Development trends and key technologies of new offshore floating production unit

——Chinese Ocean Engineering Society

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Preface

China has energy shortages. In recent years as the land-based oil and natural gas exploration and development become increasingly saturated, 80% of the incremental oil and gas are from the ocean. It has become increasingly urgent to carry out deep-water oil and gas exploration and development.

Focuses and Priorities

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Preface

In accordance with the national energy demand, the strategic objectives for the marine technology sector are: developing key technologies and equipment based on the overall principle of *two themes, four directions and the two markets.*

2 Themes:

- Deepening adjacent shallow sea
- exploring deep open sea

4 Directions

1. **Offshore marginal oil field**
2. **Deepwater oil and gas field**
3. **Utilization of natural gas hydrate**
4. **Seabed exploration and exploitation of solid mineral resources**

2 Markets

- **Based on the domestic market**
- **Developing the overseas market**

“Deepening adjacent shallow sea and exploring deep open sea” are the focuses of the research.

Deepening adjacent shallow sea

Targeting major national needs and proposing new development mode!

Deepwater oil and gas resources exploration and development in the South China Sea is involved with fighting for and safeguarding the territorial rights of our country rather than making several drillings. Therefore, during the deepwater oil and gas exploration and development, there is an urgent demand for deep-water equipment and technologies.

At present, about 13 million tons of geological reserves (about 57%) remain untouched in Chinese waters. The vast majority of these gas fields are so-called marginal small fields, mainly located in the Bohai Bay.

Deepening adjacent shallow sea

Focusing on marginal oil fields to improve the exploration success rate and recovery!

Overview of the development models of deepwater oil and gas fields

Ø Ø Key security technologies for the development of deep-water oil and gas fields:

- Security issues of oil and gas flow in the seabed pipeline (deep-water pipeline buckle arresting technology);
- Routing and laying of submarine pipeline (anti-vortex induced vibration) under the complex terrain and topography;
- Development of newly-installed devices and optimization of submarine production technology during the development process of deep-water oil and gas fields.

In allusion to the aforesaid problems, foreign oil companies and large research institutions are putting forward some new development models to address the deep-water oil and gas storage and transportation problems.

Overview of the development models of deepwater oil and gas fields

New development models：

1）浮式液化天然气Vessel FLNG

2）浮式液化石油气Vessel FLPG

New oil and gas production unit that offers integrative services of offshore natural gas / LPG liquefaction, storage and handling and features low investment cost, small risk, high mobility and safety in the exploitation of offshore gas fields.

Increasing the drilling function by installing set drilling equipment on the moon pool of the FPSO, hence enabling it to offer such functions as drilling, production, storage and handling and independent development capacity of oil fields. As a result, the development cycle is greatly shortened and the cost saved.

