

Marine Scrubber Systems

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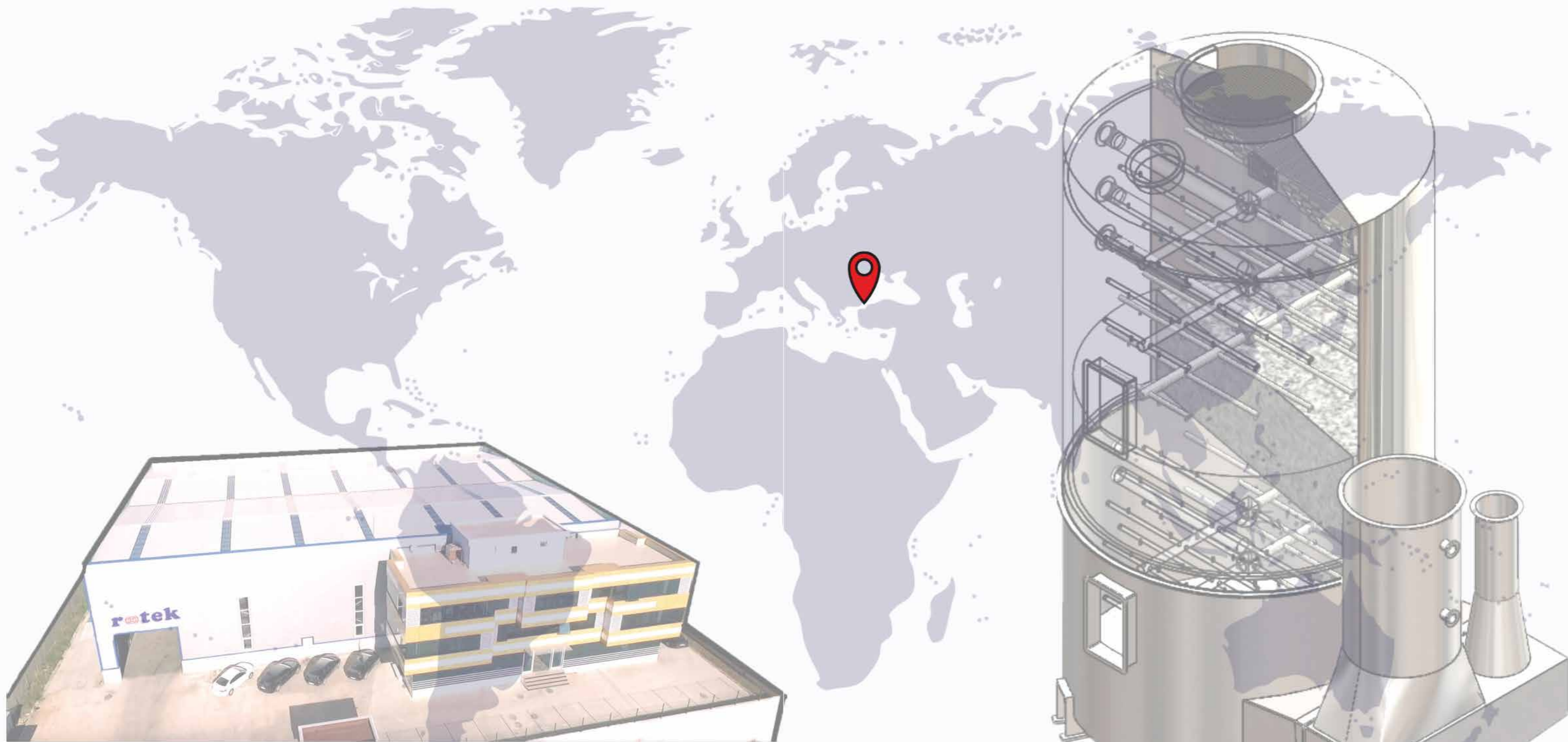
2020 Global Marine SO_x Emissions Regulation

SO_x SCRUBBER

EXHAUST GAS CLEANING SYSTEM



Rotek Exhaust Gas Cleaning Systems



Rotek has been providing comprehensive solutions in terms of chimney and exhaust systems to the customers since its establishment in 1993. The company's founders have gained experience by doing sales and installation of various European chimney companies' products in Turkish market. Our company started to produce stainless steel chimney with Rotek brand in 1993. Rotek, with this knowledge and experience, has been a pioneer until the first day of its entrance to this sector about the establishment of the chimney systems in accordance with standards and has been serving with this idea until today.

Rotek, exported hundreds of chimney systems, scrubbers, chimney filters and garbage-linen chute systems to 17 countries at Europe, Asia and Africa continents, has been an sought out brand at domestic and international projects with specifications.

Rotek is ready to put the new projects into effect successfully with its 60+ direct staff, 3000 m² production area, experienced welding staff and engineering power.

Rotek has developed Scrubber Systems, which are produced especially for chemical production plants and successfully implemented, suitable for ships as "I" type and "U" type Scrubber. "Open Loop", "Closed Loop" and "Hybrid" systems can be commissioned for both types and special solutions can be offered for all ship types in a wide range from 1 MW up to 50 MW.

