BOF PRIMARY OFF-GAS CLEANING --- SEMI DRY SYSTEMS AND THEIR OPERATION RESULTS IN CHINA*

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Abstract

There are wet or dry two types of BOF Primary Off-gas Cleaning Systems for long history in the world. Semi Dry Systems based on China pending patents by Spraying Systems is presented in this paper. More than 200 BOF operation results prove that:

1) lower dust emission: typical≦30 mg/Nm3; lowest≦10 mg/Nm3
2) at least 50% water saved
3) less maintenance
4) short downtime 7-20 days for revamping
5) waste water such as coke waste water is treated and re-used with low cost and no harmfulness

It is especially suitable for revamping present wet and dry BOF off-gas cleaning systems, also a better solution for newly built BOF project.

Keywords: BOF; primary off-gas; semi dry cleaning.

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1 INTRODUCTION

BOF primary off-gas of high temperatures 1400-1600°C contains dust 70-200 **g/Nm^3**. This gas have to be then cooled to 900-1000°C by indirect cooled duct with steam as by-product. A proper dust control equipment has to be applied for its leaning. Among 918 BOF converters in China now:

- ~500 BOF converters equip with wet cleaning systems with two or one venturi scrubbers;
- ~200 BOF converters with dry cleaning;
- ~ 200 BOF with demi dry cleaning systems.

Many Operation results have proven that **Semi dry cleaning systems can meet extremely strict environment protection requirements ⩽10 mg/m3 in China** with more benefits in terms of low revamping investment; water saving; waste water treatment and re-use; less maintenance. This brings customers with investment saving, easy to revamp and profitable solutions for present wet and even dry BOF gas cleaning systems. Fig.1 shows history of BOF semi dry technology developments in China.

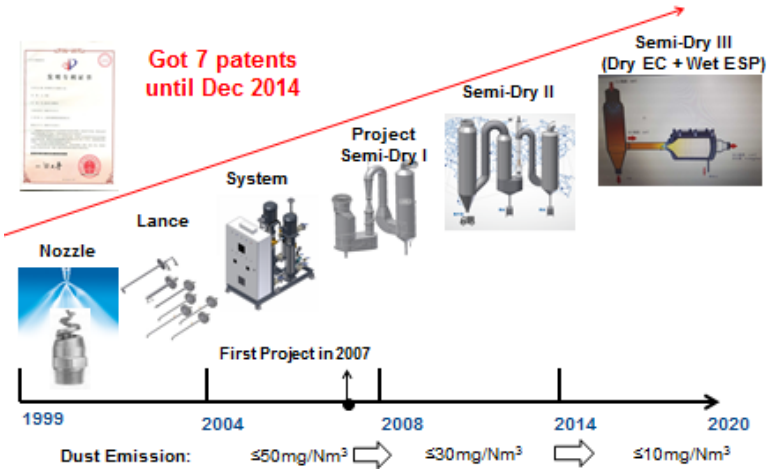

Figure 1 BOF primary off-gas cleaning semi dry systems

Semi dry Ⅰ uses wet evaporators + wet cleaning; semi dry Ⅱ uses dry type evaporators + wet cleaning; and semi dry Ⅲ uses dry type evaporator + Wet Electric Precipitator(WESP). BOF Semi dry Ⅱ systems are the priority selection for China steel customers and are introduced in more detail in this paper.

2 DEVELOPMENT

Components

A typical semi dry Ⅱ system is composed of four key parts:

1）A dry type evaporator: for cooling gas from 700-900°C to 260 °C and collecting 40-80% of total dry dusts；

2）Secondary wet evaporating and cleaning tube: for cooling gas from 260 °C

to 70 ºC or below and cleaning dusts to 100mg/m3 at outlet.

3）Long ring slit venture: cleaning dust to 30mg/m3 or below

4）Cyclonic mist separator. seen in Figure 2.

The system is connected with duct by non-metallic compensation adaptor; or new type of water seal system.

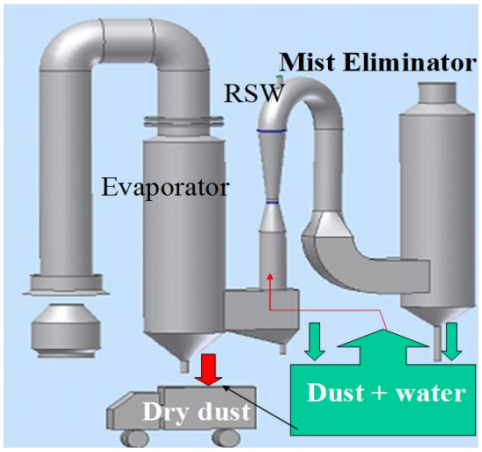

Figure 2 A typical BOF semi dry cleaning system

Operation Results

Customer A

- BOF converter size and qty: 80tx2
- Process: dry type evaporator + dry cleaning system or wet leaning system bypass
- Operation time: since 2005
- Operation results: ≦20mg/m3 at flare stack and ≦5mg/m3 at outlet of gas holder, seen in Figure 3.

