Development of Small Scale LNG Fueling Station for Yard Tractor

2014. 9. 18

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Contents

- Why are the small scale LNG?
- What is the new concept of LNG fueling station?
- Future small scale LNG business concept
- Conclusion
Change in Energy Trends

- Climate Change from environmental pollution
- Expectation of stable NG price because of Shale gas
- Needs for New business to overcome Economic Crisis

Key words in Energy Market
- LNG fueled ship
- LNG bunkering
- Small scale LNG distribution
LNG Bunkering Price Expectation

Source: DNV(2013)
Traditional LNG Value Chain

Incheon
Pyungtack
Samchuck
Tongyoung

Supply
LNG Terminal
Storage
High Pressure Pipeline

End users
Paradigm Change in LNG Storage

Huge scale LNG storage

FSRU

Small scale Storage

Medium scale Storage
Change in NG Demands

Traditional Demands
- Power Plant
- Industry
- City gas

Fueling Station

Natural Gas

Islands

LNG fueled Ship

Remote area
Small Scale LNG Supply Chain

- LNG Terminal
- Power plant
- LNG vehicle
- Satellite LNG Station
- Industries
- LNG Fueled ship
- Remote Place
Busan Green Port Plan

“Busan Green Port Plan” (2011)

Logistics Competitiveness
- Cost reduction
- Increment in Trade

Marin Air Environment
- Satisfaction of International standards
- Green Port

LNG Infrastructure
- Boost LNG technology
- Development of related Industry

The most pollutant emitting equipment in Port II

Yard Tractor Dissemination Plan in Ports of Korea

<table>
<thead>
<tr>
<th></th>
<th>New Busan</th>
<th>N Busan</th>
<th>Kangyang</th>
<th>Incheon</th>
<th>Ulsan</th>
<th>Pohang</th>
<th>Pyungtack</th>
<th>Masan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>YT 2013</strong></td>
<td>387</td>
<td>290</td>
<td>110</td>
<td>50</td>
<td>18</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>910</td>
</tr>
<tr>
<td><strong>2017 (predict)</strong></td>
<td>600</td>
<td>340</td>
<td>180</td>
<td>220</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>25</td>
<td>1,485</td>
</tr>
<tr>
<td><strong>CT 2013</strong></td>
<td>20,000</td>
<td>13,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33,000</td>
</tr>
</tbody>
</table>

Pollutant emission (g/km)

<table>
<thead>
<tr>
<th></th>
<th>CO</th>
<th>NOx</th>
<th>HC</th>
<th>CO2</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NG</td>
<td>0.0562</td>
<td>7.1228</td>
<td>0.5088</td>
<td>580</td>
<td>-</td>
</tr>
<tr>
<td>Diessel</td>
<td>0.5113</td>
<td>7.2135</td>
<td>0.5553</td>
<td>667</td>
<td>0.0492</td>
</tr>
<tr>
<td>Saving (%)</td>
<td>89.0</td>
<td>1.3</td>
<td>8.4</td>
<td>13.1</td>
<td>100</td>
</tr>
</tbody>
</table>

The most pollutant emitting equipment in Port!!
Needs for LNG Yard Tractor

- Burden for high Fuel Cost and air pollution problem in Port
- Many references in saving operation cost (20~40%) and the strong points of LNG YT in environmental aspect and working condition
- Issue for the Green Port and energy management in logistics

The biggest barrier
To propagate LNG vehicle

LNG infrastructure

- Yard had a good condition for LNG station
  - Yard tractor is just moving in the yard area
- Possibility to connect to the LNG Bunkering business for LNG fueled ship in the future
Domestic LNG Fueling station

- DaeJeon LCNG Station
- Pohang LCNG Station
- Guangyang LCNG Station
- Donghae LCNG Station

No. of LNG Vehicle in Korea

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012~2013</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Vehicle</td>
<td>12</td>
<td>33</td>
<td>72</td>
<td>92</td>
<td>18</td>
<td>227</td>
</tr>
</tbody>
</table>

- **No. of LNG Fueling station = 10 stations** (LCNG 6, LNG 4)
- **Giving-up operation** of LNG fueling station for Airport limousine bus
- **Obstacles** in propagation of LNG vehicle
  - Lack of LNG fueling infrastructure
  - High alteration cost of vehicle and delay in development of parts
  - Law economic condition in the beginning stage because of BOG
Strategy for LNG Fueling Station

Which one should go first?

LNG Yard Tractor

Priority?

LNG Fueling Facility

Demonstration project

Initiation of LNG Market
Needs for small scale LNG station

Needs for LNG station

Fixed Tank type LNG fueling Station?