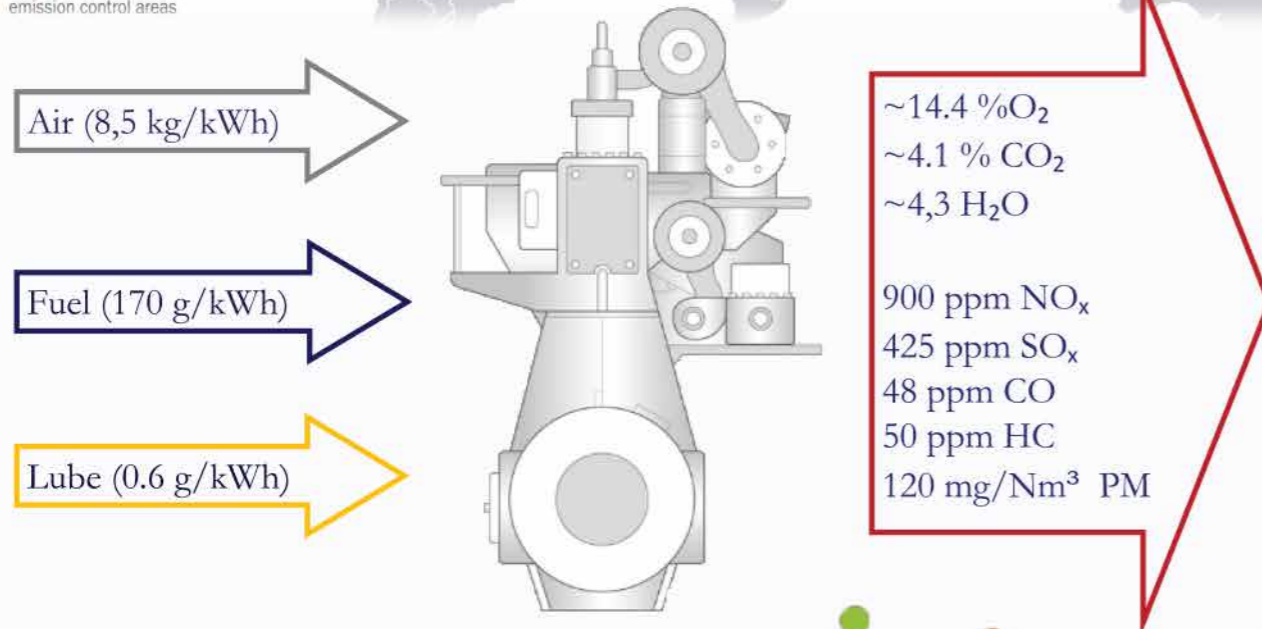
It guarantees first to increase the SO₂/CO₂ ratio to less than 0,1% with the solutions it offers and secondly to comply with MARPOL RESOLUTION MEPC.259 (68), 2015 rules in all its works.

Rotek Marine EGCS is specifically designed to meet the needs of the maritime industry and offers proven Allstream exhaust gas handling. All exhaust sources on board can be served by one common EGCS unit, enabling a fast return on investment.

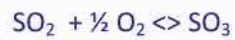
Global Marine SOx Emissions Regulation

On 1 January 2015, four so-called Emission Control Areas (ECAs) were introduced pursuant to Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL). The ECAs established under Annex VI are in the Baltic Sea, the North Sea, North America and the US Caribbean and the maximum allowable fuel sulphur content within these ECAs is 0.1%. While the introduction of the 0.1% sulphur cap in the four ECAs formed an important step in combating SOx emissions from ships, it has only impacted a relatively small share of the global shipping fleet. New and stricter regulations are however on the horizon and as of 1 January 2020 a global 0.5% cap on sulphur content in marine fuels will be introduced, revising the current 3.5% global cap.

- Emission control areas
- Possible future emission control areas



RELEVANT CHEMISTRY



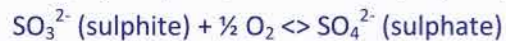
Note: only 3-5% of sulphur oxides are sulphur trioxide



