The Development of a Vertically Asymmetric Bi-lobe Tank for Large-Scale LCO2 Carrier

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ABSTRACT

In this paper, the design of a vertically asymmetrical bi-lobe tank for large-scale liquefied carbon dioxide (hereinafter referred to as LCO2) carrier is introduced. This includes the case study results of tank shape optimization to maximize cargo tank capacity and the strength assessment results based on the relevant rules and standards.

KEY WORDS: Liquefied carbon dioxide, Vertically asymmetric bi-lobe tank, Large-scale LCO2 carrier

INTRODUCTION

As greenhouse gases, particularly carbon dioxide (hereinafter referred to as CO2), have been pointed out as the major cause of global warming, the demand for reducing CO2 emissions into the atmosphere is capturing the attention of governments, industry and the investment community. To achieve this goal, CCUS (carbon capture, utilization and storage) technology is attracting attention as means of realizing a decarbonized society and a new value chain is being formed. The LCO2 carrier will play an important role in this value chain, and this will lead to increasing demand for the LCO2 carriers going forward. Generally, a pressure and temperature of liquefied gas are taken into consideration as the main design factors while designing the tank. For the large-scale LCO2 carrier with low pressurizing, a specific conditions of the storage tank should be retained for containing LCO2 at the pressure of approximately seven to eight barg and the temperature of -60 °C to -50 °C, simultaneously. These conditions have been selected to the lower limit for a large-scale tank design considering a limitation of the high-strength steel for low-temperature use. Therefore, IMO independent tank Type-C, which has resistance to internal pressure and sloshing load, is preferable.

The most common shapes for Type-C tank are a single-lobe and a bi-lobe as can be seen in Fig. 1, and it is selected considering the required cargo capacity and hull structure. For the design of a large-scale LCO2 carrier, the arrangement of vertical type bi-lobe tank in parallel to the breadth direction of the hull is most preferable to maximize the cargo volume at the given hull structure as can be seen in Fig.2. However, this bi-lobe type tank will have volume limitation when the upper and lower tank has same dimension at given design factors. To overcome this limitation at the given pressure, temperature of cargo and ship particular, the idea was utilized that the hydraulic pressure in the upper tank is smaller than that of the lower tank due to the gravity effect. In the case that both upper and lower tank are designed to have same dimension, the upper tank will have more design margin than that of the lower tank. Considering this, two cases can be approached as follows:

*Case 1: When the same material is applied to the upper and lower tank for scantling, the shell thickness of the upper tank can be designed to be thinner than that of the lower tank.

*Case 2: When the same material and same shell thickness limit are applied to the upper and lower tank for scantling, the diameter of the upper tank can be bigger than that of lower tank.

Fig. 1. Section view of single-lobe & bi-lobe tank

Fig. 2. Section view of the vertically asymmetric bi-lobe tank