Mitsubishi Power Contribution:
Current Projects in the area of Environment Protection in Serbia and Region
and
New Technology (CCS) for the future

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Abstract

There is a growing need for Air Quality Control System (AQCS) under the situation that regulation on emission has become more stringent all over the world.

To meet the world lowest level regulation in thermal power plants, Selective Catalytic Reactor (SCR), Electrostatic Precipitator (ESP) and Flue Gas Desulphurization (FGD) is the key components. In addition, reduction of CO_2 emission is demanded considering global warming.
Not only each equipment performance but system integration as total AQCS is important.

In this paper, Mitsubishi Power, Ltd.(MPW) introduces state-of-the-art MPW's AQCS technology, and on-going Current Major AQCS Projects in Serbia – TENT A FGD and TENT B FGD
and completed project in the Region – Ugljevik FGD that contribute to Environment Protection with a great deal. Also MPW makes introduction of CCS technology, one of new technologies for the future.

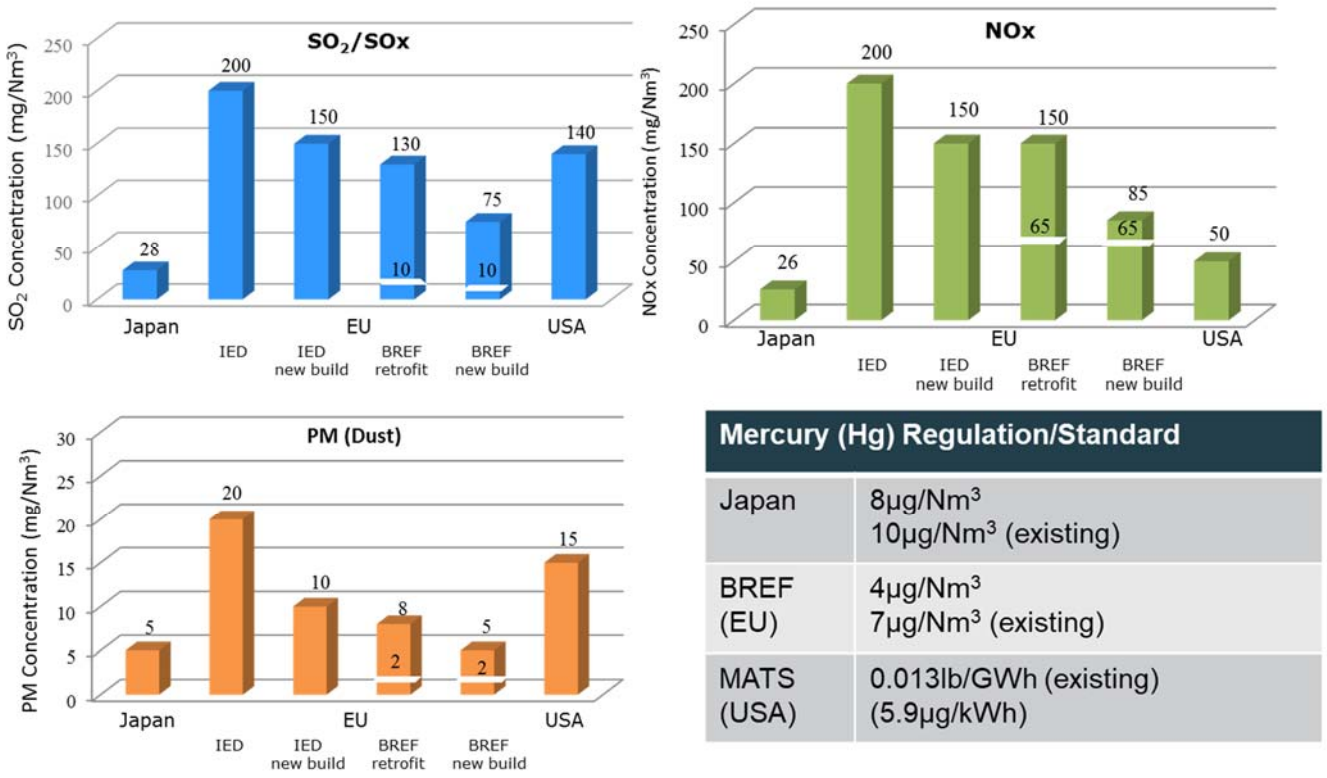
1. Introduction

There is a growing need for Air Quality Control System (AQCS) under the situation that regulation on emission has become more stringent especially in the Europe area. Most of the European power station has been already coping with the EU directive regulation.