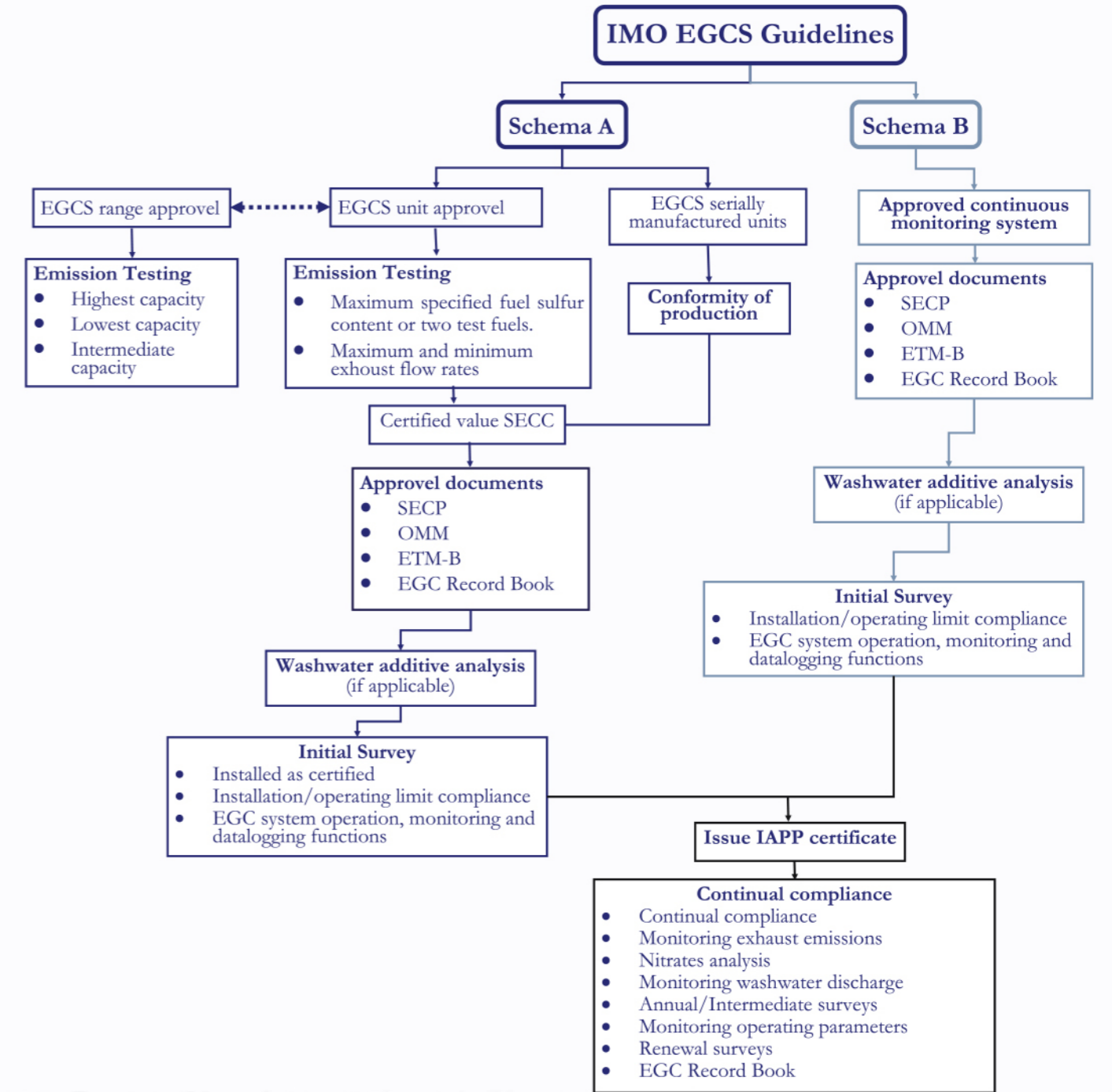
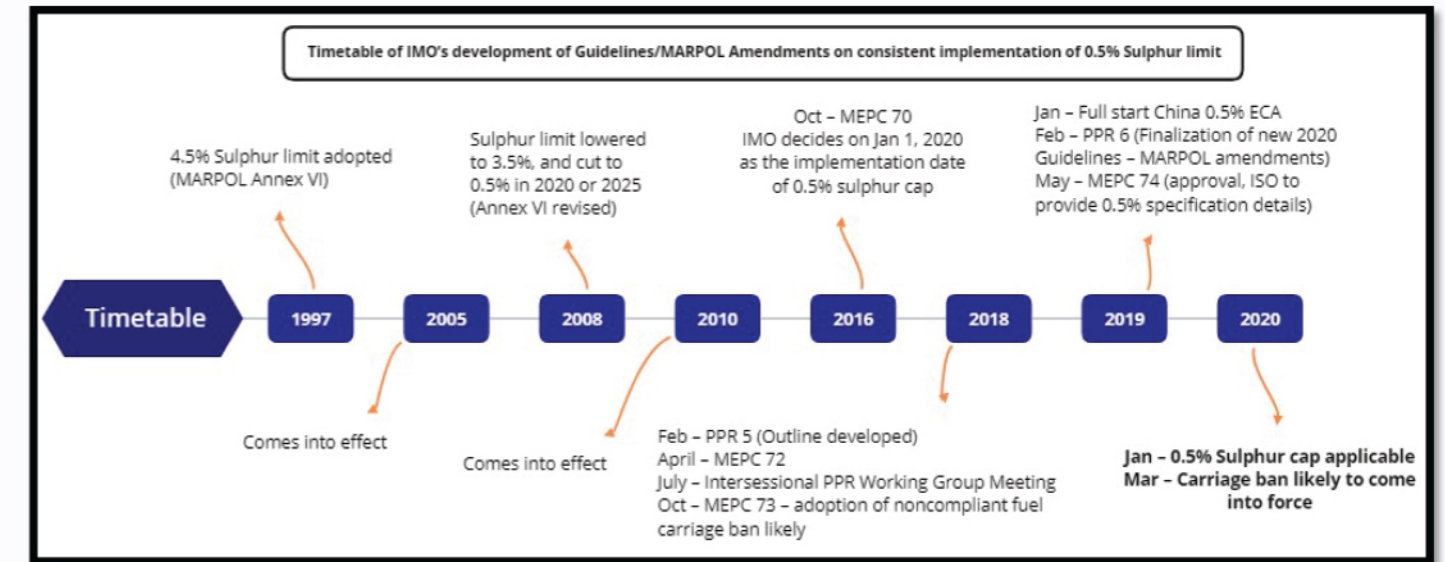
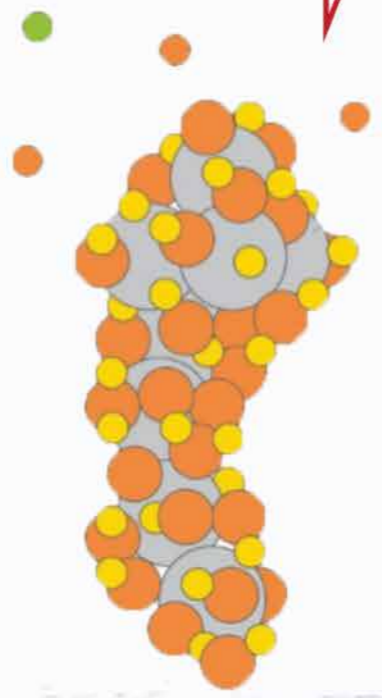
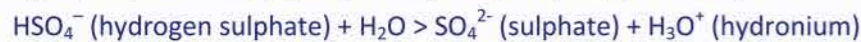
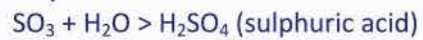
Sulphur Dioxide



