

Study of Hg and SO₃ Behavior in Flue Gas of Oxy-fuel Combustion System

September 14, 2011

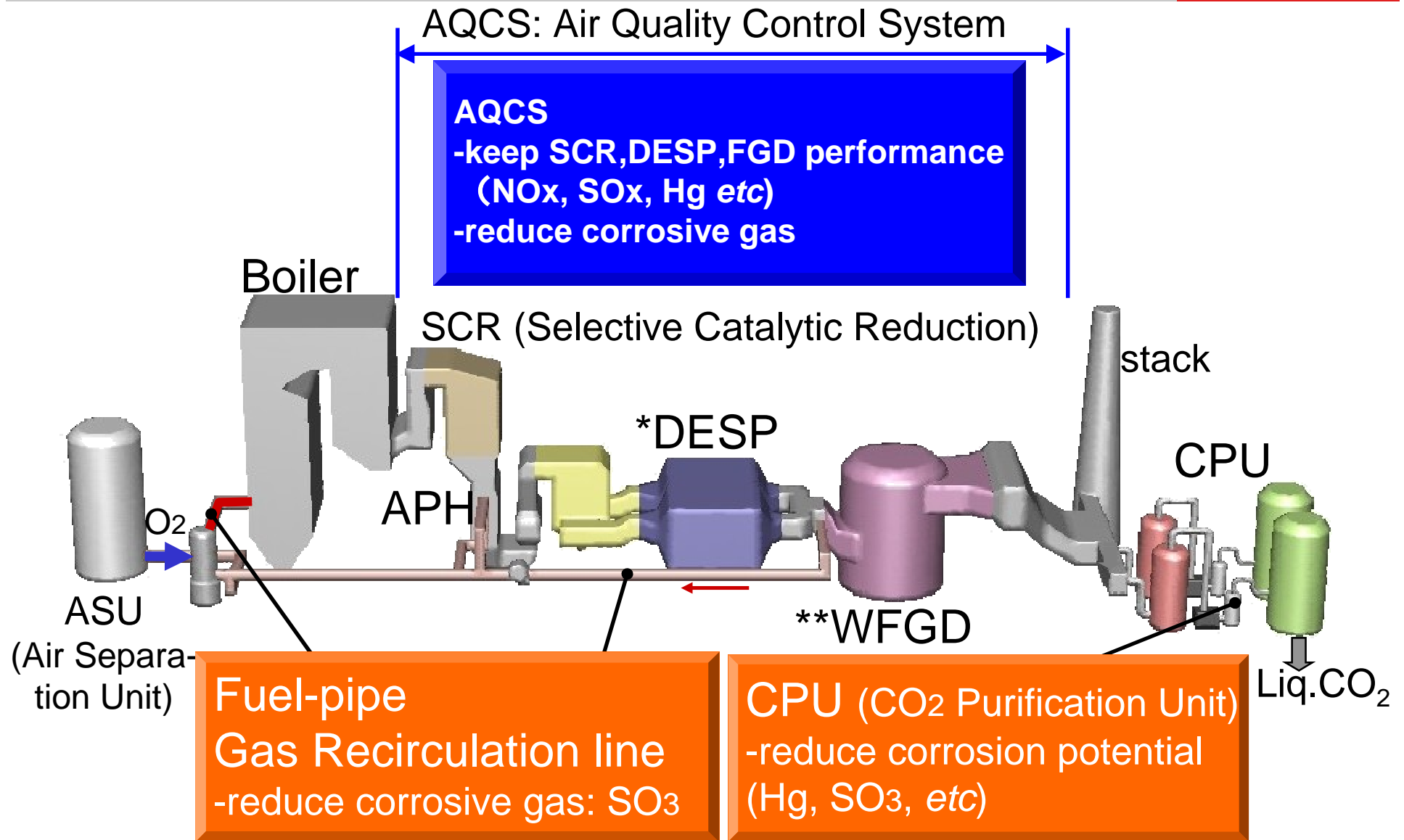
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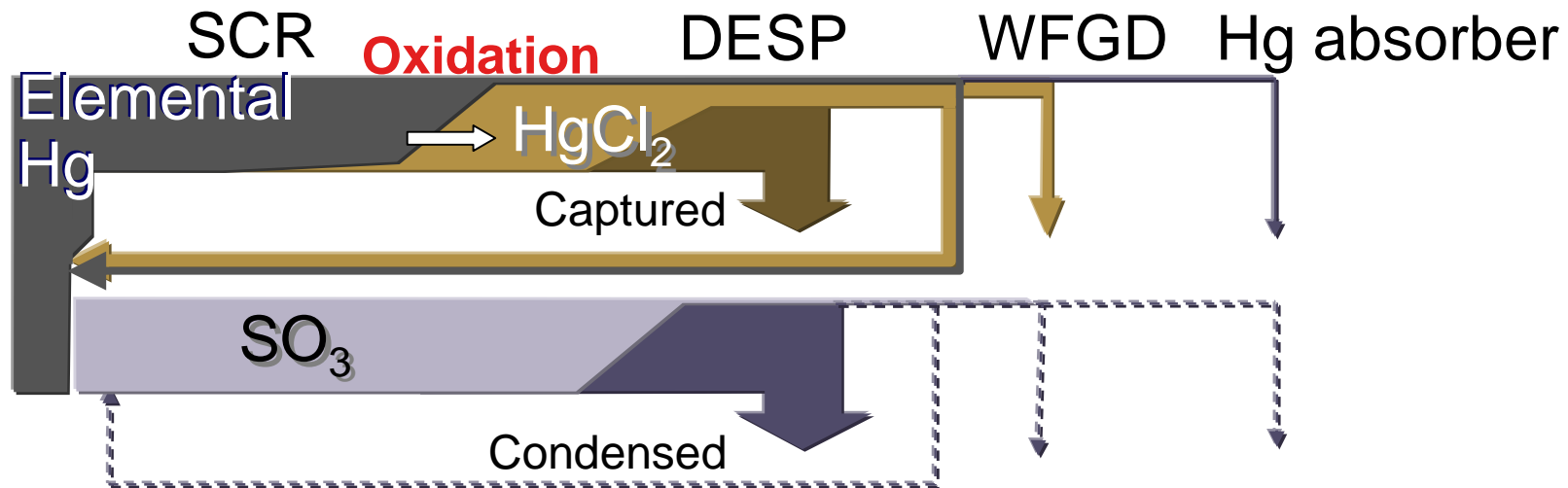
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1. Subjects on AQCS for Oxy-fuel Combustion
2. Pilot Plant Test
3. Hg and SO₃ Behavior in Oxy-fuel Combustion
4. Conclusion

