The Proposal Comparison of Absorbent Preparation System of Wet Limestone-gypsum Flue Gas Desulphurization Process

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Abstract: Taking a wet limestone-gypsum Flue Gas Desulphurization (FGD) operation data for example, the absorbent preparation system is compared based on different limestone supply way in 3 proposals: purchasing limestone powder outside, dry mill and wet mill. For dry mill vertical and horizontal type are further compared. This paper has given the operation feature of mill and main configuration comparison of 3 proposals, analyzed the initial investment and operation cost difference based on fixed assets, power consumption, main maintenance cost and price of absorbent. The advantages and disadvantages of 3 proposals are given based on comparison, also dry mill is considered more suitable for long distance absorbent preparation. The paper provides advices for the choice of FGD absorbent preparation system.

Keywords: FGD, absorbent, preparation system, proposal comparison

1 SUMMARY

Along with the strict control on environmental protection and SO_2 emission, it has been a must to built desulphurization facilities for power plant. Wet Limestone-gypsum Flue Gas Desulphurization (WFGD) is the first choice because of its cheap absorbent, high efficiency and wide adaptability. Limestone is used as absorbent in this technology and the absorbent slurry preparation system is an important part for whole reaction, as well as the FGD operation and performance. It's a key component for the safety and economical operation to choose a suitable absorbent slurry preparation system. This paper compared different absorbent preparation systems by choosing a 2×500 MW units FGD system as an example.

2 BASIC PARAMETERS

The absorbent consumption amount is 13.46 t/h, which is 269 t/d and 80760 t/y. Absorbent is limestone powder(90 %< 63 m) or limestone block (<=20 mm). The silo storage capacity is 3 days consumption amount for 2 units under BMCR condition and limestone slurry tank is 4 hours under same condition.

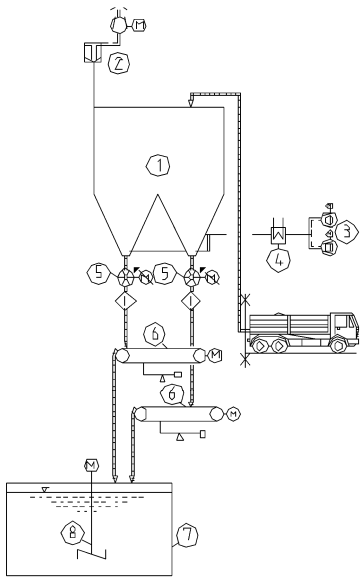
3 THE PROPOSAL OF ABSROBENT PREPARATION AND SUPPLY SYSTEM

3.1 proposal 1: Using Limestone Powder to Prepare Slurry with Water

Limestone powder is transported to plant by tank car and delivered to powder silo through pneumatic transmission. Under silo the powder is mixed with water to prepare required limestone slurry. Fig. 1 is the basic process and configuration of the system.

3.2 Proposal 2: Using Limestone Block to Prepare Slurry with Dry Mill and Water

Less than 20 mm limestone is transported in plant by truck. Through the unload system limestone is delivered to the silo, and then fed to the dry mill.

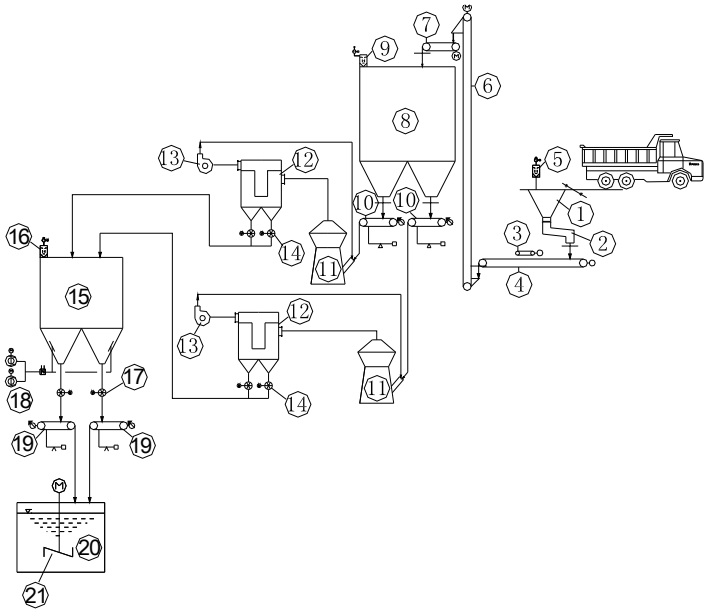


1-powder silo; 2-bag filter; 3-fluidization blower; 4-heater; 5-rotating eeder; 6-weighting feed belt; 7-limestone slurrytank; 8-agitator

Fig. 1 The basic process and configuration of proposal 1

After the mill qualified powder is delivered to powder silo. Under silo the powder is mixed with water in the slurry tank.

