

Introduction of Fuji Electric's Exhaust Gas Cleaning System

Fuji Electric Co., Ltd.
November 2018

1. Outline of Fuji Electric Group
2. Major contributions that we are doing
3. Introduction of Fuji Electric's EGCS
 - 1) Using video to show entire image
 - 2) Contribution with advanced technologies

1. Outline of Fuji Electric group

Established & Head Office

August 29th, 1923
Tokyo, Japan

Capital Stock

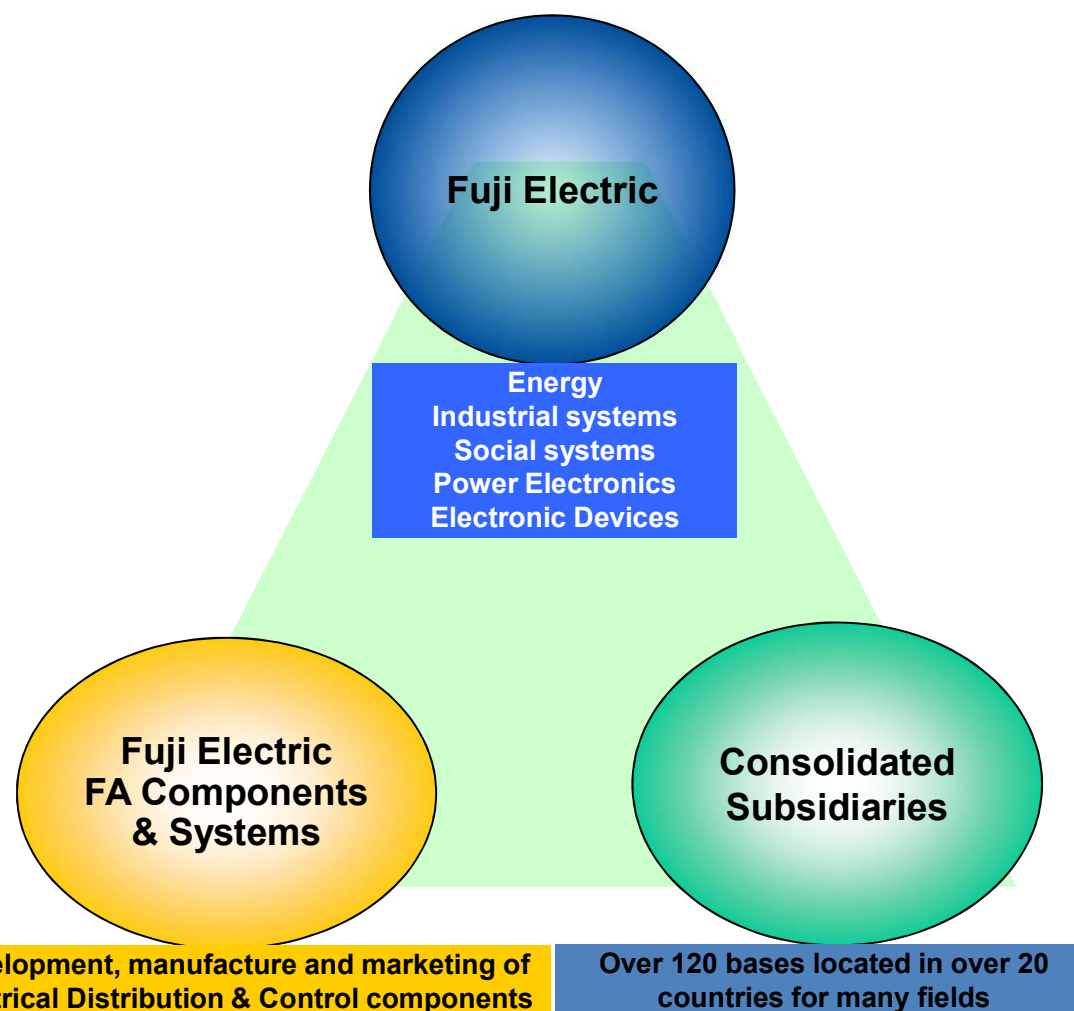
47.6 billion JPY
(US\$ 433 million) *1, *2