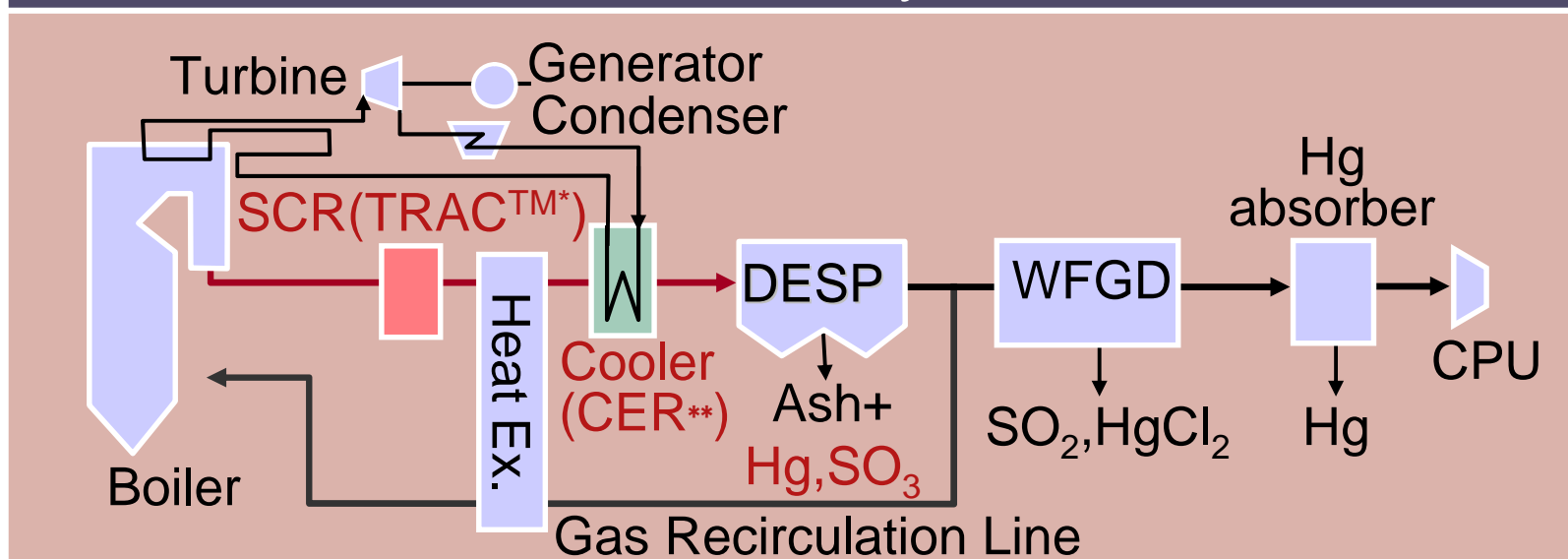
Subjects on AQCS for Oxy-fuel combustion



