New Concept of CFB Boiler with FGD

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Abstract: This paper introduces the technology characteristic of CFB Boiler with CFB-FGD on the basis of the summary of desulfurization principle in CFB boiler. The technology can overcome disadvantage of high sulfur of desulfurization in the boiler and thus pledge strict requirement of environment protection.

Keywords: CFB boiler, Desulfurization in the boiler, CFB-FGD

1 INTRODUCTION

In recent years, circulation fluidized bed flue gas desulphurization (CFB-FGD) technology has developed greatly. It has been widely adopted in large units for its characteristics of saving water, saving electricity, high efficiency, reliability and small footprint, and it has already been used in 660 MW unit.

It is well known that desulfurization in the boiler using limestone is an outstanding advantage of CFB boiler. Generally, the combustion temperature of CFB boiler keeps between 800 □–1000 □ and it is the temperature section at which the activity of limestone decomposing into lime is great and the desulphurization efficiency is high. Therefore, with appropriate Ca/S and particle size of limestone, the desulphurization efficiency of 70%–90% is able to be reached. Commonly, the desulphurization efficiency is 80% when Ca/S is about 2.2 and it reaches 90 % when Ca/S is about 3, thus CFB boiler is comparatively fit for middle and low sulfur fuel. For high sulfur fuel (for example, Sar≥3 % and the corresponding SO_2 concentration is above 6000 mg/Nm3), the boiler desulphurization efficiency should reach above 95 % to achieve the emission requirement of 400 mg/Nm3 that is prescribed by the country. Then single Ca/S will not satisfy the demand even if excess limestone is added. Besides, it may probably bring negative influence, one is the decrease of combustion efficiency, and the other is the increase of combustion temperature, causing increased NO_x emission.

In order to resolve the problem, the economic and advanced way is to adopt CFB-FGD technology after the CFB Boiler.

2 PROCESS

The flowsheet of the technology is CFB boiler→CFB-FGD absober→fabric filter or electric precipitator→ID fan→stack (Fig. 1). The flue gas which carries lots of CaO enters the absorber at the bottom and then suspends by the acceleration of venturi, forming stinging turbulent motion. This slip velocity between the flue gases and the solids is the characterising criteria for the optimal heat and mass transfer behaviour within the circulating fluid bed absorber. High pressure water is injected into the CFB absorber to make CaO convert to $Ca(OH)_2$ for absorption of harmful substances, then the dust is caught by the precipitator to achieve the intention of purification[1].

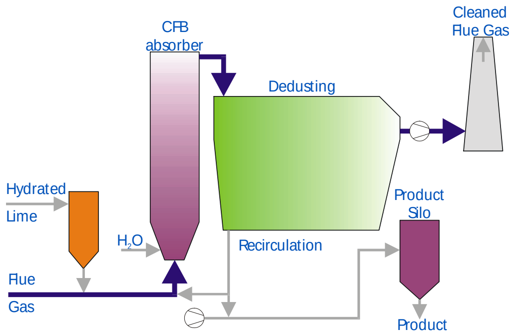

Fig. 1 The flow sheet of CFB boiler with dry desulphurization

The main chemical reactions in the CFB absober are:

$CaO + H_2O = Ca(OH)_2$ hydrating reaction

$Ca(OH)_2 + SO_2 = CaSO_3 \cdot 1/2\ H_2O + 1/2\ H_2O$ adsorption reaction

$Ca(OH)_2 + SO_3 = CaSO_4 \cdot 1/2\ H_2O + 1/2\ H_2O$ adsorption reaction

$CaSO_3 \cdot 1/2\ H_2O + 1/2O_2 = CaSO_4 \cdot 1/2\ H_2O$ oxidation reaction

$2Ca(OH)_2 + 2HCl = CaCl_2 \cdot Ca(OH)_2 \cdot 2H_2O$ adsorption reaction

$Ca(OH)_2 + 2HF = CaF_2 + 2H_2O$ adsorption reaction

$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$ adsorption reaction

3 TECHNICAL FEATURES

(1)Emission of high sulfur fuel-fired boiler can satisfy strict environmental requirement by both the desulphurization in the CFB boiler and the flue gas desulphurization. With the installation of CFB-FGD, the desulphurization efficiency in the CFB boiler may be decreased moerately to guarantee good combustion effect.

