Trend of dust collecting facilities for OG system

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Abstract: The trend of wet type dust collecting facilities as part of converter off-gas recovery system with comparing the Ring Slit Washer (RSW) with conventional venturi scrubber type (PA venturi) dust collector from the view point of renewal of old fashioned wet scrubber with least investment.
Key words: Energy saving, Dust collecting performance, Wet type dust collector, Converter off-gas recovery system

1. Introduction

The environmental control and energy saving are important issues to consider in every field. Especially the steel making factories that owns large spaces, lots of facilities and man powers, and consumes lots of energy and utilities are sure to have much influence on the neighboring environment and livings around steel making factories, and are always necessary improvement.

The LD gas exhausted from the converter contains lots of dusts mainly consist of FeO/Fe_2O_3, so for the dust collecting facilities of the OG system (Converter gas recovery system) would become significant more and more in terms of not only the increase of dust collecting efficiency but also of improvement of neighboring environment.

This document indicates the recent trend of wet type dust collecting facilities as part of OG system by comparing the conventional model of them.

2. Dust collecting system for OG system

Fig.4 shows the dust collecting facility consists of Quencher venturi and P-A venturi. This is one of the conventional dust collecting facilities of OG system.

This model is two-staged dust collecting facility. 1^{st} dust collector is Quencher of venturi scrubber type, where mainly coarse dusts are removed, and 2^{nd} dust collector is P-A venturi of venturi scrubber having movable throat, where mainly fine dusts are removed. Both of them have throat part of rectangular cross-section.

Fig.5 shows the dust collecting facility consists of Saturator and Ring slit washer (RSW). This is one of the dust collecting facilities adopted into today's modern OG system. Spray tower type Saturator has a large diameter and the pressure loss there is very low. In Saturator, spraying gas-cleaning water not only removes coarse dusts from the LD gas but also gets the LD gas to be saturated. After that, the LD gas flows into the throat part of RSW at high velocity. And its gas flow collides and mixes with droplets of gas-cleaning water sprayed from above the RSW, and then fine dusts in the gas are caught into the droplets.

3. Dust collecting mechanism of Venturi scrubber (Wet type dust collector)

Both P-A venturi and RSW are venturi scrubber type dust collectors, and it is wet type dust collecting system of trapping the fine dusts by means of water droplets that are hard to trap on their own.

Basic mechanism of wet type dust collecting is firstly trapping the dusts into the droplets of spraying gas-cleaning water, and then separating the droplets trapping dusts from the gas by passing through the mist separator using inertial force and collision. However, the finer dusts are able to pass through between water droplets.

In order to trap these fine dusts, venturi scrubber equips throat mechanism to accelerate the gas, and by colliding with the high velocity gas flow and the droplets of gas-cleaning water, they are miniaturized, accelerated and dispersed uniformly in the gas flow passage.

Therefore, dust-collecting performance of venturi scrubber is influenced by followings;

1) Colliding between high velocity gas flow with fine dusts and gas cleaning water as uniform as possible;

In case that the collision of gas flow with gas-cleaning water is not uniform, miniaturization of gas-cleaning water droplets is not enough and then probability of

collision with fine dusts becomes low.

2) Spraying the appropriate gas-cleaning water flow rate;

Dust collecting performance becomes low whether the gas-cleaning water flow rate is too low or too high.

It's generally assumed that the wet type dust collector requires much gas-cleaning water and discharges much dirty water to the outside of the facilities, but actually in dust collecting facilities for OG, feeding water to the dust collecting facilities and discharging water from them is very little because gas-cleaning water is used re-circulating through the water treatment system.

4. Comparison between Saturator/RSW type and Quencher/P-A type

Fig.1 shows dust collecting performance characteristic of P-A type (Quencher venturi / P-A venturi) and RSW type (Saturator / RSW), and it shows the relationship of Required pressure loss and Outlet dust content of both type in some gas flow rate.