Concept of Hitachi New AQCS



Hitachi new AQCS for oxy-fuel combustion

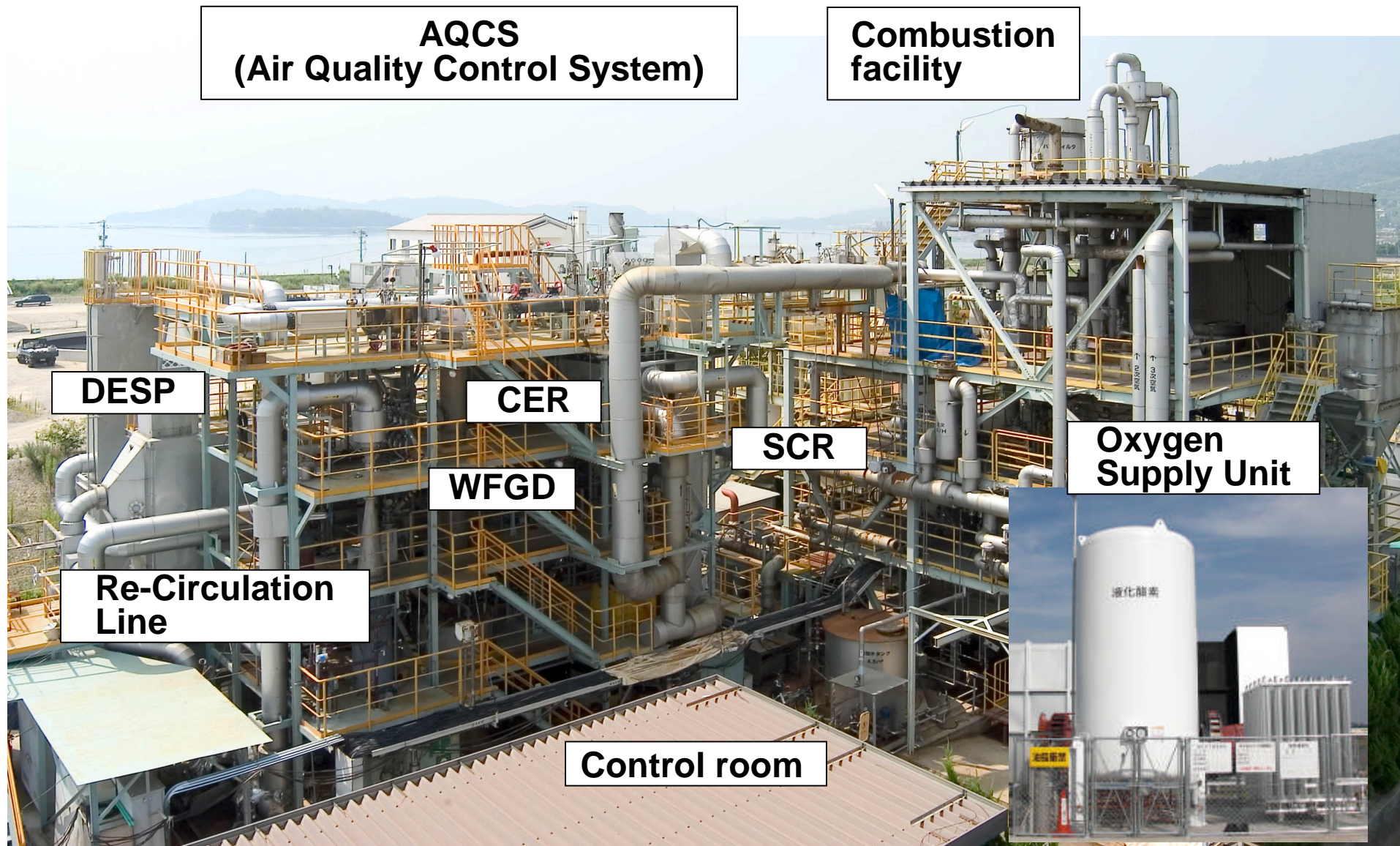


*TRAC™ (Triple Action Catalyst): Hitachi's new Hg oxidation catalyst

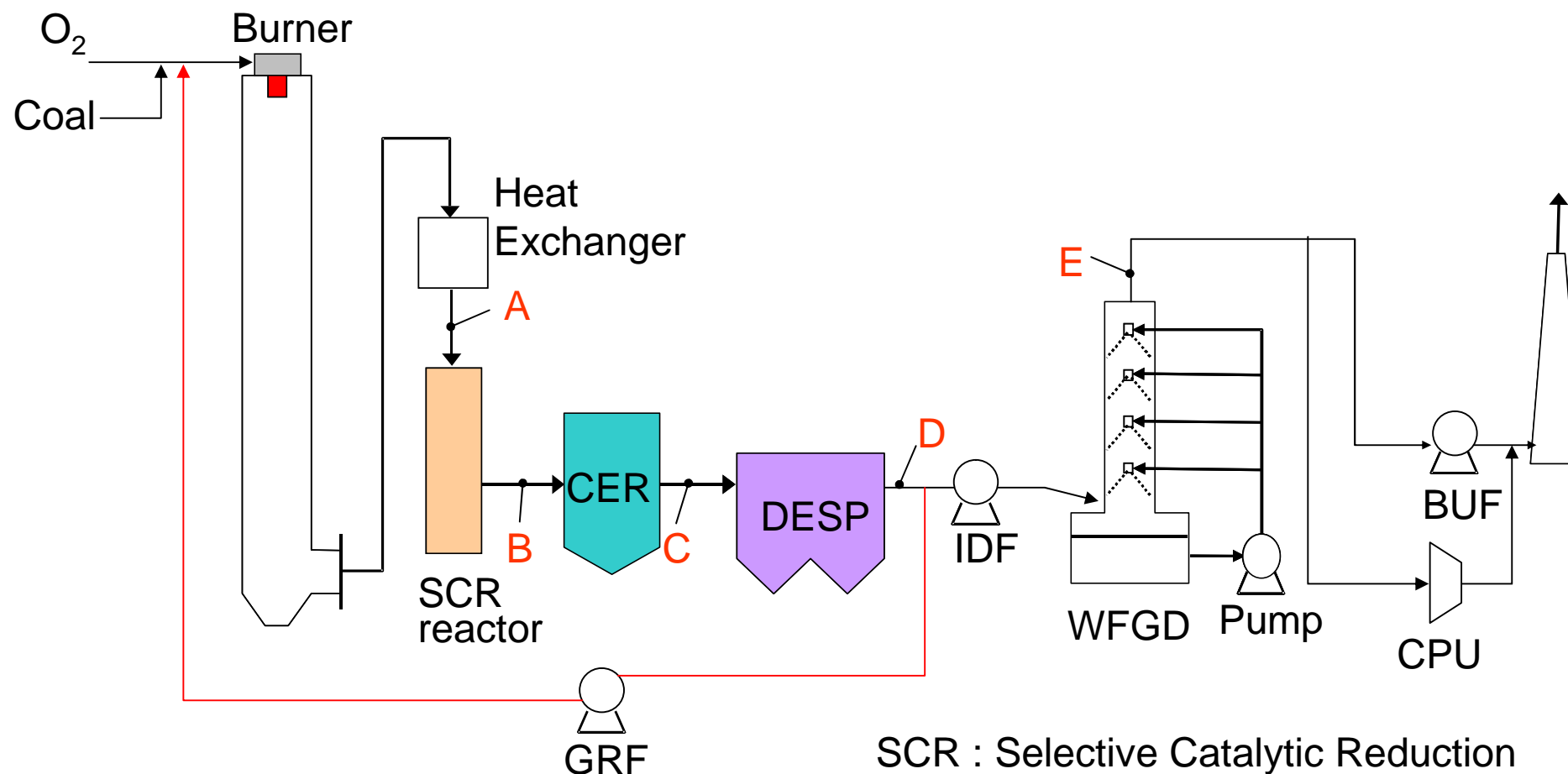
**CER (Clean Energy Recuperator)

