LiBro® FLNG Concept
MODEC, Inc. (MODEC) has developed the LiBro® FLNG concept with Toyo Engineering Corporation (TOYO) and Nippon Kaiji Kyoukai (ClassNK) as an economical solution for monetizing remote stranded offshore gas fields. The LiBro® FLNG concept applies MODEC’s LiBro® technology and Air Products’ Triple N² Expander Liquefaction technology (Air Products® AP-N LNG Process).

Key features of the LiBro® FLNG concept are:
- High efficiency by application of LiBro®
- High availability by proven equipment
- Enhanced safety by use of N² refrigerant
- Cost effectiveness by conventional ship hull design
- Early delivery by Shipyard-friendly design

LiBro®
MODEC’s LiBro® technology is based on Lithium Bromide (Li-Br) Absorption Refrigeration. The LiBro® unit produces chilled water using waste heat from gas turbine exhaust.

The Li-Br based Absorption Refrigeration unit is widely used for centralized air conditioning application onshore. Over 10,000 Li-Br Absorption Refrigeration units have been delivered. The largest unit has successfully been in operation since 2007 and the performance of the unit is well demonstrated. MODEC developed the proprietary guide plates for the distribution of absorption solution onto the entire heat exchanging surface in order to achieve the expected chilled water generation performance under sea motion conditions. The effectiveness and performance of the guide plate were demonstrated successfully using a full scale LiBro® unit and were confirmed through dynamic motion tests.

Process Configuration and Performance
A schematic process flow diagram of the LiBro® FLNG concept is shown below (Fig.-1).

Fig.-1: Flow schematic of the LiBro® FLNG

The LiBro® unit is integrated with Air Products® AP-N LNG Process and the chilled water produced in the LiBro® unit is used for precooling of the natural gas and cooling of N² refrigerant for improved LNG train efficiency. Produced chilled water is also used for cooling of the gas turbine combustion air for maximizing output of gas turbine driver. With the LiBro® unit integration, the
Safety Consideration

The LiBro® FLNG concept involves N₂ as refrigerant for natural gas liquefaction. N₂ is a non-flammable fluid and much safer compared to mixed hydrocarbon refrigerants. Air Products’ Coil Wound Heat Exchanger (CWHE) is used as the main heat exchanger for natural gas liquefaction. Air Products’ CWHE is widely applied with its robust design and high reliability. For the LiBro® FLNG concept, the CWHE shell is mechanically designed to withstand natural gas supply pressure against coil rupture scenarios.

Cost Effectiveness

Utilization of an existing standard shipbuilding hull design as the basis will contribute to significant cost savings compared to a purpose designed and built hull. Air Products® AP-N LNG Process which uses non-flammable N₂ refrigerant will allow a more compact topside design on the limited available deck space for topside equipment and piping because of reduced safety corridor requirements. In addition, the LNG production capacity can be maximized by the integration of the LiBro® unit. The LiBro® unit is compact and can be installed beneath the gas turbines. No additional deck space is required for installation.

For the typical gas composition from an offshore gas field, the standard hull design (300m x 50m) will accommodate the topside facilities with LNG production capacity of 2.0 MTPA and LNG storage capacity of 160,000 m³.

Early Delivery

The Shipyard-friendly design is adapted to the hull design of the LiBro® FLNG concept. Conversion of standard shipbuilding bulk carrier, instead of special purpose built hull, is considered as the basis of the LiBro® FLNG concept in order to realize early delivery. HHI Marine United Inc. SPB (Self-Supporting Prismatic-Shape IMO Type B) Tank, which features (1) wide & flat upper deck to enable installation of the topside plant and (2) no sloshing with internal bulkheads construction to enable partial cargo operation, are installed into the cargo space as LNG product storage and will also contribute to its early delivery.

The LiBro® FLNG concept can be applied to both new built hull and existing hull conversions.

Typical Specification of LiBro® FLNG

Typical specification of the LiBro® FLNG is summarized below. Maximum achievable LNG production capacity is 2.0 MTPA based on existing shipbuilding standard hull of “Setouchi-Max” size vessel. The LNG storage capacity can be adjusted flexibly to meet the capacity of offloading shuttle LNG carriers. The LNG offloading system can be selected for either Side-by-Side or Tandem per customer’s preference. Also the electrical motor driven LiBro®FLNG can be offered with high reliability and availability for smaller LNG production capacity.

Typical Specification of LiBro® FLNG

<table>
<thead>
<tr>
<th>L-Size</th>
<th>M-Size</th>
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<tbody>
<tr>
<td>Liquefaction Technology</td>
<td>Air Products® AP-N LNG Process + MODEC LiBro®</td>
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<tr>
<td>LNG Production Capacity</td>
<td>2.0 MTPA</td>
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<tr>
<td>Refrigerant Compressor Driver</td>
<td>Gas Turbine (PG725+G4)</td>
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<tr>
<td>LNG Storage Capacity</td>
<td>160,000 m³</td>
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<tr>
<td>LNG Offloading</td>
<td>Side-by-Side or Tandem</td>
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<tr>
<td>Condensate Storage Capacity</td>
<td>20,000 m³</td>
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<tr>
<td>Condensate Offloading</td>
<td>Conventional Floating Hose</td>
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<tr>
<td>Hull Size</td>
<td>300mL x 50mW</td>
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Fig.-3 : Topside equipment layout of the LiBro® FLNG

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