Net Sales

893.5 billion JPY (FY2017)
(US\$ 8.12 billion) *1, *2

Number of Employees (consolidated)

27,009 *1



Note: *1=As of or for year ended March 31, 2018 *2= Reference exchange rate: JPY110/US\$

2.1 Power and Social Infrastructure

Geothermal Power Generation



Nga Awa Purua Geothermal Power Station
(The world's largest geothermal power station)

Thermal Power Generation



Thermal power turbine

Hydroelectric Generation



Kurobe Dam

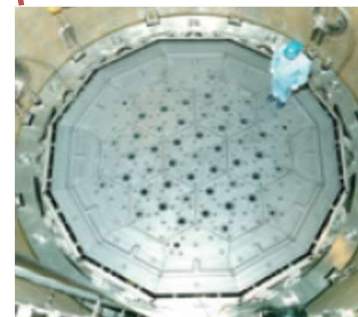


Pelton wheel

Fuel Cells



Nuclear power / Radiation



High-temperature gas-cooled reactor



Electronic personal dose meter

**Energy-related
business**

SaveBlue

Save the blue sky, save the blue ocean,
save the blue Earth

2.2 Industrial Infrastructure

Industrial Plant Business



Facility Business



Electric furnaces



Clean room system

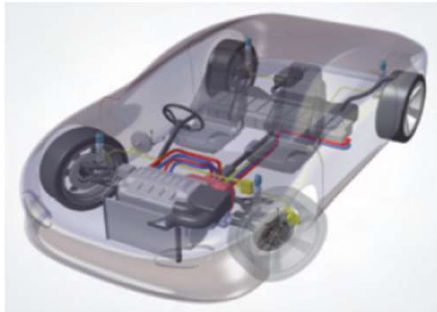


High-capacity rectification equipment

2.3 Power Electronics

Smart Community Business

Electric cars / Hybrid vehicles



Hybrid vehicle



Automotive IGBT



Quick charger

Railcars and Other public transport



Conversion equipment for the
Shinkansen Nozomi N700 series

Industrial machine and Drive systems



General-purpose
Inverters and Motors

Power Supply Business



UPS



Power supply system for servers



Internet data center (IDC)

2.4 Electronic Devices

Power Semiconductor



IGBT module



Automotive IGBT



Power ICs



Power MOSFETs

Optical Semiconductors



Organic photoconductors



Solar cell module

Electric distribution & control components



Magnetic switches



Molded-case circuit breakers

2.5 Food and Beverage Distribution

Distribution Systems Business



Wind power generation system



Wind power generation system

Social Information Systems Business



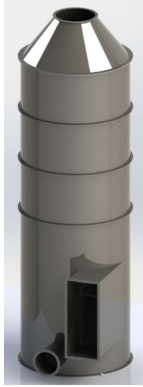
Document management system
for public administration

