Effectiveness of Fixed Fire Suppression System in Absorbing and Dispersing Ammonia

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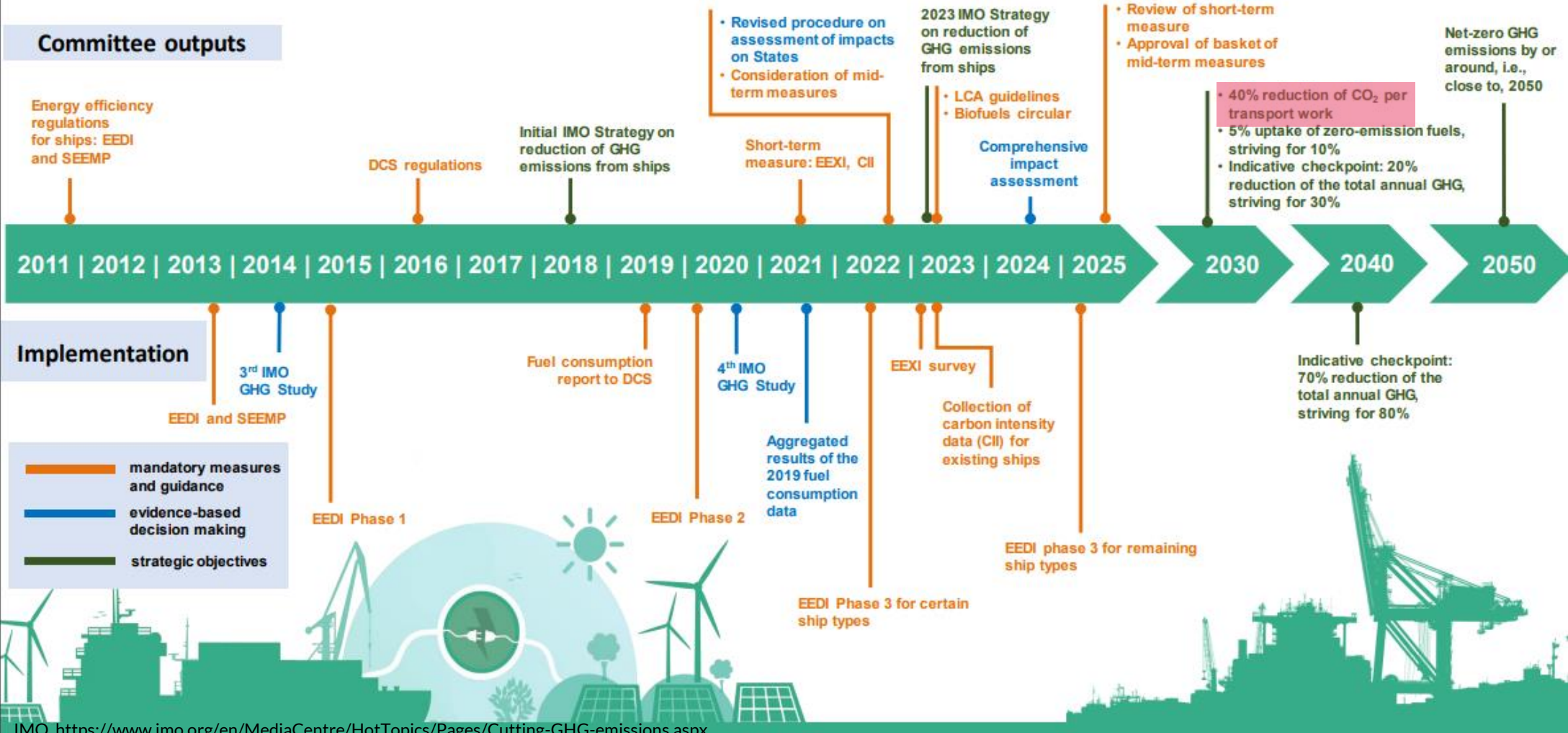
Addressing climate change

