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Review of Literature

MEASUREMENT OF COMPOSITION OF FLUE GAS GENERATED USING DIFFERENT INDUSTRIAL FUELS.

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ABSTRACT :

Flue gas clean up strategy requires determination of particulate matter as well as other pollutant gases. The devices used in this research are capable of removing particulate matter. Different industrial fuels generate different composition of flue gases. Here an attempt is made to study the composition of different flue gases generated by the various industrial fuels. Solid industrial fuels are most commonly used fuels, hence the area of interest is solid fuels. Ambient air is used for oxidation assuring complete combustion. The measurement is done using gas analyzers ATS 103 M and ATS 206 A.

KEYWORDS : *Industrial fuel, flue gases, lignite coal, bituminous coal, coal used in brick making, briquette.*

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INTRODUCTION

The gases CO, CO_2, NO, NO_2, SO_2 are responsible for acid rain[1,2] & global warming[3,4]. The major source of these gases is emission from 'chimneys' of various industries. All types of industries choose an external agency to test & report the data of emissions for self plus government record[5]. These agencies of course must be government approved. M.P.C.B. publishes the data of air pollution available from different M.I.D.C. area as well as from a few large scale industries individually. This data was observed time to time & analysed. It makes to conclude that according to reports 'no pollution is taking place. However air pollution is increasing day by day.

WHO standards[6] of fresh air

Name of the gas	Concentration
Nitrogen	71.4 %
Oxygen	17.6 %
Other gases	**1%**
Carbon dioxide	150 - 200 ppm
Carbon monoxide	0.05 – 0.3 ppm
Nitrogen dioxide	0.002 - 0.07 ppm
Nitrogen oxide	0.001- 0.3 ppm
Sulphur dioxide	0.02 - 1 ppm
A few more like water vapour helium, neon	Up to 1 ppm

WHO limits[7] for air pollution are quoted bellow:

Name of gas	Upper limit allowed
Carbon dioxide	500 ppm
Carbon monoxide	5 ppm
Nitrogen dioxide	4 ppm
Nitrogen oxide	3 ppm
Sulphur dioxide	6 ppm

Method:

An extensive study of designs of different industrial devices like furnace, water scrubber, cyclone separator, baghouse filter was done. Accordingly a scaled down structure was constructed using 6 mm steel. Specific quantity of industrial fuel (1 kg) was burnt in the furnace. The flue gas generated by burning of the fuel was allowed to pass through the entire assembly. Thermocouple sensors are used at every stage to monitor the temperature of the gases passing through.

Furnace: A steel furnace[8] made to the scale is used to burn different solid fuels. At the beneath of square part, a tough mesh is placed to hold the fuel. A fan is used to supply fresh air continuously to the fuel so that sufficient oxygen is made available to the fuel. The total flue gas is sent to cyclone separator. Almost every solid fuel furnace is provided with a cyclone separator.

Cyclone separator: Hot air along with particulate matter from the outlet of furnace enters the conical shaped device. It takes a form a cyclone & heavy particles of coal & ash of size greater than 50 µm get settled at the bottom due to centrifugal force generated by the flue gases being in motion inside the cone[9,10] . The air moves further in a bag house filter

Bag house filter: A special cloth with good adsorbing capacity is used to make long bag. Depending on size of house, the size & number of bags is chosen so that the air inside the house should not be left untouched. In this small device, 12 bags are hung. To remove the particles adsorbed on the bags compressed air is blown after some interval. The particulate matter of size 10-50 µm is trapped & dropped down at the bottom of bag house filter[11,12].

Water Scrubber: A big sized water shower is placed at the top of water scrubber. Hot air enters from the bottom & gets scrubbed (washed). Almost all particulate matter up to 10µm and some amount of water soluble gases get removed[13].

The measurements are made at the outlet of the water scrubber.
Gas Analyzers Used for the measurements are:

ATS 103 M:

A 'gas analyzer' ATS 103 M is used for the study. Its accuracy level is 1ppm & upper limit is variable from 100-5000 ppm depending on choice of gas under testing. Ambient gas testing is done using this device.

The specifications of ATS 103 M are as under:

1. Accuracy: +/-2%.
2. Sampling: Auto Suction Sampling
3. Zero Calibration: Automatic at instrument starts up with fresh air sample.
4. Power Supply: Rechargeable Ni-cad Battery Pack
5. Response Time: 30 seconds at 95% variation.
6. Operating Temperature: - 5 to 55 deg.