Mitsubishi Power, Ltd. (MPW) FGD technologies have contributed to remove SOx, NOx, and dust not only in EU countries but also in surrounding countries, such as East Europe and Balkan Area who are following to EU directive. This has necessitated installing AQCS technologies in all thermal power plants. It will be challenging task to meet the stringent pollution norms in the stipulated time.

As MPW technology has followed to regulation in Japan which is most severe in the world, and over 50 years of retrofit experience all over the world, MPW's FGD can be reliable solution to Balkan area, not only the new boiler but also retrofit AQCS plant.

Regarding the air pollutant emission regulation, typical requirement is shown in Fig. 1.



Mercury (Hg) Regulation/Standard	
Japan	8μg/Nm³ 10μg/Nm³ (existing)
BREF (EU)	4μg/Nm³ 7μg/Nm³ (existing)
MATS (USA)	0.013lb/GWh (existing) (5.9μg/kWh)

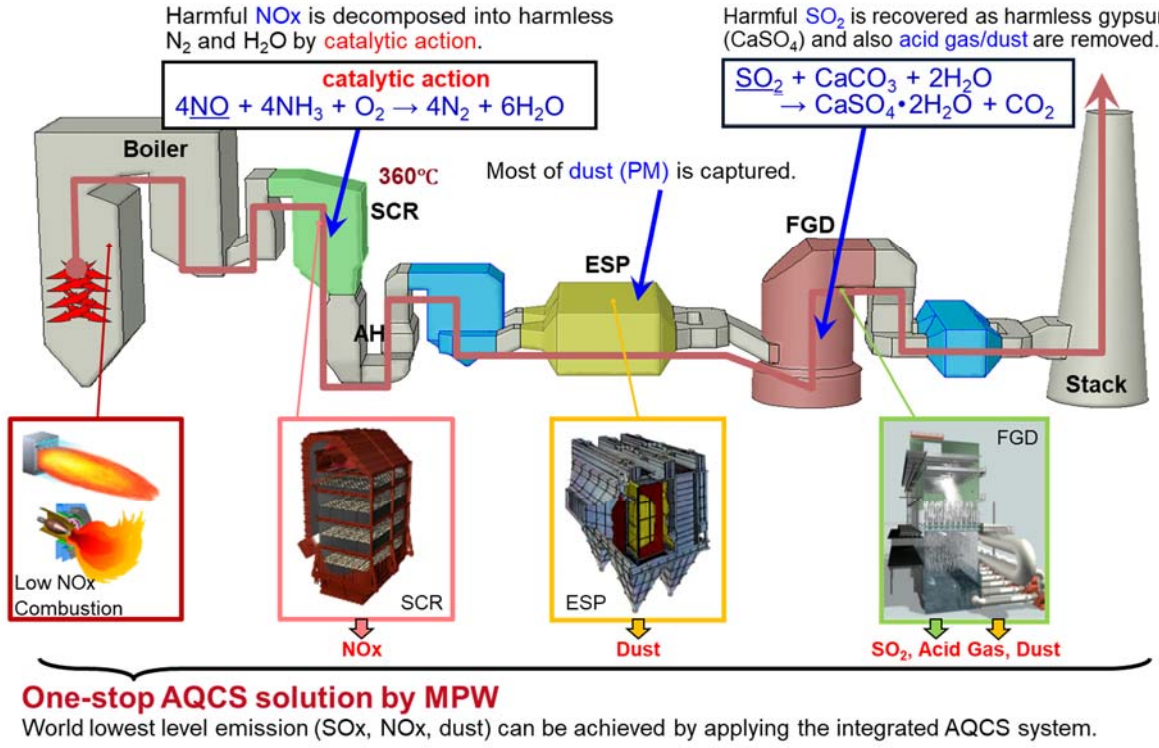
Fig. 1: Current standard emission regulation in Japan, EU, and USA

