Emission Monitoring on Ships

IMO regulated emission monitoring from the shipping industry with Siemens continuous gas analyzers

Emission Monitoring on Ships

The maritime shipping industry generates a substantial and growing part of global emissions of air pollutants including greenhouse gases. In some coastal regions, marine shipping emission are considered to contribute almost 50 % of SO_2 emissions and 30 % of NO_x emissions. Caused by increasingly strigent emission regulations and limits together with a demand in more cost efficient ship operation, the shipping industry increasingly evaluates the advantage of using emission monitoring technology on ships. CEMS (Continuous Emission Monitoring Systems) are standard since more than 30 years at stationary emission sources as reliable technology.

Meanwhile, installation of similar systems on ships has started. The most important gases are currently sulphur and nitrogen oxides, SO_x and NO_x. Annex VI (see Fig. 1) schedules significant reductions in both over the next 10 to 15 years. For SO_2, regulatory limits require either use of fuels of the correct sulphur content or exhaust gas after-treatment on board using gas scrubbers. For NO_x, engine based measures and after-treatment processes, e.g. Selective Catalytic Reduction, can be used depending on the level of abatement required.

In addition to NO_x and SO_x, offshore rig operators are required to monitor carbon monoxide (CO) and unburned hydrocarbon (HC) emissions for Integrated Pollution Prevention and Control.

ULTRAMAT gas analyzers support maritime CEM systems

Continuous gas analyzers are key components of CEM systems to determine the concentration of the relevant gases in the exhaust gas. Both analyzer availability and measuring data reliability/precision affect strongly the overall performance of a maritime CEM system. In this regard, ULTRAMAT 23 and ULTRAMAT 6 gas analyzers are the top choice for system engineering companies: Both analyzers are well known in all industries as extremely reliable and precise, well proven in rough operational environments and easy to intergrate into analyzer systems.

The regulatory framework

As maritime shipping is a global issue, environmental standards are developed by the IMO (International Maritime Organization), a United Nation's specialized agency.

- IMOs ship pollution rules are contained in the International Convention on the Prevention of Pollution from Ships, known as MARPOL (Marine Pollution) 73/78 which originated in 1973. It was modified in 1978 and fina y entered into force in October 1983.
- In 1997, the MARPOL Convention was amended by the "1997 Protocol"; which includes 6 annexes concerning all kinds of pollution from ships. MARPOL Annex VI of May 2005 is titled "Regulations for the Prevention of Air Pollution from Ships". It covers numerous regulations, where regulations 13 and 14 refer to monitoring of NO_x and SO_x emissions from ship exhausts.
- As well in 1997, the MARPOL "Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines" (NO_x Technical Code) was adopted. The purpose of this Code is to provide mandatory procedures for the testing, survey and certification of ma ine diesel engines which will enable engine manufacturers, shipowners etc. to ensure that all applicable marine diesel engines comply with the relevant limiting emission values of NO_x as specified wi hin regulation 13 of Annex VI.
- MEPC (Marine Environment Protection Committee) is a committee of IMO and develops international regulations relating to marine environmental concerns including ship recycling, controlling emissions, etc. MEPC 184(59) regulation is titled Guidelines for exhaust gas cleaning systems (EGCS).
- In 2008, revised standards of Annex VI entered into force with three topics (Fig. 1) :
  (a) Setting limits on the sulphur content of marine fuel oils
  (b) Setting limits on the emissions of nitrogen oxides (NO_x) from new ship engines
  (c) Defining "Emi sion Control Areas" (ECAs) providing more stringent regulations inside than outside these areas. ECAs currently include Baltic Sea (SO_x, since 2005), North Sea including the British Channel (SO_x, since 2005/2006) and North America, including most of the US and Canadian coasts (NO_x & SO_x, since 2012). The US Caribbean ECA (SO_x) is intended to enter into effect in January 2014. Korea, Japan, Singapore, Mediterranean Sea and Australia are probably future ECAs.
- In 2011, IMO amended MARPOL Annex VI to include EEDI (Energy Efficiency Design Index, for new ships) and SEEMP (Ship Energy Efficiency Mana ement Plan, for existing ships). Both are intended to improve the energy efficienc of vessels and to reduce the overall amount of CO_2 emissions of the shipping industry and entered into force on the 1st of January 2013.

