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The turning point in Indian environment

The human life in the earth may be continued without water for few days, without food for few weeks. However the human life in the earth may not be continued for few minutes without air. Air comes under. 24×7 in our human system. In such condition, air plus sulphur dioxide is harmful to respiratory system which leads to premature deaths and reduction in life expectancy. It is a big shock to the nation that India becomes the highest emitter of sulphur dioxide of the world, surpassing the China. It is not a encouraging trend for us. Under these circumstances MOEF and CC has notified the norms for various pollutants including sulphur dioxide emission from thermal power plants in December 2015. The norms cover various size plants for various periods with various levels of emission, with a timeframe of two years as implementation schedule. This notification is a correct notification in correct direction, but with some time delay. This notification has put about 1800000 MW in study mode, mainly of coal fired units in nature. The sulphur dioxide emission may be well controlled by installing flue gas desulphurisation (FGD) system in boiler flue gas path. By injecting lime in the flue gas path, sulphur dioxide is converted to calcium sulphite and then by reacting with oxygen, it is converted to calcium sulphate. Thus the flue gas is purified from sulphur dioxide. India has to import this technology. Technology transfer is a difficult task especially on commercial terms. This article narrates the various happenings in the country after the publication of notification.so that the reader gets the overall picture in single presentation. The implementation of the flue gas desulphurisation (FGD) system in Indian thermal power plants as early as possible, may improve the environment prevails in the country. This paper deals with various issues related to Sulphur dioxide emission and reduction measures.

Keywords: Environment, thermal power plants, Sulphur dioxide, technology transfer, flue gas.

1.0 Indroduction

1.1 Coal is the King

The installed capacity of India is about 3,31,118 MW, as was on November 2017. The overall power situation is nearing satisfactory, even though about 25% of our population is yet to be electrified. Out of 5, 97,464 villages in the country, 5,86,785 villages have been electrified i.e. about 98.5%. Regional grids are integrated and India is now a single grid. Now the power can flow from Kanyakumari to Kashmir in uninterrupted manner. The per capita power consumption is also an increasing trend, from 914 kWhr in 2012-13 to 1101 kWhr in 2015-16. The coal fired units share is about 1,93,427 MW (58.4%).

Even though the coal fired units capacity is about 60% of the nation capacity, it meets the 75% of energy requirements of the nation. Thus coal plays a major role in the development of the country.

1.2 Coal and sulphur

The analysis of coal indicates that coal has sulphur of less than one per cent to few per cent. Also coal has other sulphur due to contamination with pyrite etc. During the process of combustion, the sulphur in the coal evolves sulphur dioxide. This sulphur dioxide emission into the atmosphere causes several threat to the human society, when it exceeds the limits. The development of renewable energy sources in a big way has helped to slow down Thermal progress. Irrespective of renewable energy developments, the estimated coal consumption is in increasing trend of 600 million tonnes of coal (921 BU power generation) in 2016-17 to 901 million tonnes of cool (1246 BU power generation) in 2026-2027. This means several million tonnes of sulphur dioxide will be emitted in to the atmosphere.

2.0 Sulphur dioxide

2.1 Effect of sulphur dioxide

The pollutant emission from source to atmosphere in direct manner is termed as primary pollutants. Sulphur dioxide, nitrogen oxide and particulate matter are directly emitted from the stack toatmosphere. These three are termed as primary pollutant.

In the atmosphere changes takes place by the reaction between the primary pollutant and the atmosphere (with moisture or/and oxygen) and forms some more pollutants, termed as secondary pollutants. The sulphur dioxide reacts with oxygen in the atmosphere and forms sulphur trioxide.

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Then this sulphur trioxide reacts with moisture in the atmosphere and form sulphuric acid. The sulphuric acid is neutralized by ammonia leads to formation of sulphates or bisulphates. These sulphates group are in finer forms. Finer form means less than 2.5 micron size (PM2.5). The primary pollutant sulphur dioxide is thus partially converted to secondary pollutant, in the atmosphere.

Thus the atmosphere has sulphur dioxide gas and sulphate particles. During breathing process, these particles are entering into our lungs and causes trouble for us. The troubles are studied by WHO then and there and guidelines are being issued by WHO. The World Health Organisation indicates that the health effects of air pollution on selected population growth is as follows:

- 80 micro gram per cu.m. (annual average) - visibility and/ or human annoyance effect.
- 120 micro gram per cu.m. (annual average) - respiratory symptoms.
- 250-500 microgram per cu.m. (daily average) - worsening of patients with pulmonary disease.
- 500 microgram per cu.m (daily average) - excess mortality and hospital admission.

