

ANALYSIS ON CASCADE UTILIZATION OF LNG COLD ENERGY

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ABSTRACT

Based on the current situation and development planning of Meishan Planning Area Ningbo Province, this paper obtains a preliminary plan for cold energy utilization by analyzing the characteristics and feasibility of different LNG cold energy utilization methods. In order to improve the utilization ratio of LNG cold energy, this paper proposes a cascade utilization scheme for rubber cryogenic comminution, Meishan Ice and Snow World refrigeration and coastal fresh preservation storage, and builds a integrated LNG cold energy utilization industrial chain and determines the process of gradient utilization. Through economic analysis, it is concluded that cold energy utilization of LNG has great economic benefits.

Keywords: LNG cryogenic energy, cascade utilization, economic analysis

NONMENCLATURE

Abbreviations

LNG	Liquefied Natural Gas			
NG	Natural Gas			
CNOOC	China	National	Offshore	Oil Corporation

1. INTRODUCTION

In 2017, China's total LNG supply reached 20.25 million tons, an increase of 49% compared with 13.6 million tons in 2016. LNG receiving stations will become the main source of LNG supply increment. With the growth of LNG supply, more industries will be introduced to promote the marketization of natural gas.

After the process of purifying, drying, demineralization and heavy hydrocarbon separation, natural gas becomes a cryogenic liquid mixture named

LNG. LNG should be heated professionally before it can be used normally¹. Gasification is divided into single liquid phase, gas-liquid two-phase and single gas phase, which will release a large amount of cold energy, about 860-830kJ/kg, of which about 58% is latent heat of vaporization². If this part of high quality energy is not used, it will cause large energy loss and low temperature pollution.

2. PAPER STRUCTURE

2.1 Cascade utilization of LNG cold energy

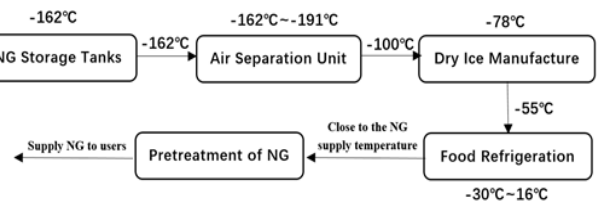


Fig 1 Schematic of LNG cold energy cascade utilization mode

The utilization of domestic LNG cold energy mainly focuses on air separation, ice and snow production, cold storage, cryogenic crushing of waste rubber, and CO₂ low-temperature capture. The lower the cold energy temperature, the higher its value. At present, due to the time and space synchronization between LNG gasification and cold energy utilization, research on this has focused on single aspect utilization³. Therefore, in order to make efficient use of LNG cold energy, a series of users with different temperature requirements should be arranged to implement the cascade mode of using LNG cold energy step by step, so as to maximize the economic benefits.

In the process of gasification, the quantity in different periods should be adjusted according to the change of downstream user load of natural gas, to