Gas sensor	Range	Resolution
CO_2	Electrochemical 0-5000 ppm	1 ppm
NO	Electrochemical 0-100 ppm	1 ppm
CO	Electrochemical 0-2000 ppm	1 ppm
NO_2	Electrochemical 0-100 ppm	1 ppm
SO_2	Electrochemical 0-100 ppm	1 ppm

ATS 206 A:

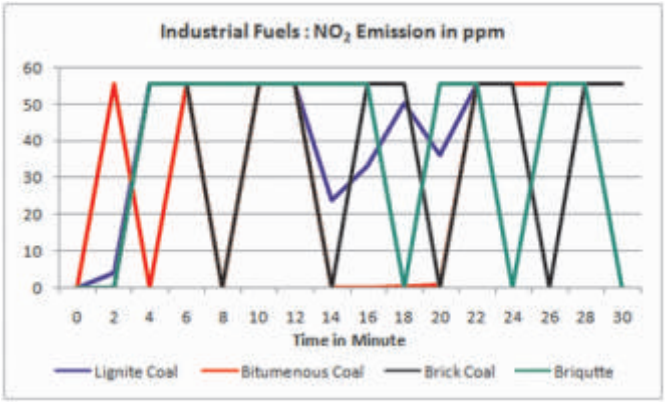
Microcontroller based embedded intelligent instrument. Range : % V/V, Auto Suction Sampling, USB/RS 232 Computer interface. NDIR sensor is used. Resolution: 0.1 unit Accuracy : ± 2%, Response time < 5 second, Data Storage : 10000

After burning 1 kg of each fuel separately, following readings were recorded for each type of gas.

Observations:

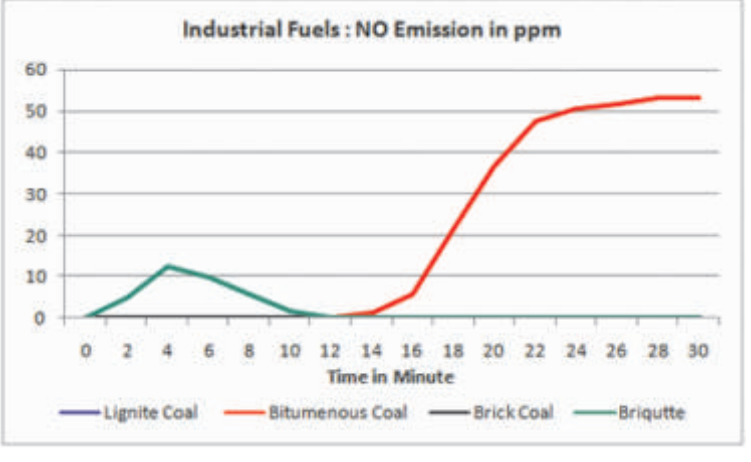
1. Emission of NO_2

Time in Minute	Lignite Coal	Bituminous Coal	Coal used in Brick Making	Briquette
0	0	0	0	0
2	4	55.6	0	0
4	55.6	0	55.6	55.6
6	55.6	55.6	55.6	55.6
8	55.6	0	0	55.6
10	55.6	55.6	55.6	55.6
12	55.6	55.6	55.6	55.6
14	23.9	0	0	55.6
16	33.1	0.1	55.6	55.6
18	50.2	0.3	55.6	0
20	36.2	0.6	0	55.6
22	55.6	55.6	55.6	55.6
24	55.6	55.6	55.6	0
26	55.6	55.6	0	55.6
28	55.6	55.6	55.6	55.6
30	55.6	55.6	55.6	0



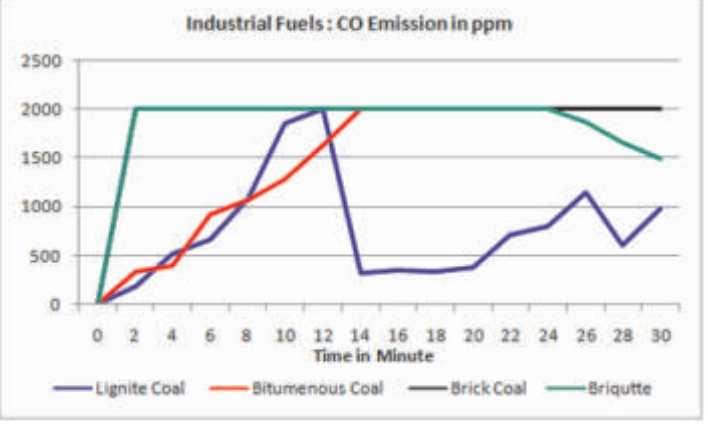
2. Emission of NO:

Time in Minute	Lignite Coal	Bituminous Coal	Coal used in Brick Making	Briquette
0	0	0	0	0
2	0	0	0	5.1
4	0	0	0	12.5
6	0	0	0	9.9
8	0	0	0	5.5
10	0	0	0	1.6
12	0	0	0	0
14	0	1.2	0	0
16	0	5.6	0	0
18	0	21.7	0	0
20	0	36.9	0	0
22	0	47.5	0	0
24	0	50.5	0	0
26	0	51.9	0	0
28	0	53.3	0	0
30	0	53.3	0	0