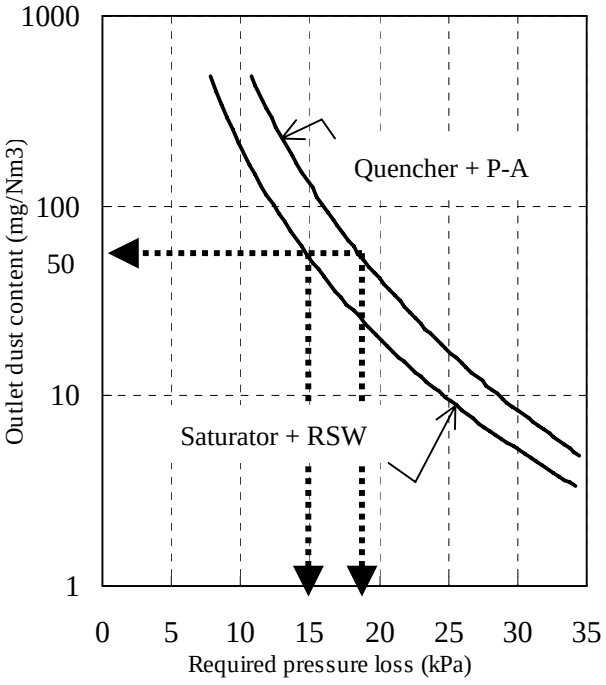

Fig.1 Dust collecting performance of Quencher/P-A venturi and Saturator/RSW

Venturi scrubber requires pressure loss in order to make gas flow high velocity. In case of the same dust collecting performance (Outlet dust content: 50mg/Nm3), required pressure loss of RSW type is lower than that of P-A type. That is, dust collecting performance of RSW type is higher than that of P-A type under the same pressure loss.

This result is mainly because of not only adopting Saturator as 1st dust collector but also difference in structure between P-A venturi and RSW.

Both of P-A type and RSW type increase efficiency of trapping dusts by miniaturizing water droplets and dispersing them uniformly at throat part. This dust collecting mechanism is same.

In P-A venturi, however, it is inevitable that some shortcuts of gas flow occur because of its structure around damper plates. Some of the gas is not through the trapping part (throat part) but through this shortcut path.(Refer to Fig.4)

Whereas, RSW, it is symmetric structure, have no shortcuts like that. And spraying gas-cleaning water from above RSE enables water droplets to disperse uniformly in throat part. Besides, RSW has longer throat part which is collision and mixing part of high velocity gas flow and water droplets, thereby dust collection efficiency is increased.

As described above, RSW have higher dust collecting performance than P-A venturi at a same pressure loss because collision of gas flow with gas-cleaning water is more uniform. In other words, at a same dust collecting performance, required pressure loss in RSW is lower than that in P-A venturi.

Fig.3 shows required gas-cleaning water, required pressure loss and power consumption of Quencher /P-A venturi type and Saturator / RSW type in case of same dust collecting performance of some LD gas flow rate.

As described above, in case of same dust collecting performance, pressure loss required in RSW is lower than that of P-A venturi. In addition, RSW is used normally being combined with Saturator for 1DC, where the required pressure loss is very low as compared with Quencher of venturi scrubber type.

The pressure loss required of Saturator / RSW type is 76% in that of Quencher / P-A venturi type, including this pressure loss in 1DC.

Required gas-cleaning water flow rate is not much difference between Quencher and Saturator, but required gas-cleaning water in RSW is lower than that in P-A venturi. This is because not only RSW is symmetric structure, but also throat part of RSW is enough long to accelerate the gas-cleaning water for miniaturizing water droplets and disperse it uniformly. As a result, RSW can achieve the required dust collecting performance with minimum gas cleaning water flow rate.

Whereas, because throat part length of P-A venturi is only 10% in it of RSW, miniaturizing and uniform dispersing of gas-cleaning water is not enough. So, in order to cover it, P-A venturi requires more large gas-cleaning water flow rate for achieving the same dust collecting performance as RSW.

Comparing with Quencher/P-A venturi type, Saturator /RSW type can achieve required dust collecting performance with lower pressure loss and less gas-cleaning water, that is, it enables capacity of I.D.Fan and gas cleaning water pump to be smaller, and can reduce power consumption.

5. Other merits of Saturator / RSW type

1) Low maintenance works

Dust adhesion and accumulation or wear at the throat part of venturi scrubber are major problems in dust collector of this kind. In the case of movable throat venturi of RSW, however, its throat part is free from such problems as dust adhesion, dust accumulation and wear because a passing fluid flow in a condition in nearly-complete parallel with the surface due to its structure. And also, Saturator is free from such problems because of its simple structure.

