

Charge acquired by Powdered Salts on moving over Metal Surfaces

ONE of the common principles of contact electrification is that considerable electrification accompanies the relative motion of two surfaces only if one or both of them has a low electrical conductivity. Dealing with the electrification which occurs when a powder or sand flows down an inclined earthed metal surface, Hudson¹ has shown, by an indirect method, that a typical insulator (zircon sand) acquires a much larger charge than a semiconductor (rutile sand). Hudson's findings were confirmed by measuring directly the charge acquired by these sands from various lengths of an earthed aluminium chute. Fig. 1 shows the results for sands of 114 μ average particle size.

The attainment of a limiting charge by the rutile is attributed to the establishment of a balance between the charging action (the nature of which is still obscure²) and a recombination of the separated charge caused by leakage due to the conductivity of the rutile³. The absence of such leakage with insulator particles allows the extended accumulation of charge, as found with zircon sand. Similar behaviour was found when the electrification was tested of glass microspheres in various states of preparation with respect to adsorbed moisture. Dry microspheres (114 μ average diameter) gave a pattern like curve A, normal ones a curve of intermediate shape, while microspheres having abnormal adsorbed moisture yielded a curve of the same shape as B (cf. Peterson⁴ working with atmospheres of different humidities).

Crystals of the common salts not only have an appreciable bulk conductivity at room temperature⁵, but ordinary specimens possess, in addition, surface conductivity due to adsorbed moisture from the atmosphere⁶. Conductivity tests showed, for example, that powdered sodium chloride has a much higher order of conductivity than either rutile sand or moist glass microspheres. It might therefore be supposed, *a priori*, that the charge acquired by powdered salts would reach a small maximum after a short traverse. Quite the reverse was found experimentally, for, as

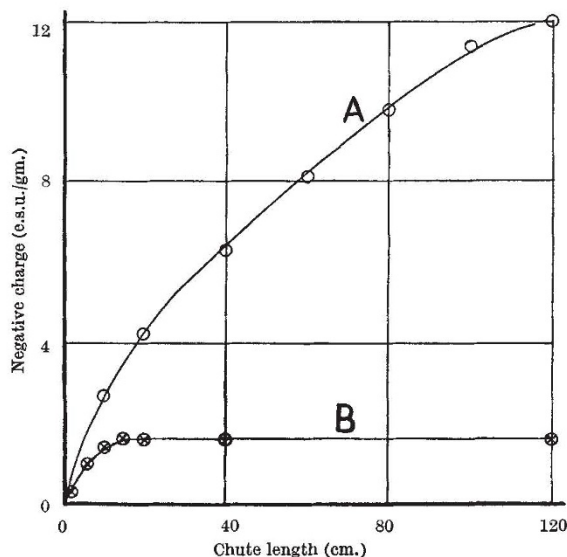


Fig. 1. Charge acquired by 114- μ zircon (A) and rutile (B) sands from an aluminium chute

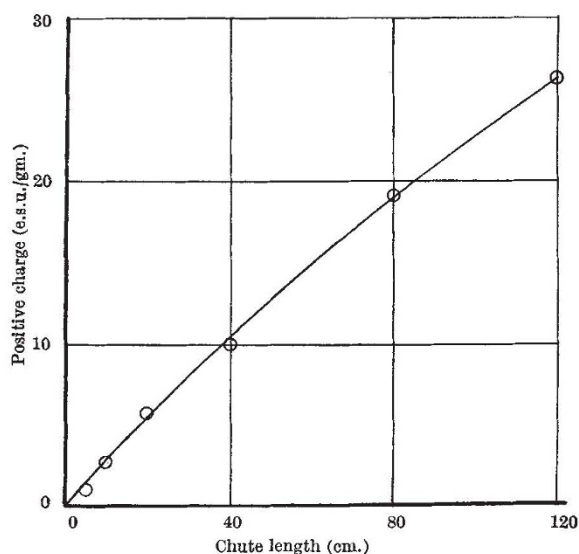


Fig. 2. Charge acquired by 211- μ sodium chloride particles from an aluminium chute

Fig. 2 shows, powdered sodium chloride (211 μ average particle size) was electrified intensely by an aluminium chute, and the accumulation of charge with distance showed almost no sign of falling off, despite the high conductivity of the salt. Other ionic compounds gave similar results, both negative and positive electrification being found with different compounds on various metal chutes. The effect of removing the moisture film from powdered sodium chloride (by evacuation for two hours) was to make it acquire a much smaller charge from the aluminium chute, namely, + 5.1 e.s.u. per gram from a 120-cm. traverse compared with + 26.4 acquired by the salt before evacuation.

The magnitude of the tribo-electric effect displayed by salts on metals shows it to be an important electrokinetic phenomenon. The rule that high conductivity leads to only slight electrification is clearly disobeyed. Further experimental work, which is being prepared for publication, suggests that this is due to ion transfer being the governing factor in electrification, whereas the rule has been based on systems involving predominantly electron transfer.

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¹ Hudson, *Proc. Australasian Inst. Min. Met.*, 145 (1950).

² Vick, *Brit. J. App. Phys.*, Supp. 2, S. 1 (1953). Henry, *ibid.*, S.6 (1953).

³ Forrest, *Brit. J. App. Phys.*, S. 37 (1953).

⁴ Peterson, *J. App. Phys.*, 25, 501 (1954).

⁵ Mott and Gurney, "Electronic Processes in Ionic Crystals" (Clarendon Press, Oxford, 1940 and 1953).

⁶ de Boer, "Electron Emission and Adsorption Phenomena", 43 (University Press, Cambridge, 1935).