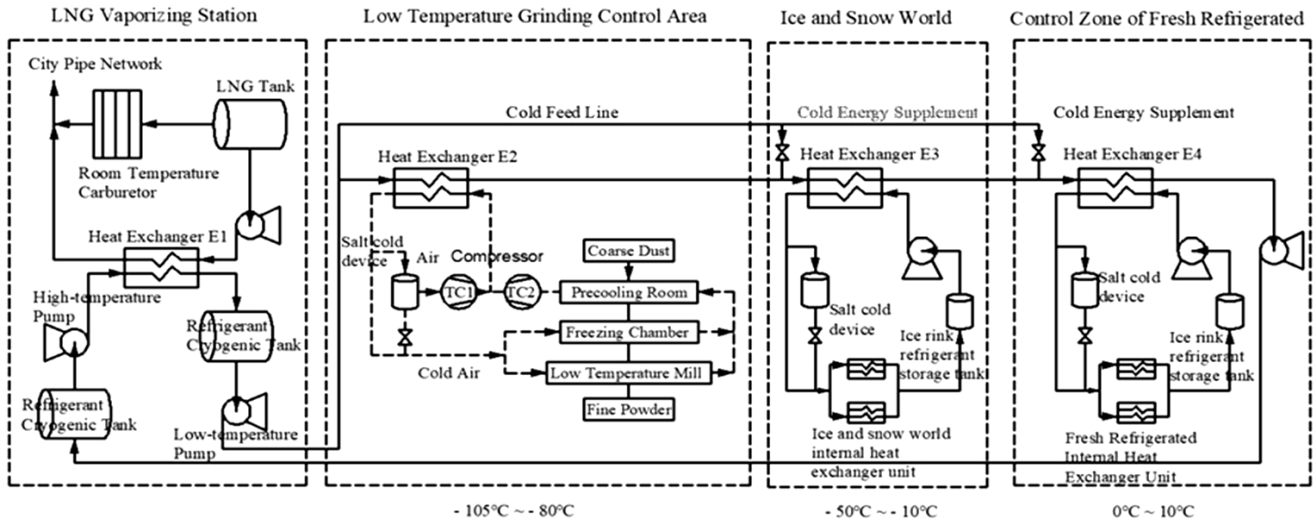


Fig 2 LNG cold energy utilization industry chain

determine the amount of cooling released by gasification. However, the time characteristics of cold energy demand in industries such as air separation and dry ice manufacturing are obviously out-of-sync with them.

In space, Cold energy utilization equipment cannot all be built in LNG receiving stations, because the cold energy utilization industry covers a much larger area than the receiving station. Moreover, the economic transport distance of low temperature cooling capacity is generally 1~3 kilometers, so the downstream industrial chain of LNG cold energy utilization must be close to LNG receiving station.

To build a complete industrial chain of LNG cold energy utilization, which involves many downstream industries, requires the consent of local governments in planning, coordination and management, as well as following the market mechanism and laws.

2.2 Cold energy utilization scheme in Meishan Planning Area

2.2.1 The technological process of cascade utilization

When compiling the energy planning of Meishan, it should be combined with the development plan of Zhejiang LNG receiving station (The 2nd phase scale: 6 million tons/year). Therefore, the geographical location and industrial characteristics of Meishan should be comprehensively considered to make full use of LNG cold energy. Based on the industrial characteristics of this region, relevant industries should be introduced to combine the single cold energy utilization mode of LNG and make full use of the cold energy grade of each

temperature level, so as to establish an industry chain of LNG cold energy cascade utilization mode.

LNG gasification stations should be set up at appropriate locations in the planning area, and LNG cold energy utilization can be carried out in three stages. The first level: cryogenic rubber crushing (-105 °C~-80 °C), along with the increase of car ownership, quantity of waste tires is also rising year by year, but the conventional crushing process energy consumption cost is large, use of cold energy of LNG cryogenic a rubber crushing is a way of energy conservation and emissions reduction, domestic existing programs are running. The second level: After low temperature crushing zone and gasification, based on the temperature of Meishan Ice and Snow World demand, LNG cold energy(-50~-10°C) can supply Meishan Ice and Snow World. The third level: the natural gas temperature is still lower than the ambient temperature after passing Meishan Snow and Ice World, so the cold storage preservation can be established according to the characteristics of the numerous seafood in the coastal area.

2.2.2 Feasibility analysis

Since the gasification pressure of CNOOC LNG is very high (above 6.0MPa), with the increase of system pressure, the temperature of LNG bubble point increases, and LNG is close to the critical region, resulting in the vaporization latent heat approaching zero. Therefore, the available cold capacity of LNG is only sensible heat, which means that the available cold capacity of LNG is less than 50%⁴. However, due to its proximity to LNG receiving stations, the total available cooling capacity is larger than that of general gasification

stations. As for the industrial chain of LNG cold energy utilization, it can be planned according to specific requirements or refer to figure 2 according to the principle of energy cascade utilization.

2.3 Economical analysis

For Meishan Ice and Snow World project, For the ice and snow town project, the electric compression chiller is used for refrigeration, and the refrigeration coefficient is 3, and the industrial electricity price is 0.95 yuan/(kW·h), namely 0.26 yuan /MJ, and the cold price is 0.087 yuan /MJ. When the LNG mass flow from the ice and snow world is about 18t/h and the effective refrigerating capacity is 7200MJ/h, the daily electricity saving is 15,000 yuan /d and the annual electricity saving is 550,000 yuan /a.

2.4 Conclusions

The utilization rate of LNG cold energy in China is still low. With the continuous development of technology and the maturity of commercial operation mode, the

LNG cold energy gradient utilization mode in Meishan Planning Area will be widely referenced and applied. The key to the implementation is to plan and construct the LNG receiving station in the downstream cold energy utilization project simultaneously, and coordinate the domestic demand in the planning area according to the market mechanism.

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