Successful Integration of Partial FGD and SCR at Sinter Plant

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Air pollution is a serious issue in ironmaking, especially the sintering process. Major air pollutants, particles, NOx, SOx and DXN, have been managed in the sinter plant. A majority of pollutants are decreased significantly by carrying out effective end-of pipe technology such as Selective Catalytic Reduction (SCR) in the sinter plant except for SOx. Therefore, Flue Gas Desulphurization (FGD) is the next prime development. However, it is difficult to integrate FGD with existing SCR due to limited space in the sinter plant. pFGD(Partial Flue Gas Desulphurization), 40 percent of flue gas with high SOx concentrations are desulphurized through the FGD, which was developed at No.4 Sinter Plant. The advanced pFGD consists of a wet-method absorber, Gas/Gas heater, electrostatic precipitator, booster fan and switched dampers of the wind-box were also established. Since 2013, friendly, environmental sintering process were fulfilled successfully to minimize the NOx, DXN, and SOx emissions by means of integration of existing SCR and partial FGD at No.4 Sinter Plant at China Steel (CSC).

Keywords: End-of-pipe technology, SOx, NOx, SCR, pFGD

1. INTRODUCTION

1.1 Review air pollution improvements at sinter plant in the past

Major air pollutants, particle, NOx, Sox, and DXN have been managed at the sinter plant. Numerous measures have been taken at CSC for the last 20 years to comply with strict regulation. Measures can be implemented in three ways: An alternative in additives and fuel; re-organization for residual into the sintering process; Multi pulse EP to remove the dust; and the dual function catalyst in the SCR(1). It's noteworthy that in our experience the SCR has been maintained in good stable operation as long as no blockages occur on the catalyst.

1.2 Assessment for FGD

After reviewing the improved results, a majority of pollutant have been decreased significantly except for SOx. To comply with resident expectations, less PM2.5 emissions and the vision of a low environmental impact, a marked reduction in SOx has to be carried out. In general, the FGD is regarded as the most widely end-of- pipe technology for SOx reduction. A variety of FGD are classified as shown as Table 1.

Sinter plants around the world can choose to apply different FGD depending on operational cost, SOx removal efficiency, and the possibility of reusing by-product. Compared to dry method FGD at Dragon Steel(2), the wet method FGD which use $Mg(OH)_2$ as the reaction agent is easier to reuse by-products. The less by-products generated from the wet-method FGD can be recycled to RMTP (Residual Material Treatment Plant) easily. The reuse cost is cheaper than the dry method resulting from less by-products and an easier recycling process.

Table 1 FGD classification

Method	AC	Dry	Wet
Reaction agent	Activated coke	$Ca(OH)_2$ $NaHCO_3$	$Ca(OH)_2$ NaOH $Mg(OH)_2$
Supplier	SXX J-POWXX	LÜXX S-VXX ALXXX	FKK TXX ECOTECK
Efficiency	> 90%	50-90%	> 90%

1.3 Development for partial FGD

On the other hand, we are also confronted by the problem of insufficient space and huge investment costs. If less flue gas is treated through the FGD, investment and necessary space can be effectively saved. Essential investigation such as the temperature, SOx content and gas volume of exhausted gas from individual wind-boxes in the sintering process have been made prior to implementation. The typical profile of SOx content and temperature are shown as Fig.1.

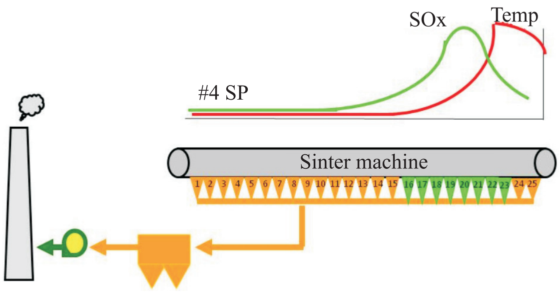

Fig.1. Typical emission profile of SOx and temperature in the waste gas along the sinter machine.

The profile figured out that the flue gas with high SOx content was generated mainly in the middle part of the wind-boxes. Partial of the FGD which only treated high SOx concentrations was decided to develop. Only 40 percent of flue gas with the high SOx concentration from the middle part of wind-boxes is treated thought the FGD.

1.4 Integration with existing SCR

As the other aspect, with the exception of newly built sinter plant, sinter plants[3] around the world are rarely capable of de-NOx and de-SOx. Those obstacles in arranging new layout are difficult in existing plants. It is difficult to integrate with existing facilities such as the SCR or waste gas recirculation system.

As mention in the last paragraph, 60 percent of waste gas from the sintering process is not cooled down. The temperature of mixing gas from the FGD can maintain at least 120℃. Compared to the original sinter process, the temperature and moisture of flue gas ahead of the SCR vary slightly. The advantage is that blockage on the catalyst resulting from low reaction temperature and high moisture of flue gas will not appear. That is why the COG consumption for reheat waste gas at SCR increases slightly. The flowchart of partial FGD integration with existing SCR at No.4 Sinter Plant (SP) is shown as Fig.2.