2. AQCS Solution by MPW

In 1960's, Japan faced problem of severe air pollution. To solve this problem, Japanese government decided to issue air pollutant emission regulation. Mitsubishi Heavy Industries, Ltd. (MHI) and Hitachi, Ltd. (HTC) respectively started the development of FGD and SCR technologies to contribute to activity of cleaning up the air pollution. In Feb. 2014, the power system division of MHI and HTC were merged and established Mitsubishi-Hitachi Power Systems, Ltd. (MHPS). MHPS has proved its own technology not only in Japan but also in Europe, USA, Asia and other areas as well. MHPS is changed to Mitsubishi Power, Ltd. (MPW) in Sep. 2020.

Not only the MHI and HTC's FGD and SCR business, in Oct. 2015, MPW integrated the precipitator business as well. Mitsubishi Heavy Industries Mechatronics Systems, Ltd. (MHI-MS) and Hitachi Plant Construction, Ltd. (HPC) establish a new company as an MPW group company. By this integration, all the Air Quality Control System (AQCS) components such as denitrification (De-NOx) equipment, electrostatic precipitators (ESP), flue gas desulfurization (FGD) equipment can be provided by MPW group and the company's expertise in all these components is incorporated in its total environmental solution.

By these solutions, world most stringent emission level of SOx, NOx, and PM can be achieved by integration of AQCS system.



As a result MPW AQCS has been currently applied to more than 300 units of FGD, 1000 units of SCR, and 3000 units of ESP all over the world as shown in figure 2.

