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MAXIMIZING EFFICIENCY OF FLUE GAS DESULPHURIZATION IN COAL BASED DRI (SPONGE IRON) PROCESSES VIA ROTARARY KILN

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ABSTRACT

Practically all fuels in common use contains variable amounts of Sulphur, most of which is discharged to the atmosphere's Sulphur dioxide (SO_2) during combustion. In addition, specific industrial processes produce large quantities of sulphur dioxide some of which are escaping into the air. It is known to be potentially harmful both from the health and economic point of view, a knowledge of the level at which sulphur dioxide is present in the air is important. Flue gas is the combustion product gas coming out of a furnace (rotary Kiln) that exists in the atmosphere via a flue (which may be a pipe/channel or chimney).
Flue-gas desulfurization (FGD) is a set of technologies and processes used to remove sulfur dioxide (SO_2) from exhaust flue gases of fossil fuel in Power plants, Iron & Steel Industry and from the emissions of other sulfur oxide emitting processes. In this paper, focus is made upon increasing the efficiency level of Desulphurization in Sponge Iron Industry.

INTRODUCTION

In Nature, Sulphur occurs in the form of elemental sulphur, sulphides and sulphates. Pollution of the air by sulphur dioxide: It is widespread since burnt of fossil fuels such as Coal & Oil contain significant amount of sulphur, when these fuels are burned then 95% is converted into SO2 while rest 5% is SO3. In whatsoever way SO_3 is formed it does not behave like SO_2 and forms $SO_3 + H_2O = H_2SO_4$. **(**Liquid aerosol /sulphuric acid mist**)** It is known to be potentially harmful, from the 1.Health and 2.Environment & even 3. Economic point of view, a knowledge of the level at which SO_2 is present in the air is important.

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Purpose of Research

As India has emerged as the World's largest Sponge Iron producer accounting for over 20 million tons annually, since the last 3 years.

The purpose are as follows

1. Study details of desulphurization processes in DRI, Steel Industries and Power Plants.
2. Introducing newer Electro-Chemical processes/ solutions in current Boilers, Rotarary Kilns, WS, EC and Wet ESP.
3. Introducing Improvements in coal burning processes in Thermal Power and Sponge Iron plants through better controls to reduce the % of SO_2 and SO_3.
4. Re-designing of Wet-Scrubber and Wet-ESP through Deep study of Wet-Scrubber and Wet-ESP.

Here our focus has been to control and increase efficiency of desulphurization processes in Rotarary Kiln based DRI/Sponge Iron plants, which uses Dolomite as a Scavenger for Sulphur present in Iron Ore and Coal.

Efficiency factor:

Part A) During Kiln Operation

1. As evident the main sulphur load comes from Coal & both reduction and De-Sulpherization takes place through diffusion by layers of Iron Ore-Coal & Dolomite.
2. De Sulpherization depends upon effective calcinations, which generally occurs between 700-900^{0}C. That's why one has to maintain temperature in 40-50 % of Kiln length (inlet zone).

Care has to be taken so that reduction should not be initiated in the first 40% length of kiln, this can be done by controlled formation of CO_2. As more CO_2 implies more reduction. Following chart depicts the standard zone wise Kiln Temperature as should be maintained in a Kiln length of 80 Meters and 4.8 meter diameter.

- Sulfur Di Oxide is now being removed from flu gasses by a verity of methods such as Wet scrubbing using a slurry of alkaline sorbent, usually limestone or lime, or seawater to scrub gases;
- Wet sulfuric acid process recovering sulfur in the form of commercial quality sulfuric acid;
- SNOX Flue gas desulfurization removes sulfur dioxide, nitrogen oxides and particulates from flue gases;
- Dry sorbent injection systems
- Wet Lime Process:- Here Pulverized Dolomite is injected into the boiler furnace, where the heat drives off CO_2, converting $CaCO_3$ to CaO (Reactive).

Here some of the conversion takes place

1. Before stack gas reaches the Wet-Scrubber
2. Most of the conversion takes place in the Scrubber after dissolved in Water

The resulting solids as well as fly ash removed from the scrubber sent to the settling pond, where water from the settling pond is recycled to the scrubber.

Experimentation

Table 1. Sulphur Balance in Sponge Iron Processes (Raw Materials + Final Products):

Sl. No.	Raw material	Operational feed rates (T/hr)	% Sulphur
1.	Iron Ore	19.0	0.010
2.	Coal	13.05	**0.75**
3.	Sponge Iron/DRI	12.92	0.040
4.	Char	1.76	0.50
5.	Flue dust from Ore	1.05	0.010
6.	Flue dust from coal	0.822	0.80