(2) Take full advantage of CaO in fly ash as absorbents. The combustion temperature of the CFB boiler is the decomposition temperature of limestone, so the porosity of

the lime is the highest and the activity is the best. Therefore, CaO in fly ash is a good kind of absorbent. There's no need to purchase absorbents under normal condition, saving the cost of absorbents greatly (the cost of absorbents occupies 40%-60% of the total cost).

(3) High pressure water into the CFB absorber is able to make lime hydrate to hydratedlime, so the dry hydrator may not be equipped, which can save equipment investment and operation cost. Besides, it's able to settle the problem which the CaO concentration in the fly ash is so high that it will influence the integrated utilization of fly ash.

(4) The technology is able to desulphurize and dedust simultaneously, so that SO_2 and dust emission may fufill environmental requirement.

4 APPLICATIONS OF CFB BOILER WITH CFB-FGD

(1) Puerto Rico Power GUAYAMA Plant in the USA (see Fig. 2)

Boiler unit: 2×300 MW
Fuel characteristic: Sar=3%-4% hard coal
Emission of SO_2: 100 mg/Nm^3
Emission of dust: 50 mg/Nm^3
Operating date: September, 1998

Fig. 2 Desulphurization and Dedust Island of Puerto Rico Power GUAYAMA Plant in the USA

(2) Lanesborough Power Plant in Ireland (see Figs. 3, 4, 5)
Boiler unit: 1×100 MW
Fuel characteristic: Sar=4% peat
CFB boiler manufacturer: F-W
Emission of SO_2: 200 mg/Nm^3
Emission of dust: 30 mg/Nm^3
Operating date: June, 2004

Fig. 3 Desulphurization and Dedust Island of Lanesborough Power Plant in Ireland

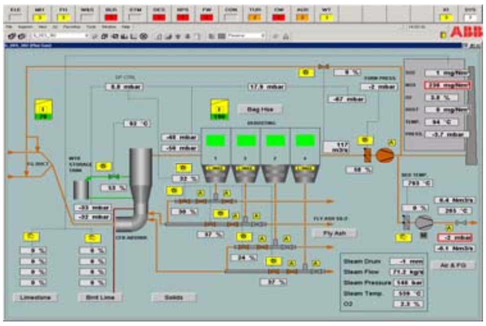

Fig. 4 Emission concentration after activated desulphurization in CFB absorber

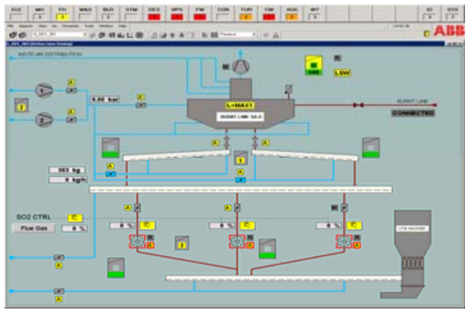

Fig. 5 No need to add lime and able to satisfy the requirement using fly ash in the boiler

(3) Power Utility Division, Sinopec Guangzhou Co., Ltd. (see Fig. 6)

Boiler unit: 2×100 MW
Fuel characteristic: Sar=6.7% petroleum coke
CFB boiler manufacturer: F-W
Gas flow rate: 465400 Nm^3/h
Emission of SO2: 200 mg/Nm^3
Emission of dust: 50 mg/Nm^3
Operating date: December, 2007

Fig. 6 Desulphurization and Dedust Island of Power Utility Division, Sinopec Guangzhou Co., Ltd.

5 CONCLUSIONS

Successful applications of CFB-FGD technology in CFB boiler have offered an economic and efficient measure to decrease SO_2 emission.

REFERENCES

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