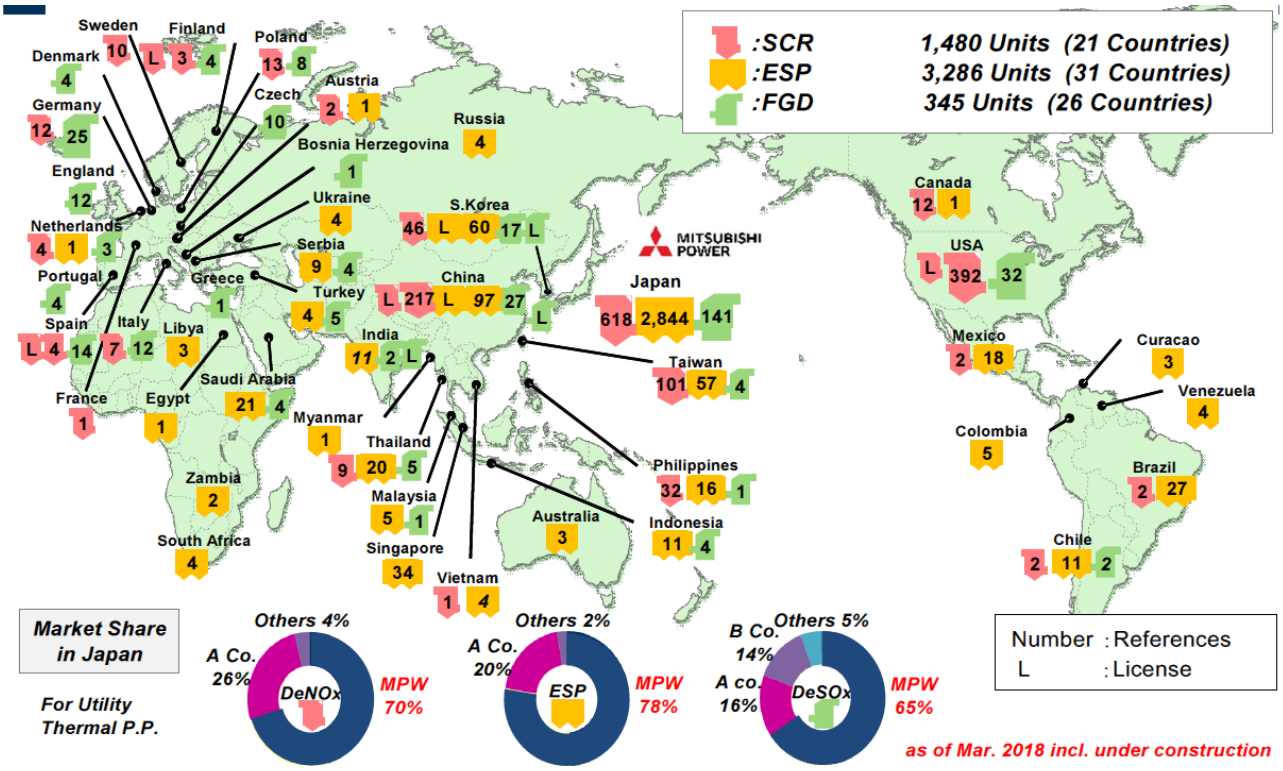


Fig. 2: MPW worldwide AQCS Delivery Record

3. MPW FGD Experience in Balkan Area No.1

[FGD completion: Ugljevik / Bosnia Herzegovina]

MPW, MPW-EDE and RUDIS contracted with RTU for the delivery of the Flue Gas Desulphurization (FGD) plant for the Ugljevik power plant capacity of 300 MW located in Bosnia and Herzegovina in July 2016.

The major specification of FGD plant is listed in Table 1.

Table 3-1: Major Specification of Ugljevik FGD

	Value
Boiler Fuel	Lignite
Flue Gas Flow Rate (Nm^3/h wet)	2.135.412
Inlet SO_2 (mg/Nm^3 6% O_2 dry)	20.000
Outlet SO_2 (mg/ Nm^3 6% O_2 dry)	200
SO_2 Removal efficiency (%)	99

The Feature of this Ugljevik FGD is very high in let SO2 concentration with high SO2 removal ratio, MPW designed for the optimized spray nozzle arrangement is the key technology to achieve such a high performance.

Figure 3-2: Overview of Ugljevik FGD plant

This Ugljevik FGD plant started hot commissioning from Dec. 2019. Due to COVID-19 situation, commissioning was suspended and restarted from Jul. 2020. Performance test was made by an independent authorized company. The major result of performance test is show in below. SO2 and dust emission complied with the required values.

Table 3-3: Major Performance test result

Item	Unit	Design	Actual	Result
Inlet SO_2	mg/Nm^3 6% O_2 dry	20,000	14,553	-
Outlet SO_2	mg/Nm^3 6% O_2 dry	<200	131	Satisfied
SO_2 removal efficiency	%	-	99.1	-
Inlet dust	mg/Nm^3 6% O_2 dry	<50	73.1	Satisfied
Outlet dust	mg/Nm^3 6% O_2 dry	<20	5.8	-

After successful performance test, FGD plant was handed over to RTU in Oct. 2020.

4. MPW FGD Experience in Balkan Area No.2 [
Ongoing FGD projects: Tent-A / Serbia]

MPW and Jedinstvo contracted with EPS for the delivery of FGD for Nikola Tesla Thermal power plant A #3 - #6, 350MW x 4unit in Serbia. In this plant, two set of 350MW Lignite boilers are treated in one FGD. 3.444.200Nm3/h is one of the largest FGD modules in the world.
The major specification of FGD plant is listed in Table 1.

Table 5-1: Major Specification of Tent-A FGD

	Value
Boiler Fuel	Lignite
Flue Gas Flow Rate (Nm^3/h wet)	4,340,000
Inlet SO_2 (mg/Nm^3 6% O_2 dry)	6,000
Outlet SO_2 (mg/ Nm^3 6% O_2 dry)	200
SO_2 Removal efficiency (%)	96.7

Not only its efficient FGD performance, but MPW's experienced multiple boiler treatment and Integrated Wet Stack technology is also applied to fit the very large unit in limited space.