Vending machines



Vending machines & Electronic money

2.6 Exhaust Gas Cleaning System for Shipping



Scrubber with Cyclone Design

The world's smallest cyclone scrubber system



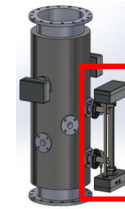
Control PLC



Inverter Drive



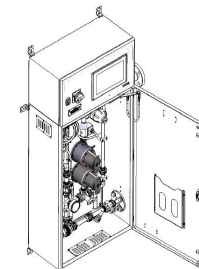
Gas Sampling system



Laser Analyzer system



HMI



Water Analyzer

3. Introduction of Fuji Electric's EGCS

1) Using video to show entire image

2) Contribution with advanced technologies

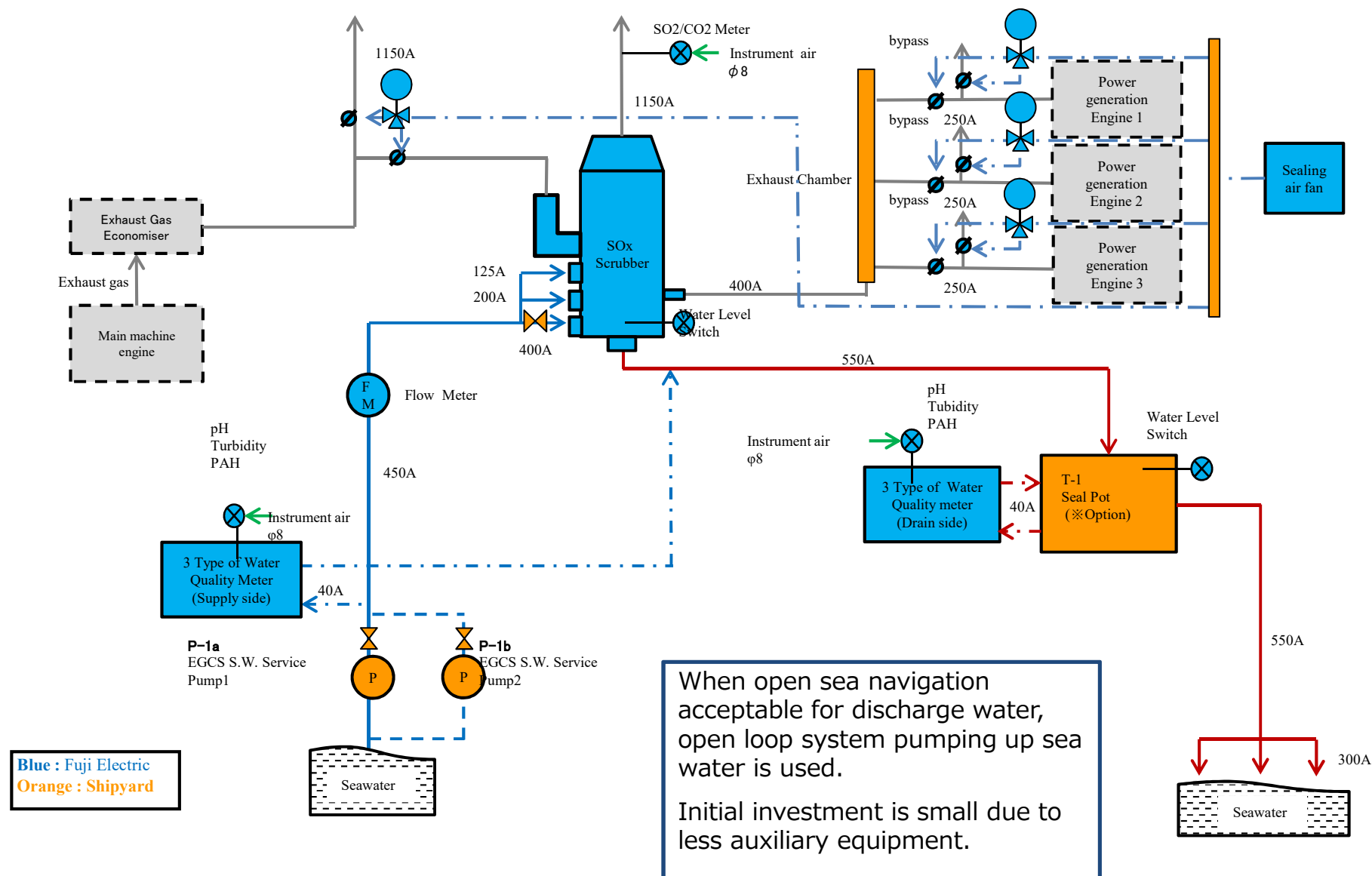
Comparison between Open and Hybrid system

	General area (0.5%S)	SECA (0.1%S)	Prohibition area of discharge water (0.1%S + no discharge)
Fuel exchange	Low sulfur oil(LSO) is used ➤ Fuel cost increases	Marine gas oil(MGO) is used ➤ Fuel exchange operation	Marine gas oil (MGO) is used ➤ Fuel exchange operation
EGCS Open loop type	Heavy fuel oil (HFO) is used	Heavy fuel oil(HFO) is used	Marine gas oil (MGO) is used ➤ Fuel exchange operation
	Open loop: Sea water volume less	Open loop: Sea water volume more	-
EGCS Hybrid type	Heavy fuel oil (HFO) is used	Heavy fuel oil (HFO) is used	HFO is used continuously
	Open loop: Sea water volume less	Open loop : Sea water volume more	Closed loop (without discharge): ➤ NaOH (15L/h *MW) is used ➤ Sludge to be wasted on ground ➤ Storage tank for discharge water is installed.