3）浮式钻井生产储卸油轮 FDPSO

新型浮式生产装置FLNG

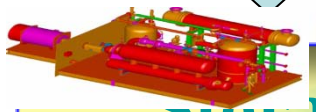
1、 Overall layout of FLNG

新型浮式生产装置FLNG

Gas treating

Liquefaction

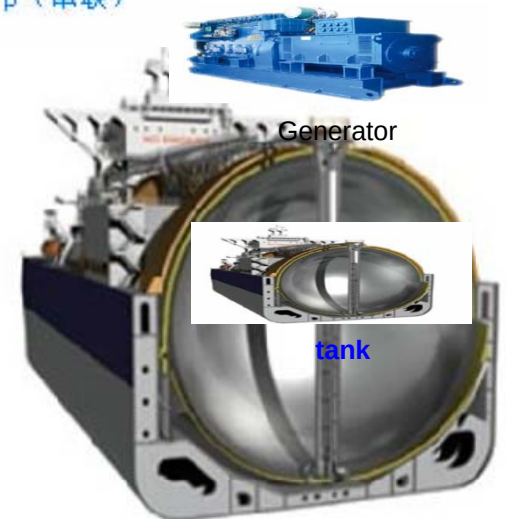
Ship to ship（串联）



Storage

Liquid condensing unit

Power system



Generator

tank

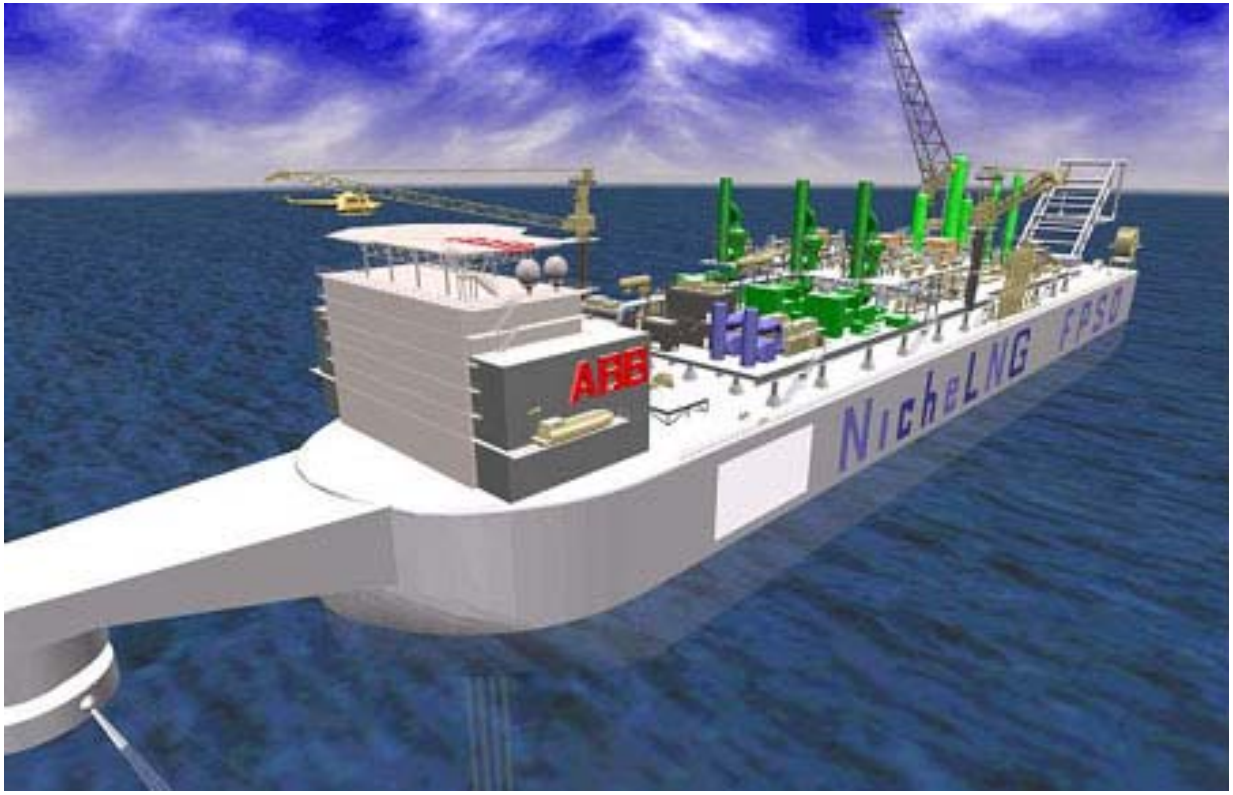
Pump

Offloading

Three sections of LNG storage tank

FLNG applications home and abroad

March 2005, ABB e proposed the Niche design concept, which passed ABS certification and is expected to complete in 2011. 312m in length, it will be the first FLNG in the world, able to produce liquefied natural gas and LPG, with a production capacity of 150 tons / year and storage capacity of up to 170,000 m3.