Note: there is no evidence that sulphurous acid exists in solution, but the molecule has been detected in the gas phase



Sulphur Trioxide



Best Return on Investment

A key issue for shipowners is the return on their investment (ROI) in new technology. Our futureproof RotekMarine SOx EGCS-models offers market competitive ROI for shipowners.

The investment cost for the EGCS unit ranges between \$1,1 million-\$2,3 million, depending on vessel type. Installation costs of approximately \$1 million must be expected, depending on yard. Estimated operating cost for the scrubber is \$18-\$45 per metric ton fuel consumed by the scrubber, depending on caustic soda (NaOH) and fuel price, fuel Sulphur level and scrubber operating mode.

Approximately 1 year payback time

If assuming a spread of \$350 per metric ton price difference between MGO (0.1% Sulphur content) and HFO, 10,000 metric tonnes of yearly fuel consumption, and total investment cost of \$ 4,5 million, the approximate payback time is 1 year (ROI will vary according to yearly fuel consumption and fuel spread).

The installation of an EGCS is the most cost-effective solution to meet the IMO Sulphur regulations. All exhaust sources on board, including boilers, can be served by one common EGCS unit, enabling a fast return on investment.



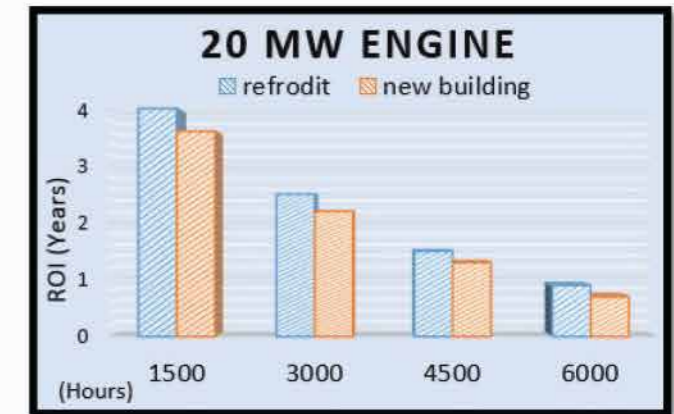
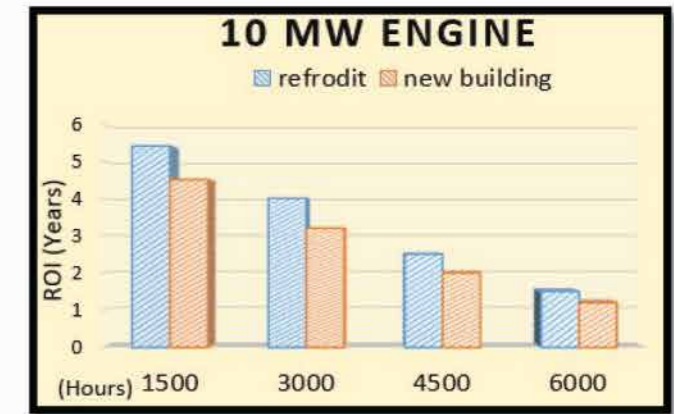
Graphics example is based on a vessel burning aprox. 10,000 tons annual fuel consumption

<p>\$ ~2,1 M Rotek Marine scrubber EGCS Investment Cost</p>	<p>\$ ~2,3 M Gross fuel savings *</p>	<p>0,9 Years Approximate payback time</p>
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* The spread between compliant fuel and HSFO is assumed to be USD 240 per tonne fuel. Estimated cost is \$18-45 per tonne fuel consumed by scrubber combustion units. Fuel cost is depending on caustic soda and fuel price, fuel Sulphur level and scrubber operating mode. In this example we have used a fuel cost of \$35 per tonne fuel.



