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SE**

Effectiveness of Fixed Fire Suppression System in Absorbing and Dispersing Ammonia

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Addressing climate change

Over a decade of regulatory action to cut GHG emissions from shipping

Committee outputs

Energy efficiency regulations for ships: EEDI and SEEMP

DCS regulations

Initial IMO Strategy on reduction of GHG emissions from ships

- Revised procedure on assessment of impacts on States
- Consideration of mid-term measures

Short-term measure: EEXI, CII

2023 IMO Strategy on reduction of GHG emissions from ships

- LCA guidelines
- Biofuels circular

Comprehensive impact assessment

- Review of short-term measure
- Approval of basket of mid-term measures

- 40% reduction of CO₂ per transport work
- 5% uptake of zero-emission fuels, striving for 10%
- Indicative checkpoint: 20% reduction of the total annual GHG, striving for 30%

Net-zero GHG emissions by or around, i.e., close to, 2050

2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025

2030

2040

2050

Implementation

3rd IMO GHG Study

EEDI and SEEMP

Fuel consumption report to DCS

4th IMO GHG Study

Aggregated results of the 2019 fuel consumption data

EEXI survey

Collection of carbon intensity data (CII) for existing ships

EEDI phase 3 for remaining ship types

EEDI Phase 3 for certain ship types

Indicative checkpoint: 70% reduction of the total annual GHG, striving for 80%

- mandatory measures and guidance
- evidence-based decision making
- strategic objectives

EEDI Phase 1

EEDI Phase 2



Background

Ammonia NH_3 as a promising future energy source:

- Easy to reach a high volumetric energy density (compared to other carbon-free fuels, such as hydrogen)
- Promising carbon-free solution for deep-sea shipping

Challenges:

- Health and environmental hazards
- Bunkering, storage, supply and consumption



An example of an ammonia tank

- Internal Pressure: 15 to 16 bar
- Double wall

Background

Ammonia

- Main production by Haber Bosch process
- Green alternatives also becoming more common by using renewable energy
- Boiling Point: 239.81K (-33.34°C)

Acute Exposure Guideline Levels

	10 min	30 min	60 min	4 hr	8 hr
AEGL 1 (discomfort, non-disabling) - ppm	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm
AEGL 2 (irreversible or other serious, long-lasting effects or impaired ability to escape) - ppm	220 ppm	220 ppm	160 ppm	110 ppm	110 ppm
AEGL 3 (life-threatening effects or death) - ppm	2,700 ppm	1,600 ppm	1,100 ppm	550 ppm	390 ppm