Pilot Plant Test

Appearance of Pilot Test Plant (1.5MWth)

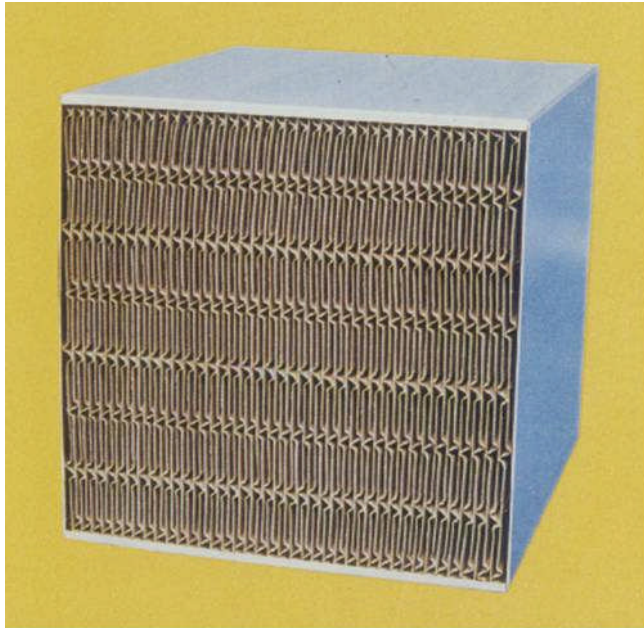


Schematic Diagram of Pilot Test Plant (1.5MWth)



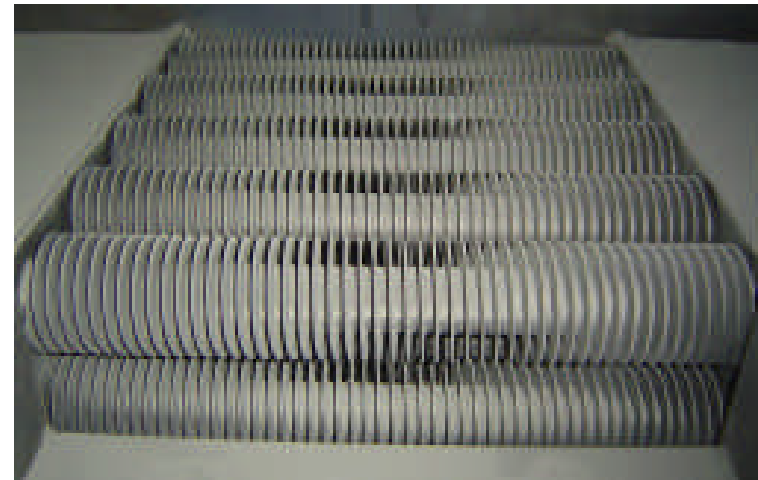
A~E: Hg and SO₃ Sampling Points

SCR : Selective Catalytic Reduction
CER : Clean Energy Recuperator
DESP : Dry Electrostatic Precipitator
WFGD : Wet Flue Gas Desulfurization



TRAC™ (Triple Action Catalyst)

- TRAC™ has a higher oxidation activity of elemental mercury while keeping a very low SO₂ to SO₃ conversion rate.



Finned tube in CER

- This structure of finned tube has been used without any troubles for many years in commercial plants in Japan

Coal Analysis

Coal brand	A	B	C
Proximate analysis			
Moisture (%)	3.7	2.0	4.2
Volatiles (% , dry)	36.3	19.0	38.8
Fixed Carbon (% , dry)	49.7	33.0	50.8
Ash (% , dry)	14.0	47.9	10.3
Ultimate analysis			
C (% , daf)	79.8	78.5	77.1
H (% , daf)	5.6	4.5	5.3
O (% , daf)	13.4	15.3	13.4
N (% , daf)	0.93	1.15	1.36
S (% , daf)	0.50	1.48	3.03
Hg (ppb , daf)	55	381	132
Cl (ppm , daf)	384	787	435
Ash analysis			
CaO (% , ash)	14.7	3.01	6.18

