PROSPECTS OF POLLUTION ABATEMENT SYSTEMS FOR INDIAN BRICK KILNS

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Introduction

Clay bricks technology is by far the most predominant and highly significant building material industry in the development of National economy for the housing sector. Presently about 80 billion bricks are being produced annually in the country with a shortfall of about 20 billion numbers. To meet the present scarcity of demand a large number of bricks manufacturing kilns are being set up in the various nooks and corners of the country. Basically four types of kilns, employed by and large by the industry, are the heap type country kilns (also known as clamps), the bull's trench, the fixed chimney and the high draught kilns. The first two types of kilns, although being used on a wider scale are thermally inefficient, yielding poor product quality and comparatively low output per unit kiln volume. The fixed chimney as well as the high draught kilns are gaining acceptance for large scale utilisation by the industry.

A large number of studies on emissions from brick kilns have been carried out by National Environmental Engineering Research Institute, Nagpur and Central Building Research Institute, Roorkee in the past several years. Basically the Suspended Particulate Matter (SPM) comprising the kiln dust and the hydrocarbon volatiles are the major pollutants. In view of this, there is a need to identify, appropriate pollution control measures for such Kilns.

Coal, is largely used as fuel for firing bricks kilns. Some other coal fired appliances are boilers, furnances, shaft kilns, down-draft furnaces, cupolas, etc. These appliances produce both gaseous (Co_2 Co, So_2, No_x, H_2s) as well as particulate matter (dust and tarry hydrocarbons). Most of the industries are in the small and medium scale sectors for which elaborate pollution control methods may not be cost effective and practicable. Various grades of coal depending upon their analyses, calorific values and other factors as available in the country are given in Table 1. Some of the Indian coals, particularly from the North-Eastern States, contain sulphur as much as 6% to 8% and this can be a source of large amount of sulphur dioxide in the atmosphere. For small furnaces using low sulphur coal, sulphur dioxide emission need not be considered to be a serious pollution hazard in the northern belt of the country.

TABLE 1

VARIOUS GRADES OF COAL FOR BUILDING MATERIAL INDUSTRIES

Source	Reserve Mt	Analysis Moisture	Ash	% Volatile Matter	Calorific Value, Kcal/kg
Grade II					
Singrauli	600	7.5-9.5	18-22	26-29	5,000-5,500
Talcher	160	8.0-9.0	16-27	28-32	4,800-5,800
Bishrampur	133	9.0-11.0	13-15	25-28	5,650-5,950
Kamptee	74	8.0-10.0	12-25	25-29	5,000-5,900
Karanpura	940	2.0-8.0	16-28	26-33	5,300-6,400
Godavari valley	800	6.0-9.0	15-24	24-33	5,200-6,100
Wardha valley	141	9.0-12,0			
Raniganj	1921	4.0-6.0	15-20	29-32	5,200-5,900
			15-29	27-35	4,800-6,400
Grade III					
South Karanpur	250	4.0-6.0	20-38	25-30	4,200-4,600
Singrauli	676	6.0-8.0	25-35	25-28	4,200-4,800
Kamptee	101	7.0-10.0	18-34	23-29	4,000-5,300
Chirimiri	12	6.0-7.0	22-27	24-27	5,100-5,500

Pollution Control Strategy

There are two methods of controlling pollution from the process industries. These are (i) by incorporating changes in the system design of the process parameters and equipment, and (ii) cleaning of flue gases by effective methods. Whereas the first method can be applied to the specific processes based on their intrinsic characteristics, the second method will be, in general, applicable for abatement of particulate matter pollution from the coalfired industries. The ambient air quality standards, as laid down by the statutory bodies for the suspended particulate matter, are given in Table 2. The emission standards for air pollution from the stacks of industrial plants are depicted in Table 3.

TABLE 2

AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATE MATTER AS LAID DOWN BY STATUTORY BODIES

Area	SPM Concentration mg/nm³
Industrial and mixed areas	500
Residential and rural areas	200
Sensitive areas	100

TABLE 3

STANDARDS FOR EMISSION OF SPM

Type of Industry	Industrial Area	SPM Values, mg/nm³ Residential & Rural Areas	Sensitive Area
Heavy polluting	500	200	100
Moderate polluting	2000	1000	500

Design Considerations

The nature as well as properties of the gas containing the particulate matter needs to be established vis-a-vis the type of harmful effect on flora and fauna. The site of location of the plant along with the degree of pollution control required is the next consideration. The significant parameters of design are (i) size of particulates and its distribution pattern, (ii) particulate concentration in gas, (iii) quantitive gas flow rate, (iv) gas temperature, and (v) system efficiency. These process parameters will determine pressure drop in the system, energy requirements, cost of the control device, running expenses for pollution abatement, etc. However, it may be noted that the size of soild particles is of paramount importance for the selection of an appropriate and cost effective solution.