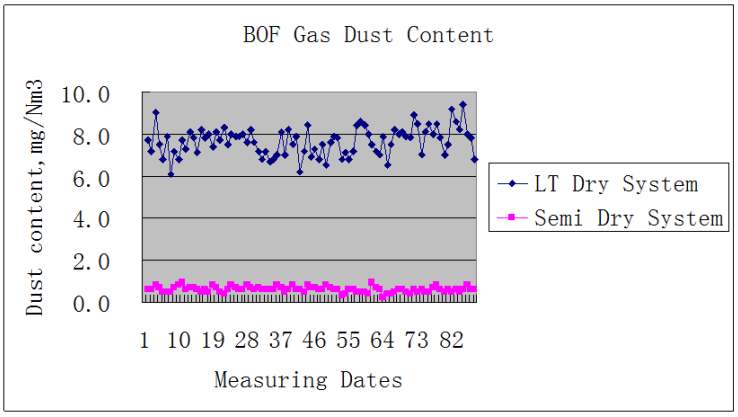

Figure 3. Dust content of recovered BOF gas: Semi dry vs. Dry system

Customer B

- ☐ **BOF converter size and qty: 120tx3**
- ☐ **Process: dry type evaporator + wet leaning system**
- ☐ **Operation time: since 2017**
- ☐ **Operation results: ≦30mg/m3 at flare stack.**

Customer C

- ☐ **BOF converter size and qty: 180tx3**
- ☐ **Process: dry type evaporator + wet leaning system**
- ☐ **Operation time: since 2016**
- ☐ **Operation results: ≦30mg/m3 at flare stack.**

Water flow rate: decrease from 950m3/h to 500m3/h

Coke waste water re-use: 50m3/h

Discussion

A, Dust content and gas pressure drop analysis

It is well known that dust content by venturi depends on inlet dust content; dust particle sizes; water/gas ration; design of venturi; technical parameters; manufacture quality; water spraying methods; gas pressure drop between inlet and outlet; however when it is put into operation, dust content is strongly related to gas pressure drop between inlet and outlet. As a examples, we can see from below curve: if we want to control dust content to 100**mg/Nm^3**， gas pressure drop between inlet and outlet should be 10-12 KPa; if this drop can be 14-16 KPa or above，dust content **can be 50mg/Nm^3** or below. This is the cases for present wet cleaning systems. In semi dry systems only 10 kPa gas pressure drop is needed for 30mg/m3 or below because of more stages of cleaning.

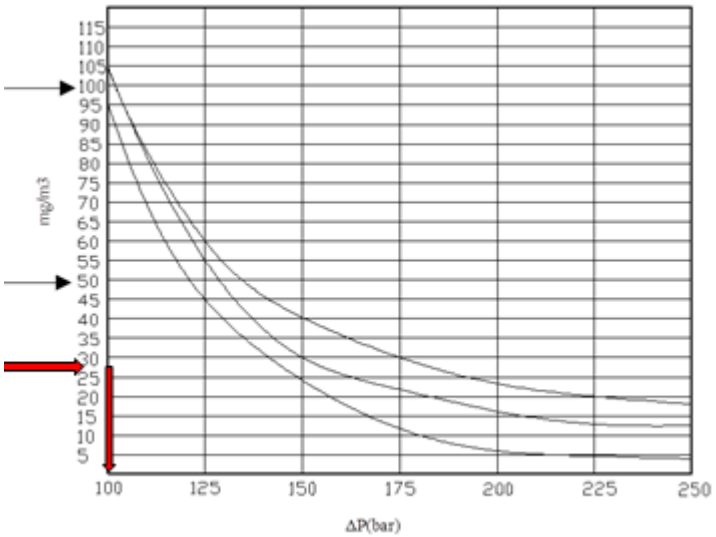

Figure 4 BOF semi dry cleaning system: dust content vs gas pressure drop

Gas cooling by saturation or evaporation---how water saved?

There are usually four types of gas cooling methods for BOF primary gas cooling after 900-1000°C: venturi; saturater; wet evaporator; and dry evaporator: venture and saturator use water increase temperature heat to withdraw gas heat; evaporator use water evaporation heat in dry and semi dry systems which have two characteristics: one is to use latent heat, so water needed can be decreased by 90%; second is that spray velocity is very high, dust collection efficiency is also high. It is measured that dust bigger up 1μm can be collected by 99%, much high than first venturi. Comparisons for four different cooling methods can be seen in table 2.

Table 1 Comparisons of BOF gas cooling methods(300t BOF)

Cooling methods	A、Venturi	B、Saturator	C、Dry Evaporator	D、Semi dry
1. Water flow rate, t/h	**1000**	**1000**	**80**	**80**
2. Gas pressure drop, kPa	3-5	1	0.3	0.3
3. Gas velocity, m/s	40-60	5	5	5
4. Investment of cooling equiment	low	middle	high	high
5. Investment of water equipment	high	high	low	low
6. Operation costs of water system	high	high	low	low
7. Installation time	short	short	long	long
8. Dust deal with	Waste water	Waste water	Dry dust	Dry dust

3 CONCLUSION

A, Semi dry BOF gas cleaning systems can meet the extreme strict environment protection requirements in low revaming investment and short down time.
B, Present wet systems may be revamped for low dust emission and more benefits.
C, Semi dry system have more functions such as treatment and re-use waste water.

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