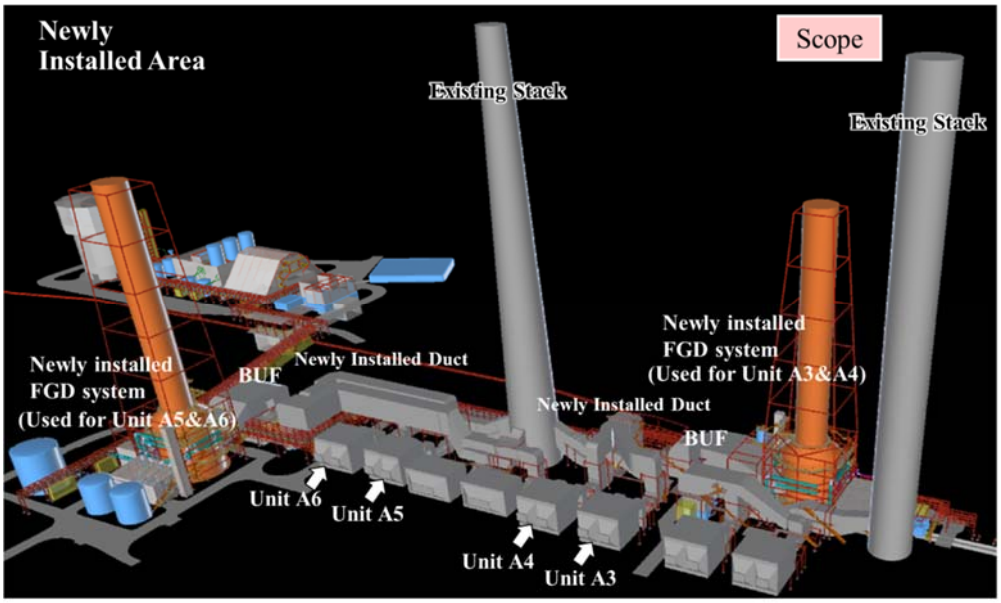


Fig.5-2 : 3D Overview of Tent-A FGD Plant

This Tent-A FGD project is under the construction and will be completed in 2023 and start operation.

5. MPW FGD Experience in Balkan Area No.3
[Ongoing FGD projects: Tent-B / Serbia]

MPW, MPW Belgrade, Gosa Montaza, Juzna Backa and Exing contracted with EPS for the delivery of FGD for Nikola Tesla Thermal power plant B #1 - #2, 670MW x 2unit in Serbia. In this plant, each 670MW Lignite boiler is treated in one FGD and total FGD units are 2.
The major specification of FGD plant is listed in Table 1.

Table 6-1: Major Specification of Tent-A FGD

	Value
Boiler Fuel	Lignite
Flue Gas Flow Rate (Nm^3/h wet)	3,950,000
Inlet SO_2 (mg/Nm^3 6% O_2 dry)	4,984
Outlet SO_2 (mg/ Nm^3 6% O_2 dry)	130
SO_2 Removal efficiency (%)	97.4

Considering BREF requirement, SO2 emission is reduced to 130 mg/Nm3. In addition to high performance of MPW's FGD, MPW's experience in Balkan area is also applied.

