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Modern Solutions for Electric Drives of Onshore and Offshore Drilling Rigs, Provided by ICPE ACTEL

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Abstract

This paper presents the AC solution for electric drives of onshore and offshore drilling rigs systems. The digital AC solution for electric drives, as the main part of the electric system provided by ICPE ACTEL, represents a state-of-the-art equipment with a lot of benefits for the drilling process. The paper shows the basic solution's principles and describes the equipment, pointing out its advantages as solution itself and in comparison with the DC solution. A case study is also presented, revealing the gains obtained in terms of efficiency criteria.

Key words: *electric drives, onshore and offshore drilling rigs, power electronics, energy efficiency*

ICPE ACTEL – Efficient Electrical Solutions Provider

ICPE ACTEL is a manufacturer of standard and „on demand" equipment for adjustment and control of industrial processes in drilling, energy (generation, distribution, transport), manufacturing industry etc.

ICPE ACTEL is a "hi-tech" company, designer, manufacturer and distributor of its own products. ICPE ACTEL is a private company, medium-sized enterprise that enjoys an excellent reputation in its field of activity.

ICPE ACTEL provides turnkey standard and on demand solutions meeting the clients' requirements, covering all the necessary activities from the drawing-up to the technical assistance within and post guarantee. Successor of the traditional Research Institute for Electrotechnics, ICPE ACTEL enjoys highly qualified technicians which enabled the company's certification as "Research and Development Unit".

The main products categories are:

- Electrical Supply and Control System for Onshore and Offshore Drilling - provide turnkey entire electrical equipment for the supply, control and adjustment of motor speed for drawworks, rotary tables, mud and lift pumps of the drilling systems (0-690Vca, 0-770Vcc, 11x1200A).
- Power Generation Equipment - Static Excitation Equipment for Synchronous Machines – products which ensure the supply, command, control and protection of the excitation winding of the generators in thermal and hydroelectric power plants and motors for various applications (10-3200Acc, 20-750Vcc).
- Safety DC Power Supply Sources – Digital Universal Rectifiers - which provide a safe DC power supply, when employed with an associated storage battery, also assuring the

formatting, charging, equalization, recuperative discharging and protection of the storage battery; they can also be used as independent DC power supply sources (10-400Acc, 12-230Vcc).

- Adjustable DC & AC Electric Drives – used in industrial applications, as follows: onshore and offshore drilling, energy, traction, conveyors, belt-carriers, pumps, fans, circular saws, mixers, centrifugal separators, winds for aerodynamic tunnels, test benches etc. (DC: 400-660Vac, 2kW-2,4MW; AC: 200-6000Vac, 0,75-1600kW).
- Others:
  - Rectifiers for Cathodic Protection against Corrosion – ensure an active cathodic protection in Cathodic Protection Stations;
  - Energy Management Systems – for power generation; ensure the synchronization of the generators for parallel operating;
  - DC Supply Structures – for power substations;
  - DC Current Supply Sources for Electrochemical Applications;
  - DC & AC Voltage Regulators – for various industrial applications;
  - Low Voltage Switch Cabinets - for the supply, command and protection of the distribution stations;
  - Transformers, Motors and Apparatus – for a lot of applications.
- Custom made complex solutions, based on the company's expertise field.

ICPE ACTEL's services include:

- Research and Development;
- Design;
- Consulting for identifying the application;
- Technical assistance at mounting;
- Technical assistance at putting into operation;
- Service within and post guarantee;
- Customer personnel training.

ICPE ACTEL's products are always accompanied by technical assistance and additional services throughout their entire lifespan, from the drawing-up of the application up to the client training.

ICPE ACTEL is always reactive to the market's demand, offering the last generation equipment. The flexibility for customizing the offer and good partnerships lead to cost efficiency. The equipment is provided with digitalized and software support for adjustment and control, operating monitoring, advanced diagnostic capabilities for failures and breakdowns and remote control. The quality is in compliance with the standards and regulations in the field and all main products' categories holds patents.

In good knowledge of Romanian Strategy in Energy and the National Plan for Energy Efficiency, ICPE ACTEL comes with his support in meeting the objectives in the field as supply security, sustainability and competitiveness, with respect to the environment.

