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Performance Studies on Some Kankar Burning Kilns

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Kankar burning kilns in some parts of the country were studied and analysed for their performance. The existing designs and methods of operation were observed to be unsatisfactory indicating the scope for improvement of these kilns generally fired with cinder, firewood, steam coal etc. Detailed studies were undertaken on a low capacity experimental kiln constructed at site. The kiln was operated semi-continuously with mixed feed of kankars and cinders. Improved burning and increased production rates were observed with fuel consumption reduced by 10-15 percent over the conventional kilns.

INTRODUCTION

Kankar lime is a hydraulic type of lime which has been widely used as a binder in the large scale construction of dams and buildings[1,2]. It is produced by the burning of kankar at elevated temperatures in kilns of various shapes and sizes in batch as well as semi-continuous operations employing fire-wood, cinders, steam, coal, etc as fuel[3,4].

It has been observed that the kilns are generally ill designed and heat wasteful. The methods of operation in vogue also leave much to be desired in so far as the performance of these kilns is concerned. The unscientific burning without any control on temperature results in the production of kankar lime of poor quality. Studies were therefore taken up in the field with a view to effecting improvements in these kilns for their redemption.

SURVEY OF EXISTING KILNS

As a first step, the designs and performance characteristics of some typical kankar-burning kilns in a few selected areas were investigated (Table 1). The kilns in the Anantpur district of Andhra Pradesh were

TABLE 1 DESIGN AND PERFORMANCE CHARACTERISTICS OF SOME KANKAR BURNING KILNS

Location of Sit	Nominal Production (t/d)	Kankar Specific Production Rate			Maximum Operating Temperature (°C)	Energy Consumption (Kcal/kg lime)	Under-burnt (%)
		Fuel (w/w)	Cross Sectional ($t/m^2/d$)	Volumetric ($t/m^3/d$)			
Dist Anantpur (A.P.) Village : Guttur	0.1	4.0	0.16	0.10	700	1315	55
Dist Anantpur (A.P.) Village : Settipalli	0.2	3.3	0.31	0.16	850	1614	40
Dist Anantpur (A.P.) Village : Maddalapalli	0.6	6.5	0.98	0.52	1000	1279	25
Sultanpur (UP)	2.5	4.0	0.33	0.11	800	1124	45
Dist Jaunpur Town : Singramau	0.9	3.8	0.42	0.14	800	1200	15
Dist Jaunpur town Village : Harzupur	0.5	3.8	0.33	0.13	840	1100	18
Dist Jaunpur Town : Jagdishpur	0.6	3.8	0.20	0.07	790	1160	20
Dist Jaunpur Town : Jagdishpur	1.0	3.8	0.33	0.07	820	1140	15
Dist Jaunpur Village : Mirpur	2.0	4.0	0.30	0.06	850	1180	15
Dist Jaunpur (UP)	1.5	3.5	0.08	0.04	750	1300	65

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usually small in size and built with stone boulders in mud mortars. Kiln no 1 was semi-cylindrical and 150 cm tall, the diameter being 90 cm. It was used in semi-continuous fashion and fibrous firewood from date palm was used as the fuel. The wall thickness was 15 cm. There was one diacharge door of 20 cm × 30 cm.

Kiln no 2 was similar in design and dimensions, but utilized a hard firewood as the fuel.

Kiln no 3 was somewhat bigger in size, the height being 190 cm and the diameter 88 cm. Other features remained the same. Steam coal, however, was used as the fuel. This kiln also operated in a semi-continuous fashion.

Kiln No 4 at Sultanpur, U P was of an entirely different type. It was about 3.0 m long, 2.3 m wide and 3.1 m tall and was provided with 4 discharge gates through 65 cm thick walls. Cinder was used as the fuel and the kiln was charged with alternate layers of kankar and the cinder. The kiln was generally run in batches, sometimes in semi-continuous manner also.