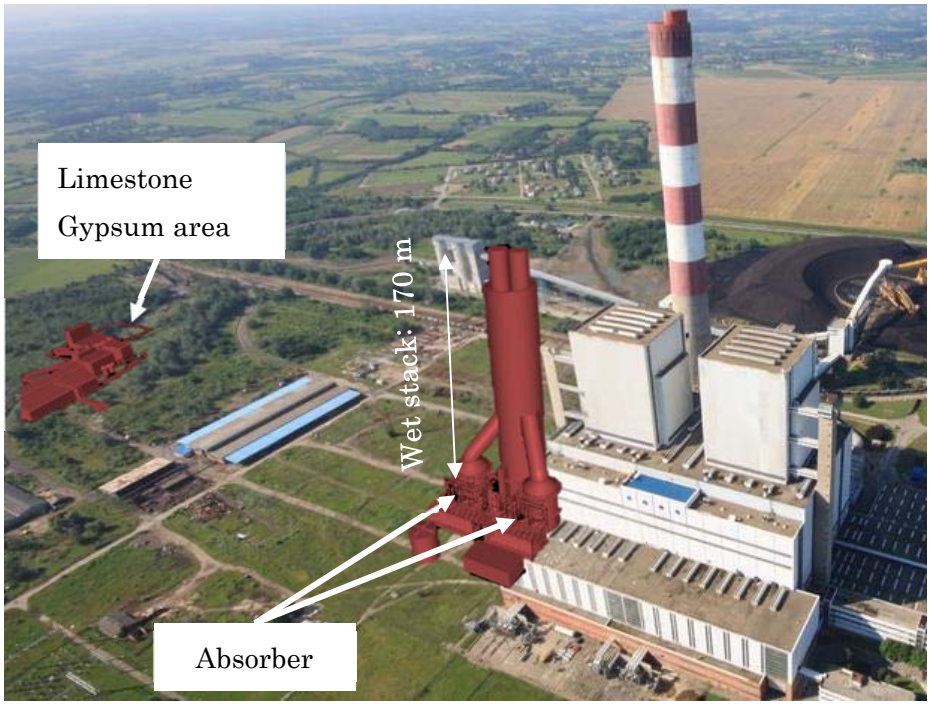


Fig.6-2 : Overview of Tent-B FGD Plant

6. Mercury (Hg) removal technology

There are two type of vapor phase mercury emitted from coal-fired boilers. They are elemental mercury (Hg^0) and oxidizes mercury (Hg^{++}). It is practically impossible to remove elemental mercury across ESP or FGD. On the other hand, oxidized mercury is removed from flue gas at FGD.

Mercury behavior in AQCS is shown in Figure 1. Hg is emitted from boiler as elemental Hg due to high temperature. Elemental Hg shall be oxidized to be captured across ESP and/or FGD.
MPW developed SCR catalyst with function of high mercury oxidation and low SO2 conversion.
Re-emission of removed mercury at FGD shall be avoided by controlling the oxidation - reduction potential (ORP) of absorbent slurry.