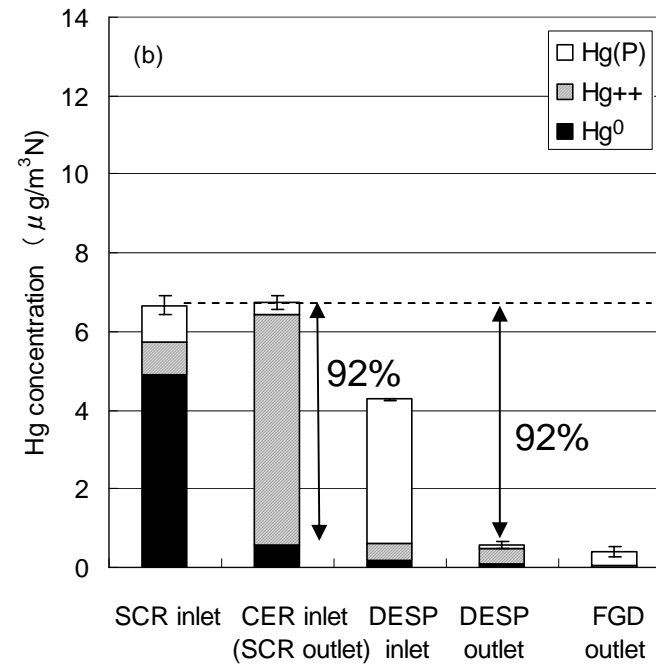
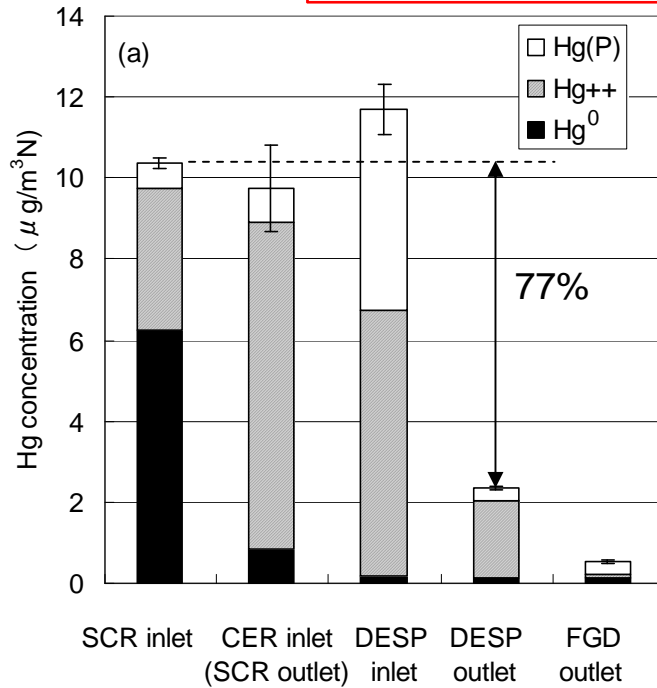
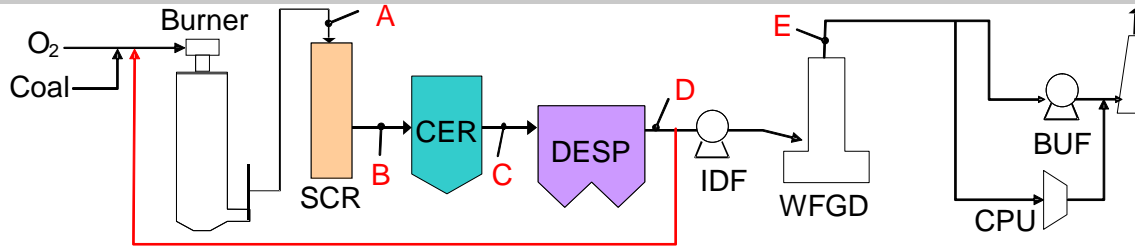
Gas composition at SCR inlet

Coal Brand	A		B		C	
	Air Combustion	Oxy-fuel Combustion	Air Combustion	Oxy-fuel Combustion	Air Combustion	Oxy-fuel Combustion
Exhaust gas amount (m ³ N/h)	1050	850	1050	850	1050	850
CO ₂ (% , dry)	13.5	85	13.5	85	13.5	85
O ₂ (% , dry)	3.5	8	3.5	8	3.5	8
H ₂ O (%)	10	31	14	40	10	30
SO ₂ (ppm, dry)	170	350	1000	4000	2000	8000
SO ₃ (ppm, dry)	7	29	35	123	71	224
Hg (μg/m ³ N, dry)	4	7	34	70	10	22
HCl (ppm, dry)	26	54	35	98	26	83

At DESP inlet temperature: 90°C (194°F)