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



IMO, https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx

Backgroud

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

Backgroud

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

Source: EPA https://www.epa.gov/aegl/ammonia-results-aegl-program

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

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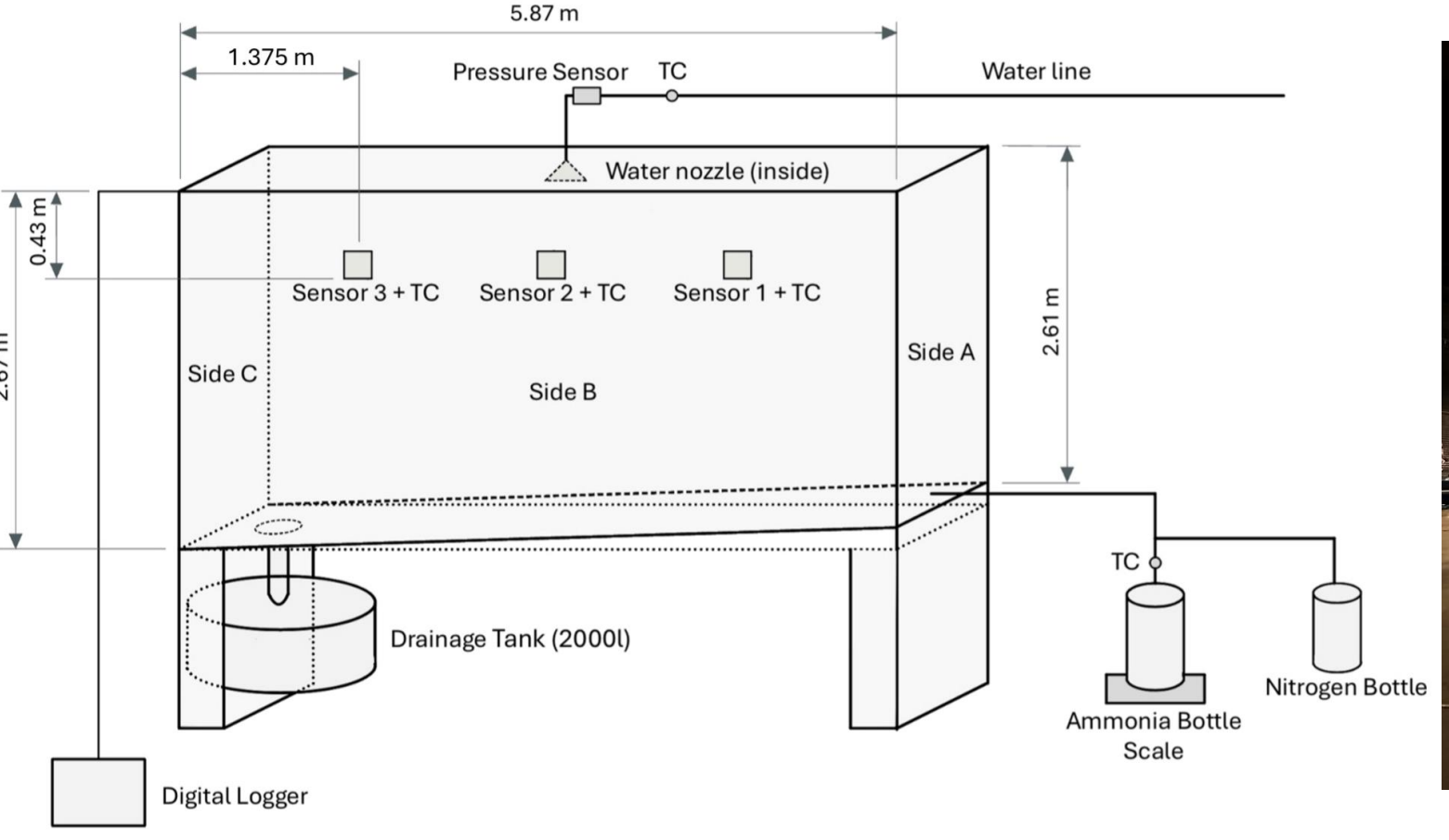
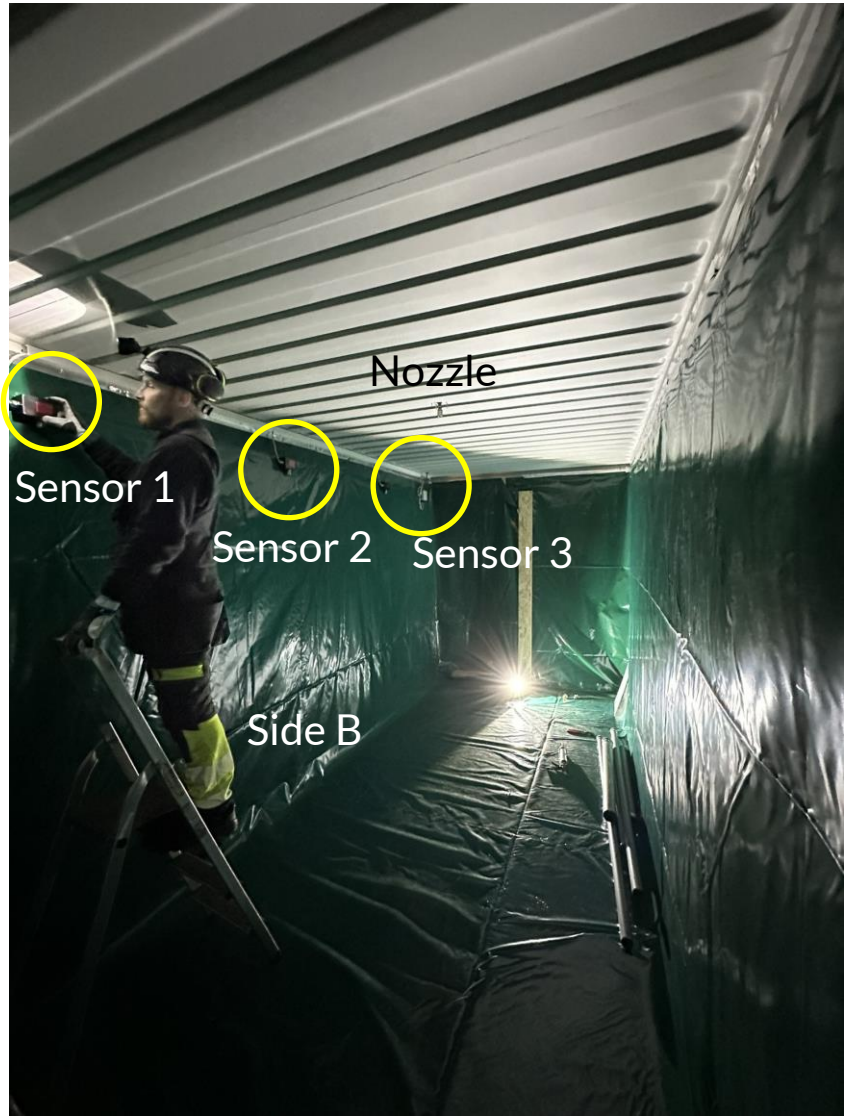
Experiments