Choice of Control Equipment

A wide variety of separating devices may be envisaged from for removal of particulates from a gas stream. For selecting a proper equipment, the considerations to be kept in mind are: (i) equipment size and space requirement, (ii) material of construction, (iii) nature of control, (iv) cost affordability, (v) maintenance requirement, (vi) safety aspects, and (vii) future needs.

With adequate knowledge about the size of dust particles and gas involved, either a single separating device or a combination of devices can be employed to achieve the desired separation efficiently. It is advisable to separate coarser particles first with low capital and operating cost. It will involve greater saving in expenditure on equipment for separation of smaller sized particles. Selection is governed by a combination of technical, commerical and legal considerations together with common-sense and experience. Choice of the auxiliary equipment such as an, pump, dust conveying and disposal system is equally important for its efficient working. Even though some standard equipment or device may be procured directly from the market, yet in most of the cases the equipment needs to be specially designed to suit specific requirements. The removal of particulate matters from flue gases of the brick kilns could be effected by the probable techniques outlined herein.

1. Chamber Type Gravitational Separators

The gravity settling chamber (Fig 1) is the simplest type of dust collection equipment. It acts on the principle of slowing down the gas flow so that particles remain in the chamber for longer duration of time to settle down to the bottom. It is suitable for particles of size greater than 40 m. Setting chambers may be used with or without baffles. Its limitation is that on account of