Hg and SO₃ Behavior in Oxy-fuel Combustion

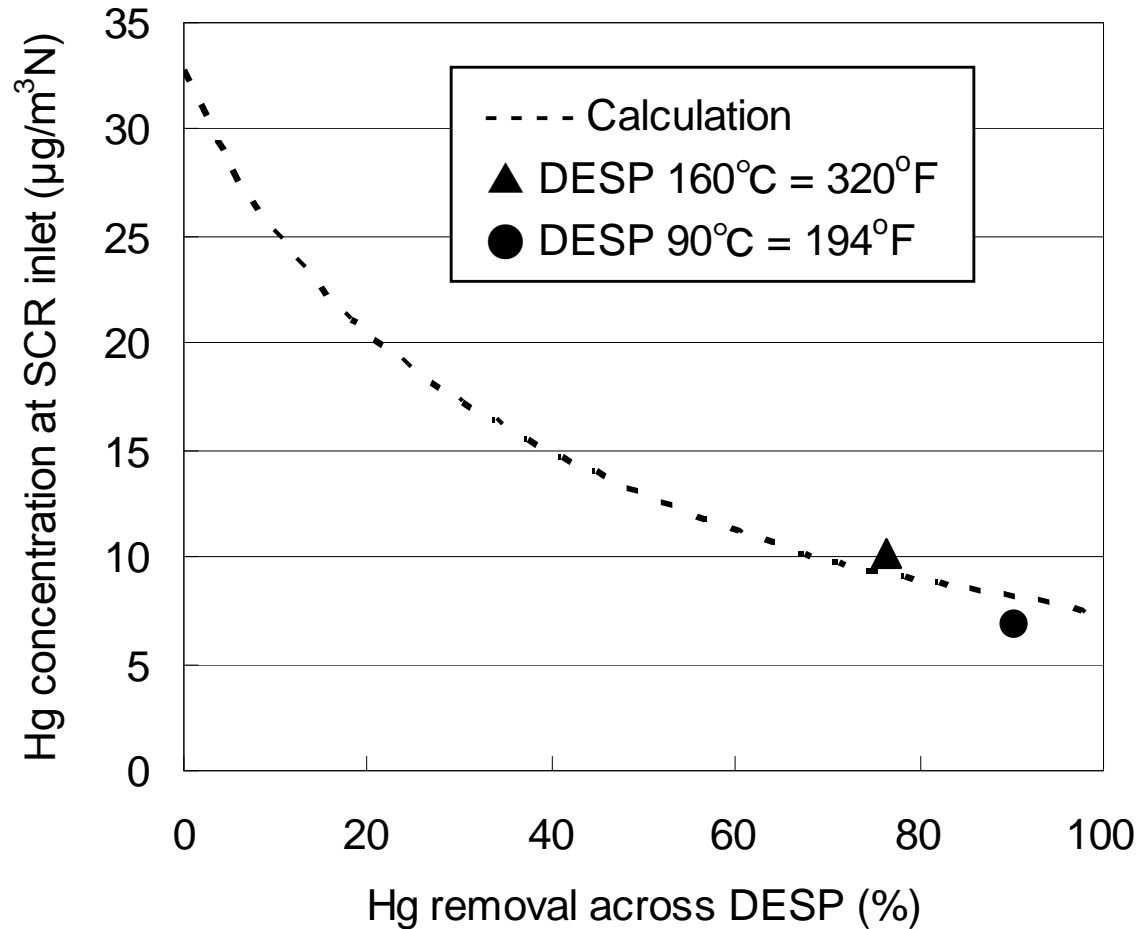
Hg behavior of oxy-fuel combustion with coal A



(a) Without CER (DESP inlet temp 160°C (320°F)) (b) With CER (DESP inlet temp 90°C (194°F))

• Hg removal across DESP increased from 77% to 92% by decreasing DESP inlet temperature from 160°C to 90°C

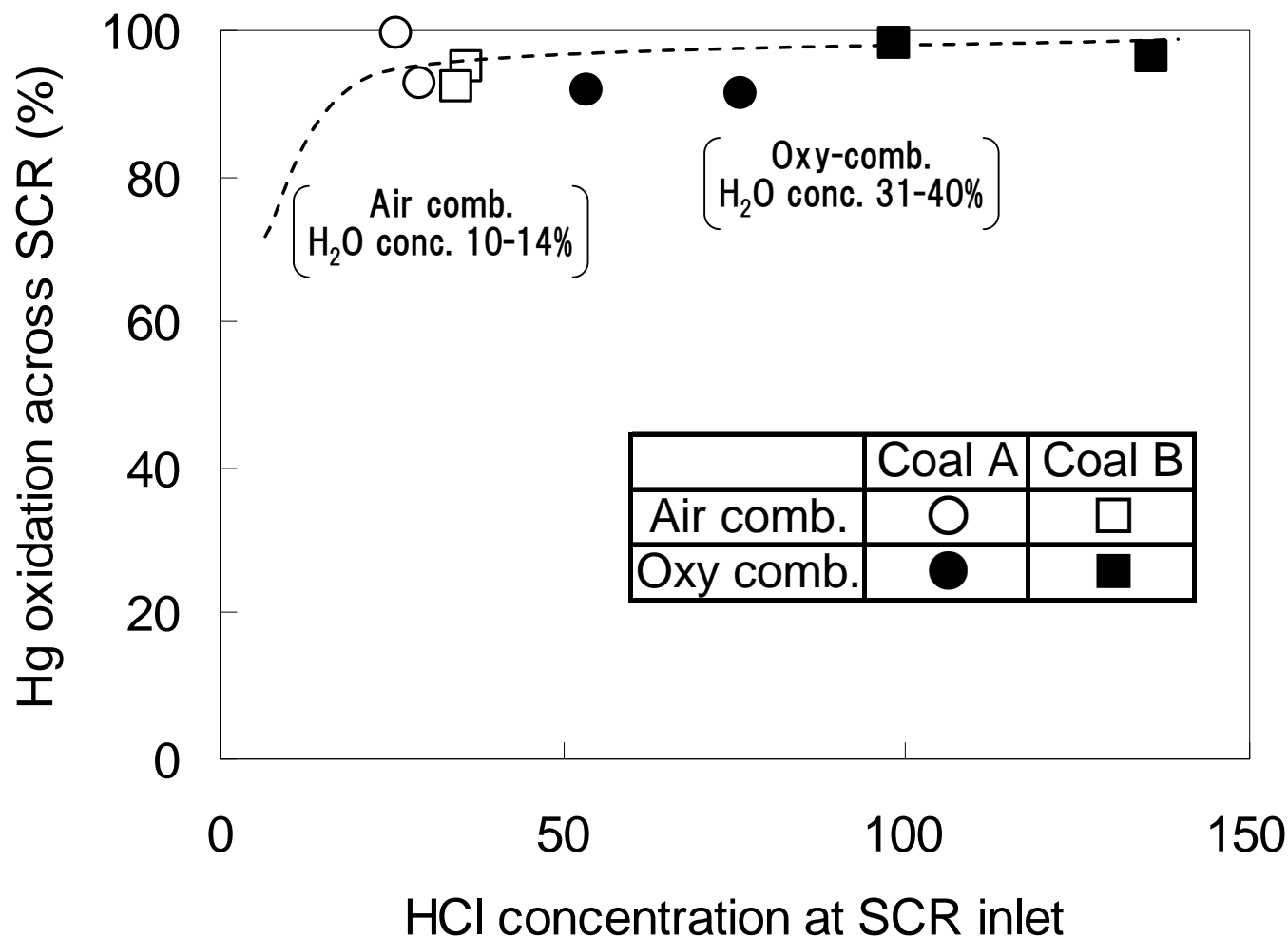
Relationship between Hg removal and Hg Conc.