2.2 Sulphur dioxide – ambient air norms in India

The national ambient air quality standard notified by Government of India is tabulated in Table 1. All values are in micro gram per N cu.m.

The above table clearly indicates that the level of sulphur dioxide emission norms in ambient air is in improving direction, from 120 in 1994 to 80 in 2009 and 40 in 2014. It has to be mentioned here that the World Health Organisation standard is 20, on 24 hours basis.

2.3 Sulphur dioxide – emission trend in India

The sulphur dioxide emission from thermal power units is indicated in Table 2, for understanding the level of emission from each unit and type. The emission mainly depends on sulphur content in fuel and fuel flow for generation and running hours. About 636 units are available in India, as on Feb 2016. India emits about 11.00 million tonnes of sulphur dioxides in last year. The average emission is estimated to be about 7.00 kg per MWHR India becomes the top most emitter of the world, in sulphur dioxide emission, pushing back China to second position. Thus the nation is in deep troubled situation and faces an uphill task of purifying the environment. The main source of emission is from power sector (46%), industries (41%) and others (13%).

2.4 Sulphur dioxides – emission control in India

The dust emission is controlled by installing electro static precipitators/fabric filters etc in India, to specified level, to meet the MOEF and CC notifications. In case of sulphur dioxide emission, no such specified level exist. During the process, according to chemical composition of ash, some sulphur dioxide may be absorbed in the ash. Generally, the sulphur dioxide emission is uncontrolled one. However MOEF and CC notifications warrant high stacks (Table 3) so that the sulphur dioxide may be distributed over wide area, leads to less concentration per area.

Table 3

Generation capacity	Stack height (metres)
500 MW and above	275
200 MW/210 MW and above to less than 500 MW	220
Less than 200 MW/210 MW	H = 14 Q 0.3 where Q is emission rate of SO_2 in kg/hr, and H is stack height in metres

Table 1

No	Period	T year 1994 - area			Year 2009 - area		year 2014 proposal
		Industries	Residence	Sensitive areas	Industries and residence	Sensitive areas	
1	Annual	80	60	15	50	20	0-40 good 41-80 satisfactory 81-380 moderate 381-800 poor
2	24 hours	120	80	30	80	80	

Table 2

	Unit MW	Hourly generation MWHR	Fuel flow 100%TMCR Kg per hour	Sulphur %	SO_2 production Kg/Hour	Kg SO_2 per MWHR	Fuel and boilertype
1	125	125	114000	6.00	13680	109.44	Lignite - CFBC
2	210	210	210000	0.7	2940	14	Lignite - PF
3	250	250	237000	0.65	3081	12.324	Lignite - CFBC
4	500	500	304000	0.3	1824	3.648	Coal - PF
5	660	660	438000	0.45	3942	5.972	Coal - PF
6	800	800	295200	0.68	4014.72	5.0184	Coal - PF

TABLE 4

Description	Sulphur dioxide		Nitrogen oxide	SPM	Mercury
Units installation	<500 MW	>500MW			
Before 31.12.2003	600	200	600	100	0.03
1.1.2004 to 31.12.2016	600	200	300	50	0.03
From 1.1.2017	100	100	100	30	0.03

Note : All values are in Milligram per Ncu.M

3.0 Developments in December 2015

MOEF and CC has notified the norms for various pollutants including sulphur dioxide emission from thermal power plants in December 2015, as indicated in Table 4.

The norms cover various size plants for various periods with various levels of emission, with a timeframe of two years as implementation schedule. This notification is a correct notification in correct direction, but with some time delay. This notification .put about 1800000 MW, mainly of coal fired units in nature, to study and review mode.

4.0 History of flue gas desulphurisation systems (FGD)

The Indian thermal power plants have to treat the flue gas to achieve the control the sulphur dioxide emission at specified level. The technology worldwide available to control the sulphur dioxide emission is flue gas desulphurisation system (FGD). The sulphur dioxide emission had caused serious environmental problems of smog etc in developed countries, in 1950s.

