The Future of Natural Gas Transportation Technology and Equipment

—Virtual Pipeline—
Since the commercial operation of the West-East Gas Pipeline I on December 30th 2004, natural gas is becoming more and more popular in China. During the past 10 years, China’s natural gas consumption grew from 46.8 BCM in 2005 to 198.1 BCM in 2015, with 15.5% annual growth rate.

In 2016, the natural gas consumption exceeded 200 BCM (205.8 BCM).
In 2016, over 300 million people used natural gas, taking up 20% of the total population. The natural gas consumption grew 6.6% in 2016 than the previous year, with 1.5% increase in indigenous production and 17.4% increase in import.

With the market developing rapidly, LNG is experiencing unexpected growth, which facilitates the innovation of natural gas storage, transportation and distribution.

In the first 10 month in 2017, China’s LNG import grew 47.7%
The development of high-tech LNG equipment gives rise to the new methods for LNG storage, transportation and distribution.

Now we can use mini skid-mounted liquefaction devices to gather and liquefy natural gas from scattered fields, or we can get LNG from large receiving terminals, and then transport LNG to downstream customers, where LNG is used directly or get regasified for other equipment.

LNG in the containers “flows” to the customers through road/rail or combined transportation, as if there is a physical pipeline. That why it is called virtual pipeline.
Upstream resourcing: get resource from existing suppliers or import LNG from overseas.

Regional storage and distribution: unified organization and management.

Downstream distribution: deliver LNG based on the upstream/downstream sales/purchase orders.
Brief Introduction

➢ What is a container?

ISO Tank Container, standardized instrument for storage and transportation, which complies with both the international and Chinese regulations. Basically, it is still a standard container, and shares infrastructures with ordinary containers.

➢ Technology and Manufacturing

The container has two layers to protect the -160°C LNG from diffusion for 90-120 days, satisfying the needs for long-distance transportation and long-term storage. Many Chinese state-owned/private companies have over 10 years of mature technology to build the 18-tons containers.
LNG container is the standard instrument for road, rail and marine transportation, which shares transportation, loading/discharging and port facilities with ordinary containers. It is an internationally-recognized safe and efficient means of transportation for liquids.
COMPARISON BETWEEN VIRTUAL PIPELINE AND TRADITIONAL MODE

1. Wellhead Production
2. Pipeline Transportation
3. Liquefaction at the Port
4. Special Storage and LNG Ports
5. Special LNG ships

Traditional Mode for LNG Export

1. Wellhead Production
2. Wellhead Liquefaction
3. ISO Container for road/rail transportation
4. Use Container Terminal for Piling and Loading
5. Use Container to Export LNG

Virtual Pipeline Mode for LNG Export
Wellhead liquefaction: skid-mounted liquefaction devices

- All equipment are modularized, and integrated into many 20-feet standard containers.
- Can be transported between different gas fields by container trailers.
- Use containers as storage for liquefied products.
KEY PARAMETERS FOR LIQUEFACTION DEVICES

- **Composition**
  Composed of many 20-feet standard containers.
  3 tons in average, 1200 m$^2$ at most.

- **Capacity**
  From 5000 m$^2$/d to 50000 m$^2$/d.

- **Facilities**
  Purification facility
  Liquefaction facility
  Storage facility

- **Staff requirements**
  Highly automatic, only 1 operator
Natural gas is liquefied into LNG from the wellhead, then loaded into LNG container and transported to terminals or customer stations via road/rail or combined transportation.
The containers can be lifted down from the trailer after it arrives at the terminal or the station, so the driver and the trailer do not have to wait to get back in time.

The containers, like other ordinary containers can be stacked up to 6 floors to save space.
<table>
<thead>
<tr>
<th>Project</th>
<th>Unit</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container Volume</td>
<td>Litre</td>
<td>43-55</td>
</tr>
<tr>
<td>Slack Container Weight</td>
<td>Ton</td>
<td>12-15.5</td>
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<tr>
<td>Maximum loading capacity</td>
<td>Ton</td>
<td>36</td>
</tr>
<tr>
<td>Design temperature range (inner Layer)</td>
<td>°C</td>
<td>-196 ～ +50</td>
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<tr>
<td>Storage time</td>
<td>Day</td>
<td>50 ～119</td>
</tr>
<tr>
<td>Size</td>
<td>/</td>
<td>12017mm(length)x2342mm(width)x2693mm(height)</td>
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<tr>
<td>Certificate</td>
<td></td>
<td>RID/ADR-T75, IMDG-T75, TIR/Customs, CSC, UIC Railways, TC Impact Approved, US DOT</td>
</tr>
</tbody>
</table>
When the containers are sent to the station by road or railway, the customers can use gas directly just like the real pipeline, facilitated with a small regasification device.
FUNCTION OF VIRTUAL PIPELINE

- **Replace the physical pipeline**
  - Replace the gathering pipeline (processing device from the wellhead to the main network)
  - Replace the long-distance pipeline (main network)
  - Replace the urban distribution pipeline (from the main network to the industrial and commercial customers)
  - Replace the auxiliary device, such as booster station, valve chamber, city gate, etc.

- **Replace the storage facility**
  - Replace the tank at wellhead
  - Replace the big-scale storage at the loading and discharging port
  - Replace the tanks in the station of downstream customers
**ADVANTAGES OF VIRTUAL PIPELINE**

- **Quick to start up**
  - No requirement for physical pipeline and LNG terminal
  - Avoiding the problem of civil construction
  - Several months to start up

- **Low cost**
  - Usage of existing logistics device and port facilities
  - Easy to operate, maintain and control cost

- **Convenient and flexible**
  - Freight volume can be customized from dozens of tons to hundreds of tons
  - Available for transport and storing

- **Environmental**
  - Minimal land occupation, civil construction and environmental damage
  - No requirement for environmental assessment (all are temporary and portable devices)