



Theoretical Predictions of SO₂ 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 SO₂ emissions.

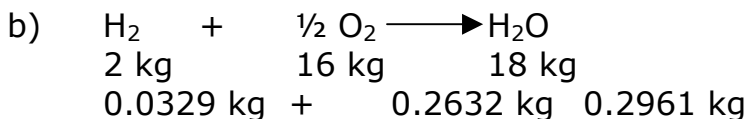
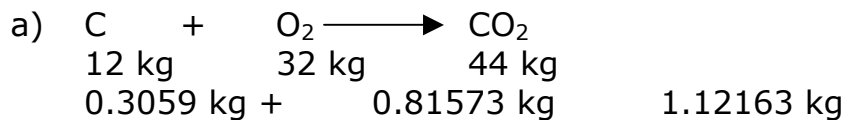
On hand prediction of SO₂, therefore becomes a necessity from pollution point of view. This may be carried out from basic stoichiometric reactions. Presented below is the method for such kind of prediction.

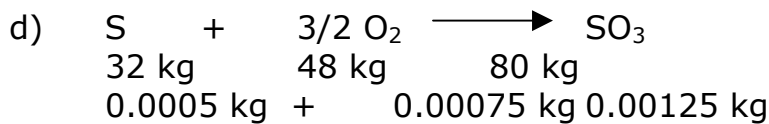
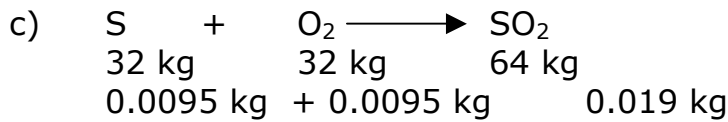
2. Stoichiometric of Combustion:

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 SO₃.
(ii) Excess Air is zero percent.





$$\begin{aligned}
 \text{O}_2]_{\text{th}} &= 0.81573 + 0.2632 + 0.0095 + 0.00075 - 0.0636 \\
 &= 1.02558 \text{ kg/kg of fuel}
 \end{aligned}$$

$$23 \text{ kg O}_2 \equiv 77 \text{ kg N}_2 \equiv 100 \text{ kg Air}$$

$$1.02558 \text{ kg} \equiv 3.43346 \text{ kg} \equiv 4.45904 \text{ kg}$$

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	1.1216 3	44	0.0254916	13.845	17.10
2	MC H ₂ O H ₂ O Total	0.335 <u>0.2961</u> 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	0.0012 5	80	0.0000156 3	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	3.4510 6	28	0.123252	66.943	82.689
7	Air th	4.4590 4				



Table 2. **SO₂ 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

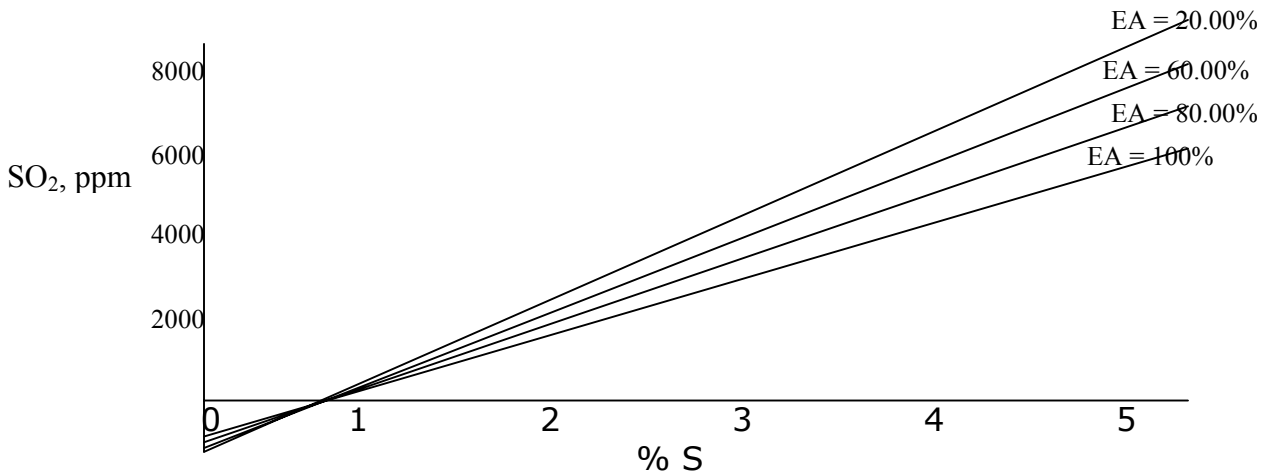


Figure - 1: SO₂ Emissions with Different Sulphur content & Excess Air Levels

Conclusion: It is clearly observed that as Sulphur content increases SO₂ emission increases nearly linearly. Similarly with higher excess air levels, SO₂ emissions seems to be decreasing due to presence of Excess O₂ & N₂. It may be stated that this charts may be used as a reference for predicting SO₂ emissions from lignite fired boiler.

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