AWTEC 2016

POLYMER MATERIAL QUALIFICATION FOR OTEC/SWAC SYSTEM
1. Bardot Group presentation
2. Material qualification track record
3. Water intake riser system
4. SWAC / OTEC system
November 30th, 2004

La Ciotat, France

London, Houston, Kuala Lumpur
Rio de Janeiro, UAE (2016)

SURF packages & Integrated Energy Solutions

70 direct employees (90% engineers)

Significant Oil & Gas projects Worldwide
**Project:** KAOMBO FPSO conversion

**Field:** KAOMBO

**Country:** Angola

**Pumping depth:** 120m

**Contractor:** Saipem SA

**Operator:** Total E&P Angola Block 32

**Scope of service:** Design, fabrication, procurement of 6 water intake risers and 2 fire water risers
MATERIAL QUALIFICATION
HDPE completed qualifications:

- Tensile / Compression tests
- Shear tests
- Thermo-chimical tests (density,...)
- Tensile / compressive creep tests
- Ageing tests
- Friction tests
- Resilience tests
- Fatigue tests (flexural) : SN CURVES

- Tensile fatigue
- Abrasion
- NaClO resistance
- Hydrostatic pressure exposure
**MATERIAL QUALIFICATION RESULT**

### AGEING

**Maximal tensile strength**

- Very Good stability of Material over the test duration
- Low dispersion with T° variation
- Very good ageing tolerance / Hypochlorite NaClO
- Test still on going

### CREEP

**Tensile creep at ambient T°**

- Rapid and stable behaviour VS Test duration
- Asymptote achieved very quickly
- Good repeatability of test

### FATIGUE

**S-N curve Fatigue flexion HDPE**

- Test complex to set up
- Large campaign is requested (Still on going)
- Large variation of SN Curves / Loads
- SN Curves test very different from literature
- Good repeatability of tests
Main Tests are:
- Pressure / Leaking Test
- Abrasion
- Fatigue
- Shocks
- Installation Tools
- Tapers

Pressure & Leaking Test
APPLICATION WATER INTAKE
<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Rubber</th>
<th>Composite</th>
<th>HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>- - -</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Diameter</td>
<td>+</td>
<td>-</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Cost</td>
<td>- - -</td>
<td>-</td>
<td>- -</td>
<td>+ +</td>
</tr>
<tr>
<td>Corrosion</td>
<td>- -</td>
<td>-</td>
<td>+ +</td>
<td>+</td>
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<tr>
<td>Deflections</td>
<td>+ + +</td>
<td>- -</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Qualification</td>
<td>+ + +</td>
<td>+ +</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Water depth limitation</td>
<td>150/200m</td>
<td>300m</td>
<td>?</td>
<td>&gt; 1000m</td>
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</tbody>
</table>
APPLICATION TO KAOMBO

- Bardot Group presentation
- Material qualification track record
- Water intake riser system
- SWAC / OTEC System
Fully integrated solutions for carbon-free energies:

- **SWAC**: Sea Water Air Conditioning
- **OTEC**: Ocean Thermal Energy Conversion
- **SWRO**: Sea Water Reverse Osmosis
APPLICATION SWAC / OTEC
USE COLD SEA WATER TO CREATE AIR-CONDITIONING

- Cold water intake pipe, may go down to 1000m depth, to reach down to 4°C.
- Water rejection pipe, at specific depths to eliminate environmental impact due to temperature difference.
- Pumps, for large volumes of water, designed to consume the minimum energy to operate.
- Heat exchangers made of titanium.
USE SEA WATER TEMPERATURE DIFFERENCE TO CREATE ENERGY

An innovative process, designed for reliability and constant energy production:

- Cold water intake pipe, may go down to 1000m depth, to reach down to 4°C.
- Hot water intake pipe, usually located in the lagoon, or on shallow waters.
- Water rejection pipe, at specific depths to eliminate environmental impact due to temperature difference.
- Pumps, for large volumes of water, designed to consume the minimum energy to operate.
- OTEC closed loop, including heat exchangers made of titanium and our revolutionary ORC turbine.
100% GREEN ENERGY INTEGRATED SYSTEM

- SWAC
  - Air-conditioning
- OTEC
  - Warm water intake
  - Cold water intake
  - Warm water return
- SWRO
  - Electricity
  - Fresh water
  - Drinking water
  - Hot water
  - Agriculture
  - Aquaculture

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**ONSHORE SOLUTION**

**SWAC System:**
Raw power 1 to 50 MWf

1 MWf = 3412141.633128 BTU

**OTEC System:**
Small demand

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**OFFSHORE SOLUTION**

**OTEC System:**
Large demand
Bardot’s SWAC/OTEC are:

- Following high R&D development
- Requesting high qualifying process
- Becoming a field proven solution
- Cost effective solution
- Opening new benefits for process
- Large improvement in terms of CO2 saving
Bardot Group to construct OTEC plant in Maldives

Bardot Group, a French company specialized in subsea engineering and equipment manufacturing for offshore energy, has signed a contract to install an ocean thermal energy conversion (OTEC) system in an eco-resort in the Maldives.

The contract, signed in the presence of the Minister of Environment and Energy of Maldives, Thoriq Ibrahim, includes engineering, procurement, construction and installation works, Bardot Group informed.

The OTEC plant will be located on an individual island from where it will pump the warm surface water and cold deep water. Electricity and fresh water will be transferred to the resort island through a water pipeline and a power cable, according to Bardot Group.

The eco-resort is being developed in a South Maldivian archipelago, a few hundred kilometers from the capital city of Male.

Designed to accommodate 300 people, the resort will be fully powered in electricity, air-conditioning, hot and cold water, and fresh and drinking water by the OTEC system.

The project is expected to be completed early in 2018.
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