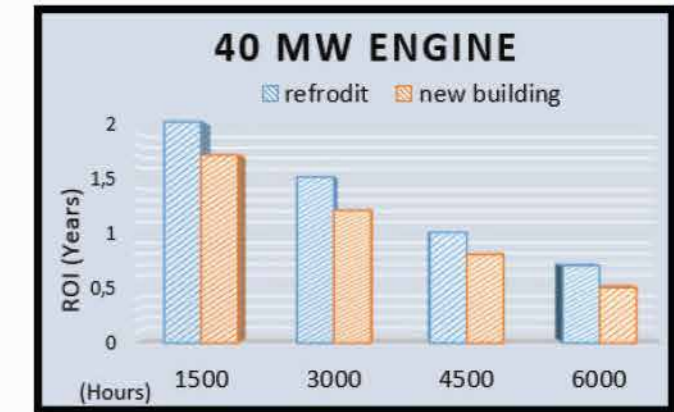
Return on Investment Samples



For all types of vessels

Fuel savings will pay for the investment in an exhaust gas cleaning system. However, the payback time will of course vary depending on a variety of factors e.g. fuel prices, engine size, fuel consumption, time spend in ECAs and running hours.

Rotek Marine offer turnkey solutions suitable for new buildings as well as retrofits. Our solutions fit all types of engines and boilers.

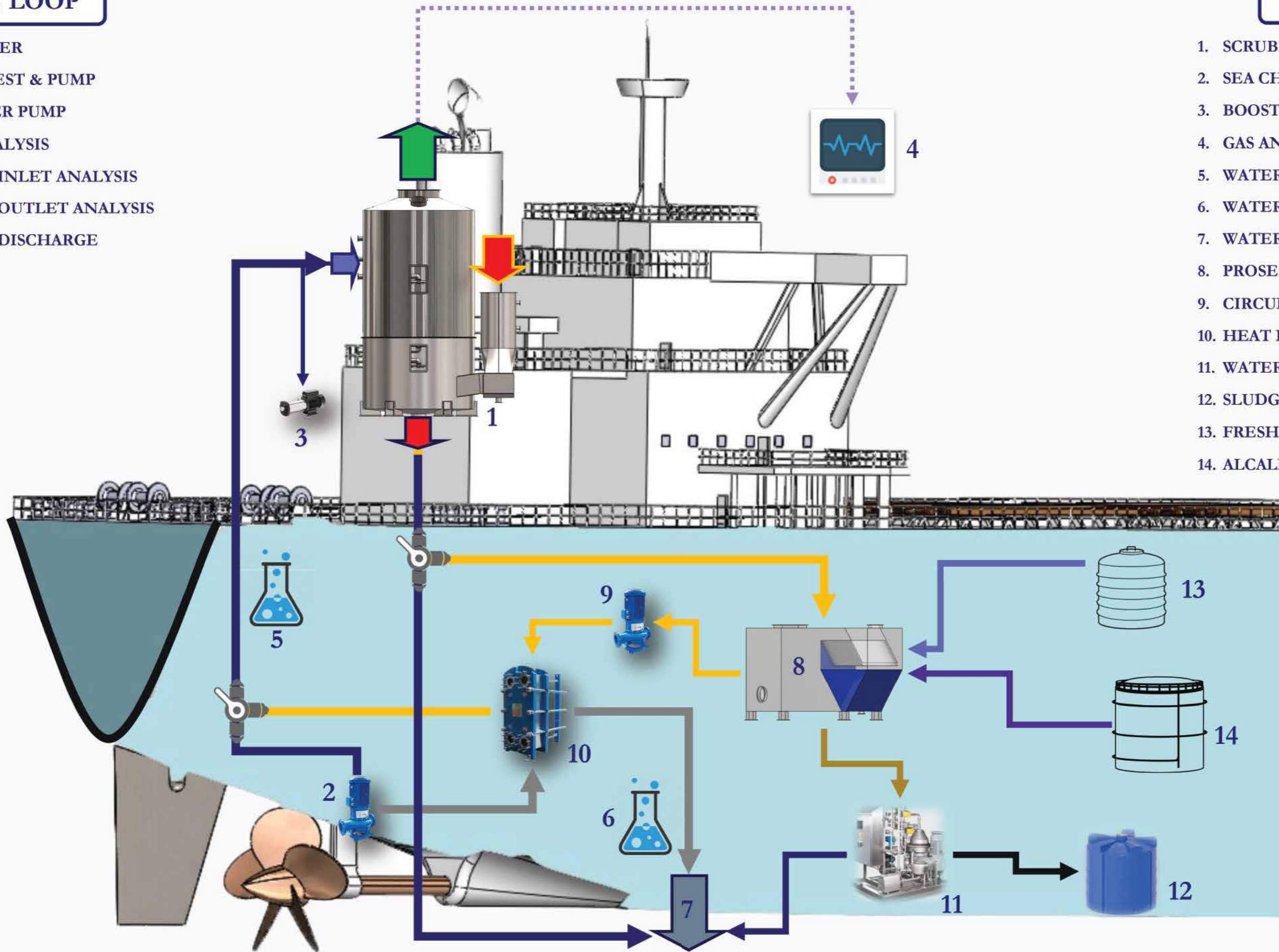


OPEN LOOP

1. SCRUBBER
2. SEA CHEST & PUMP
3. BOOSTER PUMP
4. GAS ANALYSIS
5. WATER INLET ANALYSIS
6. WATER OUTLET ANALYSIS
7. WATER DISCHARGE

HYBRID

1. SCRUBBER
2. SEA CHEST & PUMP
3. BOOSTER PUMP
4. GAS ANALYSIS
5. WATER INLET ANALYSIS
6. WATER OUTLET ANALYSIS
7. WATER DISCHARGE
8. PROSES TANK
9. CIRCULATION PUMP
10. HEAT EXCHANGER
11. WATER TREATMENT UNIT
12. SLUDGE TANK
13. FRESH WATER ADD
14. ALCALINE ADD



U TYPE



Rotek “U” type Scrubber Systems promise maximum performance even under the most difficult conditions. It performs pre-cooling with spray type nozzle. SO_x removal from exhaust gas occurs in rashing bushings.

