Grain Size Affects Clay Distribution

13. As we know definitely that grain size affects clay distribution, it is interesting to consider the causes for this effect. One marked difference in sands of different grain size is the total surface area, which increases as the grain size decreases. Undoubtedly, more work is required to distribute a given amount of "bond" over a larger surface area than over a smaller surface. Hence, we would expect finer sands to require a longer milling time for proper bond distribution.

14. Our experiments, however, were not carried to the point where we could either prove or disprove a direct relation between surface area and bond distribution. We must be satisfied at this time, therefore, merely to present our findings on surface area, which we feel is a factor that cannot be ignored in interpreting results of molding sand investigations.

Relation of Surface Area to Grain Size

15. Several years ago the writer attempted to obtain an expression of the relative surface area to grain size of washed Ottawa sand. Three methods were used, as follows:

(1) A small sample of each screen size was obtained and the number of grains in each sample counted. From these figures the surface area in millimeters per gram was calculated, assuming for simplicity that all the grains were true spheres.

(2) A number of grains of each screen size were examined under a microscope, and the longest and shortest diameters in the plane at right angles to the line of sight were measured by means of a micrometer eye-piece. In the absence of means for measuring the diameter parallel to the line of sight, it was assumed that this diameter was equal to the shorter of the two actually measured. From these figures the average surface area and volume per grain was calculated. From the average volume, the average number of grains per gram was calculated.

(3) Assuming that all of the grains were true spheres of a diameter equal to the average of the opening of the screen through which they passed and of the

screen on which they were retained, the number of grains and surface area per gram were calculated.

16. We realized, of course, that all of these methods were in error and that the error was on the low side. However, we hoped to secure some relative figures that might prove useful in

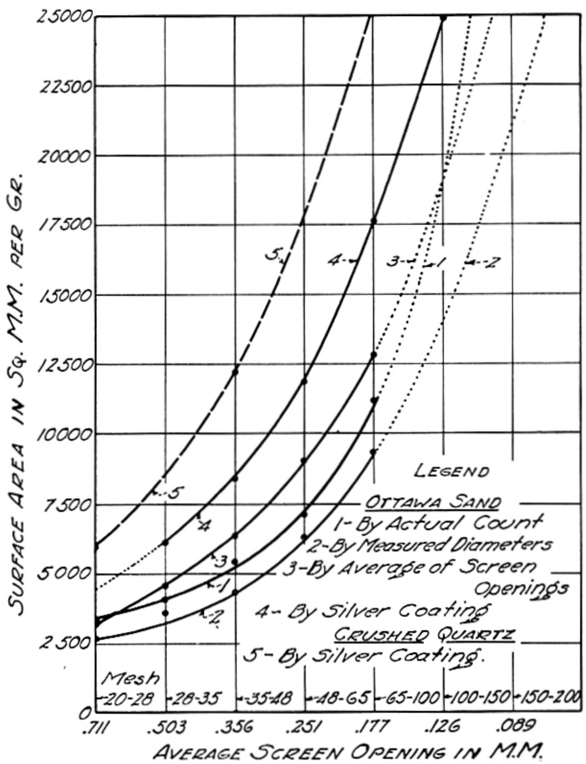

FIG. 5—SURFACE AREA OF VARIOUS SIZES OF OTTAWA SAND AND CRUSHED QUARTZ AS MEASURED BY DIFFERENT METHODS.

connection with problems concerning synthetic molding sands and their use.

17. By referring to Fig. 5 it can be seen that the third method—employing the average of the screen openings—because it gave the highest figures, evidently was the best of the three. This method is the simplest and had been used previously by other investigators. As will be seen, however, it fell far short of giving the actual figures.

Other Investigations on Surface Area

18. Some time later, Gross and Zimmerley[1] found that quartz particles take on a layer of silver of equal thickness when given similar agitation in the same modified mirroring solution. By coating quartz crystals (the surface area of which had been accurately determined) in the same solution with the sized sand and subsequently determining the amount of silver in the various coatings, the surface area of Ottawa sand was quite accurately determined. The results of their determination are plotted as curve No. 4 in Fig. 5. Curve No. 5 in the same figure shows the surface area of crushed quartz particles as determined in the same manner by the same investigators.[2]

19. The surface area of all molding sands undoubtedly will fall between that of Ottawa Sand (Curve No. 4, Fig. 5) and of crushed quartz (Curve No. 5, Fig. 5). These two curves give a clear picture not only of the influence of grain size on surface area but also of the marked influence that the shape of the sand grains has on this factor.

20. We regret that we have been unable to continue our investigations far enough to establish a definite relation between either surface area or bond distribution and the useful properties of a molding sand. Our excuse for presenting the results of an incomplete investigation is that it presents a new and perhaps useful approach to some of the vital problems confronting investigators in foundry sands.

Summary

21. A new microscopic method for determining bond distribution in simple synthetic molding sands is described. The influence of grain size on clay bond distribution is shown. Results of various attempts at measuring surface area of sand grains are given and discussed.

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1 John Gross and S. R. Zimmerley, "Crushing and Grinding: I—Surface Measurement of Quartz Particles;" *A. I. M. E. Technical Publication No.* 46 (1928).

2 John Gross and S. R. Zimmerley, "Crushing and Grinding; II—The Relation of Measured Surface of Crushed Quartz to Sieve Sizes"; *A. I. M. E. Technical Publication No.* 126, 1929.