NOTE ON THE EFFECT OF CHANGES IN THE VISCOSITY OF WATER ON THE RESULTS OF MECHANICAL ANALYSES CONDUCTED AT VARYING TEMPERATURES.

By G. W. ROBINSON, B.A.

Adviser in Agricultural Chemistry, University College of North Wales, Bangor.

SOME discordant results obtained in mechanical analysis during a spell of cold weather led the writer to enquire into the effect of temperature on the separation of the various fractions of a soil by mechanical analysis.

According to Stokes' law, the limiting velocity of a particle of diameter a falling in a liquid of viscosity η is proportional to $\frac{a^2(\rho - \sigma)}{\eta}$, ρ being the density of the solid, and σ that of the liquid.

Now in any given separation, the depth of liquid and time of subsidence are adjusted so that all particles of diameter greater than a certain value shall be left behind on decantation. If, for any reason, η varies, since v is not changed the diameter, a , of the smallest particles which are left behind on decantation will be proportional to $\sqrt{\eta}$.

The value of η is subject to considerable change when the temperature is varied. For water, Thorpe and Rodger¹ give the formula

$$\eta = \frac{0.017941}{(1 + 0.023120t)^{1.5423}},$$

where t = temperature in degrees centigrade.

The densities, ρ and σ , are also subject to a change with the temperature, but these are of a smaller order of magnitude and may be ignored in comparison with the changes in η .

Calculating $\frac{\eta_{15}}{\eta_{15}}$ by this formula we get $\frac{\eta_{15}}{\eta_{15}} = 1.33$.

That is to say that by a fall of 10° from 15° to 5° C., the viscosity of water increases by 33 per cent. Since the diameter a is proportional to $\sqrt{\eta}$,

$$\frac{a_{15}}{a_5} = \sqrt{\frac{1.00}{1.33}} = \frac{1.00}{1.15},$$

¹ *Phil. Trans.* 1894, A, p. 1.

where a_{15} is the diameter of the smallest particles left behind on decantation at 15° C. and a_5 the diameter of the smallest particles left behind on decantation at 5° C. From this it is seen that the limiting diameter at 5° C. is 15 per cent. greater than it is at 15° C. If there is a large proportion of particles at or about this limiting diameter it will mean that considerably smaller values will be obtained for the fraction left behind on decantation if the decantation is performed at a lower temperature.

An experiment was performed in which some ignited fine sand was well mixed with an approximately equal quantity of ignited silt. Duplicate two gram lots were taken and after stirring well with water in beakers allowed to settle through 7.5 cm. for 75 seconds. The water was at 6° C. The sedimentations were repeated six times by which time no more silt remained in suspension after 75 seconds. The residual fine sand was collected, dried for several hours and weighed. The fine sand was then mixed again with the silt from which it had been separated at 6° C. and a separation was effected in exactly the same way at 11° C. The fine sand obtained at 11° C. was again dried and weighed. A further separation was made at 16° C. in exactly the same way. The results are as follows.

Temperature	Weight of fine sand, grams		
	A	B	Mean
6° C.	1.053	1.062	1.058
11° C.	1.123	1.114	1.118
16° C.	1.149	1.140	1.144

Putting the weight of fine sand obtained at 6° C. as 100, we have

Temperature	Amount obtained
6° C.	100
11° C.	105.7
16° C.	108.1

This shows that a change in temperature, by altering the viscosity of water, does affect the values obtained in mechanical analysis by sedimentation. It is recommended therefore that sedimentations be carried out, as far as possible, at a uniform temperature, say 12 to 14° centigrade. So far as the writer is able to find out, this point has not up to the present been emphasized.

(Received March 3rd, 1915.)