It is produced from SMO254, 904L and Super Duplex materials. Our U type Scrubbers are not suitable for dry running. They are suitable for operation at Open Loop and Closed Loop.

U TYPE SCRUBBER

Power (MW)	Gas Flow (kg/s)	Diameter (mm)	Height (mm)	SCRInlet (mm)	SCR Outlet (mm)	Discharge (mm)	Prosess Tank (m ³)
1,50	3,2	1300	6000	400	400	170	10
2,00	4,3	1500	6500	500	500	200	
3,00	6,4	1800	6800	600	600	230	
4,00	8,5	2100	7000	700	700	250	
5,00	10,7	2400	7200	800	800	300	15
6,00	12,8	2600	7400	900	900	350	
7,50	16,0	2900	7600	1000	1000	400	
10,00	21,3	3300	7800	1100	1100	420	
12,00	25,6	3600	8000	1250	1250	450	25
15,00	32,0	4000	8300	1400	1300	500	
17,50	37,3	4200	8500	1450	1400	540	
20,00	42,6	4500	8800	1550	1500	580	
25,00	53,3	4800	9500	1700	1700	620	35
30,00	63,9	5400	10000	1900	1800	680	
40,00	85,2	6000	11000	2200	2050	700	45
50,00	106,5	6500	12000	2400	2200	800	

* The final measurements are obtained by vessel-specific calculations.

I TYPE

Rotek “I” type Scrubber takes minimum space in chimney construction. It is suitable for dry running although it has cooling system in dry running. It performs pre-cooling with spray type nozzle. SO_x removal from exhaust gas occurs in rashing bushings.

It is produced from SMO254, 904L and Super Duplex materials. It has low back pressure. It is also suitable for operation at Open Loop and Closed Loop.



I TYPE SCRUBBER

Power (MW)	Gas Flow (kg/s)	Diameter (mm)	Height (mm)	SCRInlet (mm)	SCR Outlet (mm)	Discharge (mm)	Prosess Tank (m ³)
1,50	3,2	1000	9000	400	400	170	10
2,00	4,3	1200	9200	500	500	200	
3,00	6,4	1400	9500	600	600	230	
4,00	8,5	1600	10000	700	700	250	
5,00	10,7	1800	10200	800	800	300	15
6,00	12,8	2000	10000	900	900	350	
7,50	16,0	2200	10500	1000	1000	400	
10,00	21,3	2600	10600	1100	1100	420	
12,00	25,6	2800	11000	1250	1250	450	25
15,00	32,0	3100	11500	1400	1400	500	
17,50	37,3	3400	11500	1450	1450	540	
20,00	42,6	3600	12500	1550	1550	580	
25,00	53,3	4000	13000	1700	1700	620	35
30,00	63,9	4400	13200	1900	1900	680	
40,00	85,2	5100	13400	2200	2200	700	45
50,00	106,5	5700	13600	2400	2400	800	

* The final measurements are obtained by vessel-specific calculations.

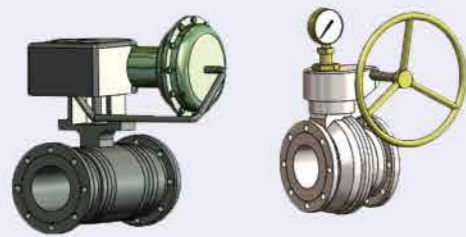
Nozzle: Various nozzles are used in our designs for cooling and cleaning units. These nozzles provide minimum back pressure resistance and work at maximum efficiency in gas scrubbing.



Demister Unit : It allows the separation of liquid particles in the gas and the efficient operation of the system.



Valves: Many and various sizes of valves are used in the scrubber system. The most suitable and accredited products are used in our product.



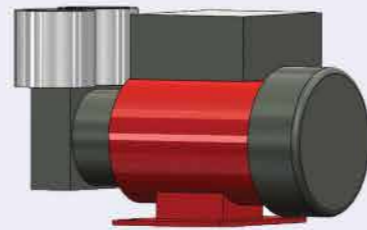
Pump: It is used to provide process water from the sea and to provide a cycle in a closed system. Specially produced pumps for scrubber systems are used in our system.



Heat Exchanger: It is used for cooling down the scrubbing water when running in closed loop mode to ensure that the exhaust gas temperature exiting the scrubber unit.



Booster Pump: In our scrubber system, pressure is raised to increase efficiency and used for rapid cooling of gas. This pump allows you to boost the water pressure to receive a high amount of water through injection nozzles.



Emission Control: With continuous measurement feature, we use emission measurement systems that meet the requirements of Imo regulation. The analyzer measures SO₂, CO₂ and NO_x concentrations using UV and IR absorption, DOAS. The sulphur content in the bunker oil is measured based on the SO₂ /CO₂ ratio in ppm/ Vol.%.