The five other kilns studied, *ie*, Kiln no 5 to Kiln no 9 were all in the district Jaunpur, U P. They were all fired with cinder as the fuel and belonged to the general category of conical kilns. Their diameters varied from 1.4 m to 2.9 m and heights varied from 2.0 m to 4.2 m.

Kiln no 10 was a typical cinder fired Maidani Bhatti, raised over the ground and operated in a batch manner only. The overall batch time was about 20 days for a production of 30 tonnes per batch.

PRELIMINARY SURVEY DATA

Preliminary studies were carried out on some existing kankar burning kilns at different locations and the data collected on their design and performance characteristics were analysed and the same are reported in Table 1.

The survey revealed wide variations both in designs and operational practices of these kilns. The capacities of the kilns studied were from 0.1 t to 2.5 t per day. The kilns were cylindrical, conical as well as rectangular in shape and the same were being fired with cinder, firewood, steam coal, etc, at the different sites. The maximum operating temperature varied from 700-1000°C. The degrees of underburning were generally high of the order of 20 to 50 percent. As such the energy consumption varied from 1100 to 1600 K cals per kg of kankar lime. The kilns were operated both batchwise as well as in a semicontinuous fashion. It has already been pointed out that the batch kilns are highly heat wasteful and must not be used in lime burning by the industry[5]. However, the designs and the operational methods left much to be desired for getting the optimum results from the semi-continuously fired kilns.

DEVELOPMENT OF AN EXPERIMENTAL KILN

For the calcination of kankars, only a mixed-feed vertical kiln can be utilized, because it not only requires low capital investments, but its operational expenses are also low. Such a kankar burning lime kiln is designed to operate in three zones, namely, the preheating, the calcination and the cooling zones. The burning of kankars leads to the evolution of carbon dioxide in the calcination zone. In addition, the combustion of the solid fuel results in the production of flue gases in this zone. The size of the kankar particles does not change appreciably during their downward movement in the vertical kiln. The draft in the kiln is directly proportional to the square of the gas velocity[6]. Thus with a view in maintaining the uniformity of the draft the internal cross-section of the calcination zone of the kiln should be tapered downwards[7]. It may be observed that the temperatures in the burning zone have been assumed more or less uniform, of the order of 850°C-1000°C, generally obtained in the kankar burning kilns fired with cinder.

The limestone and fuel particles get preheated from ambient temperature to the calcination temperature in the preheating zone on account of the exchange of heat with the flue gases. Similarly, the air induced into the kiln at the bottom gets heated up through the transfer of heat from the calcined lime particles in the cooling zone of the kiln. Thus in order to maintain a uniform draft the internal cross section of the preheating zone is tapered upwards, and the same is tapered downwards in the cooling zone.

In view of the principles mentioned in the foregoing, the model of a small sized experimental kiln was developed and utilized in the experimental investigations.

STUDIES ON THE EXPERIMENTAL KILN

The low capacity experimental kiln was constructed in ordinary brick masonry with clay mortar at a selected site in District Jaunpur, U P. It was a cylindro-conical type of kiln corresponding to an average inner diameter of 1.1 m and height approximately 2.5 m. The average thickness of the masonry shaft was 0.6 m. A part of the kiln was initially filled with firewood at the bottom and thereafter cinders and kankars were laid in alternate layers keeping the kankar to fuel ratio of 2 : 1 by volume. Thereafter the kiln was fired and after stabilization of the fire kiln was operated semi-continuously using mixed feeds of kankars and cinders in different proportions so as to obtain the optimal results. The kiln was operated maintaining the three zones, the preheating, calcining and cooling, over a period of several hours. The operating temperatures were controlled in the operating schedules worked out at the site.