In addition, spray nozzles for gas-cleaning water are free from clogging, and nozzle wear is hardly occurs because hollow-cone type spray nozzle of large aperture is adopted in RSW type.

Normally, these are maintenance-free except at periodic converter shutdown.

2) Compact layout

Layout of P-A type is normally separated Quencher and P-A venturi (Fig.4). Whereas, layout of RSW type is not only separate type but also one tower type that RSW is equipped in Saturator as shown in Fig.5. And also, the revamping of only 1st DC or 2nd DC is possible as appropriate.

3) Po control

RSW (or P-A venturi) have an important role of Hood gas pressure (Po) control as well as of dust collecting.

By changing movable throat opening of 2nd DC in accordance with generated gas flow rate, OG can minimize both puffing out of exhaust gas from the converter's mouth and coming in of air to the Hood during blowing.

Fig.2 shows the relationship of damper opening and gas flow rate. Available variation range of RSW damper opening is larger than that of P-A venturi opening. (Gas flow rate is 100% when RSW damper opening is nearly 100%, whereas, gas flow rate is already 100% when P-A damper opening is about 65%.) This means that RSW can adjust for small changing of gas flow rate. That is, RSW can be more accurate control of Po.

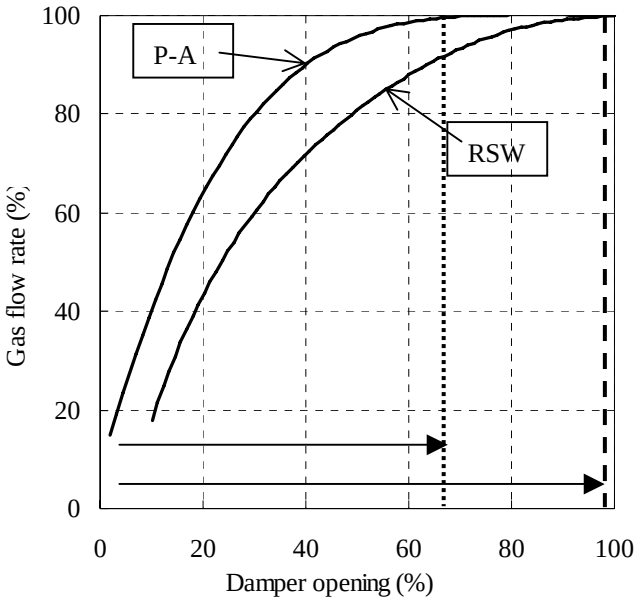

Fig.2 Gas flow rate characteristic

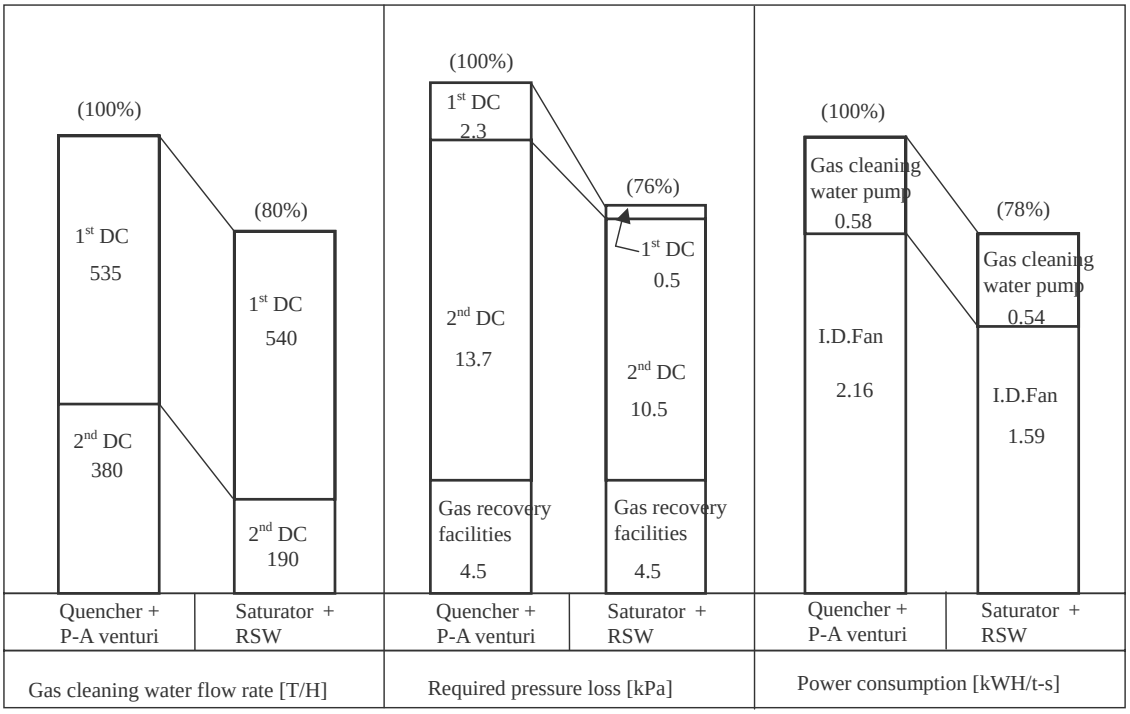

Fig.3 Comparison between P-A venturi type and RSW type

6. Result of dust collecting performance for Saturator / RSW type