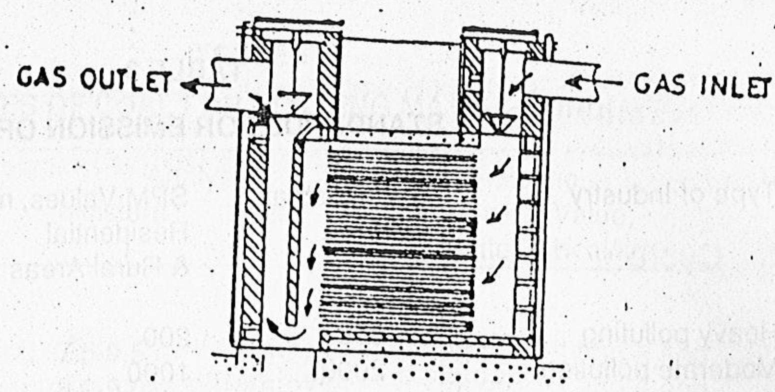

FIG. 1. CHAMBER TYPE GRAVITATIONAL SEPARATORS

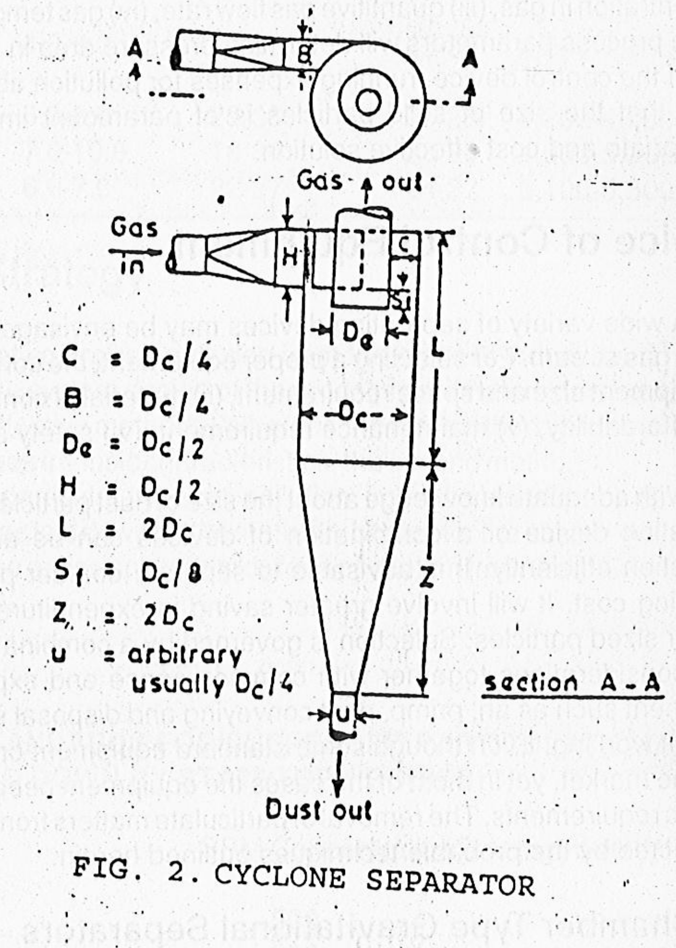

FIG. 2. CYCLONE SEPARATOR

longer retention time, larger chamber volumes are generally required. The gas velocity ranges from 1 m/s to 2 m/s. Setting chambers have low efficiency, but they have a distinct advantage in terms of low cost, low pressure drop, simple fabrication and operation, and dry dust collection of particulate matter.

2. Cyclone Separators

Cyclone separators (Fig 2) are by far the most popular devices used for the separation of dust particles from gaseous emissions. This has some relevance to brick kilns where the sizes of a major bulk (about 65%) of particles has been monitored to exceed 10 microns. A representative cyclone has been depicted in Fig 2. It is basically an inertial separator incorporating cylindro-conical structure without involving any moving parts. The dust laden gas stream is injected tangentially into the annular space of the cyclindrical portion and the movement of gases along with the dust particle follows the downard swirling action. In the process the centrifugal forces are generated. A force differential is caused between the larger and smaller particles vis-a-vis the denser and lighter particles. Thus the larger and the denser particles tend to move downwards, along the inside of the external wall of the cyclone. The same are flushed out from the bottom of the equipment whereas the lighter and smaller sized particles follow an inner vortex upwards and the same are discharged along with the processed gas stream from the top middle cyclindrical outlet. For the particle size range of 10-20 microns, a separation efficiency of the order of 50-55 percent can be achieved for the volumetric gas flow rate of 7,000-9,000 m^3/hr at 80-120 ^oc. An investment of Rs. 1.0 Lac on the overall contorl unit involving the cyclone is envisaged for the fixed chimney brick kiln. The pressure drop in the range of 25-100 mm w.g. is generally encountered with high inlet gas velocities of the order of 5-7 m/s.

The cyclone dust separators have, in general, wide applications because these are simple in design, construction and operation, and relatively inexpensive both in initial and operational costs. The selection of material of construction is, however, influenced by the chemical and physical nature of the dust. Consturction and fabrication of this structure with standard mild steel sheets may be taken up for gaseous emissions from the brick kilns. For handling the larger gas volumes and for achieving higher separation efficiencies multiclones may also be deployed which are basically a larger number of cyclones in parallel modes.

Furthermore, the efficiency of cyclone increases with the increase (i) density of dust, (ii) inlet gas velocity (iii) cyclone body length, (iv) ratio of cyclone diameter to its outlet diameter, (v) smoothness of cyclone inner wall, and (vi) number of gas revolutions. A cyclone is very simple in design and construction having low initial investment, low operational cost, practically no maintenance and requiring smaller floor space.

3. Gravity Spray Chamber

A particle laden gas can be scrubbed by bringing it into closer contact with a liquid and thus removing small sized particles effectively. Water is generally used as a scrubbing medium. The particle laden gases and water spray move counter-currently to each other in a chamber (Fig 3). The fine water particles trickle down under the action of gravitational force in a gravity scrubber, whereas some packing medium is used for intimate mixing of liquid and gas in a packed bed scrubber. The separation of particles occurs generally by impaction, interception

