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PUZZOLANIC ACTIVITY OF KAOLIN FIRED WITH ADMIXTURES OF ZINC OXIDE

Puzzolanic activity of kaolin and a kaolinitic clay heated with additions of zinc oxide has been studied. It is found that there is a large increase in puzzolanic activity, as measured by lime reactivity tests, in samples fired at 800°C. with addition of 0·01 per cent of zinc oxide.

IT IS KNOWN THAT KAOLIN IN THE UNFIRED STATE has low puzzolanic activity and that its puzzolanic activity increases on firing. Maximum puzzolanic activity is developed when kaolin is heated at about 800°C. It is also known that the presence of iron oxides in clays increases the puzzolanic activity of *surkhi*[1]. Puzzolanic activity of kaolin heated at the optimum temperature (800°C.) with additions of zinc oxide is reported here.

Commercial kaolin was heated for 4 hr at 800°C. without and with additions of 0·001, 0·01 and 0·1 per cent of zinc oxide. It is found that there is a change in the puzzolanic activity of kaolin fired under these conditions and that there is a large increase in puzzolanic activity in samples fired with addition of 0·01 per cent of the oxide. Tests show that when the 0·01 oxide composition is fired at 800°C. there is about 50 per cent increase in compressive strength above that of kaolin fired similarly without the addition of zinc oxide.

Materials used for these experiments were: (i) commercial kaolin, (ii) hydrated calcium oxide, laboratory quality lime, (iii) standard Ennore sand and (iv) Analar zinc oxide (B.D.H.).

Puzzolanic activity was measured by lime reactivity tests. The adsorption of lime from saturated calcium hydroxide solution by the materials was studied in some cases. For lime reactivity tests, 5 cm. cubes were cast following a method described elsewhere[2]. After casting, the cubes were placed in a humid chamber for 48 hr and then cured under humid conditions at 50°C. for 8 days and tested for compressive strength.

For lime adsorption measurements the samples were freed from all solubles and conductance measurements were carried out in a pyrex glass vessel using 100 ml. of saturated calcium hydroxide solution and 5 g. of the sample; a continuous record of the resistance was kept for various durations. A Philips a.c. resistance bridge was used at 1000 c/s. for the measurements with a pair of platinum electrodes previously standardized.

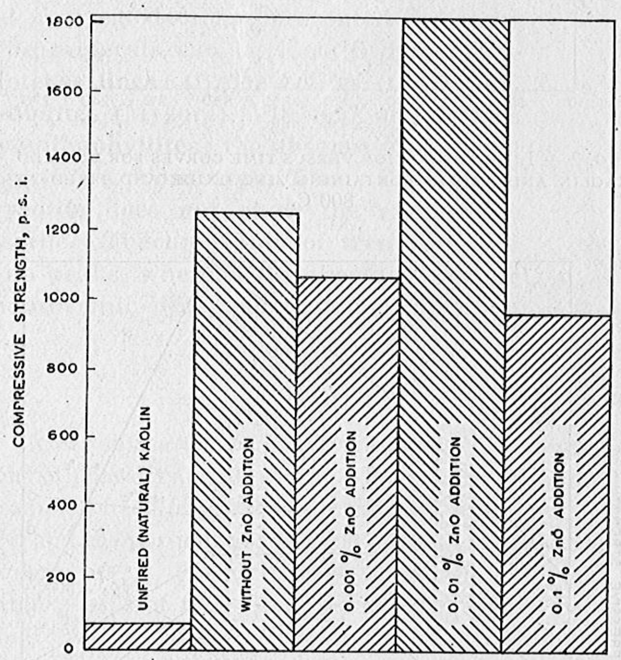

FIG. 1 — EFFECT OF ADDITION OF ZINC OXIDE ON THE COMPRESSIVE STRENGTH OF KAOLIN BLOCKS

The results of compressive strength tests on kaolin blocks are given in Fig. 1 which shows that there is a large increase in the average compressive strength when kaolin is fired (at 800°C.) with 0·01 per cent zinc oxide over that fired without addition. Compressive strength of blocks from samples containing 0·1 and 0·001 per cent of the oxide should have intermediate values. The observed low strengths may be due to non-uniform mixing.