Experiments

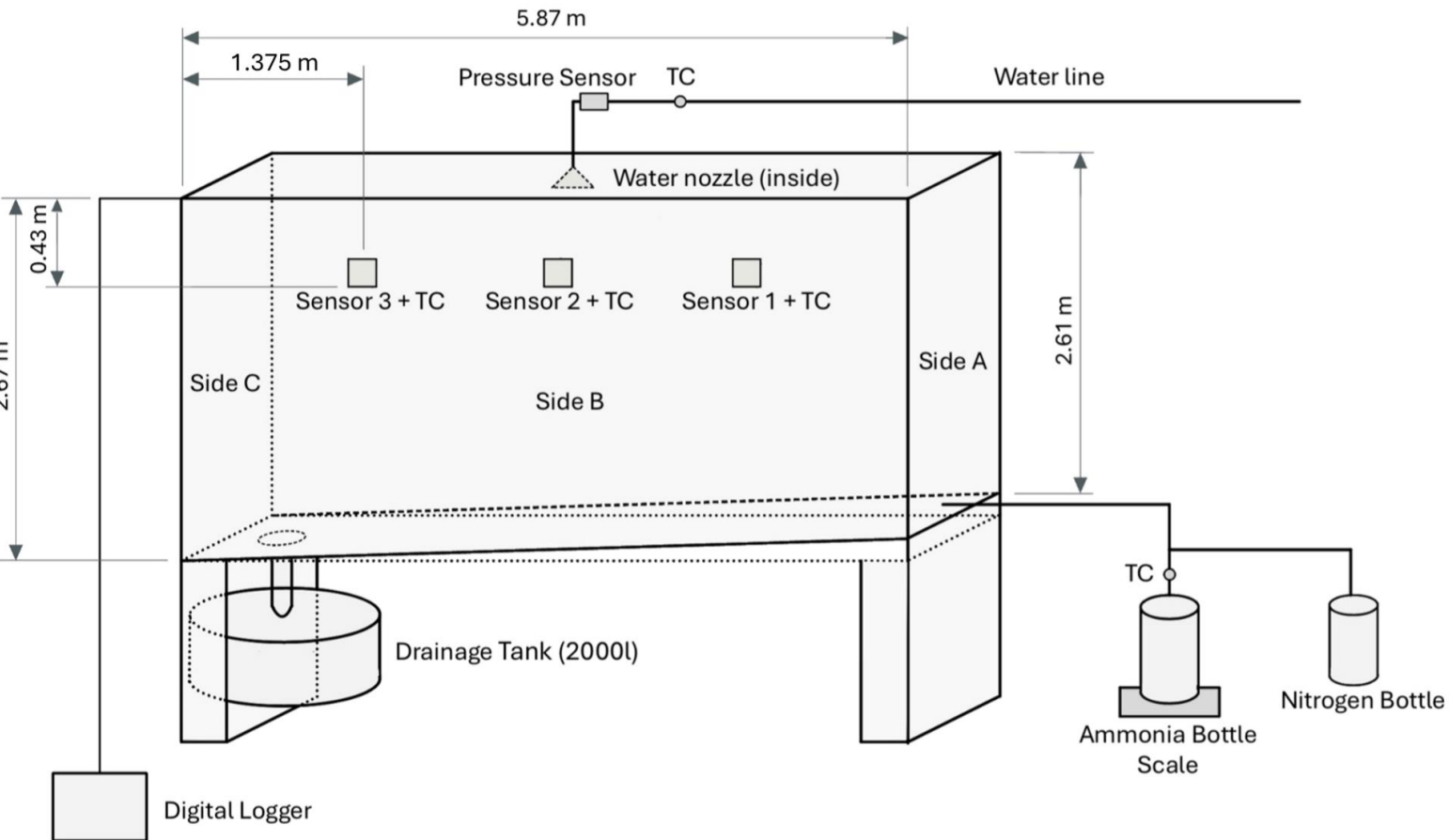
Objectives:

- Study established fixed fire suppression systems for absorbing and dispersing gaseous and liquid ammonia in a confined space.
- Identify correlations between ammonia concentration using different nozzles and pressure in the suppression system.

Focus:

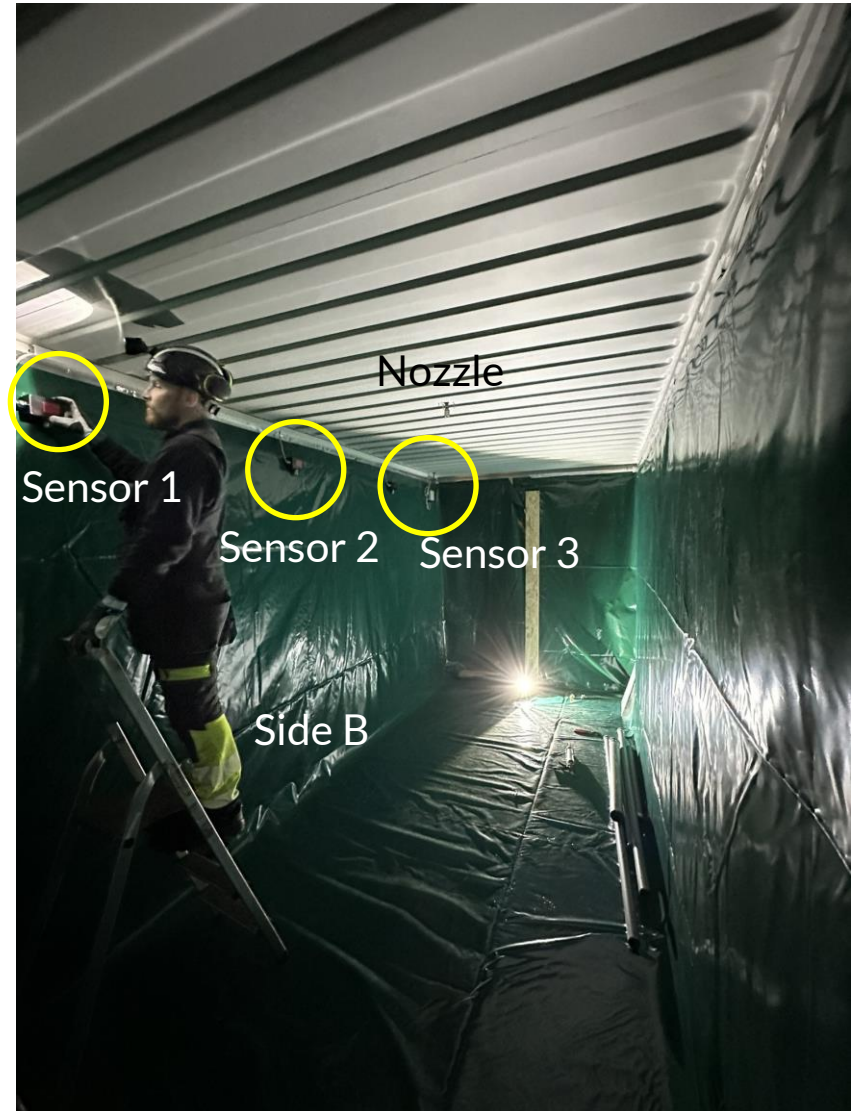
- Water mist nozzles approved according to IMO MSC/Circ. 1165
- Comparison between different types of suppression systems

Experiments



Tested parameters:

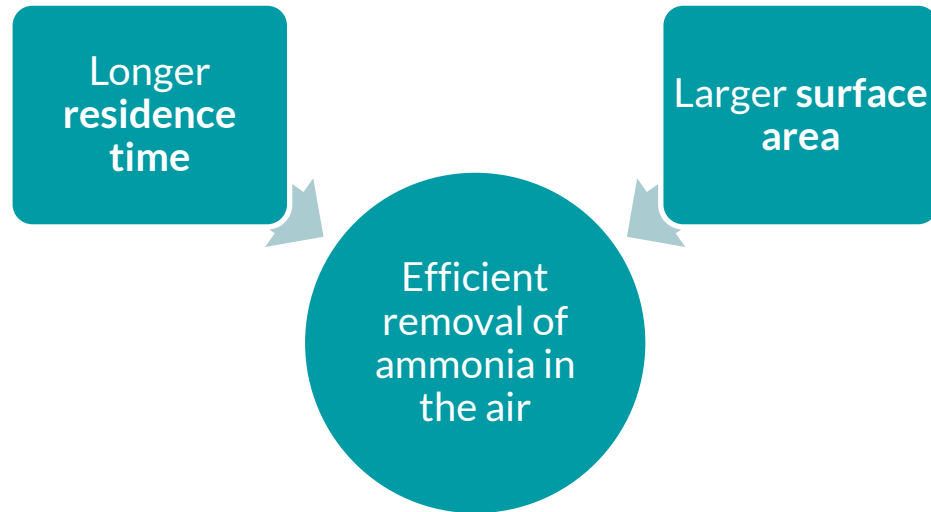
- Gaseous and liquid ammonia
- 3 Nozzle types:
 - high pressure water mist system (**HP** mist)
 - low pressure water mist system (**LP** mist)
 - sprinkler system (**Sp**)
- Pressure ranged from 0.8 bar to 70 bar
- Amount of released ammonia
- Amount of released water



Experiments

What to expect?