To overcome this problem, lime slurry was injected in to the flue gas path and the sulphur dioxide was converted to calcium sulphite. Then this calcium sulphite react with air and form calcium sulphate (solid) and removed from the flue gas stream. Thus the flue gas is purified. This process is termed as wet process and has yielded good results worldwide. The wet process reaction details are given below.

$SO_2 + H_2O \rightarrow H_2SO_3$

$CaCO_3 + H_2SO_3 \rightarrow H_2O + CO_2 + CaSO_3$

$CaSO_3 + 1/2\ O_2 \rightarrow CaSO_4$

$CaSO_4 + 2H_2O \rightarrow CaSO_4 . 2H_2O$

Subseqently; various new technologies were also developed in parallel to control sulphur dioxide emission. The developed countries such as America, Europe and Japan are the main emitters of sulphur dioxide, have implemented these technologies in their units and sulphur dioxide emission is kept well under control in these countries, for the past few decades. China also followed these concepts and implemented the same from 2000 onwards and the emission is in very much reduction trend. Thus the world major emitters of sulphur dioxide has kept the emission in control except India.

4.1 CONSTRAINTS IN IMPLEMENTATION OF FLUE GAS DESULPHURISATION SYSTEM (FGD)

The addition of any new system to the existing system is a difficult task, as the existing system is in service for several years in different conditions. The main constraint is our conservative system which always filled with hesitation to acceptance. The various .constraints are as mentioned below.

1. Availability of sufficient space for installation.
2. Availability of limestone.
3. Handling of byproducts.
4. Suitability of existing chimney/need of new chimney.
5. Routing of fluegas ducts.
6. Increase in capital expenditure.
7. Increase in O&M expenditure.
8. Increase in auxiliary power consumption.
9. Increase in tariff rates.
10. Outage of unit for implementation.
11. Technology transfer bottlenecks.

The constraints 6 to 9 are common for all Indian thermal power plants under review. This may be resolved suitably by taking up with CERC/SERC. Technology transfer bottlenecks may not be there as it happens in massive manner. The outage of unit for implementation is for betterments only. The constraints 1 is a real constraint which require detailed study, if space is not available. The limestone and by products may be resolved as sufficient time is available. The retrofitting process is already experienced in various countries. The technology is simple one and has less rotating equipment/systems only. Thus the FGD system is feasible.

5.0 The way forward by CEA in FGD implementation

CEA, the apex body in the power sector, has actively arranged discussion with each region, to find the ways and means of implementation. Discussions were held with concerned groups, to evolve the methodology. The major outcome details are as mentioned below.

- The initial review by CEA of MOEF and CC notification published in DEC2015 has put about 555 units (179548 MW) into study and review mode.
- The units likely to be retired and operates at very low PLF in continuous manner are excluded from phasing plan. (8907 MW)
- The lesser size units (less than 25 MW) need not install

FGD system as it is techno economically not viable.

- The collection of ESP emission data from the 555 units indicates that emission from about 299 units (115214MW) is meeting the MOEF and CC notification published in DEC 2015. Hence ESP up gradation/retrofit is needed for about 256 units (64334 MW).
- In the 256 units, about 45 units (17855 MW) has space for FGD provision. It is observed that wet FGD installation reduces the SPM emission also. Hence, FGD will be installed first. Based on the outcome of the performance of FGD system, ESP upgradation/retrofit will be decided.
- About 202 units (95915 MW) has space for FGD installation. About 74123 MW has no space for FGD installation.
- About 39 units. (9510 MW) has been provided with FGD system.
- Units under construction will be commissioned first and the FGD installation will be taken up as a retrofit measure. This is to avoid the occurrence of contractual complications.
- The quantum of limestone required may be in higher order. This will be taken up with mining ministry (may be the nodal agency)
- The implementation has to carried out in phased manner'
- Capital power plants does not come under review.
- The PLF of 50% will be considered for Tariff increase calculation, due to FGD and other modification works.
- The use of exiting chimney/erection of new chimney considering new parameters was discussed. MOEF and CC has to issue the notification for chimney height.
- The region wise units list for implementation was prepared.
- The region wise list has to be studied by RPC, power plant, POSOCO,etc for preparation of implementation schedule.
- Also, CEA has released the typical technical specification for Wet FGD installation for reference and guidance in DEC 2017, after various discussion with Manufacturers and Thermal power plants. The guarantee parameter is specified as 70 Microgram per cu.m.
- The phase in schedule for each region was prepared considering the power situation anticipated in that region, is tabulated in Table 5.