FLNG applications home and abroad

Owner (builder)	Topside	Capacity（MTPA）	Liquefaction method	Principal part	Reserve(m^3)	Enclosure System	Stage
FLEX LNG（Samsung）	Kanfa/Costain	1.7	Two-stage expansion of nitrogen	Vessel	170000	SPB(SS)	General Contracting
Höegh LNG(Daewoo)	CB&I Lummus	1.6-2.0	Propane pre-cooling	Vessel	190000	Membrane	Bidding stage
SBMLinde	Linde	2.5	Mixed Refrigerant	Barge	230000	SPB(SS)	Bidding stage
SHELL	SHELL	3.5（2.0）	Mixed Refrigerant	Barge	160000 -200000	Membrane	Bidding stage
Aker/Statioil	Aker	5.8	Mixed Refrigerant	Barge			Bidding stage
Bluewater	Air Products	Field Specific	Propane pre-cooling	Vessel or Barge	Gas field determined	Gas field determined	Concept stage
BW Offshore	Mustang	1.0	Two-stage expansion of nitrogen	Vessel		散货Vessel 嵌入SPB或者球式	Concept stage
Hamworthy	Hamworthy	0.5-2.2	Two-stage expansion of nitrogen	Vessel	Gas field determined	Gas field determined	Planning stage
Teekay	Mustang	0.5-1.0	Two-stage expansion of nitrogen	Vessel 或Barge		2 SPBs	Concept stage
Exmar EBLV Excelerate	Black & Veatch	1.0-2.0	Mixed Refrigerant	Vessel		Membrane	Concept stage
Saipem（Moss Maritime）	Air Products	1.0-2.5	Mixed Refrigerant	Vessel	270000	Membrane	Planning stage
TGE Marine	TGE	0.4-1.5	Mixed Refrigerant	Vessel		Type C	Concept stage
ConocoPhillips	ConocoPhillips	5.0	Carbon Dioxide pre-cooling	Barge	350000		Concept stage
Sevan Marine	Kanfa	1.5	Two-stage expansion of nitrogen	cylindrical FPSO	200000	Cylindrical LNG tank	Concept stage
Inpex	JGC/KBR	4.5	Mixed Refrigerant	Barge			可行性分析

Global FLNG projects

FLNG applications home and abroad

3 major and mature tanks used for LNG transport vessels:

Angle-independent

FLNG applications home and abroad

Features of applicable FLNG tanks

Tank type	Features
Angle-independent	No load level limits, requiring the whole deck space, high vessel utilization rate, the highest cost, easiest internal space maintenance, but little experience. There are only 2 across the world.
Spherical tank	No load level limits, the deck space is limited, utilization rate of physical vessel volume is low, cost the least and easy for internal maintenance. However, when the reserve on the vessel is too large and hence needs 5 cylindrical tanks, a whole-through deck will be needed because the strength of the vessel comes from not only the deck by the two sides of the tanks, which is of limited space.
Thin-film single-row cabin	With load level limits, flat deck space, high utilization rate of vessel volume, and medium building cost. However, it is hard to make internal maintenance and building experience is required.
Thin-film double-row cabin	With certain load level limits, flat deck space, medium utilization rate of Vessel volume and medium cost. However, the internal space maintenance is difficult.

