Design Concepts for LNG FSRU/FPSO with IMO type C cargo tanks

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Carriers & Offshore Units
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Content:

– TGE’s experience and expertise in regards to this topic

– Design concept for LNG-FSRU/FPSO
  ➢ Containment systems
  ➢ FSRU
  ➢ FPSO

– FLNG and small LNG carriers with IMO type C cargo tanks)
TGE’s experience and expertise in regards to this topic

- EPC contracts for LNG storages and terminals (export and import)
- Conceptual design studies for up to 300,000 m³ LNG FSRU
- EPCS contracts for cargo systems of LPG FSOs (newbuild and conversion)
- Market leader for ethylene carriers with IMO type C cargo tanks
- Design and fabrication (with subcontractor) of > 140 IMO type C cargo tanks
LNG Receiving Terminal for Reganosa

Location: Mugardos, Spain

Owner: Reganosa

Completion: 2007

First ship unloading: 05/2007

Storage capacity: 2 x 150,000 m³
LNG Receiving Terminal for Transgâs Atlântico

Location: Sines, Portugal
Owner: Transgâs Atlântico
Completion: 2003

Annual throughput: abt. 5.2 bcm
Storage capacity: 2 x 120,000 m³
Design code: BS 7777 and EN 1473
LNG Liquefaction Plant, Shan Shan, Xinjiang, P. R. China

Location: Shan Shan, Xinjiang, P. R. China

Owner: Xinjiang Guanghui Industry and Commerce Group Co.

Completion: 2003

Natural Gas Treatment and Liquefaction Plant for 1,500,000 Nm3/d

LNG Storage and Distribution Plant with 30,000 cbm LNG Storage Tank
LNG-FSRU conceptual design studies

Generic design for topsides (gas handling system) of 250,000 – 300,000 m³ FSRU

Total capacity: 250,000 m³
Cargo tanks: 5 x 50,000 m³ (Type B)
Max. boil-off rate: 0.15 % per day
Operation modes: - shuttle tanker offloading
- no offloading
- no send-out
Send out: via turret – riser – subsea pipeline
LNG-FSRU: Performance data

- send out capacity
  - peak: 900 t/h (1,000 MMSCFD)
  - base load: 720 t/h (800 MMSCFD)
  - min. (holding): 50 t/h (56 MMSCFD)
- send out pressure: 60 – 80 bar
- offloading capacity: max. 12,000 m³/h
- max. BOG handling: 12 t/h
- max. power requirem.: 12 MW
- max. seawater consump.: 15,000 m³/h
78,000 m³ FSO “N´KOSSA II”, A.P. Møller, DK

- Shipyard: ODENSE LINDØ Denmark
- Completion: 1996
- Classification: BV
- TGE scope: Chilling units, deck piping system, booster pump, cargo heater, HAZOP studies
- Vessel: 78,000 m³ conversion to FSO
95,000 m³ LPG-FSO for ConocoPhillips

- Shipyard: Samsung Heavy Industries, Korea
- Owner: ConocoPhillips
- Completion: 2003
- Class: LRS
- TGE scope: EPCS-contract, complete gas handling system
Market leader for ethylene carriers with IMO type C cargo tanks

References:
• biggest Ethylene carrier (5 x 22,000 m³)
• largest series of Ethylene carriers (12 x 8,000 m³)

Actual order book:
• 29 ethylene carriers at 5 shipyards
• first combined LNG/Ethylene carrier with electric propulsion

TGE’s scope: gas plant and tanks
Design and fabrication (with subcontractor) of > 140 IMO type C cargo tanks

Tank material references comprise: 5% Nickel-steel, 0.5% Nickel-steel, High strength steel, Stainless steel
TGE design concept for LNG-FSRU/FPSO

Principal design idea:

– Containment system:
  • capitalize on extensive experiences in the field of type C tanks for ethylene carriers

– Equipment
  • Transfer the experience from LNG terminal design to offshore environment
Typical containment systems for LNG

- dominating membrane tank design for LNG-carrier is vulnerable to sloshing loads
- spherical tanks generate enormous problems to place a process plant and are limited to very few fabricators
- IHI type B tanks are self supporting but limited to license at very few yards
TGE design concept for LNG-FSRU/FPSO

TGE containment systems: type C tanks

- upgrade of type C tanks (pressure vessels) from Ethylene to LNG service
- material grades: for LNG service (-163 °C)
  - 9% Ni-steel, Stainless steel 304L, Aluminium
- tank design pressure: abt. 4 bar g
- no sloshing problems
- tanks can be fabricated outside shipyard
- no secondary barrier required
TGE design concept for containment system

• Tank types
  – cylindrical tanks up to 10,000 cbm capacity per tank
    • design parameter: dia: 18.5 m; length: 43.5 m
    • design density: 0,5 t/cbm
    • design pressure: 4,0 barg
  – Weight: approx. 550 tons (9% Ni)
  – Specific weight: approx. 56 kg/cbm
TGE design concept for containment system