<Prohibition area of discharge water>

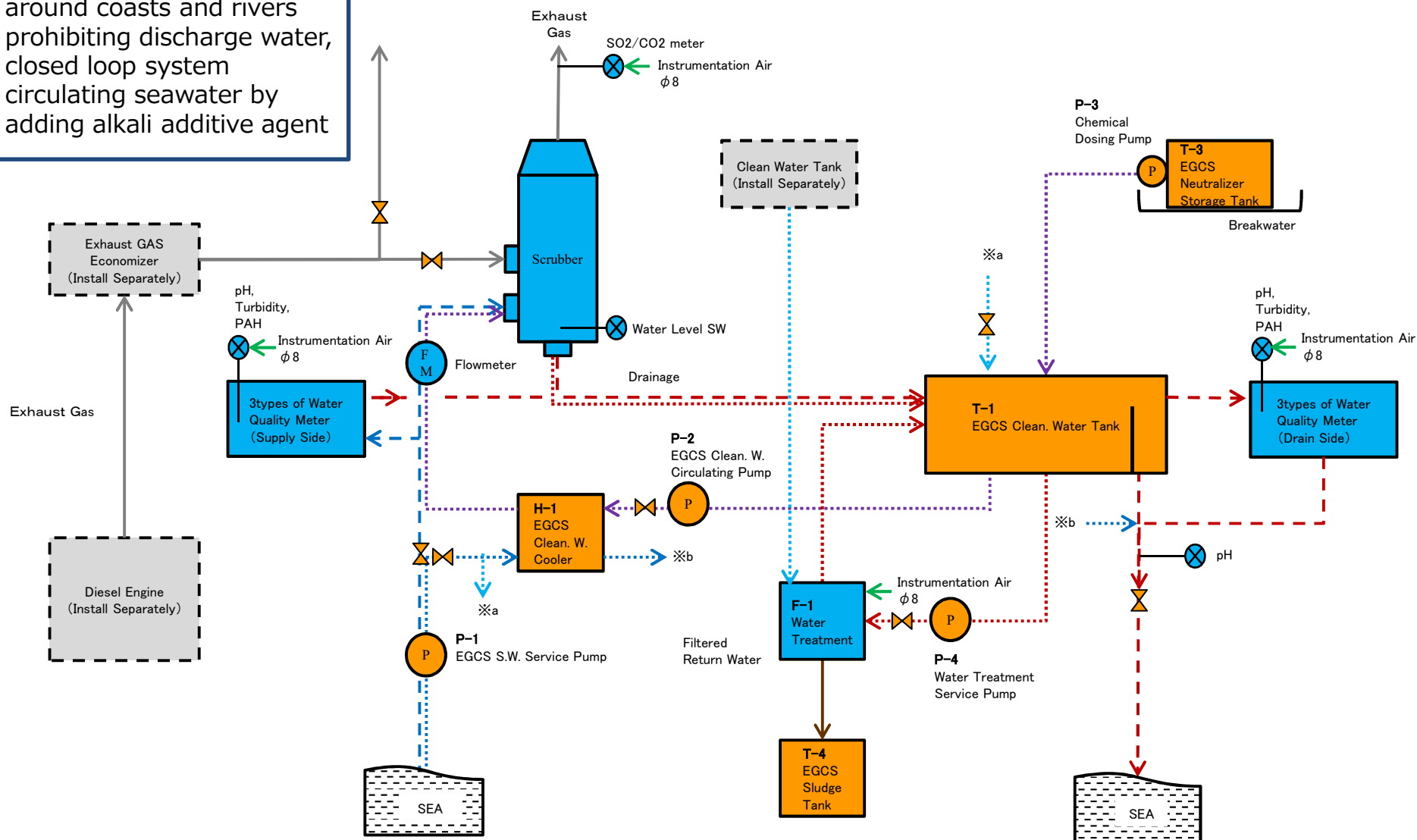
- Rivers and ports in Germany
- Within 3 miles from Belgium coasts & ports
- California, Connecticut & Hawaii in USA