Table-1 shows some results of dust collecting performance of OG system adopting Saturator / RSW type dust collector.

Table-1 Results of dust collecting performance

Plant	Guaranteed value	Actual measured value
A	50 mg/Nm3	5 mg/Nm3
B	40 mg/Nm3	5 mg/Nm3
C	30 mg/Nm3	5 mg/Nm3
D	40 mg/Nm3	14 mg/Nm3
E	50 mg/Nm3	6 mg/Nm3
F	100 mg/Nm3	9 mg/Nm3

7. Conclusion

Today, we recommend adopting Saturator / RSW type to dust collecting facility of OG system.

Saturator / RSW type dust collector have higher dust collecting performance, and it can achieve a specified dust collecting performance with lower pressure loss, less gas-cleaning water and less power consumption than conventional wet type dust collector.

And also, this type dust collector is suitable for replacing and revamping of existing facilities because of its flexible layout. Improvement of dust collecting performance and energy saving effect can be achieved by minimum revamping works.

The reason for adopting the wet type dust collector to OG system is above all extremely high safety, which discharging the gas in this facility in emergency is very quick because its facility itself is compact and potential of explosion is very little because its facility treats the gas in a wet condition.

Adopting RSW type or revamping into RSW type can achieve higher dust collecting performance and energy saving effect, keeping this high safe operation. So, it can meet the needs growing more and more from now for energy saving and decrease of environmental burden.