ICPE ACTEL is very much implied in the concept of "Energy efficiency", especially in electric drives. For getting the efficiency, ICPE ACTEL has a systemic approach, by analyzing the application as a hole. So, there are ensured not only static and transitory performances but also energy savings. A lot of such optimized solutions provided by ICPE ACTEL stand very good references in the field and authorize the quotation of "ICPE ACTEL-ENERGY EFFICIENCY PROVIDER".

AC Electric Drives Solutions for Onshore and Offshore Drilling Rigs, Provided by ICPE ACTEL

The AC electric drives drilling systems provided by ICPE ACTEL are innovative equipment, using AC/AC converters. The AC drilling system is a state-of-the-art solution, with last generation technologies embedded, based on microprocessors and specialized software. The software ensures the optimum control of the regulation process of the drilling gears, with the on-line possibility of setup, adjustment and monitoring. There are also available remote controls which enable the commands and diagnostics of equipment's good running, faults and breakdowns. The technical solution ensures the optimum regulation of the driven motor, in order to obtain the static and transitory performance and optimizing the operating, according to the technical and energy efficiency criteria. Thus, end-user energy efficiency is obtained.

As ICPE ACTEL can be provider of the integral electrical equipment on a drilling rig, the energy efficiency is obtained at the system's level.

The aim of the ICPE ACTEL's drilling solution is to ensure a good running of the gears on a drilling rig: drawworks, round table and mud pumps. It is about a complex technical solution supplied either from the national grid or from the generator sets, structured as a micropower plant. The system consists of:

- The synchronization and coupling station, SSCG type, with:
  - Low and medium voltage input distribution for generator sets;
  - Output distribution for consumers;
  - Generators' sets measure, synchronization and coupling to bars set.
- The medium voltage station, SMT type, with:
  - Medium voltage cells for supply from the national grid,
  - National grid's parameters measuring.
- The transformers station, ST type, with:
  - Transformer for AC/AC converters' supply;
  - Transformer for auxiliary supply.
- The distribution, supply, command and regulation station, SDACRN type, with:
  - Low voltage distribution;
  - AC/AC converters.
- The auxiliary consumers' distribution station, MCC type, with:
  - Distribution for 3x400Vac, 230Vac, 24Vac;
  - Rectifier AC/ DC;

- Stationary batteries.

- The drilling console, PSS type, structured as synoptic panel, with serial communication with the electrical equipment on the rig.
- Local panel for pumps, PL type.
- Foot throttle converter.

The equipment is meant to run outdoor, in special conditions as follows:

- Protection degree: IP54;
- Operating temperature range: -40…+50ºC;
- Tolerated climate: TA1;
- Execution conditions: explosion proof;
- Quality: in conformity with ISO 9001/2000.

The drilling systems provided by ICPE ACTEL represent innovative equipment, the solution described in this paper having been validated on the SATURN drilling rig.

In this example, where there are 11 motors of 800kW/ each, with a running simultaneity coefficient of 0.6, the heart of the system is represented by the electric drives with controlled speed and torque. The analyzed variant is equipped with AC motors, which presents a lot of advantages in comparison with the DC motors. The general schema for SATURN's equipment is shown in figure 1.