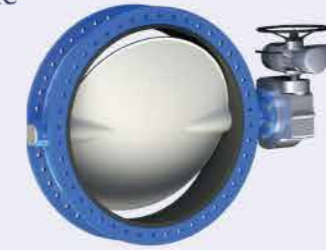


Water Analysis: Chemical analysis of process water entering and leaving the system is performed. Selected products meet the requirements of Imo regulation. The system has achieved a marine type approval for monitoring of all media (PAH, turbidity, and pH/temperature) required in MEPC. 259(68).



Dampers: It is provided with bypass dampers at Scrubber Systems. Approved dampers are used in our units.

Electric and pneumatic options are available.



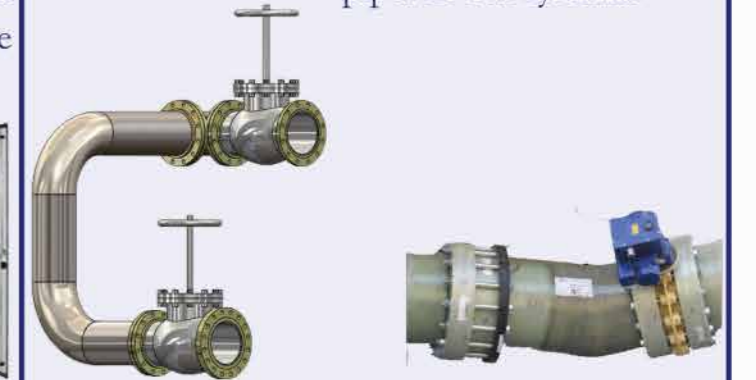
Water Treatment Unit: In closed loop and Hybrid Scrubber systems, process water is improved and the consisted sludge is separated.



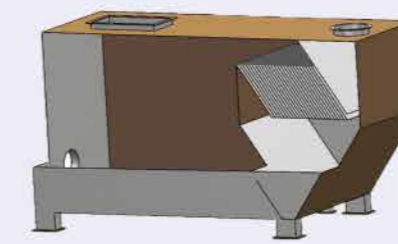
The control equipment monitors pumps, temperatures, flow, water treatment and ex-haust gas composition in complete compliance with MARPOL Annex VI. The control system includes easy to use HMI.



Pipe System: We recommend using GRE pipes in our systems.



Process Tank: Process tanks which are designed by Rotek and increase system efficiency are recommended.



Alcaline Dosing Unit: Is a custom-built dosing and monitoring system that can utilize Sodium Carbonate (Na₂CO₃), Magnesium Oxide (MgO) or Caustic Soda (NaOH) depending on the requirements of the preferred vessel profile.

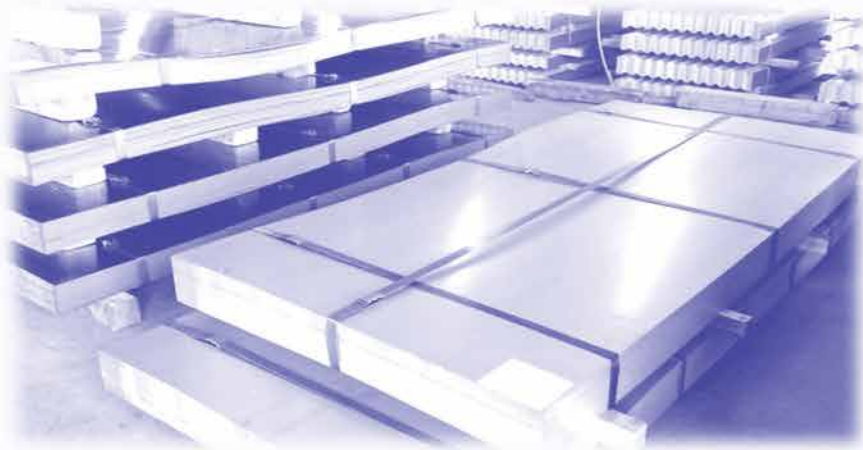


Servis: You are valuable to us. We offer 24/7 Service. Our service department can be contacted at any time for assistance.

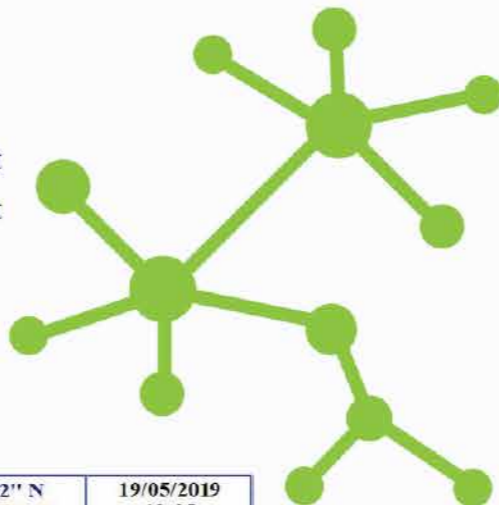


Rotek can supply the required chimney equipments to the Scrubber System in accordance with Customer requests.