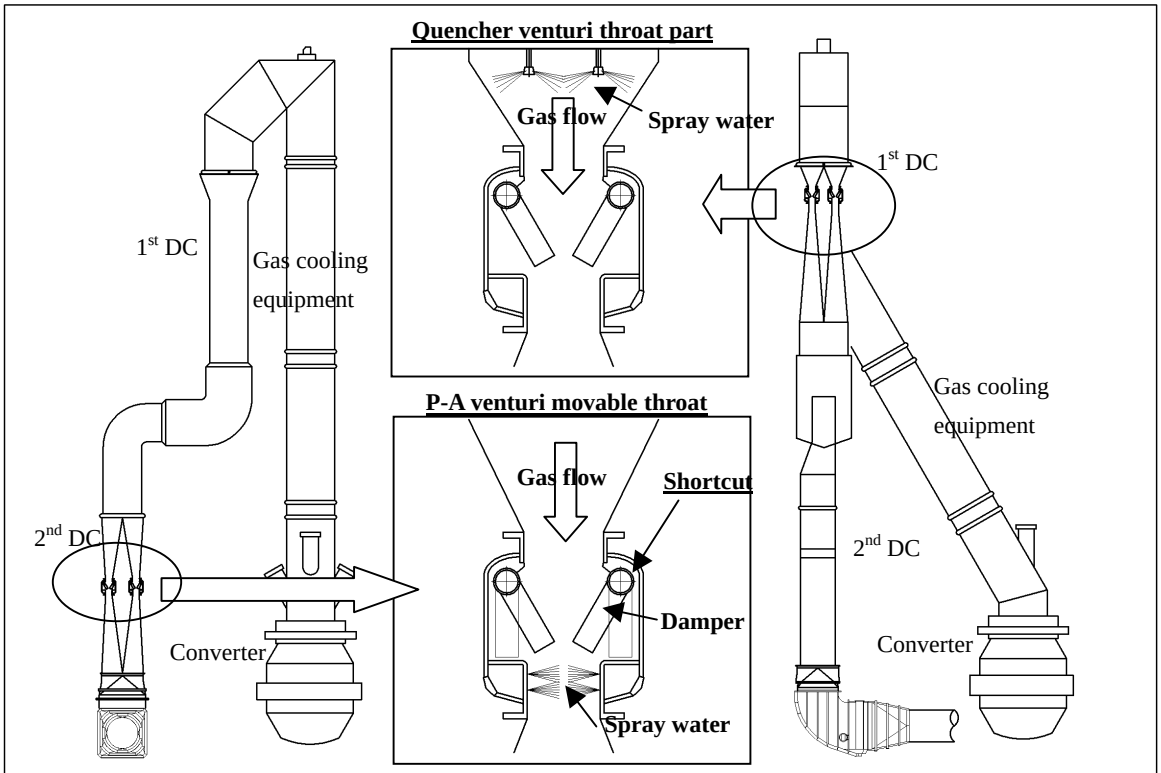

Fig.4 Quencher / P-A venturi type Dust collector

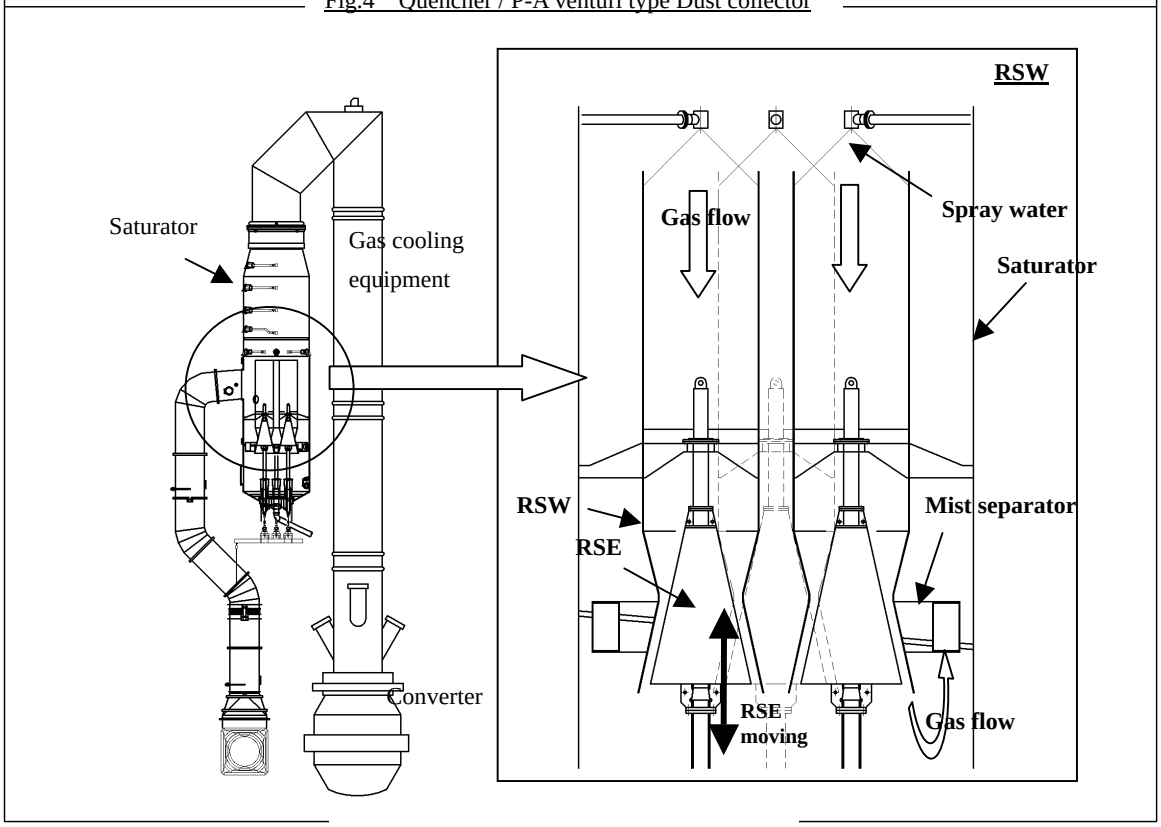

Fig.5 Saturator / RSW type Dust collector