

# Case study on bunkering time limit of gas fueled ship during Ship-to-Ship LNG bunkering procedure

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## 1. Introduction

As an alternative energy source, the demand for LNG had increased rapidly. Moreover, in order to comply with the stringent emissions requirement of IMO, using natural gas as fuel of ship is considered as a realistic and feasible solution. For LNG fueled ship, the LNG bunkering process would be different from HFO bunkering, in which the cryogenic liquid transfer would generate a considerable amount of boil-off gas (BOG).

In this case study, dynamic simulation for boil-off gas between the cargo tank(4500 m<sup>3</sup>) of bunking ship and fuel tank(700 m<sup>3</sup>) of receiving ship during LNG bunkering was investigated and analyzed based on the commercial software Aspen HYSYS.

## 2. Model method

The time limit of the bunker scenario is set to 60~150 minutes for the complete ship to ship LNG bunkering procedure. In order to more easily distinguish the different actions during the bunkering operation the procedural description is divided in three stages: Before, During and After bunkering.

The ship to ship LNG bunkering procedure is divided into two parts: the start up of the system and the shutdown of the system.

## 3. Dynamic simulation

A ship to ship LNG bunkering scenario is performed by the commercial software Aspen Hysys. Table 1. shows the bunkering and receiving tanks' conditions at the period of start and finish of bunkering scenario.

		Bunkering Ship (4538m <sup>3</sup> )	Receiving Ship (700m <sup>3</sup> )
Before Bunkering	Tank Pressure (Bar)	2.799	5.776
	Temperature (°C)	-147.0	-134.5
	Tank Level (%)	90.0	20.5
After Bunkering	Tank Pressure (Bar)	2.898	3.062
	Temperature (°C)	-146.4	-145.6
	Tank Level (%)	77.05	89.96

Table 1. Conditions of bunkering and receiving ship

## 4. Results

The Fig.1 shows that the amount of BOG return mass from receiving ship is increasing rapidly and proportionally with the bunkering time until the time limit reached at 120 minute. The peak point is at 120 minute and the value of total BOG return mass is 10,535.42 kg. Therefore, at the actual bunkering process when the fuel tank of receiving vessel's volume is 700 m<sup>3</sup>, the bunkering process finished within 120 minutes will be the best. Moreover, the bunkering scenario might be finished the faster the better so that the BOG generation will be reduced

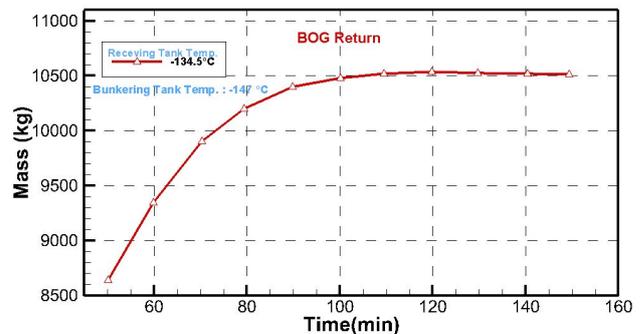


Fig. 1. BOG variation in different bunkering time limit.

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