Oxy-fuel comb.
with coal A
SCR inlet temp.
380°C (716°F)

- The amount of Hg re-circulated to the furnace was decreased as Hg was removed by the DESP.

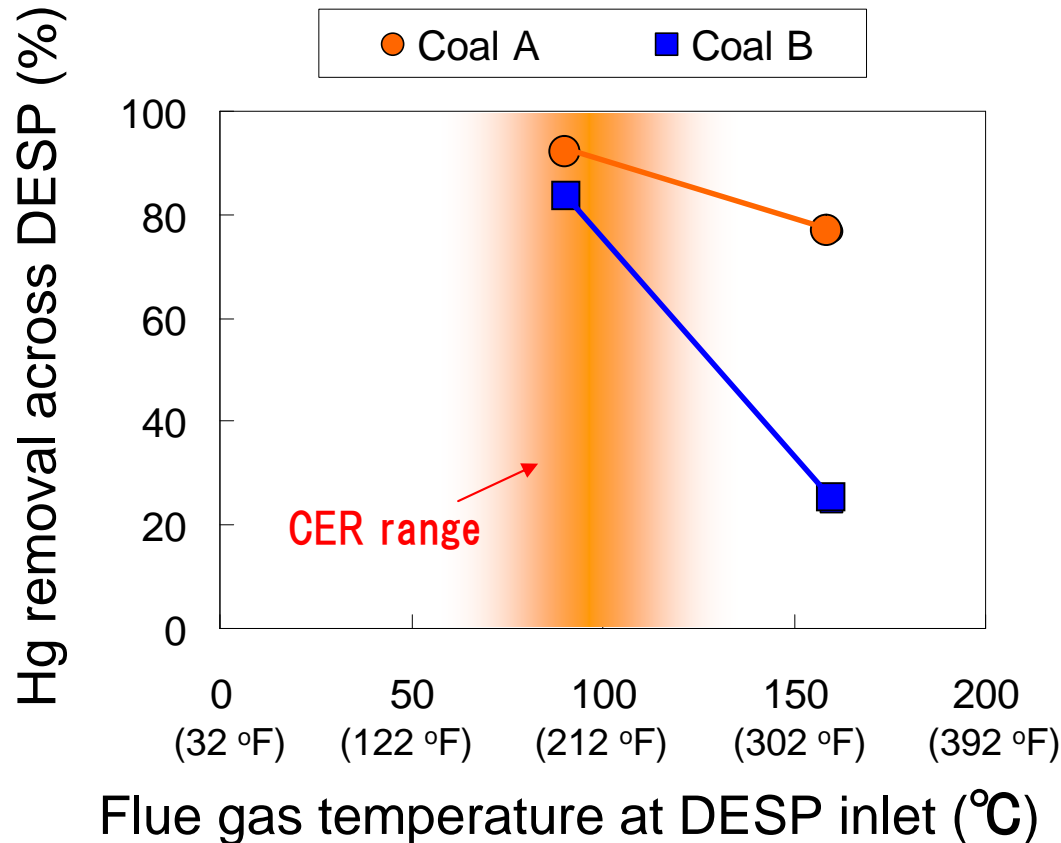
Effect of HCl on Hg oxidation across the SCR



Oxy-fuel comb.
SCR inlet temp.
380°C (716°F)

- Hg oxidation across SCR increased with HCl conc. in both air and oxy comb.
- Original chlorine content of coal was high enough to oxidize Hg efficiently

Effect of flue gas temperature on Hg removal across DESP

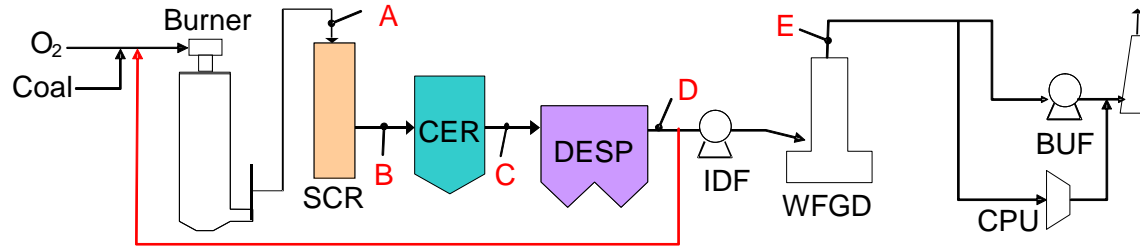


Oxy-fuel comb.
SCR inlet temp.
380°C (716°F)