2. EXPERIMENTAL METHOD

2.1 Basic principle

Wet method FGD which uses $Mg(OH)_2$ as the reaction agent was applied at No.4 SP at CSC. Absorption of flue gas component of SO_2 by means of contact with slurry water of $Mg(OH)_2$ through the FGD absorber. The fundamental reactions are stated as the following equations：

$$SO_2+Mg(OH)_2 \rightarrow MgSO_3+H_2O \quad ....(1)$$

$$SO_2+MgSO_3+H_2O \rightarrow Mg(HSO_3)_2 \quad ....(2)$$

$$Mg(HSO_3)_2+Mg(OH)_2 \rightarrow 2MgSO_3+2H_2O \quad ....(3)$$

$$SO_2+(1+k)/2Mg(OH)_2 \rightarrow kMgSO_3+$$
$$(1-k)/2Mg(HSO_3)_2+kH_2O \quad ....(4)$$

The process water has to be treated by means of oxidation and filter. Then the water with $MgSO_4$ can be blown down.The fundamental reactions are stated as the following equations：

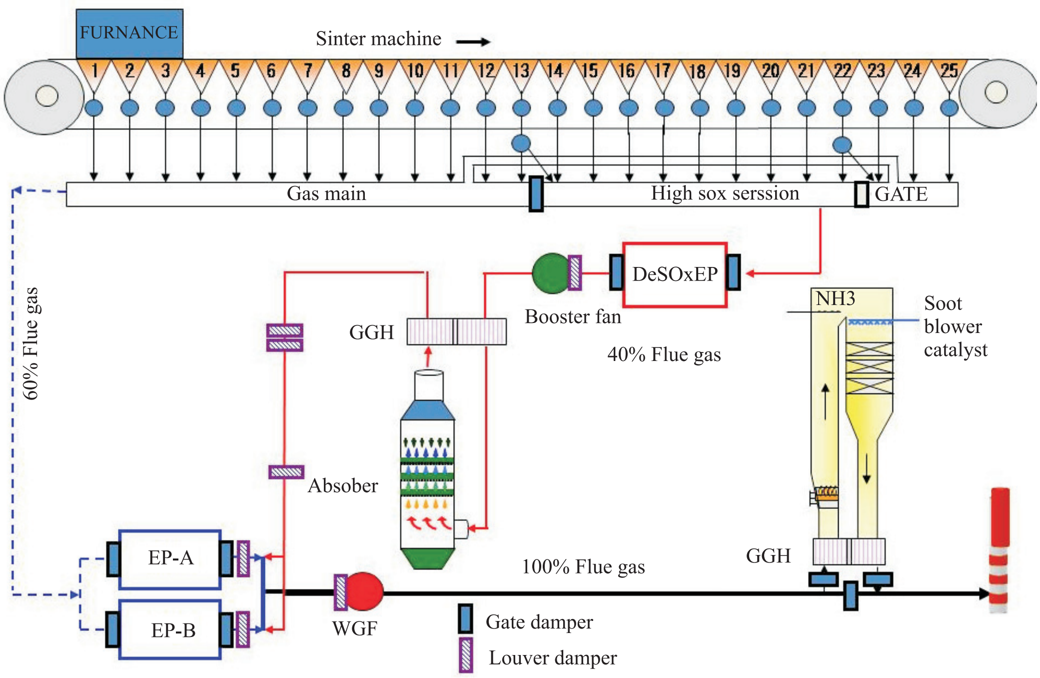

Fig.2. Flow chart of No.4 SP at CSC.

$$2MgSO_3+O_2 \rightarrow 2MgSO_4 \quad (5)$$

$$Mg(HSO_3)_2+O_2 \rightarrow MgSO_4+H_2SO_4 \quad (6)$$

The by-product from the filter can be recycled to RMTP.

2.2 Feature of pFGD

The pFGD consists of six main parts: $Mg(OH)_2$ slaking system; absorber; waste water filtering from absorber system; additional EP; booster fan; GGH (GAS GAS Heater). The layout of partial FGD integrated with existing SCR at No.4 SP is shown in Fig.3.

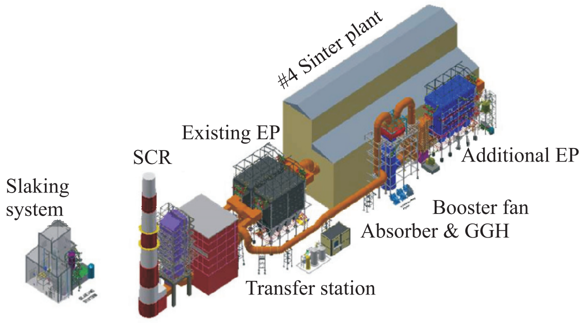

Fig.3. Layout of pFGD at No.4 SP at CSC.

