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Air Pollution Hazards from Brick Kilns

Dr M Aslam, *Non-member*
R S Srivastava, *Non-member*
Dr A K Minocha, *Non-member*
R G Gupta, *Member*

Various types of brick kilns were investigated for stack emissions. Dust and hydrocarbons were identified as chief pollutants. Particle size analysis of dust emitted from movable chimney kiln and its impact on ambient air quality were also studied. Based on these studies, recommendations have been drawn on their comparative pollution hazard and need for optimization of operational parameters to improve their thermal performance and reduce pollution emission.

INTRODUCTION

Brick production in India is mostly carried out in small clamps, updraught intermittent kilns and continuous Bull's trench kilns[1-3]. Most of these units are thermally inefficient as these are based on age-old technologies. The use of low efficiency kilns, poor grade of coal, and absence of pollution control device result in huge pollution emission from this industry. As these kilns are usually located in rural areas around urban and sub-urban centres, the air pollution created by them not only poses serious occupational health hazard but also adversely affects the agricultural/vegetable crops and fruit plantations.

A number of papers[4-7] presented at National Workshop on 'Building Material Technologies and Pollution Abatement' highlighted the impact of pollution emission from building material industries on environment. Not much attention has been paid so far[8-9] either on studying the emission pattern in brick industry or on devising pollution abatement system for them. Detailed investigations were, therefore, carried out at this Institute to study the emission behaviour of various types of brick kilns and their impact on ambient air quality and the results are reported in this communication.

EXPERIMENTAL PROCEDURE

Three types of brick kilns (a) Bull's trench kiln of movable chimney type, (b) Bull's trench kiln of fixed chimney type and (c) High draught kiln of normal capacity (25 000-30 000 bricks/day) fed manually with slack coal and other local fuels, were selected for the studies. Charging holes of three rows were fed simultaneously in seven-ten min. The time of charging cycle varied from 20 min to 40 min.

Stack Emission

Stack emission studies in three types of kilns (Table 1) were carried out as per standard methods. Dust and benzene-soluble hydrocarbons were determined by gravimetric methods[10-11] while SO_2, NO_x, and H_2S were determined spectrophotometrically[12-14] and CO and CO_2 contents were determined by Orsat method[15]. Stack monitor (Envirotech Model APM 610) was used for stack monitoring studies. Flue gas velocity and temperature were measured with the help of differential manometer and Toshniwal thermocouple and pyrometer respectively. 10 to 20 samplings were done for measurement of each pollutant. Particle size distribution of dust (Table 2) was studied with the help of Anderson cascade impactor. The aspiration was done isokinetically for each pollutant. The coal used in these kilns was slack coal obtained from Bihar mines. A few of the coal samples were analysed for their proximate and ultimate composition (Table 3).

TABLE 1
POLLUTION EMISSION FROM DIFFERENT TYPE OF BRICK KILNS

Parameter	Bull's Trench Kiln		High Draught Kiln
	Movable Chimney	Fixed Chimney	
Stack height, m	12-15	28	12
Flue gas temp, °C	80-220	70-150	70-100
Flue gas velocity (Average), m/s	2.95	3.41	6.30
Dust (Av), mg/Nm^3	1675	405	365
SO_2(Av), mg/Nm^3	2.33	1.91	4.64
H_2S (Av), mg/Nm^3	0.72	0.08	0.06
NO_x (Av), mg/Nm^3	2.12	0.67	1.29
C_6H_6 (Av), mg/Nm^3	124	135	279
CO_2 (Av), %	2.6-6.8	1.6-4.8	1.0-2.8
CO(Av), %	0.3-0.4	0.2-0.25	0.1-0.15

Ambient Air Quality

Ambient air quality was measured in the vicinity of brick kilns to study the impact of stack emission on ground level concentration. High volume air samplers (Envirotech Model APM

TABLE 2
PARTICLE SIZE DISTRIBUTION OF DUST FROM BULL'S TRENCH KILN

Size, μm		Percentage Distribution (Cummulative)
Less than	0.5	8.5
	1.0	17.8
	2.0	25.7
	5.0	30.7
	10.0	34.0
More than	10.0	66.6

Dr M Aslam, R S Srivastava, Dr A K Minocha and R G Gupta are with Central Building Research Institute, Roorkee.

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TABLE 3
ANALYSIS OF COAL SAMPLES

Type of Analysis	Parameter, %	Sample I	Sample II
Proximate Analysis	Moisture	4.4	4.7
	Ash	30.7	20.4
	Volatile matter	23.6	31.2
	Fixed carbon	41.3	43.7
Ultimate Analysis	Carbon	52.23	59.83
	Hydrogen	3.62	4.44
	Sulphur	0.65	0.61
	Nitrogen	1.20	1.18

410) were used for measurement of dust and gaseous pollutants such as SO_2 and NO_x. Three monitoring stations were set up 3 m above ground level in an area of 3 km aerial radius to record 24-hourly concentrations of dust and gaseous pollutants (Table 4).

The kiln site has a high concentration of dust due to various kiln operations such as fuel charging and loading/unloading of unfired/fired bricks. Excessive dust pollution created primarily by these operations was recorded at three points on the kiln platform (Table 5).