6.0 Analysis of certain points

7.2 No space for FGD implementation

It is observed that certain thermal power plants have no space for FGD implementation. It may be true that considering the economic layout adopted in engineering stage. This does not mean that these units shall be allowed to run with present emission rate. In case of two or more units exist in such a plant, one unit has to retired and the ESP space of that unit may be shared by adjacent units for installing FGD system. This plant may be compensated by allowing to run at maximum load to earn the required revenue. Otherwise, online injection of dry lime may be considered for these units. This does not require space. This will definitely decrease the sulphur dioxide emission of that thermal power plant.

7.3 Exemption for low capacity units (less than 25 MW)

On techno economic grounds, low capacity units are in the path of exemption. These units may be advised to explore the possibilities of switch over to natural gas as fuel wherever feasible so that the sulphur dioxide emission will be less. The future low capacity units may be sanctioned only with natural gas as fuel or fuel with less emission.

7.4 Captive power plants

There is no information about captive power plants emission. The current emission level in these plants has to be obtained and reviewed. The natural gas as the fuel for the current/future low capacity captive power plants may be examined.

7.5 Implementation schedule

The implementation schedule is liberally scheduled considering the power requirement of the regions. The schedule starts from 2019 and completes by 2023 and thus spread over for four years The next ten years may be a lean period for thermal power project sectors, as the national electricity policy (draft) indicates that no thermal power plant installation is envisaged for the next five years i.e. up to 2022. Hence the various infrastructures available in the country may be sufficient/diverted to meet the site requirement of men and machinery involved in FGD works. The only concern is supply of FGD system equipment by FGD vendor

Table 5

	Region	No of units	Total MW	FGD implementation schedule
1	Eastern	39	16670	31.12.2020 to 31.03.2023
2	Northern	70	27405	31.03.2020 to 30.06.2023
3	Southern	41	20240	30.09.19 to 31.12.2022
4	Western	145	58257	31.03.2020 to 31.12.20203
	India	295	122572	30.09.2019 to 31.12.2023

which may be proprietary in nature. .In fine uninterrupted erection and commissioning of FGD system is possible.

7.6 Further revision of norms

It is interesting to note that the national electricity policy (Draft) does not envisage coal fired units for the period of 2017-2022. Also, it indicates that addition of about 40000 MW only for the period of 2022-2027. Thus the coal fired units installation may be rare in future till 2027. Hence these future units (40000 MW) norms shall be more stringent than present norms.

8.0 Conclusions

India becomes the highest emitter of sulphur dioxide of the world. At this juncture, the MOEF and CC notification of December 2015 and the current happenings shows some light in the environment tunnel. Hence it is the need of the hour to implement the FGD systems in the country at the earliest without further delay. This will make healthy Indians and hence strong India.

The emission norms for the future units of about 40000 MW (2022-2027) shall be more stringent than the present norms.

The low capacity (less than 25 MW shall switch over to natural gas to control the sulphur dioxide emission, may be examined.

The captive power plants shall also have to be reviewed for current Sulphur dioxide emission level and reduction measures if required.

The thermal power plants which has no space for FGD implementation, may retire the centre unit so that the adjacent units may install FGD system in the ESP area of the retiring unit. As compensation, these units may be allowed to load the units more than the other plants in the region.

Letus expect clear Indian environment from 2023

Acronyms

BU - Billion Units.

CEA	Central Electricity Authority.
CFBC	Circulating Fluidised Bed Combustion
CERC	Central Electricity Regulatory Commission. Cu.M-Cubic Meter
ESP	Electro Static Precipitator
FGD	Flue gas Desulphurisation System. Kg- Kilogram
KWhr	Kilo watt Hour. MWHR - Megawatt Hour
MOEF and CC	- Ministry of Environmental and Forest and Climate Change. MW - Mega Watt.
PF	Pulverised Fuel
PLF	Plant Load Factor.
PM2.5	Particulate matter less than 2.5 micron diameter. POSOCO - Power System Operation Corporation.
RPC	Regional Power Committee.
SERC	State Electricity Regulatory Commission. SPM - Suspended Particulate Matter.
SO2	Sulphur Dioxide
TMCR	Turbine Maximum Continuous Rating. WHO -World Health Organisation.

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