A significant increase can be observed in the adsorption of lime by kaolin fired with 0·01 per cent zinc oxide (Fig. 2; lime adsorption curves). Lime adsorbed in kaolin fired at 800°C., though less in the initial stages, increases with time whereas in unfired kaolin there is large initial adsorption which

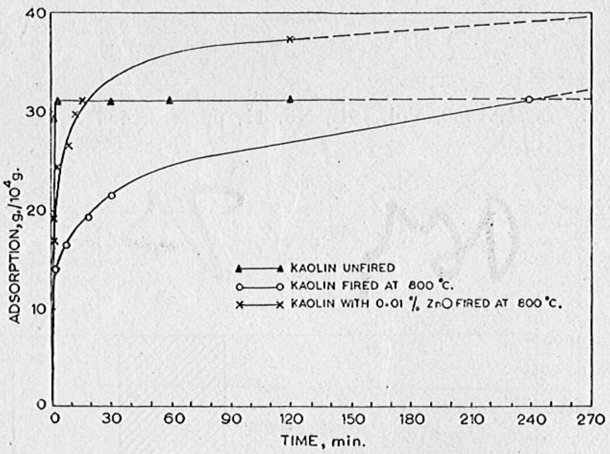

FIG. 2 — LIME ADSORPTION VERSUS TIME CURVES FOR UNFIRED KAOLIN AND KAOLIN CONTAINING ZINC OXIDE AND FIRED AT 800°C.

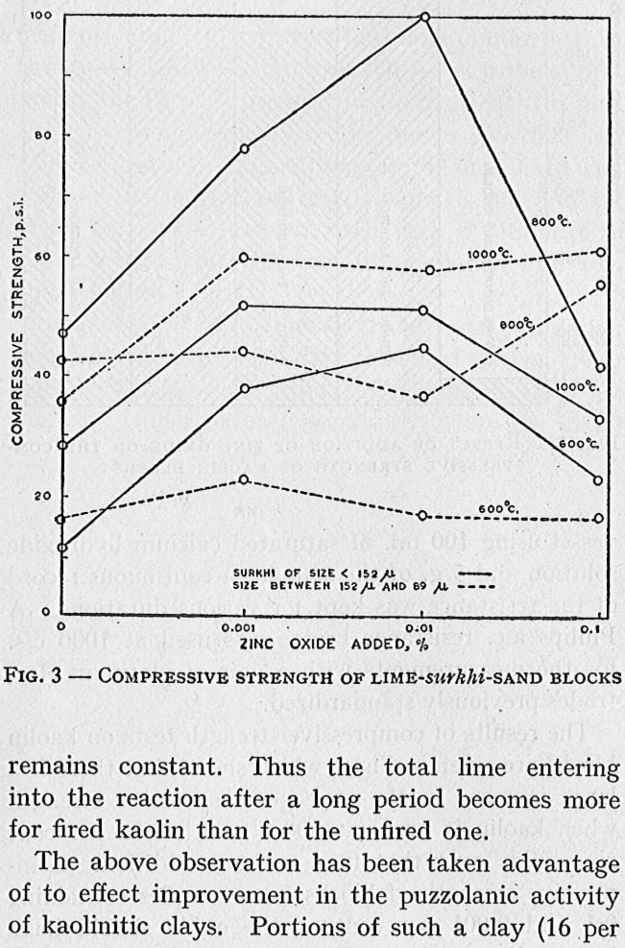

FIG. 3 — COMPRESSIVE STRENGTH OF LIME-*surkhi*-SAND BLOCKS

remains constant. Thus the total lime entering into the reaction after a long period becomes more for fired kaolin than for the unfired one.

The above observation has been taken advantage of to effect improvement in the puzzolanic activity of kaolinitic clays. Portions of such a clay (16 per cent clay fraction) were heated for 4 hr to 600°, 800° and 1000°C. without and with additions of the oxide. Samples of *surkhi* thus obtained were ground and sieved into two fractions, one passing through 100 mesh sieve so that grains of sizes $<152\ \mu$ were present, and the other passing 100 mesh and retaining >170 mesh so that the grain size ranged between 152 and 89 μ. The results of compressive strength tests on lime-*surkhi*-sand blocks from these two fractions are shown in Fig. 3.

The strength developed in these blocks is particularly low. There is increase in compressive strength of blocks from *surkhi* of size $<152\ \mu$ on addition of the oxide. Maximum increase in strength is obtained when the addition of the oxide is 0·01 per cent. The pattern of variation in strength (Fig. 3) is similar to that observed with kaolinitic clays. Compressive strengths of blocks from *surkhi* of size between 152 and 89 μ show the following peculiarities (Fig. 3). For those obtained with addition of oxides, the strength is highest with the samples fired at 1000°C. and the increased strength is independent of the amount of oxide added in the range studied. Of the samples fired at 800°C. those containing 0·1 per cent zinc oxide show a large increase in strength. Change in mineralogical composition of the two fractions may be responsible for these variations. For blocks from *surkhi* without addition of oxide, maximum compressive strength is obtained in sample heated at 800°C.

Further work is in progress.

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