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LIME BLOWING AND MECHANISM OF DOCKING

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Introduction

Black cotton soils, which occur over large areas of Central and Western India are largely contaminated with nodular limestone or kankar. This contamination in soil and brick clay presents a serious problem in the manufacture of bricks. Bricks made out of such clays are observed to flake and disintegrate on exposure to air due to 'lime-blowing'[1]. This is prevented by 'docking' i.e. soaking in water. According to Fischer[2], this might be due to the solubility of $Ca(OH)_2$ in water. As the solubility of $Ca(OH)_2$ at 30°C is only 0.11 gm./100 gm. of the solution and decreases at higher temperatures,[3] it is unlikely that the solubility would be a major factor governing the prevention of lime blowing by docking. The present investigation was undertaken to find out the changes which occur during 'docking'.

Experimental and discussion

Kankar used in these investigations was separated by hand picking from Indore soil and subsequently washed free of all adhering particles. The calcium carbonate content of kankar was found to be 76.7% and that of the limestone obtained from Kalsi, Dehradun, was found to be 99·3%. Calcium was determined by the standard volumetric method. Differential thermal analysis was done specially to identify the impurity, if any, in kankar. The analysis was carried out semi-automatically by raising the temperature of the furnace at the rate 10°C/min. The D. T. A. results (Fig. 1) indicate an endothermic peak at about 835°C caused by the decomposition of $CaCO_3$, the endothermic peak area of the limestone sample being more than that of kankar. This confirms that the $CaCO_3$ content in limestone sample is higher. The additional endothermic peak of small magnitude at about 100°C in case of kankar indicates the deyhydration temperature of the impurity present as montmorillonitic clay.

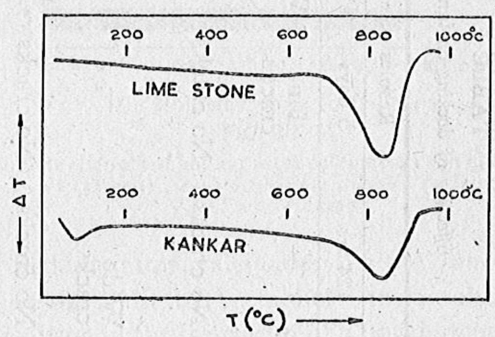

FIG. 1

DTA curves for limestone and kankar

Apparent volume measurements were carried out by mercury displacement method. The samples were calcined at 900°C for 3 hours in an electric muffle furnace. Slaking of the calcined product was carried out in a specific gravity bottle to facilitate determination of the true volume of $Ca(OH)_2$ formed. The low solubility of $Ca(OH)_2$ in water was taken into account while calculating the true volume.

Bricks were made from black soil mixed with kankar or limestone particles passing

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TABLE I

Effecting of docking on lime blowing

Sl. No.	Brick	Firing temperature (°C)	Treatment	Results of exposures				Remarks
				24 hrs.	5 days	10 days	15 days	
1.	Black soil + Kankar	900	Nil	—	Fine cracks	Wide cracks with spitting	Disintegrated	—
2.	,,	,,	Docked	No cracks	No cracks	No cracks	No cracks	No deterioration even after exposure for several months.
3.	Black soil + Limestone	,,	Nil	Wide cracks	—	—	—	Disintegrated into pieces after 48 hours.
4.	,,	,,	Docked	No cracks	No cracks	No cracks	No cracks	No deterioration even after exposure for a prolonged period.

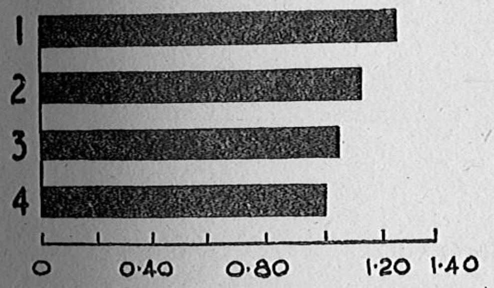
TABLE II

Volume and weight changes accompanying the firing of kankar and limestone

Serial No.	Sample	Initial weight (gm)	Initial apparent volume (Va) (cc)	Weight after calcination* (gm)	Apparent volume after calcination* (Va) (cc)	True volume after slaking (Vt) (cc)	Apparent volume on exposure to air (Va) (cc)		
							1 day	3 days	4 days
1.	Kankar	2.72	1.02	1.70	1.06	—	—	1.14	1.26
2.	Kankar	1.20	0.47	0.75	0.52	0.28	—	—	—
3.	Limestone	1.24	0.43	0.73	0.42	—	0.58	—	—
4.	Limestone	1.45	0.50	0.84	0.48	0.36	—	—	—

through 2 mm. sieve. These were exposed to air for 1 to 15 days before and after 'docking' and their disintegration was observed visually (Table 1). When the brick containing kankar was exposed to air for 5 days, it resulted in fine cracks and led to disintegration of the bricks after 15 days. A brick containing limestone however showed cracks within 24 hours of exposure to air and crumbled to pieces after two days. The bricks that were docked showed no tendency to crack even after several months.