OPEN LOOP SYSTEM FLOW CHART



HYBRID (OPEN/CLOSED LOOP) SYSTEM FLOW CHART

When inland navigation around coasts and rivers prohibiting discharge water, closed loop system circulating seawater by adding alkali additive agent



Major equipment of Fuji's EGCS



Scrubber with Cyclone Design

The world's smallest cyclone scrubber system



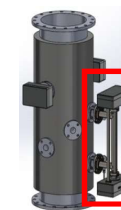
Control PLC



Inverter Drive



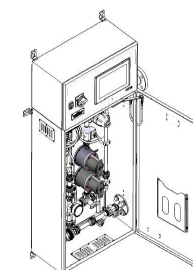
Gas Sampling system



Laser Analyzer system



HMI



Water Analyzer

Scope of major supply

- General sea areas other than ECA (from 2020) : Open system is estimated to increase.
- Emission Control Area (ECA) (from 2015) : Hybrid system (open + closed) has needs.

	■ Scope of major supply		
Open system	SOx scrubber	Our own product	<Sea areas for use> • All sea areas <Market trend> • More than 90% of EGCS with open
	SO2/CO2 analyzer	Our own product	
	3 component water analyzer	Foreign product	
	Supervisory control system	Our own system	
Hybrid system (Closed/ Open)	SOx scrubber	Our own product	<Sea areas for use> • Sea areas prohibiting discharge water (Genmany, Belgium & USA) • Low alkali sea areas (Baltic sea) <Market trend> • Needs in ECA: Open50% : Hybrid50%
	SO2/CO2 analyzer	Our own product	
	3 component water analyzer	Foreign product	
	Supervisory control system	Our own system	
	Water cleaning system	Foreign product with marine class approval	
	Water alkaline system		

Fuji's SOx Scrubber



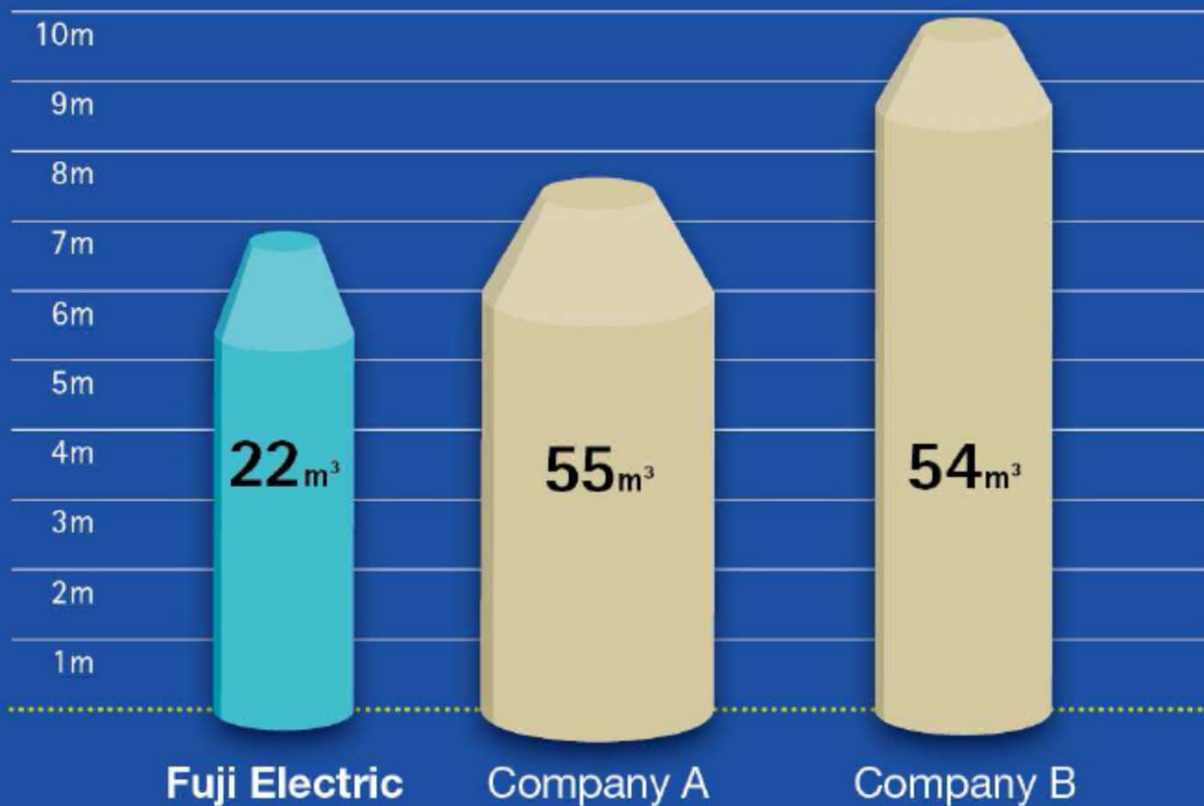
- Developed for marine use by ourselves
- Cyclone technology (patented)
- No moving parts (Only nozzles inside)
 - Simple structure
 - Minimum footprint
 - Low pressure loss
- High desulfurization ratio >98%