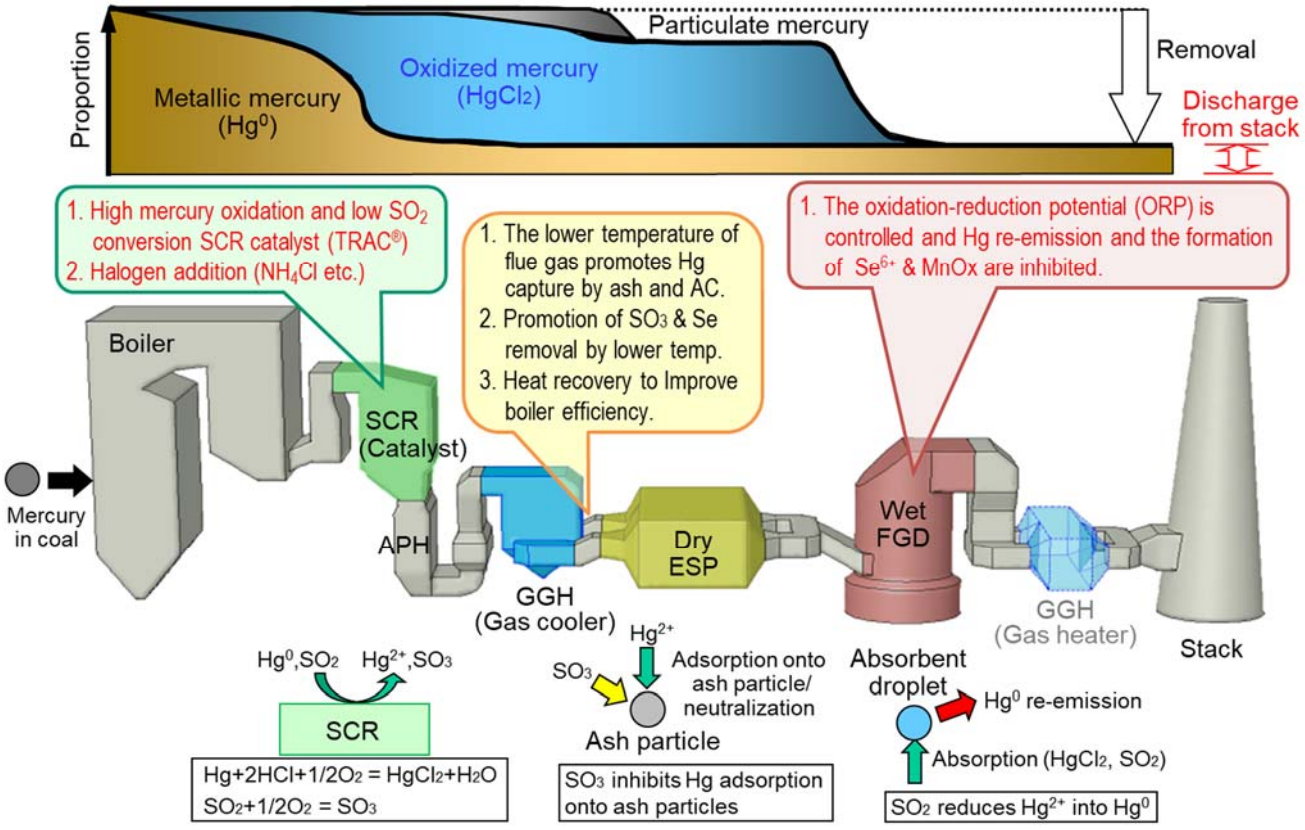


Figure 6-1: Hg behavior in AQCS

7. Carbon dioxide capture and storage (CCS) Technology

Mitsubishi Heavy Industries (MHI) has developed CO2 recovery process called KM CDR Process (Kansai Mitsubishi Carbon Dioxide Recovery Process) since 1990. CO2 capturing capability is up to 98% or higher. As shown in Figure 7-2, 14 plants are under operation and 2 are under construction.