• Tank types
  – bilobe tanks up to 20,000 cbm capacity per tank
    • design parameter: dia: 19.0 m; length: 45.5 m
    • design density: 0.5 t/cbm
    • design pressure: 4.1 barg
  – Weight: approx. 1350 tons (9% Ni)
  – Specific weight: approx. 67 kg/cbm
TGE design concept for LNG-FSRU

- Basic design data for 80,000 cbm:
  - Tank capacity: 8 x 10,000 cbm
  - Barge dimensions: 258 x 46 x 25 m
  - Barge steel weight: approx. 20,500 tons
General 80.000m³ LNG-FSRU
3D Model of 80,000m³ LNG-FSRU
Containment system for LNG-FSRU
TGE design concept for LNG-FPSO

- Capacity: up to 1.5 Mio. tons per year
- Containment system:
  - identical to LNG-FSRU concept
- Liquefaction process:
  - TGE offers the design for BOG-re-liquefaction systems of up to 6 t/h capacity with nitrogen cycle
    - specific consumption: abt. 0.75 kWh/kg
TGE design concept for LNG-FPSO

• Liquefaction process:
  – For mid-size plants of up to 1,5 Mio. tons per year, TGE need to partner
  – Process under review:
    • Dual turbine nitrogen cycle:
      – specific power requirements: abt. 0.55 kWh/kg
    • Cascade cycle or single mixed refrigerant
      – specific power requirements: abt. 0.31 kWh/kg
FLNG and small LNG carriers with IMO type C cargo tanks

- LNG shuttle tanker for LNG-FPSO/FSRU service
  - depending on total supply chain the design pressure of type C tanks may be very advantageous (energy saving at liquefaction)

- Small LNG ships with type C tanks for short distance trading
  - flexible operation due to pressure vessel tanks
  - flexible vessel employment of multi cargo ships in developing market
  - “Coral Methane” was designed by TGE and delivered to Anthony Veder Group in May 2009: The first LNG/Ethylene Carrier of 7,500 m³ capacity
TGE design approach for small LNG ships

• Maximising the know-how from ethylene carriers design
  – TGE‘s market share for delivery of gas handling systems and cargo tanks is more than 70%
• Minimising the CAPEX for small LNG carriers
• Maximising the flexibility for a combined LNG/Ethylene/LPG-carrier to enhance profitability
From Ethylene to LNG

- Starting in 2005 TGE made a complete design study for 30,000 cbm LNG carrier with Bureau Veritas
- Ship design was based on previous LEG-carrier
- Complete FEM analysis of cargo hold system
- An „Approval in Principle“ was achieved in 2006
- As tanks are independent tank type C, the ship can be built at any experienced shipyard
- CAPEX has been estimated as 10 – 15% above Ethylene-carrier price level
Cargo tanks for 22,000 m³ Ethylene-carrier

- 5,700 m³ (4 tanks)
- 4.7 bar g
- 480 t
- 5% Nickel steel
Small LNG carrier with type C tanks

• Tank design example for 30,000 cbm capacity:
  – 4 Bilobe tanks each abt. 7,500 cbm capacity
    • Dia: 15.2m; width: 24.6m; length: 29.9 m
    • Design density: 0.6 t/cbm:
      – partial loading for higher densities
  • Min. design pressure: 2.71 barg for AISI 304L, 4.0 barg for 9% Ni-steel (due to pressure formula in IGC-Code)
• Tank weights:
  – 9% Ni-steel: abt. 485 tons
  – AISI 304L: abt. 525 tons
Tank insulation for LNG

- Tank insulation for Ethylene:
  - Typical Polystyrene panels glued to tank surface with abt. 230 mm thickness and k-value of abt. 0,19 W/m²K

- Tank insulation for LNG application
  - Investigations show that same insulation type may be applied (spherical LNG tanks use same technology)
  - Insulation thickness of 300 mm possible in one layer with a k-value of abt. 0,13-0,14 W/m²K; boil-off rate is abt. 0,21-0,23 %/day
  - Additional expansion joints necessary
30,000 m³ LNG-Carrier

lbp = 175.2 m
b = 27.6 m
d = 8.8 m
speed = 17.5 kn
Bilobe tank for arrangement for LNG-carrier:
BOG handling for LNG

- Max. loading: 90.3%
- X8 Ni9
- NV 304L
- Basic LNG Composition
  - N2: 2%
  - CO2: 0%
  - C1: 89%
  - C2: 5.5%
  - C3: 2.5%
  - C4: 1%

- Tank Volume: 30,000 m³
- Insulation: 300 mm Polystyrene
- Initial pressure: 140 mbar g

- Sailing Time [d]
Thank you for your kind attention

for further information please mail to
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