Restricted condition to move between terminals

Solution

Small Scale LNG Stations In each sector
Types of LNG Fueling Facility

- Fixed Tank Type
- Package Type
- Mobile Type
- Skid Mounted Type
- ISO Tank Container type

Next ?
Tank container Type LNG Station

Tank Container Type LNG Station

Movable

Fixed
Unloading Methods

- Crain
- Reach Stacker
- Special Forklift

Movable

Fixed
Fixed Tank vs. Tank Container

**Fixed Tank + Lorry**
- On site fixed LNG Tank
- Transferring LNG
- Time for transferring LNG
- Treatment of BOG
- Good for large demands

**ISO Tank Container**
- No on site fixed LNG tanks
- No Transfer & No BOG
- Quick Ready to supply
- Good for small demands
Small Scale LNG supply concept

Features

- Easy to install
- Easy to response to the demands
- Low Installation cost
- Quick Installation
- Easy to scale up
- Variety in application

First Step

LNG Terminal

Remote Demands

LNG Yard Tractor

LNG fueled ship Bunkering
## Engine Specification

<table>
<thead>
<tr>
<th>Items</th>
<th>Cummins QSB6.7</th>
<th>Hyundai G-CNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP</td>
<td>215hp/2500rpm</td>
<td>228hp/2500rpm</td>
</tr>
<tr>
<td>Torque</td>
<td>77kgf.m</td>
<td>65kgf.m</td>
</tr>
<tr>
<td>Type</td>
<td>In line, 6 cylinder</td>
<td>I6, OHC, 4V/V</td>
</tr>
<tr>
<td>Bore × Stroke (mm)</td>
<td>95×115</td>
<td>107×118</td>
</tr>
<tr>
<td>Displacement</td>
<td>6,700cc</td>
<td>6,798cc</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>17.2 : 1</td>
<td>10.5 : 1</td>
</tr>
<tr>
<td>Weight</td>
<td>475kg</td>
<td>606kg</td>
</tr>
<tr>
<td>Size (L/W/H)</td>
<td>1059/725/960</td>
<td>1080/974/904</td>
</tr>
</tbody>
</table>

### Diesel Yard Tractor

- Cummins QSB6.7
- 215hp/2500rpm HP
- 77kgf.m Torque
- In line, 6 cylinder Type
- 95×115 Bore × Stroke (mm)
- 6,700cc Displacement
- 17.2 : 1 Compression ratio
- 475kg Weight
- 1059/725/960 Size (L/W/H)

### LNG Yard Tractor

- Hyundai G-CNG
- 228hp/2500rpm HP
- 65kgf.m Torque
- I6, OHC, 4V/V Type
- 107×118 Bore × Stroke (mm)
- 6,798cc Displacement
- 10.5 : 1 Compression ratio
- 606kg Weight
- 1080/974/904 Size (L/W/H)

### Test results of LNG YT

<table>
<thead>
<tr>
<th>Items</th>
<th>Diesel Engine</th>
<th>NG Engine</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 (g/kwh)</td>
<td>1.036</td>
<td>597</td>
<td>42.4 %</td>
</tr>
<tr>
<td>PM (g/kwh)</td>
<td>0.181</td>
<td>0.000</td>
<td>100 %</td>
</tr>
<tr>
<td>Noise (dB)</td>
<td>82.8</td>
<td>65.8</td>
<td>20 %</td>
</tr>
<tr>
<td>Vibration</td>
<td>High</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Fuel Efficiency</td>
<td>1.29 km/L</td>
<td>1.59 km/kg (1.27 km/Nm3)</td>
<td></td>
</tr>
</tbody>
</table>
Future of Busan port

On shore LNG Bunkering Station

Small scale LNG station (2-1, 4B)

Middle scale LNG station (1-2, 3B)

Small scale LNG station (2-4, 3B)
Small Scale LNG Business Model

On Shore satellite Station

Bunker shuttle

Container shuttle

LNG Terminal

Container Trailer

LNG station

Tank Lorry

Island

Container shuttle

Terminal

LNG station

Tank trailer

Container Terminal

Tank Lorry

Island
Future LNG Business in Korea

- Incheon LNG Terminal
- Pyountack LNG Terminal
- Samchuck LNG Terminal
- Off Shore LNG Terminal
- Island Power Generation
- LNG Bunkering Shuttle
- LNG fueled Ship
- Jeju LNG Terminal 2018~
- LNG Yard Tractor
- Tongyoung LNG Terminal
- LNG Yard Tractor
Conclusion

- **LNG Yard Tractor** is the solution for reducing air pollution and Green port strategy; Basement for propagation of LNG Yard tractor to other ports

- **ISO LNG Tank container type of LNG fueling station** can be the best option at the beginning and for small demands; Need to renewal Law and proffer equipments

- **LNG fuel can increase the logistics competitiveness**; Need to connect to other applications such as LNG fueled ship and LNG train as well as LNG tractor

- **The Small scale LNG distribution model** can be connected to new business applications especially in the country where there is no pipeline networks
Thank you !!

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