RESULTS AND DISCUSSION

Stack emission studies on different kilns showed that flue gases from movable chimney kiln contained more than 1500 mg/Nm^3 suspended particulate matter (SPM) while in other two type kilns, it was less than 500 mg/Nm^3. Though there are no statutory limits laid down for emissions from brick kilns, it could be inferred that the dust emissions from movable chimney kilns were much higher than the limits laid down by Central Pollution Control Board (CPCB) for emissions from any type of industry in rural and residential areas. During the first ten min of charging, black smoke was discharged which mostly consisted of organic volatiles and fine coal dust. It slowly changed to white smoke having mostly ash and burnt clay particles during later part of the burning cycle.

A glance at the quantum of gaseous emissions from different type of kilns showed that their emission levels were insignificantly low (Table 1). Emission level of hydrocarbons in all

TABLE 4
AMBIENT AIR QUALITY AROUND BRICK KILNS

Sampling Station	Direction	Distance, km	Dust, µg/Nm^3	SO_2, µg/Nm^3	NO_x, µg/Nm^3
I	NE	3.0	757	7	21
II	SW	0.5	887	5	20
III	NE	0.5	741	7	25

TABLE 5
GROUND LEVEL CONCENTRATION OF DUST ON THE KILN

Sampling Station	Position	Time	Dust Concentration, µg/Nm^3
I	20 m, N	09.00 to 12.00 am	2600
II	20 m, N	03.00 to 06.00 pm	2300
III	25 m, N	08.00 to 12.00 am	2400

the kilns was high which may be due to the use of bituminous coal and partial burning of organic volatile matter. However, large variation in hydrocarbon emissions could be attributed to variation in volatile matter content of coal as well as partial replacement of coal with fire-wood and other cellulosic wastes. Particle size distribution of dust collected from the flue gas showed that more than 66 per cent of particles were above 10 µm in size while 32 per cent were in respirable range and 8.5 per cent were below 0.5 µm (Table 2).

Proximate and Ultimate analyses of two coal samples showed them to be low grade steam coal with high ash content (30-32 per cent). Fixed carbon content was only 40-45 per cent. High amount of smoke and dust emitted from movable chimney type Bull's trench kiln may be due to high ash and volatile matter content of coal and incomplete combustion of coal as a result of poor kiln design and low chimney height. Use of high stack (28-30 m) in fixed chimney Bull's trench kiln coupled with better thermal efficiency of this kiln and more complete combustion of coal results in low dust emissions. As the thermal efficiency of kiln is further improved in high draught kiln, the level of dust emission is reduced.

Ground level concentration of dust and gases in the vicinity of Bull's trench kilns of moving chimney type showed that the ambient air had about 700-900 µg/Nm^3 of dust, 5-7 µg/Nm^3 of SO_2 and 20-25 µg/Nm^3 of NO_x. While the gaseous pollutants were negligibly small in ambient air, dust level was found to be quite high. This could also be due to excessive dusty conditons created by traffic on road passing through the kiln area.

Dust concentration on the kiln platform, where operational activities of the kiln such as loading/unloading of unfired/fired bricks and charging of fuel take place, was much higher (2400 µg/Nm^3). This dust is injurious to occupational health as major protion of it is in respirable range.

Exposure to such high levels of coal and dust particles without use of respiration mask etc may cause irritation of skin and eyes and induce pulmonary diseases such as pneumoconiosis and silicosis which are caused by inhaling siliceous dust. Excessively hot conditions on the kiln platform particularly in summer provide unhealthy conditions for workers. The level of heat exposure ought to be kept to the minimum to prevent serious physiological disturbance or injury to workers. In brick kiln, the thermal load on workers is increased by the sensitive heat that escapes from the kiln top over the workplace. Its major components are radiant heat from the top of the kiln, surrounding hot wind and hot gases escaping from the feeding holes during charging operation. It is imperative that different standards above the limits of simple comfort are required for such industries as it is not economically feasible to provide sufficient cooling, of the air to offset completely the added thermal load.

Brick and tile industry in India is concentrated mostly in northern plains and it remains active during October to June. During winter months, the heat radiated from the kiln top makes the workers thermally more comfortable but during April-June, they are exposed to intolerable thermal discomforts. The excessively hot conditions during this period may cause various heat-induced illnesses such as heat exhaustion, dehydration, heat cramp and heat stroke apart from occasional skin burns. To partly dissipate the heat stresses on workers, they could be provided with certain protective dresses and shoes. The manual charging of fuel could either be modified or partially mechanised to guard them against direct exposure to hot flue gases escaping the feeding holes.

CONCLUSIONS

Conventional Bull's trench kilns of movable chimney type give out excessive dust and smoke emissions due to their poor thermal efficiency and should, therefore, be phased out. Fixed chimney Bull's trench kiln produces low dust emission when its chimney height is raised to 30 m. Further, high draught kilns are energy efficient and produce dust emission within permissible limits as laid down by CPCB for medium industries in rural/residential areas.

Better quality of bituminous coal with lower ash and volatile matter (such as SLV coal) should be provided to the industry to reduce dust and hydrocarbon emissions. Apart from phasing out less efficient kilns, manual feeding of fuel should be modified or partially mechanised to protect the workers from exposure to hot flue gases escaping the feed holes. Protective aprons/dresses/shoes should be provided to workers to protect them against excessive heat at their work place specially during summer months.

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