		2011	from 2012	from 2015	from 2016	from 2020	from 2025
Sulfur content in marine fuel	Standards outside ECAs	4.5%	3.5%	3.5%	3.5%	0.5%	0.5 %
	Standards applied to ECAs	1%	1%	0.1%	0.1%	0.1%	0.1%
ECAs (Emission Control Areas)		Baltic Sea North Sea Channel	North America	US Caribbean (from 2014)			
NO_x **emission limits** for new engines		from 2021					
		Tier II	Tier II	Tier II	Tier III		
		From 14.4 to 7.7 g/kWh depending on engine speed rpm.			From 3.4 to 1.96 g/kWh depending on engine speed rpm		
EDDI Target (CO_2 reduction) for new ships not yet mandatory; „%": reduction related to 2013		from 2013		from 2015		from 2020	from 2025
			Phase 0 0%	Phase 1 10%		Phase 2 20%	Phase 3 30%

Fig. 1: Standards of Annex VI as of 2013

Accepted measuring technologies

NO_x Technical Code (see page 2) states which types of measurement technologies should be used for measurements of gaseous emissions from marine diesel engines (Fig. 2). The NO_x Technical Code states as well, that "other types of analyzers may be used, if they yield equivalent results to the referenced equipment".

Siemens is a leading supplier of process analyzers and process analysis systems to most segments of the producing industry and for emission monitoring with a worldwide presence in sales and support. The broad product range includes i.a. continuous gas analyzers such as the NDIR-based ULTRAMAT 23 and ULTRAMAT 6.

Analysis methods stated in the NO_x Technical Code	
CO	NDIR
CO_2	
NO_x	CLD
SO_2	Not specified
O_2	Paramagnetic, zirconum dioxide or electrochenical cell
NH_3	Not specified
HC	FID
Other analyzer types may be used	

Fig 2: Anlysis methods

ULTRAMAT 23

The ULTRAMAT 23, since decades available and continuously upgraded, links highest technological level with longtime operational reliability. Its multi-channel design allows the simultaneous measurement of up to four gas components using NDIR, electrochemical and paramagnetic sensor cells. Thus, the ULTRAMAT 23 is extremely versatile, economical and space saving. In a typical assembly it e.g. simultaneously determines carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxyde (SO_2) and oxygen (O_2). For emission monitoring, the ULTRAMAT 23 is certified y TÜV (Germany) and SIRA (UK) according to EN 14181/EN 15267.

ULTRAMAT 6

ULTRAMAT 6 is most frequently used for demanding applications such as corrosive gases, use in explosive areas, or lowest measuring ranges with high measuring performance and quality. This is achieved by modern electronics and physical elements that are adapted to the measuring task. The ULTRAMAT 6 measures up to four infrared active components in a single unit. The use of optical couplers and the optional use of optical fil ers to increase the selectivity mean that, in many cases, the analyzers can be used for measurements even in complex gas mixtures. This also guarantees measurements of lower concentrations and lower detection limits.

Features and user benefits (selection)

	ULTRAMAT 23		ULTRAMAT 6	
	min. range	max. range	min. range	max. range
SO_2	150 vpm	2,5 % vol.	50 vpm	100 % vol.
NO	100 vpm	5000 vpm	100 vpm	3 % vol.
CO	50 vpm	100 % vol.	10 vpm	100 % vol.
CO_2 *)	50 vpm	100 % vol.	5 vpm	100 % vol.
O_2	5 % vol.	25 % vol.	0.5 % vol. **)	100 % vol. **)

*) typical ranges for emission monitoring: 0 ... 5 / 25 % vol.

**) ranges refer to analyzer ULTRAMAT 6 / OXYMAT 6

Fig. 3: Min. and max. measuring ranges

ULTRAMAT 23

- Unparalleled cost/performance ratio
- Selective measurement of up to 3 IR-active componenrs and Oxygen or H_2S with electrochemical cell
- No calibration cylinders required for every day calibration: automatic zero calibration with ambient air
- Automatic correction of variations in atmospheric pressure
- Mechanically cleanable measuring cell
- Flexible interfacing and remote maintenance capabilities through RS 485, RS 232, PROFIBUS PA/DP and SIPROM GA

ULTRAMAT 6

- Highly selective measurement of up to 4 IR-active components
- Measuring ranges down to low ppm range
- Different versions available including corrosion-resistant materials in gas path (option) for measurement of corrosive sample gases
- Mechanically cleanable sample cells: Cost saving in further use in case of pollution
- Electronics and physics: gas-tight isolation, purging possible, IP65: High service life even in harsh environments
- Flexible interfacing and remote maintenance capabilities through RS 485, RS 232, PROFIBUS PA/DP and SIPROM GA

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