



Full electrical solution for FPSO

Variable-Speed Drive Systems (VSDS) for topside and subsea motors
CLOV Offshore, Angola Oilfields

The case

A new development pole in Angola

CLOV is the fourth development pole in Angola's deep offshore Block 17, which is operated by Total. Also known as the "Golden Block," Block 17 covers nearly 4,000 square kilometers, from 150 km to 270 km off the coast. CLOV is a stand-alone development in a four-field cluster consisting of the oilfields Cravo, Lirio, Orquidea and Violeta. These oilfields contain reserves of 505 million barrels of oil at a water depth of 1,050 m to 1,400 m.

The first full electrical FPSO

In early 2011, GE's Power Conversion business was awarded a contract to supply seven complete VSDS, including induction motors, for the main gas compressors and the water injection pumps, as well as two VSDS for subsea multiphase pumps. This project represents the first floating, production, storage and offloading unit to be fully equipped with electric variable-speed drive equipment. The total electrical power is about 50 MW.



imagination at work



The challenge

Because the project calls for in-depth facilities and production techniques, the customer required high-performing, reliable and efficient systems that would help optimize production in a space-constrained environment. With those key drivers in mind, Power Conversion designed and provided a compact and lightweight electrical solution based on proven, high-performance technologies for the offshore facility's pumps and compressors.

Feeding topside equipment

Transformers and MV7000 converters, which are feeding induction motors, will be installed topside for the high- and low-pressure compressor units and water injection pumps. Their compact design allows for a smaller electrical room. Thanks to the converter 24-pulse topology for network bridge, no harmonic filter is necessary, thus allowing an additional reduction of the equipment footprint and capital expenditures. By using a 6 kV converter, the size and weight of cables between the motor and the converter also are decreased by half.

Feeding subsea equipment

The transformers and MV7000 converters to be installed topside will feed the subsea multiphase pump induction motors through 11 km umbilical. Power Conversion's advanced converter control allows for driving a motor with a step-up transformer and long step-out distance between the subsea motor and the topside converter.

Our solution

- **Four complete VSDS for the high-pressure compressor units**, each comprised of:
 - Step-down transformer
 - Medium-voltage MV7000 converter
 - 9.61 MW induction motor 6 kV/1,717 rpm
- **One complete VSDS for low-pressure compressor unit** comprised of:
 - Step-down transformer
 - Medium-voltage MV7000 converter
 - 4.89 MW induction motor 6 kV/1,717 rpm
- **Two complete VSDS for water injection pumps**, each comprised of:
 - Step-down transformer
 - Medium-voltage MV7000 converter
 - 8.7 MW induction motor 3 kV/1,900 rpm
- **For the subsea multiphase pumps:**
 - Step-down and step-up transformers
 - Two medium-voltage MV7000 converters feeding a 2.3 MW induction motor 6 kV/3,797 rpm

Medium-voltage converters bring high-quality performance

With the most compact design available for a medium-voltage converter, Power Conversion's high-performance MV7000 solution is based on the latest generation of powerful press-pack IGBT (PPI) technology. The proven Pulse Width Modulation (PWM) three-level inverter provides high-quality performance. Its adjustable PWM patterns and frequency bring a wide range of flexibility for low switching losses, low motor total harmonic distortion, operation at high frequency up to 300 Hz or at long distance, and negligible amplitude of torque pulsation at the motor shaft.

The compressors, water injection pumps and subsea pumps for CLOV are powered by the MV7000 converter series. Their water-cooled design, ideal in a space-constrained environment such as offshore applications, allows for reduced investment in room ventilation and air conditioning. In addition, it makes the use of high-capacity diodes and PPI optimal versus footprint. Water-cooling converters also operate with very low noise.

Powerful medium-voltage induction motors

Our medium-voltage induction motors offer lower weight and inertia advantages as well as lower maintenance costs for applications requiring high reliability.

They are available on any type of drive system for most industrial applications, including FPSOs. These machines also offer higher overload capacity and represent a more cost-effective solution compared to equivalent synchronous machines.



Induction motors supplied for CLOV provide the following benefits:

- More complete plant safety with pressurized Expx IIAT3 motor
- High efficiency with a direct-drive gearless solution
- Optimized footprint thanks to water-cooled technology
- Smooth startup with variable-speed drive control
- Operating expenditure savings with reduced maintenance service



Vision

In addition to routine tests on each item of the VSDS, the system (including the cooling system) needed to be tested under full load prior to installation.

Testing began in mid-2011. At the end of the first half of 2012, all of Power Conversion's equipment had been successfully tested at rated power (full speed, full load). The equipment now is being integrated on the FPSO, with commissioning expected to begin before the end of 2013. Final tests will take place onsite prior to the production phase, which is scheduled for 2014.

By mid-2010 the cumulative production of Block 17 had reached 1 billion barrels of oil. With the 2014 startup of CLOV FPSO, the block's fourth production hub, an additional 160,000 b/d of oil will be produced.

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