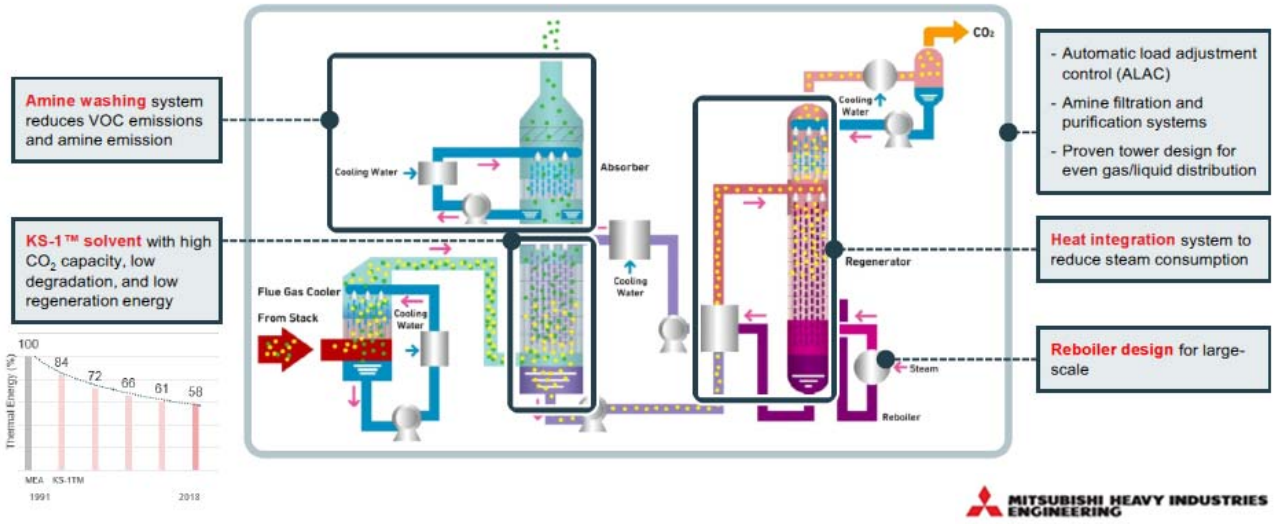


Fig.7-1 : Flow diagram of KM CDR Process

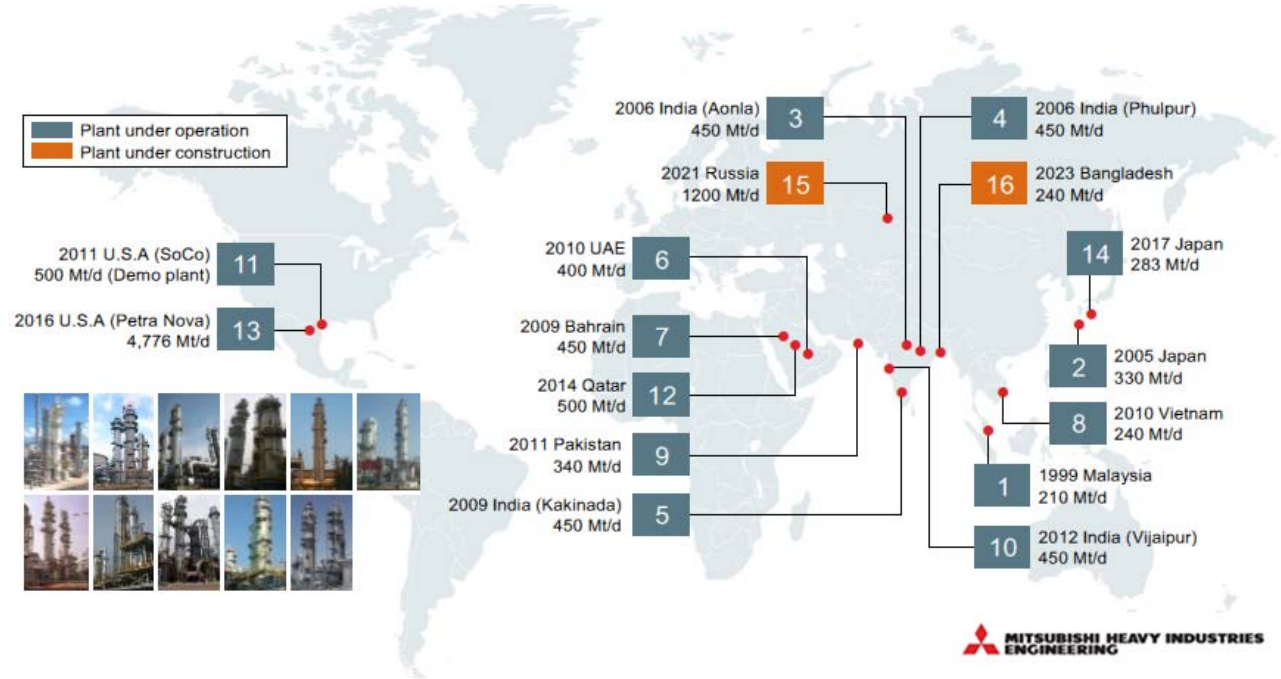


Fig.7-2 : Worldwide experience of KM CDE Process

8. Summary

Balkan area becomes one of the focused FGD market. MPW has become one of major FGD supplier in Balkan area.
Besides as described in the above, MPW has own special not only FGD but also SCR, ESP and mercury removal technologies. When BREF is applied to Balkan area in the future, MPW will be able to contribute to clean up air pollution in Balkan much more than now using our abundant experience.
In addition, MHI has developed own CO2 capturing technology as one of new technologies for the future.

Based on the enough experience and continuous R&D activities, MPW contributes to environmental protection for Serbia and Region. In addition, MPW contributes to Serbian industries by maximum utilization of local suppliers.

9. Reference

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