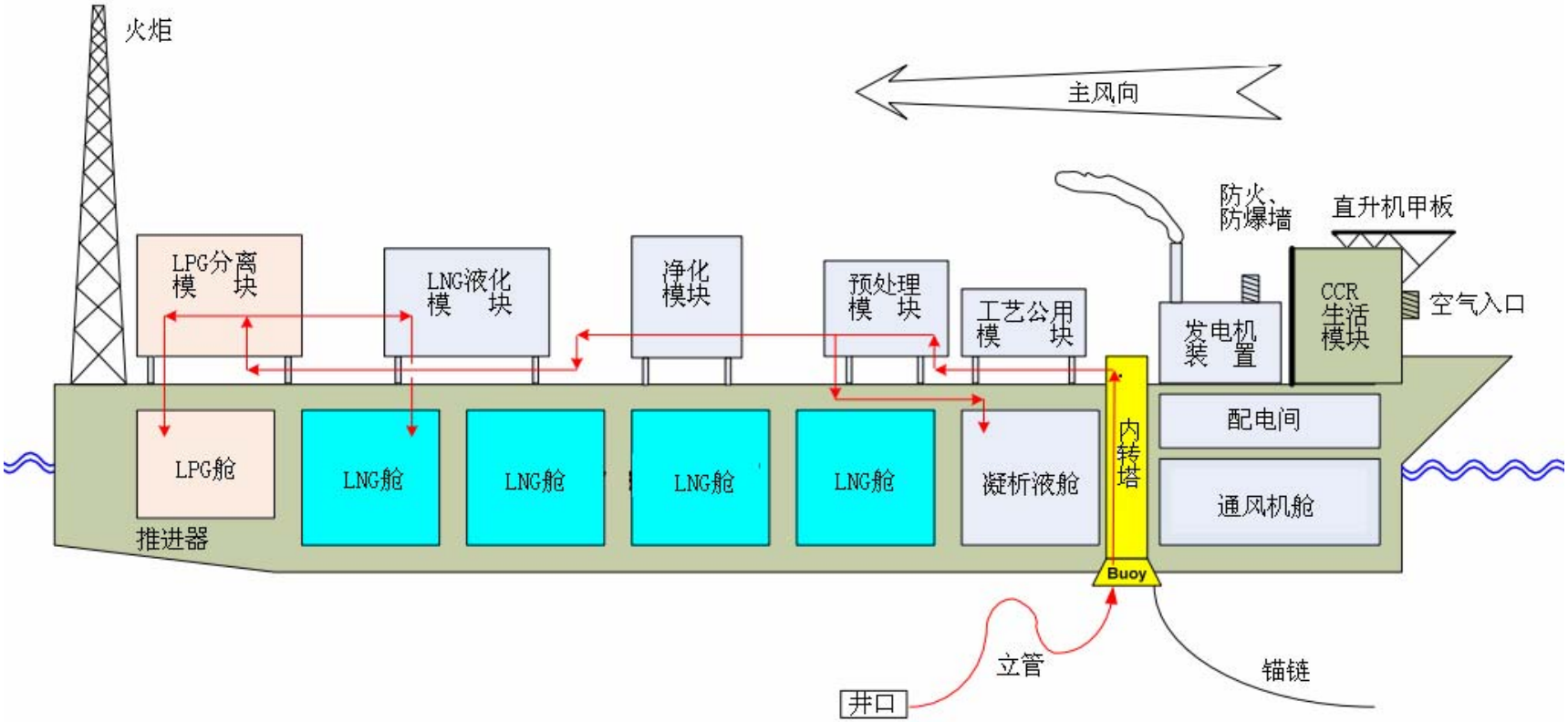
FLNG applications home and abroad

a) Layout requirements

The layout of FLNG plant should be based on a basic principle as follows: according to the prevailing wind direction, or from the living quarter to the other end of the vessel. The arrangement shall be made in the downward order of risk degree, to be exact, from the most secure, the medium secure, low secure, low risky, medium risky, to the most risky. The most secure and relatively safe will be adjacent and the relative risky will be next to the most dangerous, with the universal module arranged in the middle. At the same time, the impact of the swaying of the floating body on the process module should be taken into account as well.

FLNG applications home and abroad

a) Layout requirements



FLNG applications home and abroad

b) General requirements and choice of production, purification and liquefaction processes

The overall requirements process: anti-leak, fire-proof, explosion-proof, anti-ice blocking and anti-static.

Due to the constraints of the FLNG space and the marine operating environment conditions, the process should be designed optimally to comply with the principle of reliability, safety, operability, small occupation of space, efficiency, economics, etc.

The selection of equipment should comply with the principle of stability, safety and reliability and small occupation of space. That is, as for the choice and selection of equipment and process, we should give full consideration to the process and equipment where the floating doesn't shake much, runs more safely, is easier to operate and more economic. In addition, the wind, waves, temperature, relative humidity, salinity and other marine environmental factors on the life and performance of the process systems and equipment should also be taken into account.