AEA Annual Conference 2023@Atlanta

Introduction of Ammonia Tug Boat Project

2023.11.15

NYK Energy Transport (USA)

NYK LINE NIPPON YUSEN KAISHA

NYK GROUP

Development of Ammonia Fueled Ships (GI Fund Project)

Ammonia Fueled Tugboat

Apr 2022
Safety Evaluation Study

May 2022
MoU with Yokohama City re the introduction of Ammonia Fueled Tug boat

First

July 2022
Obtained AiP
＊as Ammonia Fueled Tug

AiP
Approval In Pricipal

Aug 2022
Ship Conversion Contract
(Keihin Dock Shipyard@ Kanagawa Prefecture)

First

May 2023
Successful combustion test at 80% mixing ratio using actual engine (as an actual 4st marine engine)

World's First

Estimated Delivered in 2024

For	In Charge	FY2021	FY2022	FY2023	FY2024	FY2025	FY2030	・・・	FY2050
Main Engine	株式会社IHI原動機 IHI Power Systems Co., Ltd.	4-stroke engine development, manufacturing and test operation			Delivery				
Vessel Development	NYK LINE	Vessel Design, Test Operation and Construction				Demonstration/Operations			
Operation	NYK LINE	Compliance with Laws/Regulations Establishment of Operation Manual							
Project Schedule		HAZID		Risk Assess.					
		Concept Design	Basic Design	Detailed Design	Conversion	Trial			

ClassNK

- Technical verification of safety
- Basic research for the development of international guidelines
- Support for Regulatory Compliance

Ammonia-fueled Ships Development Project :Tugboat & Deep sea

Project Cost	**Total: JPY12.3 billion / Subsidy: JPY 8.4 billion (maximum)**
Period	**FY2021～2027**

Ammonia Fueled Tugboat (2024 delivery)

- Target co-firing rate over 80%
- Modification of LNG powered tug
- **AiP obtained** in July 2022

May 2023
IHI Power System commenced NH3 combustion test in the prototype 4-stroke NH3 engine

AFAGC – Ammonia Fueled Ammonia Gas Carrier (2026 delivery)

- Target co-firing rate :60 to 95%(M/E)
- Target co-firing rate :80%(G/E)
- AiP obtained in Sept 2022

May 2023
J-Engine commenced NH3 combustion test in the test rig of the 2-stroke engine

A-Tug: Recent Achievements

The world's first success of 80% ammonia co-firing test of a 4-stroke engine by IHI Power Systems Co., Ltd.

- In May 2023, a Land-Based test for stabled combustion of 80% ammonia co-firing test
- The world's first achievement to complete the 80% co-firing test of a prototype 4-stroke ammonia engine

Modification of LNG fueled tugboat to A-Tug by Keihin Dock Co., Ltd (100% NYK group subsidiary)

- Modification of LNG fueled tugboat to A-Tug will start from the end of Oct 2023
- This modification is world's first challenge and demonstrates the potential use of existing LNG fueled tugboat for A-Tug

Safety Methodology from NYK as Operator

Why NYK is leading the industry to develop ammonia-fuelled vessels.

➞ To ensure operational safety and operational methodology

1) "Improve remote monitoring and operation“

To change mind-set fundamentally, minimize the need to enter the E/R whenever possible

2) "Isolated environment for ammonia and personnel"

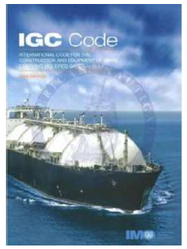
To enter and perform maintenance, create and define safety methodology, such as compartmentalization barrier, using ventilation control and personal protective equipment.

3) "Availability of Evacuation Routes"

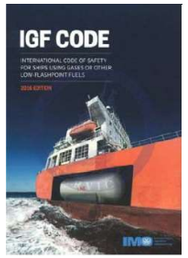
Route to Escape trunks and Strategic placement of work shops

Ammonia Fueld Vessels -Issues Related to Regulations-

At this time, no regulations exist for the use of ammonia as a marine fuel.
*Ammonia-fueled ships to be built before the IMO guidelines are established will be reviewed and approved by the Flag State through a safety assessment based on the classification guidelines (Alternative Approval Scheme).



✓ **IGC CODE**
(International Regulations on the Construction and Equipment of Ships for the Transportation of Liquefied Gas)
⇒ Ammonia, a toxic product, is not allowed to be used with fuel.



✓ **IGF CODE**
(International Regulations on Safety of Ships Using Gas Fuel and Other Low Flash Point Fuel)
⇒ The rule assumes methane (LNG) and does not cover ammonia, which is not a low flash point fuel.

- Regulations are needed to take into account the physical properties of ammonia (toxicity/flammability/corrosiveness), minimize risk to the environment/crew/vessel, and achieve the same safety/reliability as existing fuel.
- Contributed to the development of guidelines through GI projects, etc., and verified through NYK's demonstration operations.

Completed and Ongoing

Completed

- **HAZID (Hazard Identification Study) was conducted** in April 2022, risk scenarios were identified, and drafting of response plan was completed.
- Conversion work started in October 2023, and **social implementation will be completed in June 2024.**
- Regarding 4-stroke engines manufactured by IHI Power Systems, stable testing was completed in May 2023 at 80% co-firing rate on actual equipment, and since then, **co-firing rate has been 80% or higher and exhaust gas treatment (N20, unburned ammonia) has been successfully reduced to almost zero**.
- We are on track to achieve an even higher mixing.

Ongoing

- Ammonia bunkering **Truck to Ship method operating procedures** are being developed.
- Examining **how safety protective equipment for crew should be provided** in compliance with classification guidelines/regulations (mainly the High Pressure Gas Safety Act).
- Establishing **criteria for entering engine rooms/plant rooms** with high risk of leakage.

Ammonia to Zero.

アンモニアで地球を救え。

NYK GREEN EARTH

produced by NYK LINE NIPPON YUSEN KAISHA