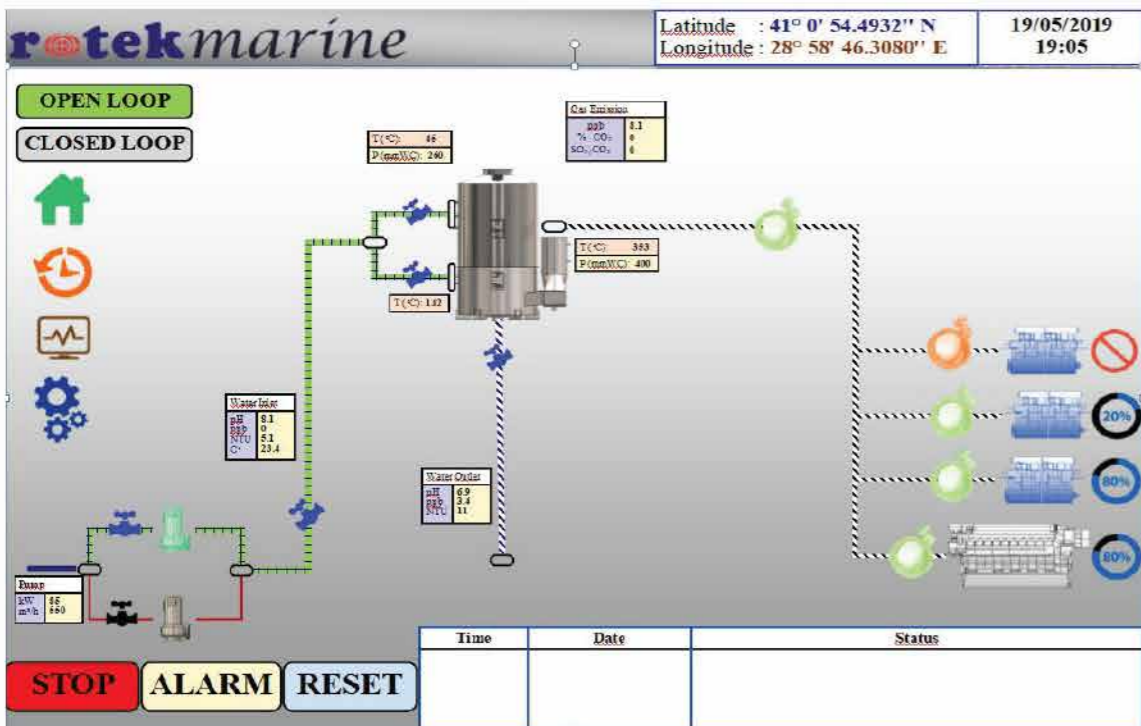


Special Coating for Sulphuric Acid



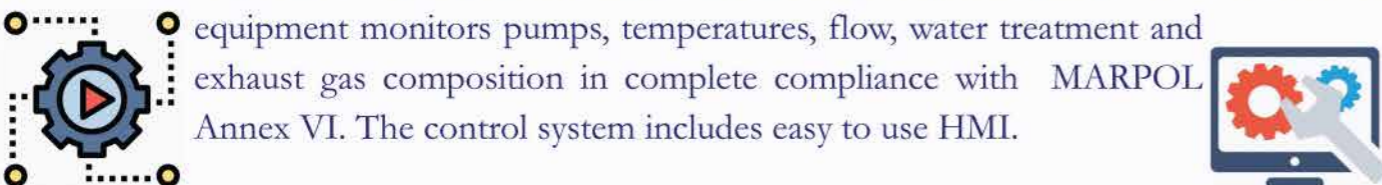
Our Scrubbers, which are produced with the best materials, are also more protective with special coatings. It uses a special coating that provides resistance up to 600 °C.

Control Panel



Easy-to-use – Online Access

We offer customized solutions designed to meet customer-specific requirements. Our system offers an extremely user-friendly interface with touch screen control. The control equipment monitors pumps, temperatures, flow, water treatment and exhaust gas composition in complete compliance with MARPOL Annex VI. The control system includes easy to use HMI.



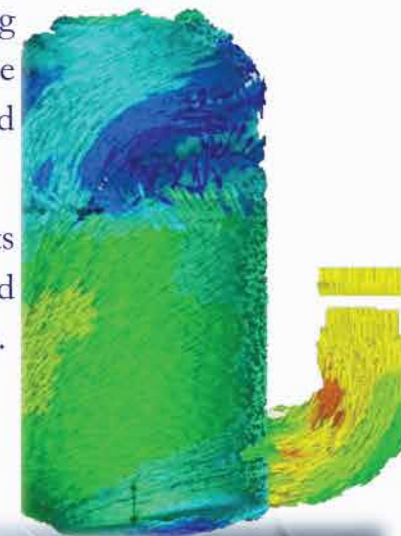
Engineering & Know-How & Experience



Rotek develops design thanks to its abilities and realises static and flow analysis of the developed design. Thermal calculations, material life, chemical reaction and process algorithm of scrubber systems can be done with the technical team. Rotek offers the most optimum solutions thanks to its know-how gained through the past experiences.

Rotek offers wide range of welding processes like argon, mig etc. with the highest quality workmanship especially at stainless steel and its varieties to its customers since its inception. The welding personnel get trained within the scope of continuous improvement and certified by the relevant accreditation institutions.

In addition to the selection of the most ideal material in its products, it uses special coatings with a high level of acid and temperature resistance and maximizes the Scrubber's economic life.



rotekmarine

"Quality is never an accident. It is always the result of intelligent effort. There must be the will to produce a superior thing."

John Ruskin

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