Limestone dry mill can use vertical or horizontal type. For this project the initial investment of vertical mill is higher than that of horizontal one, but the annual operation cost of horizontal mill is 0.168 million yuan higher than that of vertical one because of its high power consumption. Considering the same operation and maintenance requirement of two mills, vertical mill has better economical efficiency. What follows in the paper using vertical mill to make comparison. The basic process and configuration of proposal 2 see Fig. 2



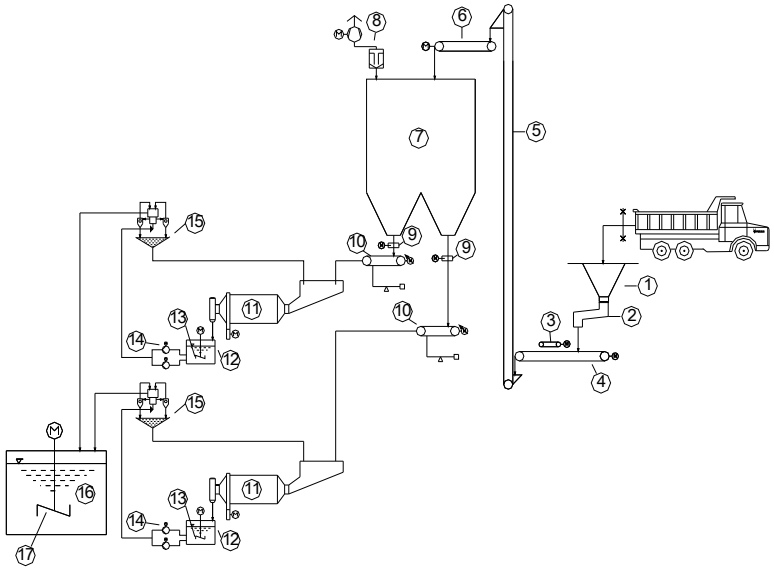
1-dump skip; 2-viberation feeder; 3- ironing separator; 4-belt conveyor; 5-bag filter; 6-bucket elevator; 7-drag conveyor; 8-limestone block silo; 9-bag filter; 10-weighting feed belt; 11-limestone dry mill; 12-bag filter; 13-suction blower; 14-rotary feeder; 15-limestone powder silo; 16-bag filter; 17-rotary feeder; 18-fluidization blower; 19-weightin feed belt; 20-limestone slurry tank; 21-agitator

Fig. 2 The basic process and configuration of proposal 2

The layout area of limestone discharging and dry mill system is about 28×45□1260 m^2, installing in sequence dump skip, vibration feeder, belt conveyor, bucket elevator, drag conveyor, limestone block silo, weighting feed belt, limestone dry mill, limestone powder silo, rotary feeder, limestone slurry tank etc., bag filter located on top of the powder silo.

Same as proposal 2, purchasing less than 20 mm limestone block and transporting in plant by truck, limestone is delivered to silo after unload system. Then limestone is fed to wet mill, the outlet slurry from mill is separated by hydrocyclone. Qualified slurry goes to slurry tank as the overflow of hydrocyclone. The basic process and configuration of wet mill system see Fig. 3.

3.3 Proposal 3: Using Limestone Block to Prepare Slurry with Wet Mill and Water



1-dump skip; 2-viberation feeder; 3- ironing separator; 4-belt conveyor; 5-bucket elevator; 6-drag conveyor; 7-limestone block silo; 8-bag filter; 9-plug board valve; 10-weighting feed belt; 11-limestone wet mill; 12-recirculation tank; 13-agitator of recirculation tank; 14-recirculation pump; 15-limestone hydrocyclone; 16-limestone slurry tank; 17-agitator

Fig. 3 The basic process and configuration of proposal 3

The total layout area of the system is about 18×45=810 m^2, installing in sequence dump skip, vibration feeder, belt conveyor, bucket elevator, limestone block silo, weighting feed belt, limestone wet mill, limestone slurry tank and slurry pump. Dump skip, vibration feeder and belt feeder are located underground, wet mill, recirculation tank and pump are located on the 0 m floor of mill plant, the limestone hydrocyclone are installed on the 10 m floor.

3.4 The cost-effectiveness Analysis of 3 Proposals

3.4.1 Operation Comparison of Dry Mill and Wet Mill

Dry mill and wet mill are both operated continuously and the product of dry mill can be stored in silo, but for wet mill utilizing and grinding at the same time without storage function. If the end product should be stored for a long time the volume of slurry tank will be huge and diseconomy obviously.

Considering operation, the dry mill will be more flexible and normally have higher storage capacity than wet mill, which is suitable for unstable absorbent resource. At the same time, if the absorbent need to be transported in long distance, for powder material it can be done by pneumatic method, but for slurry it will be very hard to choose pump due to high flow resistance and also the flushing of pipe will be hard because of deposition.

Because of noise and dust pollution of preparation system, more and more power plants tend to move the preparation system to the area far away from plant, so it's more suitable to choose dry mill under such condition.