Tested parameters:

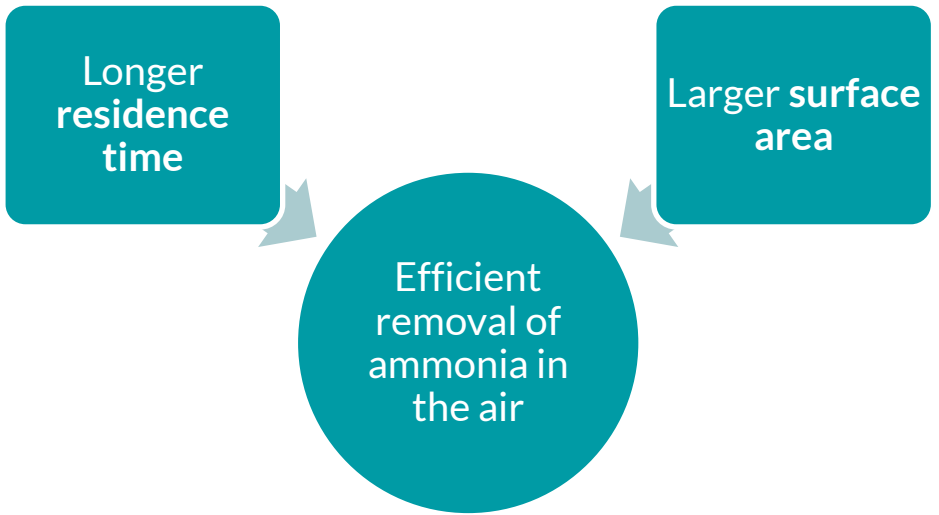
- Gaseous and liquid ammonia
- 3 Nozzle types:
  - high pressure water mist system (**HP** mist)
  - low pressure water mist system (**LP** mist)
  - sprinkler system (**Sp**)
- Pressure ranged from 0.8 bar to 70 bar
- Amount of released ammonia
- Amount of released water