Table 2. Based on the Coal Quality, % S as found is depicted below

Coal Grade	% of $S^{(Total)}$
A.	0.23
B	0.43
C/D	0.47
E/F	0.75

Input	Output
a) S from ore: 1.90kgs. b) S from Coal: 97.875 kgs. Total: 99.775 kgs.	a) In Sponge iron: 5.168 kgs. b) In char: 8.8 kgs. c) Flue dust in ore:0.105 kgs. d) Flue dust in coal; 6.576 Kgs. Total: 20.649 kgs.
Thus it can be estimated that around 80% of Sulphur is released via Exhaust Flue gases in the form of SO_2 and SO_3 gases (Provided these gases are not filtered/scavenged using Electro and Chemical Process)	

Table 3. Dolomite is added to the kiln feed in order to control the Sulpher % content of Sponge Iron. Particle Size plays an important role as smaller particle size ensures larger specific surface area & better diffusion

Zone	1	2	3	4	5	6	7	8	9	10
Temp	750	800	850	900	920	950	980	1000	1010	1020

Table 4. It is mainly the coal, which introduces sulphur in to the process. Depending upon the composition, in which Sulphur is contained in the coal (in the form of Sulphide, pyrite, Sulphate, Organic) as picked up by the sponge iron.

Size of Dolomite	Std.% to be fed
+ 3 mm	5.0
-3 to + 2 mm	45.0
-2 to + 1	45.0
-1 mm	5.0

Table 5. Case 1: Optimized efficiency results using only Kiln operation

Input in Kgs	Output in Kgs	% S Lost	SO2 % in Stack Gas (mcg/m3)
100	20	80	130

Table 6. Case 2: Optimized efficiency results using Both (Kiln and Flu Gas De Sulpherization)

Input in Kgs	Output in Kgs	% S Lost	SO2 % in Stack Gas (mcg/m3)
100	35	65	110

It's quite apparent that by applying Case 2 , not only the % lost of Sulpher being reduced but also the SO2 in stack gas come s under central Pollution Control Board Norms (120 mcg/m^3)

Figure 1. Image above depicts a general D R I Production process using Rotarary Kiln

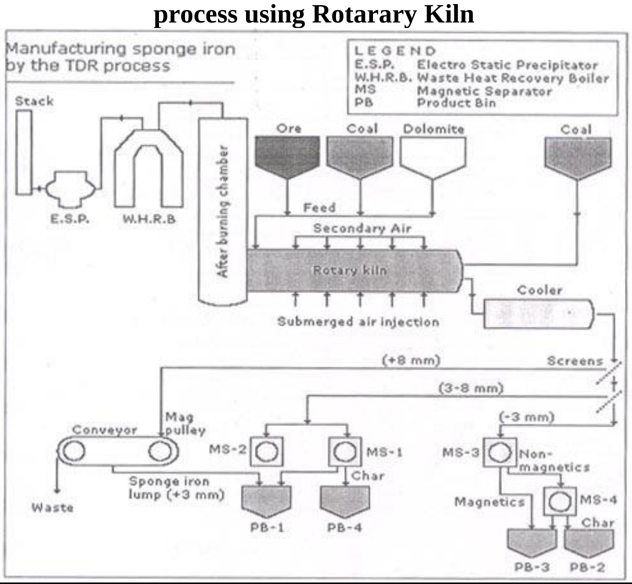
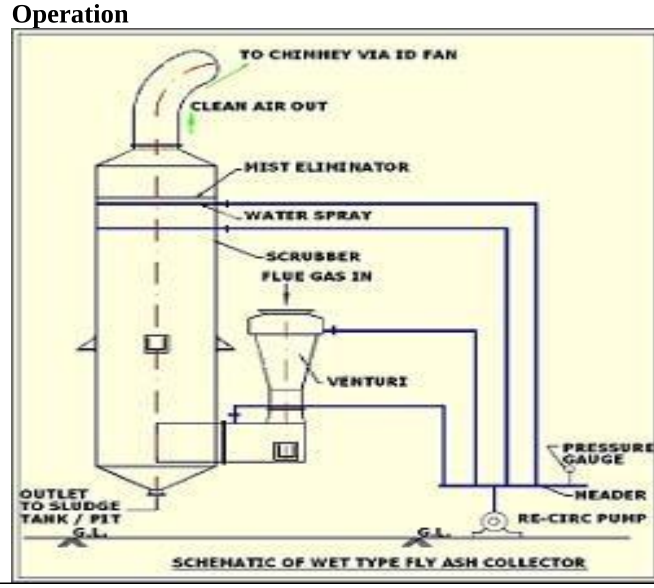


Figure 2. Part B) During DSC (Dust Settling Chamber) Operation



IMPLICATIONS/CONCLUSIONS

The proposed ideas cited in this article to desulpharize the Flue gas are based on some observations. The in plant trials primarily requires adequate technological will backed by appropriate design and organizational zeal and finally the financial input to arrive at positive conclusion for the development/ innovation of an indigenous technology without going in for implants.

It is quite apparent that the Iron & Steel industry in India is already witnessing high production levels by World standards and is poised for unprecedented growth in near future.

Hence the aspects of environmental degradation and sustainability need to be examined carefully so that the country prospers but not at the cost of risking our future.

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