). Since the

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‡ x is a function of the axial ratio of the suspended particles (Fricke 1924).

surface area of the bentonite used was $800 \text{ m}^2 \text{ g}^{-1}$, and the platelets were 10 \AA thick, thus the axial ratio is $50:1$, and α can be calculated (Fricke 1924) to be 0.0446 .

Table 1 shows the calculated surface conductances and the ζ -potentials necessary to give them.

These values indicate that the ζ -potential is constant with increasing concentration of electrolyte up to $N/40$ at which point it drops sharply.

TABLE 1
SURFACE CONDUCTANCE CALCULATED BY ζ -POTENTIALS

KBr (N)	λ_s ($10^{-9}/\text{ohm}^{-1}$)	ζ_1^* (mV)	ζ_2^\dagger (mV)
0.1	Negative	—	—
0.05	1.33	48	58
0.0333	2.61	74	87
0.025	4.82	99	114
0.0167	3.93	98	113
0.0125	4.20	102	117
0.0083	3.55	108	123

* ζ_1 , the ζ -potential calculated assuming there is an electro-osmotic contribution to surface conductance.

† ζ_2 , the ζ -potential calculated assuming there is no electro-osmotic contribution to surface conductance.

Thus on the basis of this concept the suspension behaviour may be quite normal; as electrolyte concentration increases, the ζ -potential decreases, and this decrease (in ζ -potential) causes a decrease in surface conductance which is reflected in a decrease in suspension conductance. Thixotropic gelation would be expected to occur at some low value of the ζ -potential. The suspension in $N/10$ potassium bromide solution should have a low ζ -potential and as a consequence a low surface conductance; that it is in fact negative in these results indicates that perhaps gel obstruction is partly responsible for the lower measured suspension conductance at this concentration.

References

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