Table 1 Main features comparison of dry and wet mill

No.	Item	Dry mill	Wet mill
1	Main motor power	200 kW	380 kW
2	Flexible for limestone	Big size (<50 mm)	Small size (<20 mm)
3	Refill of grinding material	Off-line	On-line
4	Operation noise	Lower	Higher
5	Product size	90% pass 250 mesh	90% pass 250 mesh
6	Maintenance requirement	Lower	Higher
7	Power consumption	Bulk 17 kW/t, higher for main and fluidization blower	Bulk 30 kW/t, lower for recirculation pump and no other power requirements
8	Grinding material loss	15 g/t	/

3.4.2 Main Equipment Comparison of 3 Proposals (Table 2)

Table 2 Main equipment comparison of 3 proposals

No.	Item	Purchasing powder	Dry mill	Wet mill
1	Transportation system	None	50 t/h	50 t/h
2	Limestone block silo	None	730 m^3	730 m^3
3	Weighting belt feeder	None	0-11/2 sets	0-11/2 sets
4	Mill output	None	11 t/h	11 t/h
5	Main accessories	None	Suction blower	Recirculation pump
6	Product separation equipment	None	Bag filter	Hydrocyclone
7	Limestone powder silo	950 m^3/1 set	320 m^3/1 set	None
8	Fluidization system of silo	1 set	1 set	None
9	Bag filter	1 set	2 set	1 set
10	Bag dust collector	None	2 set	None
11	Rotary feeder	0-11 t/h /2 set	0-11 t/h /2 set	None
12	Limestone slurry tank	180 m^3	180 m^3	180 m^3

3.4.3 Comparison of 3 Proposals on First Investment and Annual Operation Cost (Table 3)

(1) Fixed assets difference

Considering the equipment and installation cost, based on purchasing powder proposal and 30 years service time for FGD, dry mill has a difference of 12.9 million yuan or 0.43 million yuan in average, wet mill has a difference of 9.52 million yuan or 0.32 million yuan on average.

(2) Power consumption

Based on 6000 h annual operation time, the power consumption of purchasing powder is 0.18 million kWh, that of dry mill and wet mill are both 3.6 million kWh. Considering 0.2 yuan/kWh, the annual power cost of purchasing powder is 36000 yuan, that of dry mill and wet mill are 0.72 million yuan.

(3) Main repair cost difference

If based on purchasing powder, dry mill has a difference about 0.26 million yuan, for wet mill it's about 0.2 million yuan.

Integrate all above cost and absorbent purchasing cost, the comparison of 3 proposals see sheet 5.

Table 3 The difference comparison of initial investment and annual operation cost of 3 proposals

(Unit: $\times 10^4$ yuan)

Item	Purchasing powder	Dry mill	Wet mill
Fixed asset difference	0	43	32
Annual power cost	3.6	72	72
Annual maintenance cost	0	26	20
Limestone cost	565	140	140
Annual cost difference	568.6	281	264

Note:

1. Counting based on 2 units;
2. Equipment annual utilization time is 6000 h
3. Electricity average costs 0.2 yuan/kW;
4. Limestone powder costs 70 yuan/ton, limestone block is 17.3 yuan/ton.

4 CONCLUSIONS

4.1 Performance Comparison of 3 Proposals

(1) technical performance comparison

3 proposals, purchasing limestone powder from outside, using wet mill or dry mill, will all meet the requirements of project.

Proposal 1: purchasing limestone powder from outside. The advantages are simple process, nearly no noise and dust pollution, lower space requirement, power consumption, maintenance cost and initial investment. The disadvantage is the high price of limestone powder, and also it must have stable source of limestone powder.

Proposal 2: using vertical dry mill. The advantages are high-efficiency energy utilization, compact structure, high flexible for limestone, also with high storage capacity which is suitable for unstable source of limestone. The disadvantages are complex mechanical structure, high cost of system venting and drying measure if needed, also the high maintenance requirement because of grinding face wearing and hydraulic system failure under high pressure.

Proposal 3: using wet mill. It has the advantages of low cost of limestone block and no need for mid silo, also with the disadvantages of complex process, huge space requirement, heavy maintenance work and high initial investment. For wet mill proposal the discharge equipments should be installed near the preparation plant, which will require large space and cause dust pollution if located in power plant, also will be irrational because of much long slurry pipe if located outside power plant.

(2) Economical comparison

From above it's clearly that concerning comparison of annual investment and operation cost, purchasing limestone powder is 5.685 million yuan, 2.81 million yuan for dry mill and 2.64 million yuan for wet mill. So dry mill and wet mill cost nearly the same, purchasing limestone powder is higher because of the high price of limestone powder.

4.2 Conclusions

3 proposals are all ripe technology which can be used in WFGD. The conclusion can be reached from above analysis, that although dry mill need extra venting, powder silo and more equipments, the total cost doesn't increase dramatically, also the dust pollution source can be put outside plant which is benefit for management and operation of power plant.