Cyclone method made the size smaller but the desulfurization with higher than 95% was impossible before. Fuji broke through such limitation.

How different our scrubber?

Fuji provides the world smallest scrubber.

Volume comparison for a 8 MW engine



SaveBlue

Save the blue sky, save the blue ocean,
save the blue Earth

Fuji Electric's SOx scrubber



SOx scrubber line up

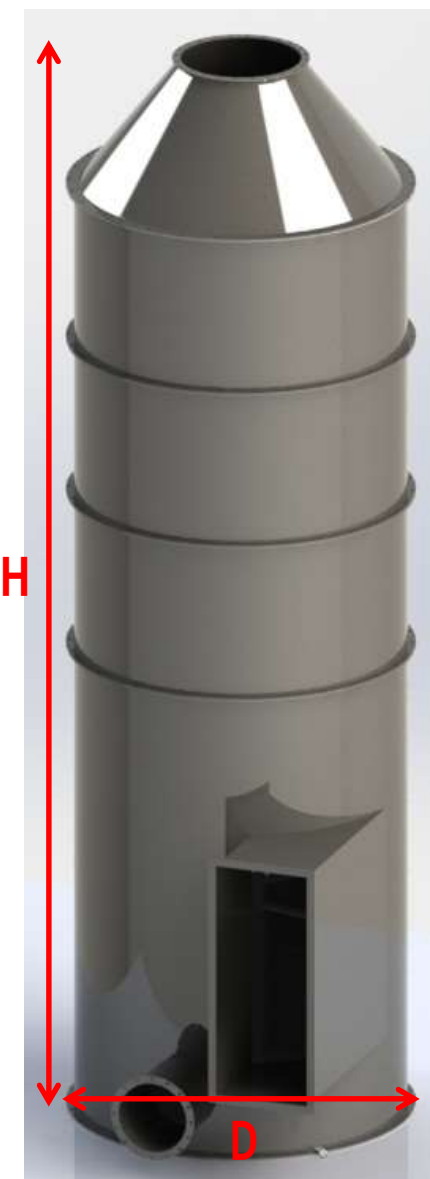
	Engine capacity	Exhaust gas rate	M Diameter	M Height	Kg Approx. weight
S	~8MW	~15kg/s	2.0	7.0	5,000
M	~12MW	~24kg/s	2.3	8.0	6,000
L	~16MW	~32kg/s	2.7	9.2	7,000
2L & XL	~24MW	~55kg/s	(3.2)	(11.2)	(10,000)

Above sizes are planned line up.

The dimensions are indicative and can be different according to design conditions.

XS sizes are not in detailed design.

2L & XL sizes are planned to be released in early 2019.



