FLOCCULATION AND DEFLOCCULATION

LECTURE XV

CHARLES F. BINNS

This seems to be a formidable title but there are no simpler words which will convey the idea. The root of both terms is "flock" which the dictionary defines as a "tuft-like mass". It is recognized that a clay consists largely of very small masses, the particles of which are held together by a cohesive force. These masses are not grains, they are quite soft and can easily be smoothed by finger pressure. In some clays the masses are large enough to lie on a sieve of 100 mesh, in others they are so small that they will pass through the same mesh freely. The increase or enlargement of the flocks is called flocculation and their dispersion is deflocculation.

The theory is that the force which holds the clay particles in flocks is a form of electricity and it then becomes evident that if this electric force can be discharged the flocks will no longer hold their form.

The force of attraction exerted by electricity may be illustrated by an interesting experiment. A scrap of tissue paper is cut into very small pieces on to a china plate. A glass rod or a stick of sealing wax is briskly rubbed with a piece of silk and when this is held over the plate the paper pieces will leap up and cling to the rod. They are attracted by the electricity which has been generated by rubbing. A metal rod will not do because metal will conduct the electric current through the body of the experimenter and its effect will be lost.

It follows from this that if the clay flocks are held by an electric charge and if a conductor can be furnished that will carry the charge away the flocks will fall apart and deflocculation will be accomplished.

It is well known that electricity will not pass through pure water, which is a non-conductor; but if a little salt is dissolved in the water the solution becomes a conductor and the freedom of the electric flow is in proportion to the amount of salt dissolved. This is the principle employed in the deflocculation of clay.

The experiment which proves this requires more elaborate equipment than those which have so far been described. It consists of: 1. 6 glass cylinders of 500 cc (cubic centimeter, capacity and furnished with corks, 2. a glass graduate of 100 cc., 3. a glass stoppered bottle of about 200 cc., 4. a supply of distilled water and 5. some washing soda. Into each cylinder 400 cc of distilled water is measured. About 150 cc. water is put into the bottle with a few spoonsful of the soda which should be crushed ar powdered. The bottle is shaken well until the water has dissolved all the soda that it can. This is shown by a residue of crystals left undissolved at the bottom. Some time must be allowed, with repeated shakings, for the water to be saturated. In the first cylinder the pure water is left unchanged. To the second there is added 5 cc. of the soda solution, to the third 10 cc.; to the fourth 15 cc., 20 cc., to the fifth and 25cc., to the sixth.

The clay to be used is powdered and weighed into six portions of 20 grams each and one portion is poured into each cylinder. The clay falls through the liquid and settles at the bottom. Each cylinder is now closely corked and vigorously shaken up and down and upside down for as long as the experimenter can hold out, then the cylinders are placed in numerical order and left to subside.

After some hours the following phenomena may be observed. First cylinder, the clay has settled to the bottom and the water is clear. Second, the clay has settled but not quite as closely as in the first and there may be a slight cloudiness about the upper edge. Third, the settling is not so compact and there is a cloudiness in the water. This is increased in the fourth and in the fifth, the whole of the water is milky and the line of the subsided clay can hardly be discerned. The sixth may or may not show a tendency to become clear.

This is a characteristic series but the actual appearances will vary with the clay used. Some clays will not respond to washing soda and a stronger salt such as caustic soda must be used but if several clays are tried at least one will behave as described. The soda dissolved in the water has changed it into a conductor of electricity or "electrolyte", the flocks have been relieved of their electric charge and have fallen apart so that the particles remain suspended instead of subsiding. The strength of solution necessary to produce this result is that in the cylinder in which the clay is most completely suspended. Flocculation is the reverse of this. An acid solution will cause the clay to settle more completely because the flocks have been increased and enlarged.

The facts described have a practical bearing upon the use of clay. Long ago it was discovered that if a clay were allowed to "age" before use, its working qualities were greatly improved. It became more plastic and less liable to crack so that the potters liked to use it. Clay cellars were built so that a large stock ofprepared clay could be kept to ripen. This is still done in Europe and sometimes in America but the demands of rapid production have largely made the practice obsolete. It was discovered some years ago that the addition of a small amount of acid to the clay produced a similar effect. In a general way a flocculated clay requires an increase in water of plasticity, becomes more plastic in nature and shrinks slightly more in drying.

Deflocculation has an important practical value in the well known "soda casting process". It has no place or use in the working of a clay in the plastic condition but in casting with slip deflocculation is marked by several valuable features. The effects are, as might be expected, exactly the opposite of those enumerated under flocculation; less water is needed, plasticity is decreased and shrinkage is lessened. Instead of plain water for making the slip an electrolyte is used and while slight variations may be necessary with different clays the following procedure is generally effective. There are needed two glass beakers of 200 cc., capacity, a small supply each of soda ash and liquid silicate of soda and a 500 cc. graduate. Three and one half grams of soda ash are weighed into one of the beakers and the same weight of silicate of soda into the other. They must not be mixed. Water is added to each and when the soda ash is dissolved both solutions are poured into the graduate. The silicate of soda will need to be diluted, so that it will pour. The beakers are rinsed with clear water which is also poured into the graduate. This is now filled with water to the500 cc.,mark and the electrolyte is ready. The clay body should be powdered and mixed dry and 1000 grams weighed. A large bowl or a pail will serve for the mixing. The liquid is poured in first and the dry clay added gradually. A vigorous stirring is essential. It takes a little time and effort to produce a smooth slip and when finished it will be of proper thickness for casting. One hundred cc. will weigh about 134 grams. This slip will keep for some time but it must be covered to arrest evaporation. It will not thicken by subsidence nor should water be added. If too thick a little more electrolyte solution may be used. Pieces cast from this slip will shrink but little more than if made from plastic clay.

This process is now in general use in a great many manufactories and it has greatly simplified the casting process. The modern practice is to cast nearly all hollow pieces, even very large ones. The dry scrap from this process should not be mixed with the scrap from plastic clay. It can be used up by mixing with new batches of its own class of material.