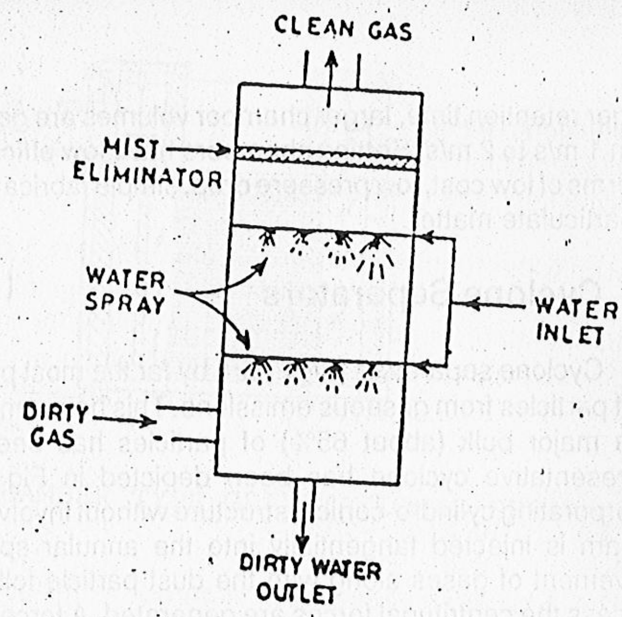

FIG. 3. GRAVITY SPRAY CHAMBER

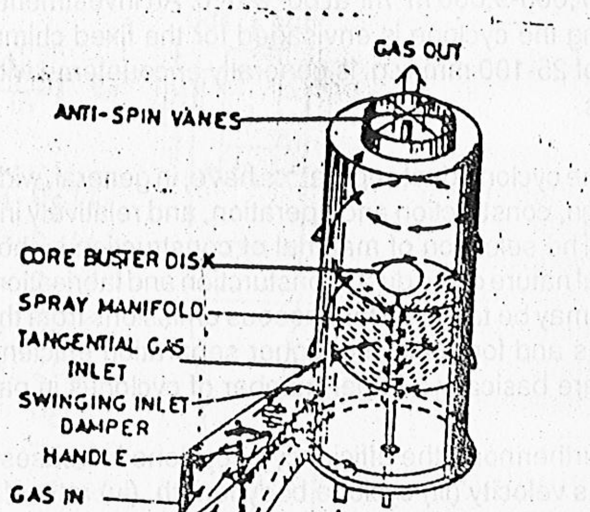

FIG. 4. A CYCLONE SCRUBBER

and diffusion. The separated particles along with the liquid, in the form of a slurry, are collected at the bottom of the wet scrubber and are disposed off. The cleaned gas is passed through a mist eliminator and collected at the top.

The water requirement varies from 0.41/nm³- 1.01/nm³ of gas handled. The advantages of such scrubbers are : (i) efficient collection of small sized particles {55 nm}, (ii) can tolerate high temperature, (iii) low initial as well as maintenance cost, and (iv) no condensation problem. The disadvantages are : (i) high water requirement and slurry disposal problem, (ii) more severe corrosion than dry systems, (iii) water pump and spray nozzles need to get the required pressure for water spray (2 kg/cm² - 8 Kg/cm²), and (iv) relatively high maintenance cost.

4. Cyclone Scrubber

It is basically a combination of dry gas cyclone and a water spray mechanism. The dust laden gas is introduced tangentially into the main circular body of the cyclone and fine droplets of water are sprayed through nozzles in the annular space of the cyclone (Fig 4). The particles collected along the inner wall, because of the action of centrifugal forces, are washed down the cyclone by the water sprayed. The same are collected at the bottom of the cyclone in a slurry tank for disposal. The cleaned gas is exhausted into the atmosphere from the top of the cyclone through a chimney. The advantages and disadvantages are similar to those of the other wet scrubber equipment described earlier.

Energy Requirements

To operate a dust control unit, energy is consumed as : (i) work done to move the dust laden air stream, basically to resist the frictional losses incurred by the flow of the Stream through the equipment, and (ii) additional energy of a form suited to the type of collecting force being employed. This kind may be pumping as in the scrubber. The first kind of energy is ubiquitous for all separation equipment. The pressure drop in the air stream as it flows through the system is estimated and the corresponding power requirement is computed based on the flow rate of the stream in appropriate units. Higher collection efficiency requires higher power. The same may range from 0.1 kW to 2 kW for 1000 m³ of gas per hour for various kinds of equipment.

Concluding Remarks

The building material industries are usually in the small and medium scale sectors where the scale of operation does not permit elaborate pollution control equipment to be evolved and installed, as the level of investment is rather low. Simple inertial, gravitational chamber or cyclone separator may be designed and installed based on the specific requirements. For collection of finer dust particles (< 5 nm), suitable scrubbing or spray system can be conceived and experimented to obtain reasonably high separation efficiency. The methods described in this paper are for fixed chimney and the high draught brick kilns.

The conventional country kilns and the Bull's trench kilns need elaborate mechanisms which may not be technically and economically viable. The country kilns or clamps, in particular need to be discouraged or abandoned; and the Bull's trench kilns need to be scattered away from the congested localities.

Acknowledgement

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BLESSED YOU ARE

You cannot help anyone, you can only serve; serve the children of the Lord, serve the Lord Himself, if you have the privilege. If the Lord grants that you can help anyone of his children, blessed you are; do not think too much of yourselves. Blessed you are that that privilege was given to you when others had it not. Do it only as worship.

—Swami Vivekanand