Fuji Electric's Gas Analyzer

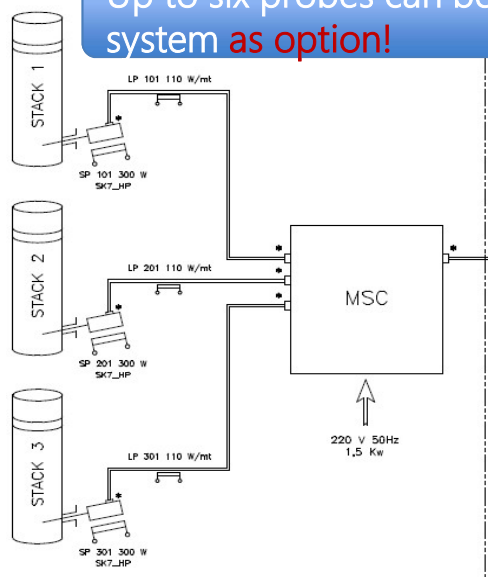
**Measure maximum
Seven (7) gas components**

SO₂, CO₂
(Option: Nox, CO, PM, HC, O₂)

Certificate for Ship
Four (4) certificates

- **DNV-GL**
- **LR**
- **RINA**
- **CLASS NK**

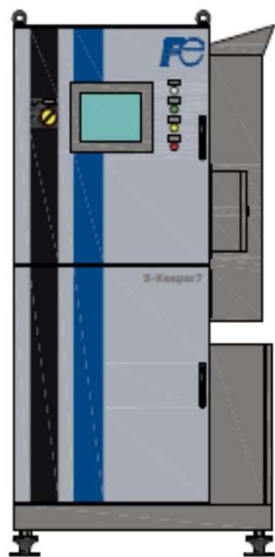
Up to six probes can be connected to one analyzer system as option!



Regular Maintenance Items

Gas Analyzer

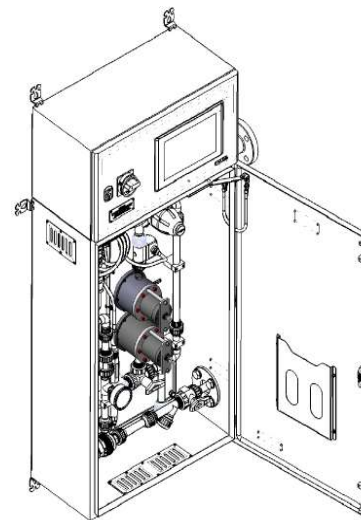
Item	Gas analyzer
Measured gases	SO ₂ /CO ₂
Maintenance by crew	Replace filter /month
	Calibration /month (automatic)
Maintenance by manufacturer	Regular inspection / year



Gas analyzer

3 Component Water Analyzer

Item	Water analyzer		
Measured components	pH	Turbidity	PAH
Maintenance by crew	Calibration /month	Check light volume/month	Check light volume/month
	Cleaning strainer/month	Cleaning strainer/month	Cleaning sensor/month
Maintenance by manufacturer	Replace probe/year	Return sensor/year	Return sensor/year



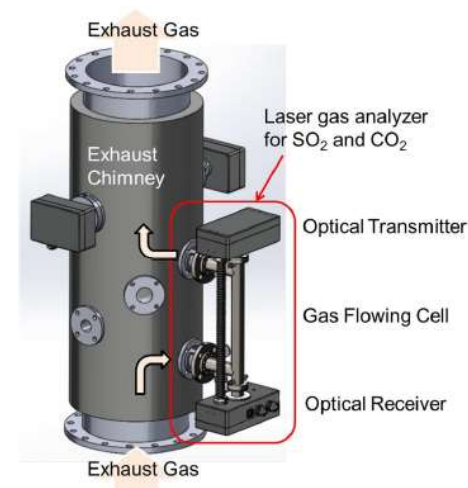
3 component waster analyzer

Fuji Electric's Laser Gas Analyzer

Sales release planned in January 2019

Features:

- Small size: 1/4 of traditional analyzers
- Fast response: within 5 seconds
- Less maintenance: Only 1 calibration per year
- No gas cylinder is required.



Regular maintenance items

Items	Gas analyzer
Measured gases	SO2/CO2
Maintenance by crew	Replace filter/3 months
Maintenance by manufacturer	Regular inspection/year

Reference (Demonstration Experiment)

Statement of Fact for Fuji Electric's EGCS

Inspection on board for main engine



Actual Owner : SHOEI KISEN KAISHA
Shipbuilder : IMABARI SHIPBUILDING
Hull No. : S-1595
IMO No. : 9757785
Type of Ship : Bulk carrier
Capacity : 84,000 M.T. D/W
Delivery Date : March, 2016



SOx放出量適合計画書 (SOx Emission Compliance Plan) (SECP)