Ammonia is highly water-soluble

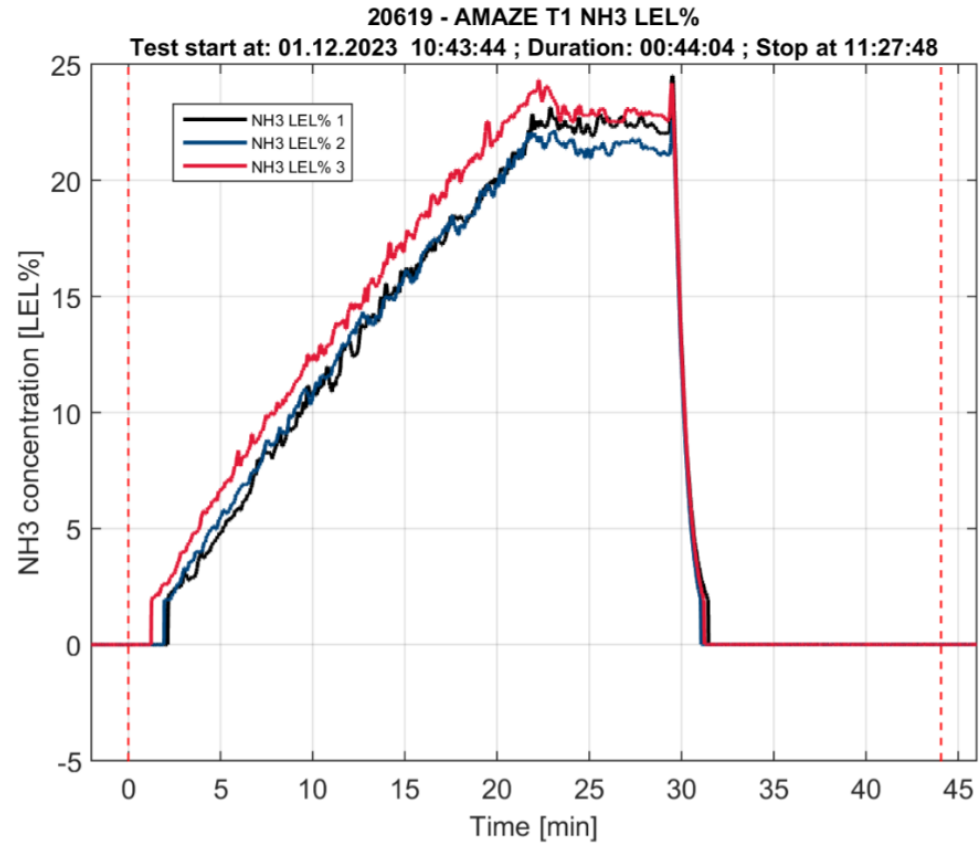


AI generated figure



A water mist system with small droplet sizes should be efficient in ammonia absorption.

Experiments



Experiments

Test No.	1	2	3	4	5
Suppression system	HP	HP	HP	HP	HP
Pressure (bar)	60	60	70	60	50
NH ₃ type	gas	gas	gas	gas	gas
NH ₃ amount (kg)	1.07	1.07	1.5-2	1.5-2	1.5-2
Water consumption (kg)	513	500	1375	1071	1500
Flow Rate (kg/min)	37.3	42.1	45.9	41.6	37.9
Test No.	6	7	8	9	-
Suppression system	LP	Sp	HP	Sp	
Pressure (bar)	16	0.8	60	0.8	
NH ₃ type	gas	gas	liquid	liquid	
NH ₃ amount (kg)	1.5-2	1.5-2	1.07	2	
Water consumption (kg)	1088	>2000	1304	>2000	
Flow Rate (kg/min)	21.7	69.6	40.1	71.7	

Experiments

Summary

- The tested high-pressure water mist system reduced ammonia concentrations to acceptable levels (~110 ppm) within 12-40 minutes at 50, 60, or 70 bar.
- The tested low-pressure water mist system required approximately 50 minutes to achieve similar results.
- The tested sprinkler system took significantly longer to reach the same concentration level, about 63-97 minutes for gaseous and liquid ammonia.

Acknowledgement

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Thank you!

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