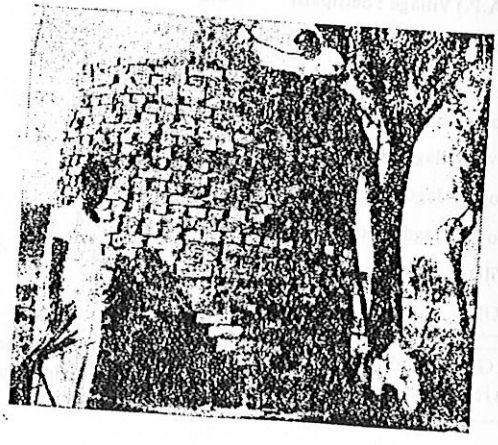

Fig 1 A view of the experimental set-up

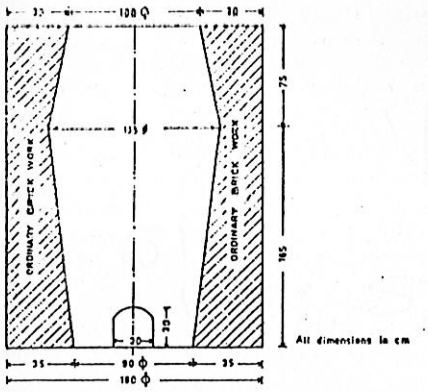

Fig 2 Dimensional details of a kiln

The temperatures were measured using chromel-alumel stainless steel sheath type of thermocouple with appropriate pyrometer. The data on optimum values of productivity, kankar to fuel ratio, degree of underburning, etc were recorded. A view of the experimental set up is shown in Fig 1 and the dimensional details of the kiln are given in Fig 2. The samples of kankars and burnt lime were collected and tested in the laboratory.

RESULTS AND DISCUSSION

The chemical analysis of the kankars used in the firing run is given in Table 2 and the proximate analysis of cinders is reported in Table 3.

The operational results obtained in this experiment are mentioned in Table 4.

The computed average values of the productivities based on inner cross-sectional area, volume of the kiln and the energy consumption for the semi-continuously operated cinder-fired conventional lime kilns as surveyed were observed as 0.32 t/m²/d, 0.10 t/m³/d and 1150 Kcal/kg, respectively (Table 1); whereas the experimental kiln yielded the values as 0.47 t/m²/d, 0.20 t/m³/d and 796.7 kcal/kg, respectively. In other words the production rates could be increased by 46 percent and energy in term of fuel consumption could be saved by about 31 per cent over the conventionally designed and operated kilns. The degree of underburning could also be brought down to about 15 percent indicating enough scope for improvement in the quality of the kankar lime produced as well.

TABLE 2 CHEMICAL ANALYSIS OF KANKAR STONES

CONSTITUTENT	PERCENT (W/W)
LO_1	30.15
SiO_2	24.48
R_2O_3	7.41
CaO	35.79
MgO	2.04

TABLE 3 PROXIMATE ANALYSIS OF CINDERS

CONSTITUTENT	PERCENT (W/W)
Moisture	5.0
Volatile matter	0.0
Fixed carbon	36.5
Ash	58.5

TABLE 4 DATA OBTAINED FROM EXPERIMENTAL RUN

Size of kankars	:	10—25 mm
Size of cinders	:	6—15 mm
Kankar to cinder ratio by weight	:	5.6
Average production on daily basis	:	0.5 t
Specific production rate cross-sectional	:	0.47 t/m²/d
Volumetric	:	0.20 t/m³/d
Operating temperatures range in burning zone	:	750—950°C
Underburnt fraction	:	15 per cent
Energy consumption	:	796.7 kcal/kg

CONCLUSIONS

These investigations reveal that the kilns that are being utilized for calcining kankar are neither well designed nor operated properly. They not only are heat wasteful, but also do not utilize the supplied energy in a proper manner. It is possible through appropriate modifications in the design and operational methods to improve the productivity and quality of such kilns. Kankar burning has more or less been a cottage industry and the production of kankar lime in a scientific way must be encouraged by the Government agencies involved in the promotion of hydraulic lime.

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