Absorber equipped with the Moretana plate has a high efficiency removal rate of SOx emission. Removal efficiency is controlled by the PH value of recirculation water in the absorber. 70 percent of cooling and process water in the absorber uses blow down water. To overcome the pressure drop from the whole facility (e.g. existing SCR, sinter bed, absorber), a booster fan is equipped. In addition, in order to decrease the energy in reheating the flues gas at the existing SCR, a heat exchanger between high temperature and low temperature flue gases by GGH is necessary. Additional EP is designed to capture the dust in flue gas to reduce the particles ahead of the absorber. The pFGD also takes into consideration the in and out switching flexibly during the respective maintenance and starts up of the sintering process. In general, all the optimized solutions for predictable challenges have been proposed.

3. RESULT AND DISCUSSION

The pFGD has been applied successfully at No.4 SP at CSC since 2013.The performance after operation is listed as the following.

Achieve good temperature balance between existing sinter EP and additional EP. The operating temperature at the existing sinter EP still exceeds 130°C. Corrosion resulting from low temperature at existing EP will be prevented.

Utilization of blow down water for wet FGD. The blow down water consumption exceeded 300 t per day, but less treated water was consumed in this process.

No blockages were found on the catalyst at the SCR after the operation, because the inlet moisture of the flue gas ahead of the SCR can be controlled to less than 15%.

Less COG consumption at the SCR compared with that of conventional full capacity wet FGD.

Only 1 t per day by-product was generated from pFGD. Achieve expectations for less by-products treatment.

Less visible mist from the chimney compared with the full capacity wet FGD. The smoke from the chimney looks no difference than before. No complaints were received from the residents living the vicinity of the sinter plant after the pFGD operation.

The removal efficiency of SOx through the absorber maintained and exceeded 93%. The concentrations of SOx have been decreased by 70 ppm. In other words, SOx emissions have decreased by 0.448 Kg/T.S. Particulates have decreased by 18 t per year. The result is shown in Fig.4. NOx emissions are also very well controlled under the regulation in Taiwan. The result is shown in Fig.5

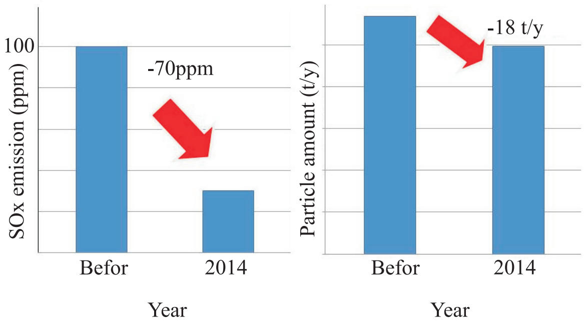

Fig.4. The SOx and particulate comparison between before and after pFGD operation.

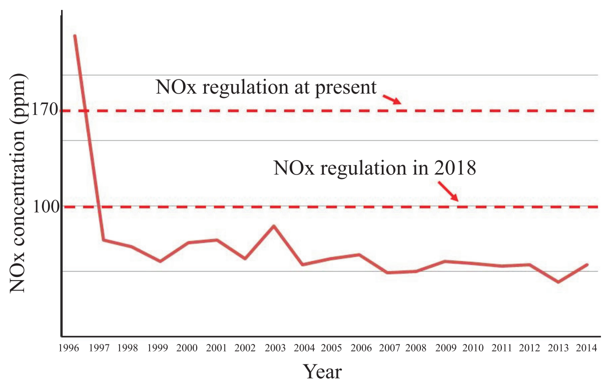

Fig.5. NOx emission trend at No.4 SP at CSC.

4. CONCLUSIONS

The advanced end-of-pipe technology for all emission reduction at sinter plant is proposed first. Friendly environmental sintering processes have been applied successfully to minimize the NOx, DXN and SOx emissions at No.4 SP at CSC, by means of integration between the existing SCR and pFGD. It is not only No.4 SP to be upgraded but also No.2 and No.3 SP are planned for the implementation accordingly. CSC continues to fulfill friendly environmental sintering processes in Taiwan.

REFERENCE

1. Ming-Sung Chen et al.: Challenges for the Environmental Protection Management at Sinter Plant of China Steel in the New Era, 2001.
2. Stafen Hotzinger et al.: The Successful Application of the Latest Siemens VAI Sinter Technologies at the Sinter Plant No.1 at Dragon Steel Taiwan, ABM Reduction Conference, Brazil, 2010.
3. Rainer Remus et al.: Best Available Techniques (BAT) Reference Document for Iron and Steel Production, 2013. □