Theoretical Predictions of SO_2 in Lignite Fired Boilers & Furnaces

1. **Introduction**: Lignite is a low-grade solid fuel. It usually contains high moisture levels and has Sulphur in the range of 1 to 5%. Presence of Sulphur along with moisture and ash makes this fuel as one of the worst fuel for boiler as it creates the problem of fouling, clinkering and SO_2 emissions.

On hand prediction of SO_2, therefore becomes a necessity from pollution point of view. This may be carried out from basic stoichiometric reactions. Presented below is the method for such kind of prediction.

2. Stoichiometric of Combustion:

2.1 Lignite Composition:

Moisture content	:	33.5%
Ash content	:	23.5%
Carbon	:	30.59%
Hydrogen	:	3.29%
Nitrogen	:	1.76%
Sulphur	:	1.00%
Oxygen	:	6.36%
Higher calorific value	:	11.70 MJ/kg

2.2 Assumptions:(i) S = 1% & 5% of S is converted to SO_3.
(ii) Excess Air is zero percent.

a) $C + O_2 \longrightarrow CO_2$
12 kg 32 kg 44 kg
0.3059 kg + 0.81573 kg 1.12163 kg

b) $H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$ 2
kg 16 kg 18 kg
0.0329 kg + 0.2632 kg 0.2961 kg

c) $S + O_2 \longrightarrow SO_2$ 32 kg 32 kg 64 kg
0.0095 kg + 0.0095 kg 0.019 kg

d) $S + 3/2\ O_2 \longrightarrow SO_3$ 32 kg 48 kg 80 kg
0.0005 kg + 0.00075 kg 0.00125 kg

O_2]th = 0.81573 + 0.2632 + 0.0095 + 0.00075 - 0.0636
= 1.02558 kg/kg of fuel

23 kg O_2 77 kg N_2 100 kg Air

1.02558 kg 3.43346 kg 4.45904 kg

Table 1: **Flue Gas composition for S = 1.0% & Excess Air 0.00%**

Sr. No.	Constituent	Mass kg/kg	Mol. Mass	Moles	Composition	
					Wet Basis %	Dry Basis %
1	CO_2	1.12163	44	0.0254916	13.845	17.10
2	MC H_2O H_2O Total	0.335 0.2961 0.6311	18	0.0350611	19.043	0.00
3	SO_2	0.019	64	0.0002969	0.161 1610 ppm	0.199 1988 ppm
4	SO_3	0.00125	80	0.00001563	0.00849 84.89 ppm	0.0105 104.87 ppm
5	O_2]Excess	0.00	32	X = 0.00	0.00	0.00
6.	N_2]th + f	3.45106	28	0.123252	66.943	82.689
7	Air th	4.45904				

Table 2. **SO_2 emission (ppm) as a function of Sulphur Content and Excess Air Levels**

Sr.No.	Sulphur, %	Excess Air Levels				
		0.00%	20.00%	40.00%	60.00%	100.00%
1.	1.00	1988	1646	1405	1225	976
2.	2.00	3544	2987	2581	2273	1834
3.	3.00	5267	4439	3836	3377	2725
4.	4.00	6960	5865	5068	4461	3600
5.	5.00	8622	7265	6277	5525	4458

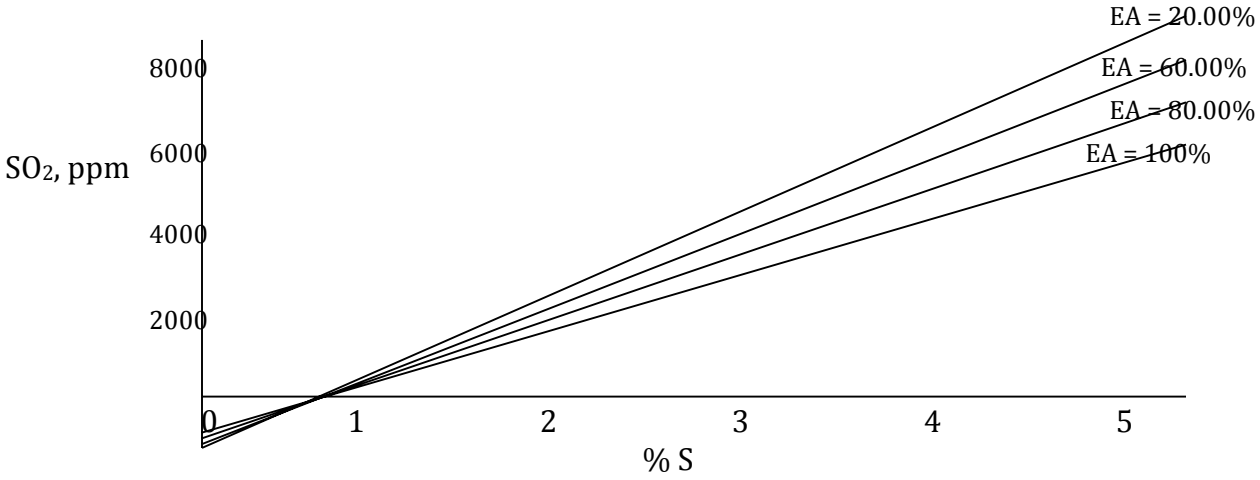

Figure – 1: SO_2 Emissions with Different Sulphur content & Excess Air Levels

Conclusion:

It is clearly observed that as Sulphur content increases SO_2 emission increases nearly linearly. Similarly, with higher excess air levels, SO_2 emissions seems to be decreasing due to presence of Excess O_2 & N_2. It may be stated that this charts may be used as a reference for predicting SO_2 emissions from lignite fired boiler.