It will be observed from Table II, Figs. 2a and 2b that kankar shows an increase in apparent volume (Va) after calcination for 3 hours at 900°C. Kankar contains about 23.3% of extraneous matter in the form of clay, Fe_2O_3, organic matter, which may form a very viscous melt at 900°C and the escaping CO_2 from $CaCO_3$ might cause a slight bloating of the sample. Limestone contains much less impurity and hence its apparent volume decreases after calcination (Table II Fig. 3a) except in a few samples which expand[4].

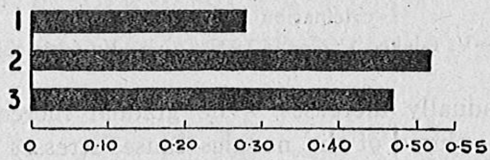


Volume change (c c)

FIG. 2a

Changes in apparent volume of kankar after calcination and exposure to air
1—Va (4 days exposure) ; 2—Va (3 days exposure) ; 3—Va (900°C) ; 4—Va (original)
Va—Apparant Volume

On exposure to air, the calcined kankar nodule (sample 1, Table II) increases in volume from 1.06 cc to 1.14 cc in three days and to 1.26 cc in 4 days. The nodule probably retains its hardness till the 4th day after which it starts disintegrating. This is confirmed from the observation on bricks containing kankar (Table I) which developed cracks after exposure to air for 5 days. Limestone (sample 3, Table II) when exposed to air shows an increase in apparent volume from 0.42 to 0.58 cc. within 24 hours (Fig. 3a). This would indicate that limestone expands at a faster rate than kankar. It is observed that bricks containing limestone disintegrate after 48 hours of exposure (Table I).

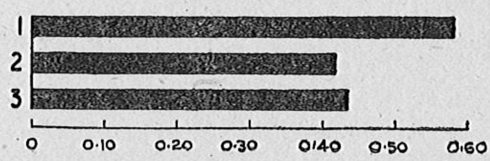


Volume change (c c)

FIG. 2b

Volume changes of kankar after calcination and slaking
1—Vt (slaked) ; 2—Va (900°C) ; 3—Va (original)
Vt—True Volume

Slaking after calcination of the samples was observed to be almost instantaneous resulting in the formation of a powdery mass. The apparent volume of kankar nodules before slaking is found to be 0.52 cc. and the true volume of $Ca(OH)_2$ formed after slaking is 0.28 cc. (Fig. 2b). The apparent



Volume change (c c)

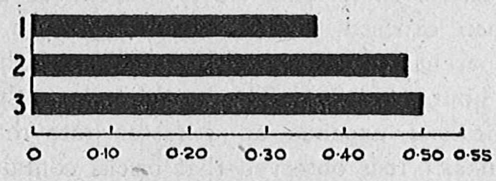
FIG. 3a

Change in apparent volume of lime stone after calcination and exposure to air
1—Va (24 hours exposure) ; 2—Va (900°C) ; 3—Va (original)

volume of limestone is 0.48 cc. and falls to 0.36 cc. after slaking (Fig. 3b).

On the basis of these observations the behaviour of nodules in a brick may be explained as follows :

When a brick is exposed to air, the apparent volume of the lime nodules in it



Volume change (c c)

FIG. 3b

Volume changes of lime stone after calcination and slaking

1—Vt (slaked) ; 2—Va (900°C) ; 3—Va (original)

gradually increases, The gradual increase in volume of the nodules causes stresses in the bricks. At the outset the nodules near the surface of the brick cause surface spitting and later become powdery. However, the nodules situated deeper within the brick still retain their hardness and continue to expand due to slow diffusion of moisture from the air, and ultimately di integrate the brick.

When, however, a brick containing li nodules is docked, the rapid absorption water brings about immediate slaking a break down of the nodules into a powde mass. Since the true volume of the resul ing calcium hydroxide is considerably le than the apparent volume of the nodu originally present, no disruptive force developed within the brick and lime blowi is prevented.

Acknowledgement

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REFERENCES

1. N. C. Majumdar and N. K. Patwardhan, T *Indian Builder*, Annual No. 1957.

2. W. Fischer, *Ton. Ztg.*, **51**, No. 102, 1843, (19

3. N. V. S. Knibbs and B. J. Gee, **'Lime a Limestone'**, Salem Engineering Ltd., Canada, 1959.

4. H. C. Bijawat and S. L. Sastry, **'High Calci Limestones of India'** Council of Scientific & Ind trial Research, New Delhi, 1957.