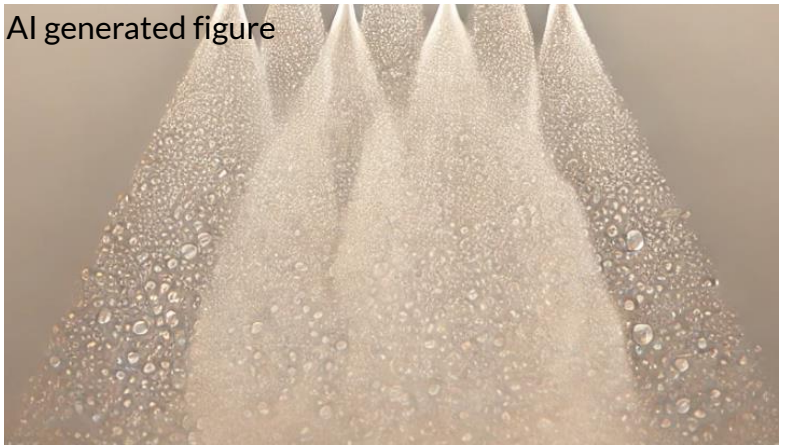


Experiments

What to expect?

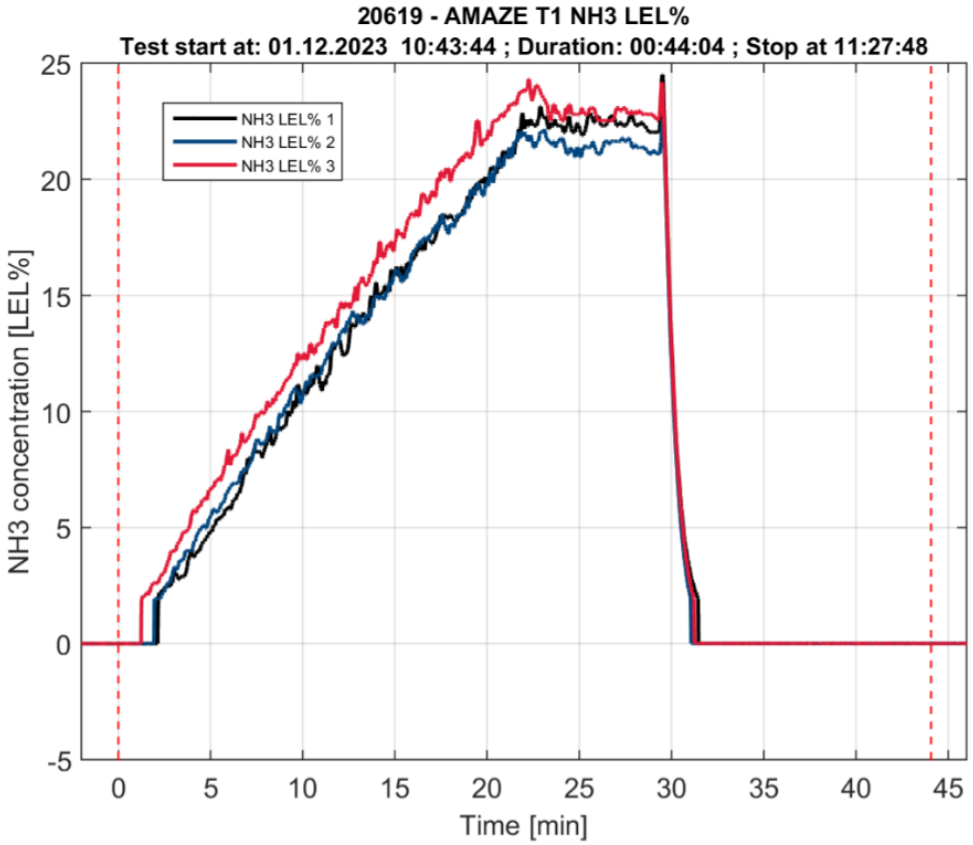
Ammonia is highly water-soluble





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	

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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.

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Thank you!

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https://risefr.com/services/research-and-assessments/amaze