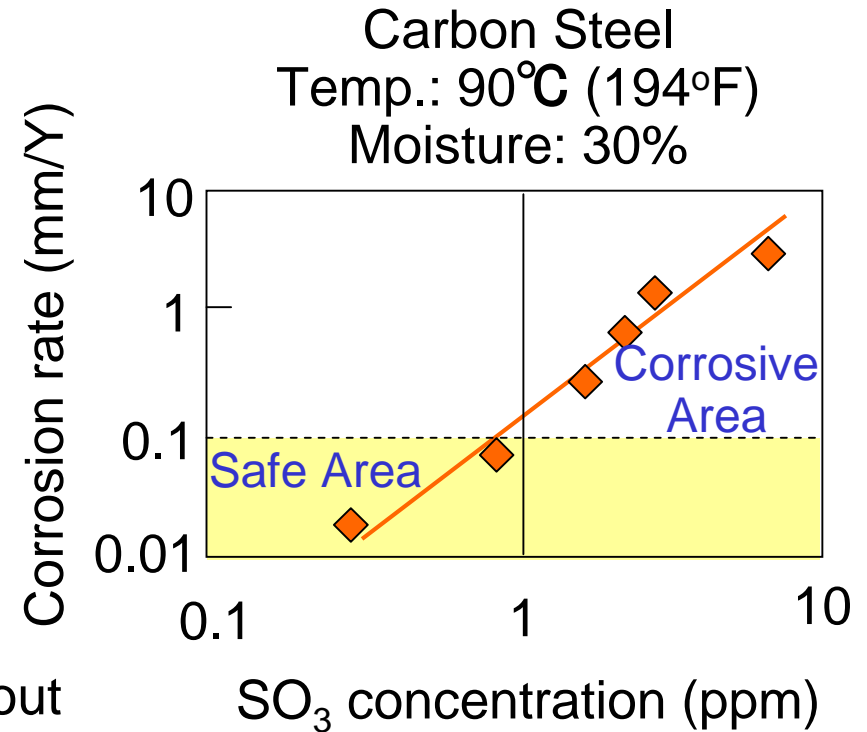
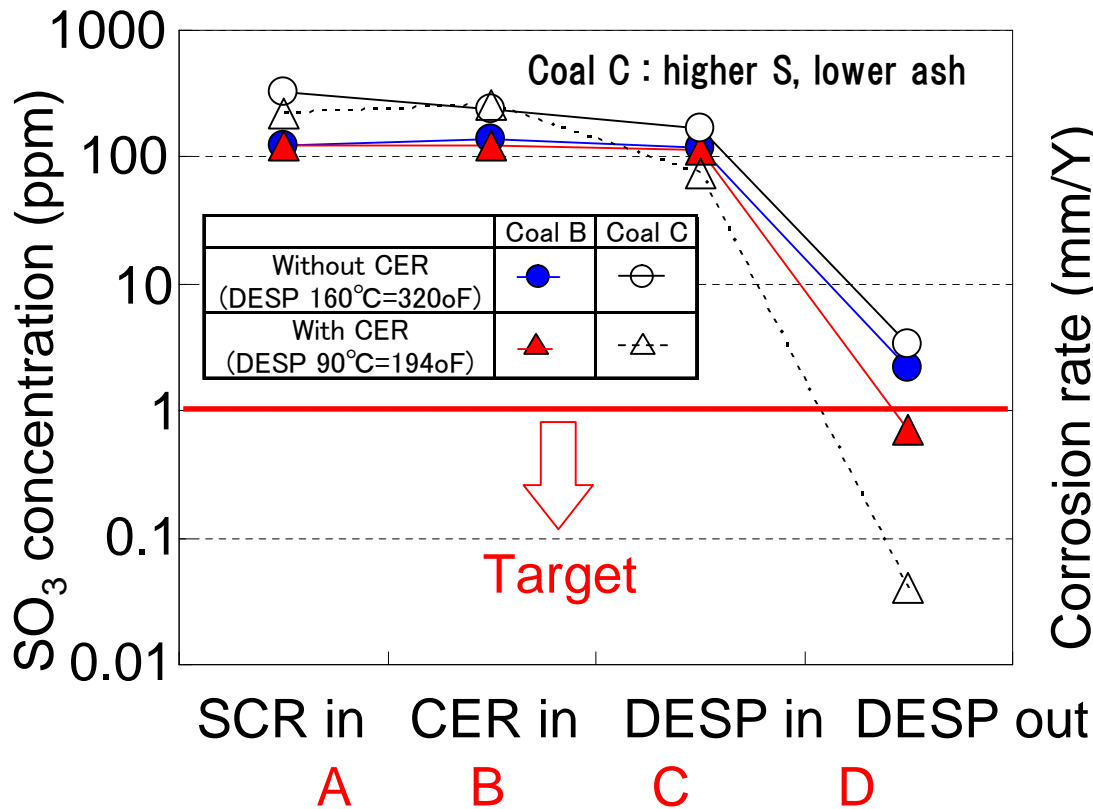
Item	Unit	Coal A	Coal B
Specific surface area of ash	m ² /g	8.1	1.0

▪ CER system was very effective in removing Hg

SO₃ Behavior of Oxy-fuel Combustion of Coal B



Oxy-fuel comb.
SCR inlet temp.
380°C (716°F)



• SO₃ conc. at DESP outlet decreased to less than 1ppm by using CER.

4. Conclusion

- (a) Hg concentration at the SCR inlet for oxy-fuel combustion was higher than that for air combustion due to the re-circulation of flue gas containing Hg.
- (b) The sum of Hg⁺⁺ and Hg(p) at the SCR outlet was 92% of the total Hg under oxy-fuel combustion condition.
- (c) Both Hg and SO₃ removal increased across the DESP as the gas temperature at the DESP inlet was reduced by a CER. SO₃ concentration at DESP outlet decreased to less than 1ppm. Therefore, corrosion of the equipment and ducts of oxy-fuel combustion system can be prevented.

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HITACHI

Inspire the Next