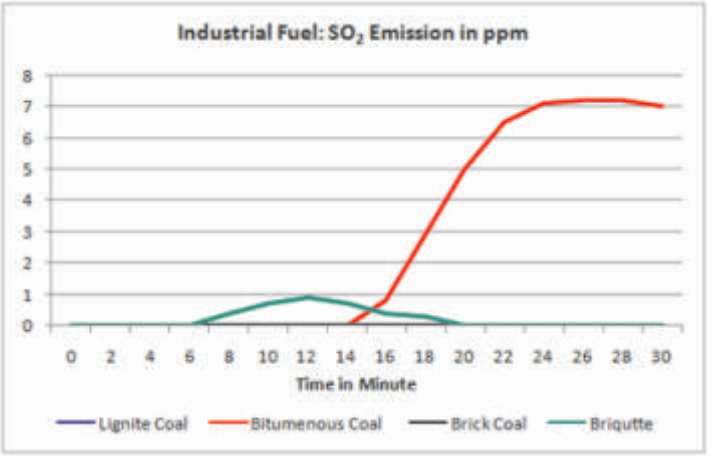
3. Emission of CO:

Time in Minute	Lignite Coal	Bituminous Coal	Coal used in Brick Making	Briquette
0	0	0	0	0
2	181	332	2000	2000
4	506	385	2000	2000
6	657	924	2000	2000
8	1086	1066	2000	2000
10	1853	1276	2000	2000
12	2000	1617	2000	2000
14	318	2000	2000	2000
16	339	2000	2000	2000
18	333	2000	2000	2000
20	370	2000	2000	2000
22	709	2000	2000	2000
24	802	2000	2000	2000
26	1142	2000	2000	1870
28	605	2000	2000	1652
30	980	2000	2000	1495



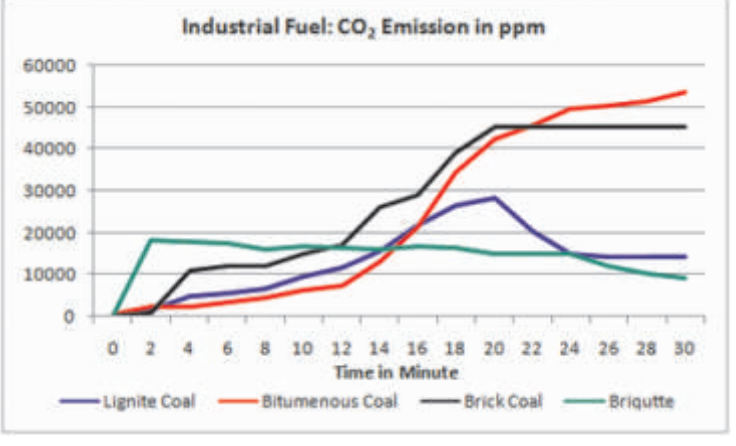
4. Emission of So_2:

Time in Minute	Lignite Coal	Bituminous Coal	Coal used in Brick Making	Briquette
0	0	0	0	0
2	0	0	0	0
4	0	0	0	0
6	0	0	0	0
8	0	0	0	0.4
10	0	0	0	0.7
12	0	0	0	0.9
14	0	0	0	0.7
16	0	0.8	0	0.4
18	0	2.9	0	0.3
20	0	5	0	0
22	0	6.5	0	0
24	0	7.1	0	0
26	0	7.2	0	0
28	0	7.2	0	0
30	0	7	0	0



5. Emission of Co2:

Time in Minute	Lignite Coal	Bituminous Coal	Coal used in Brick Making	Briquette
0	0	482	0	0
2	1300	2400	800	18100
4	4700	2300	11000	17900
6	5500	3400	11900	17400
8	6500	4300	12100	16100
10	9300	6400	15000	16700
12	11500	7400	17100	16200
14	15500	13300	26100	16000
16	21700	21400	29100	16700
18	26500	34500	39000	16300
20	28400	42500	45200	15000
22	20300	45600	45200	15000
24	15000	49600	45200	15000
26	14100	50600	45200	12100
28	14200	51600	45200	10000
30	14100	53700	45200	9100



CONCLUSIONS:

1. With NO_2 emission, there is no specific pattern.
2. Emission of NO is zero in lignite coal and coal used in brick making. It has very small value in case of briquette

and after some time, it becomes zero.
3. Emission of CO is very high in all the fuels.
4. Considerable SO_2 emission is observed when bituminous coal is burnt.
5. CO_2 emission is comparatively at lower level in briquette.

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