1) 主機関 main engine	CONFIDENTIAL
型式 Model	MAN B&W 6S60ME-C7.1
最大出力 Maximum output	9,000kW × 82 rpm
種類 Cycle	2 stroke
最大燃料油硫黄分 (Maximum Sulphur content in fuel)	3.5%
Sulphur Limit	0.1%
OPEN LOOP Main Engine Load	85%
CLOSED LOOP Main Engine Load	50%

Engine builder : MITSUI E & S
Engine type : 6S60ME-C7.1
Output : 9,000kW
Revolution : 82 rpm

ClassNK
R&D PROJECT



Reference (Orders) of SOx Scrubber Systems

As of Nov. 1, 2018

No.	Ship type	System	Size/ Engine	Delivery
0	84BC	Hybrid / New built	S / 6 to 8MW	Mar. 2016
1	64BC	Open / New built	S / 6 to 8MW	Oct. 2018
2	1900TEU	Open / New built	L / 12 to 17MW	Oct. 2018
3	1900TEU	Open / New built	L / 12 to 17MW	Dec. 2018
4	1900TEU	Open / New built	L / 12 to 17MW	Feb. 2019
5	1900TEU	Open / New built	L / 12 to 17MW	Apr. 2019
6	182BC	Open / New built	L / 12 to 17MW	Nov. 2018
7	64BC	Open / New built	S / 6 to 8MW	Feb. 2019
8	64BC	Open / New built	S / 6 to 8MW	Apr. 2019
9	64BC	Open / New built	S / 6 to 8MW	Jun. 2019
10	64BC	Open / New built	S / 6 to 8MW	Aug. 2019
11	64BC	Open / New built	S / 6 to 8MW	Oct. 2019
12	182BC	Open / New built	L / 12 to 17MW	Mar. 2019
13	182BC	Open / New built	L / 12 to 17MW	Mar. 2019
14	63BC	Open / New built	S / 6 to 8MW	Mar. 2019
15	1900TEU	Open / New built	L / 12 to 17MW	Mar. 2019
16	1900TEU	Open / New built	L / 12 to 17MW	May 2019
17	1900TEU	Open / New built	L / 12 to 17MW	Jul. 2019
18	88BC	Open / New built	M / 8 to 12MW	Feb. 2019
19	81BC	Open / New built	M / 8 to 12MW	Apr. 2019
20	182BC	Open / New built	L / 12 to 17MW	Sep. 2019
21	81BC	Open / New built	M / 8 to 12MW	Jun. 2019
22	63BC	Open / New built	S / 6 to 8MW	Jul. 2019
23	63BC	Open / New built	S / 6 to 8MW	Aug. 2019
24	82BC	Open / New built	M S/ 8 to 12MW	Jul. 2019
25	64BC	Open / New built	S / 6 to 8MW	Mar. 2019
26	40BC	Open / New built	S / 6 to 8MW	Dec. 2019
27	84BC	Open / New built	M S/ 8 to 12MW	Aug. 2019
28	81BC	Open / New built	M / 8 to 12MW	Sep. 2019
29	81BC	Open / New built	M / 8 to 12MW	Oct. 2019
30	182BC	Open / New built	L / 12 to 17MW	Sep. 2019

Reference (Orders) of SOx Scrubber Systems

As of Nov. 1, 2018

No.	Ship type	System	Size/ Engine	Delivery
31	1900TEU	Open / New built	L / 12to17MW	Sep.2019
32	82BC	Open / New built	MS/6to8MW	Sep.2019
33	88BC	Open / New built	M/8to12MW	Sep.2019
34	81BC	Open / New built	M/8to12MW	Oct.2019
35	182BC	Open / New built	L / 12to19MW	Oct.2019
36	81BC	Open / New built	M/8to12MW	Aug.2019
37	81BC	Open / New built	M/8to12MW	Nov.2019
38		Retrofit		
39		Retrofit		
40		Retrofit		
41		Retrofit		
42		Retrofit		

New orders In November

After-sales service network for marine EGCS business:

【Domestic & Overseas Service Network】

In addition of our own service offices in Japan, and meanwhile, around 50 service offices with partners are ready.

Thank you very much for your attention