

experiment, and which has, it will be seen, a definite physical signification.

To my surprise, an examination of the experimental data indicated that  $\phi$  was sensibly constant, the figure found being 0.55. I fully expected that  $\phi$  would increase as the critical velocity was approached; but the experimental evidence did not bear this out.

Incidentally, I was able to show that when the fluid traversing the tube was water, which in practice always contains dissolved gases, there was a second 'critical' condition besides that corresponding to the critical velocity. Up to a temperature of about 80° C., gases are but slowly liberated from water; but if the pressure be atmospheric, they come off freely if this temperature be exceeded. This results in the breaking up of the laminar film, and there is then, as experiment shows, a sudden and large reduction in the resistance to heat transfer when the wall temperature rises above some 80° C.

The complete research was published in *Engineering* of July 6, 1923, *et seq.* H. M. MARTIN.

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#### The Anomalous Flocculation of Clay.

THIS is a rather belated reply to Prof. Comber's letter to *NATURE* of Sept. 18, 1926 (vol. 118, p. 412), but we should like to refer to one or two points. It is a little difficult to be sure of what Prof. Comber means by the statement that "Flocculation of clay by calcium salts is anomalous when considered in the light of prevalent theories," when, perhaps, no theories on this question can be said to be prevalent. With regard to the facts (on which the theories ought to be based) we profess to have established the following:

(1) Clay flocculated by dilute hydrochloric acid and then purified from electrolytes by dialysis or other means is nearly free from exchangeable bases.

(2) Such clay (containing only 0.1 per cent. of replaceable calcium) is readily flocculated by sodium hydroxide: this seems in direct conflict with the last paragraph of Prof. Comber's letter. Further, kaolin and pure silica containing no exchangeable calcium can be readily flocculated by sodium hydroxide.

(3) It is more easily flocculated by the chlorides than by the hydroxides of either sodium or calcium where the concentration of the base does not exceed 0.5 *N* and 0.002 *N* respectively.

(4) At higher concentrations it is more easily flocculated by hydroxides than chlorides, and this is true both for sodium and for calcium.

(5) In the case of suspensions of pure silica containing only particles less than 2 $\mu$  diameter, flocculation cannot be brought about by the chlorides at concentrations up to normal, whilst in the case of the hydroxides, *N*/60 and *N*/10 are sufficient for calcium and sodium respectively to produce flocculation in one hour.

(6) The flocculation of silica differs from that of clay in that the former is only flocculated by sodium or calcium chloride in an alkaline medium. The concentration required decreases with increasing alkalinity, and this also holds for clay above a pH of about 9. If, however, a small amount of aluminium hydroxide is precipitated on the silica, there results an electro-negative suspension of which the behaviour towards flocculants is remarkably similar to that of clay. In particular, it shows the phenomenon of successive flocculation, deflocculation, and flocculation on the addition of increasing quantities of alkaline

solutions of sodium chloride, as described in the case of clay in our previous letter to *NATURE* (May 1, 1926, p. 624).

These are the facts so far as we have gone: silica and clay are certainly different in respect to flocculation phenomenon, but it is better not to call either anomalous.

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#### The Financing of Research Associations.

MANY of the industrial research associations of Great Britain have, in the opinion of the leaders in their respective industries, amply justified their existence. In view of the possible cessation of their State subsidy, these associations must consider means for raising revenue adequate for their continuance on a permanent basis.

The present method of soliciting annual donations from firms and trade associations leaves a research association in a recurring state of financial uncertainty which makes it difficult to plan any extensive or expensive research. The refusal of some firms in the industry to co-operate is a further handicap.

In the case of some associations, the time is ripe for ascertaining the amount of support likely to be provided from the industry itself and from the users of its products. I include the users because it often happens that they reap much of the financial benefit arising from the work of the association, as, for example, when this work results in the improved efficiency of electrical generating or distributing plant.

In industries in which a desire exists for the continuance of their research associations after the expiry of the subsidy, it would be necessary to estimate the amount needed to place the work on a satisfactory basis, and to ensure that this amount can be secured, as a minimum, for, say, ten years. It seems reasonable to ask the firms interested to agree to a voluntary levy of a small percentage of the turnover of each of them. In some industries one pound for each thousand pounds of turnover would provide sufficient revenue, provided the scheme were widely supported. No firm need disclose the amount of its turnover except, in confidence, to a chartered accountant.

Such a scheme for placing the finance of the associations on a more permanent basis is not likely to be approved by the financial heads of firms without pressure from those concerned in the continuance of co-operative research; the purpose of this letter is to impress on those readers of *NATURE* so concerned the advisability of considering the advantages and difficulties of such a scheme, and, if approved, of pressing it on the notice of those who would need to be influenced to subscribe.

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#### Surface Film of Aluminium.

It is generally believed that the surface of aluminium is normally covered with a thin layer of aluminium oxide or hydroxide, and that the metal possesses the property of forming this film on freshly cleaned surfaces. Bengough and Hudson (*Jour. Inst. Metals*, 21, p. 143) state, "the metal is normally covered with a layer of oxide," and Seligman and Williams (*Jour. Inst. Metals*, 23, p. 169), "It is generally assumed that aluminium exposed to air is covered by a film of oxide or hydroxide which prevents