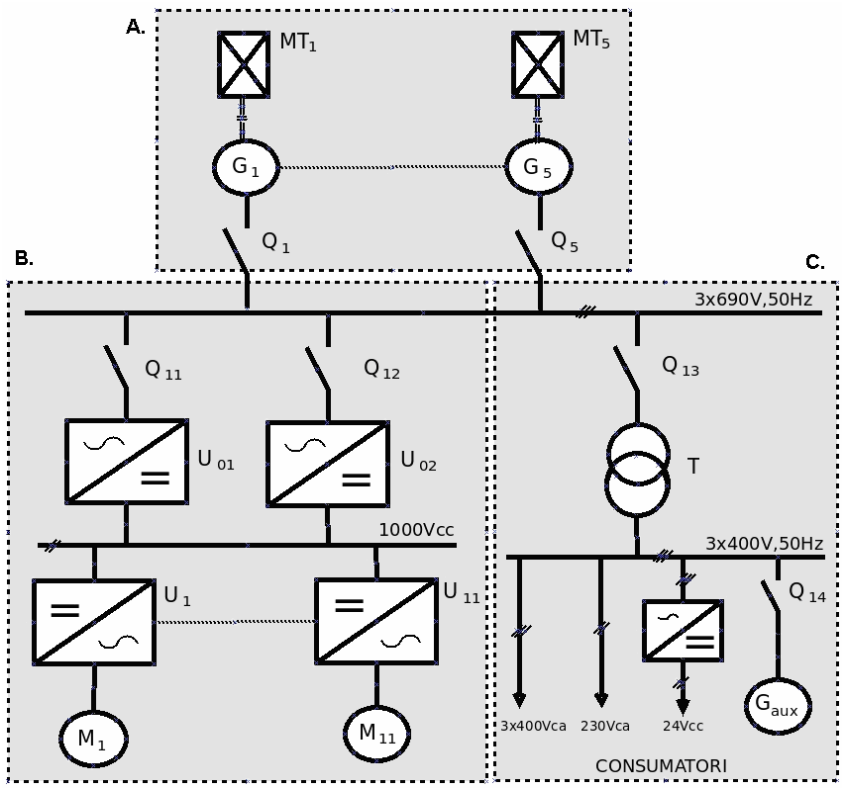

Fig. 1. General schema for electrical drilling rig system

The solution comprises 3 modules, as follows:

A. Voltage supply source, consisting of the 5 generator-sets, MT1-G1÷MT5-G5 type, governed by a POWER MANAGEMENT SYSTEM (PMG). The main functions of the system are:

- Synchronization of generator sets with the mains, in automatic, manual and semiautomatic regime;
- Coupling/uncoupling command of each generator set, in function of the load;
- Protection of each running generator set;
- Running rotation of the generator sets, in order to balance the operating time.

By using the PMG, the fuel savings are with about 18% lower than in case of the DC solution (as on ATLAS, JUPITER rigs).

B. Energy conversion, consisting of the followings:
   - Fully controlled rectifiers U01, U02, which convert the AC energy in DC energy;
   - Inverters U1÷U11, which convert the DC energy in AC energy, with U and f variable parameters;
   - AC asynchronous squirrel-cage motors M1÷M11.

In comparison with the DC solution, where the mechanical characteristic M=f(n) is the same, the power factor at the 690V, 50Hz power bar is sensibly increased, as well as the energy savings, as shown below:
   - In DC solution, the average power factor is about 0.45;
   - In AC solution, the average power factor is about 0.86;

The substantial decrease of reactive power, including loses due to the circulation of reactive energy, leads to fuel savings of about 15%.

C. Auxiliary services, consisting of the transformer T and the bar for supply voltage 3x400V, 50Hz, structured as MCC module, have the following advantages:
   - Substantial reduced maintenance time;
   - Technical assistance ensured by medium qualified personnel.

Resulting from our appraisals, the fuel savings decrease with about 2%.

In the last years, ICPE ACTEL has exported drilling equipment in countries such as: France, Iraq, Russia (Siberia), Kazakhstan, Ukraine, Libya, Indonesia and United Arab Emirates. There are also offshore drilling rigs to be mentioned, such as: Gloria, Atlas, Fortuna, Jupiter, Orizont, Prometeu, Saturn etc.

Advantages of ICPE ACTEL's AC Electric Drives

ICPE ACTEL is providing not only an equipment, but a complex solution.

The solution's design ensures the optimization upon performance and energy efficiency criteria and is customized for the presented application.

The AC solution advantages compared with the DC solution are as follows:
- Increased lifespan with about 20%;
- Reduced drilling time with about 14%;
- Greater availability with about 20%;
- Lower weight with about 50%;
- Lower costs for assembling and putting into operation with 300…6000EUR;
- Decreased maintenance costs with 800…8000EUR/product lifespan;
- Reduced energy consumption at the end-user with about 35%.

The AC electric drives are generally characterized by:
- Very good quality and reliability, as result of using brand components/subassemblies and compliance to the field regulations;
- High safety in operating, essential for energy generation systems;
- Cost efficient, as result of major companies partnership and good management;

- Setup and monitoring in operating regime, software aided, as result of last generation technologies use, PLC and DSP types;
- Remote control, by using specific components;
- Easy putting into operation, maintenance and repair, using monitoring and diagnosis software techniques;
- Technical assistance assurance for the entire lifespan.

Therefore, ICPE ACTEL is a very good choice for an optimized electric drives solution for onshore and offshore drilling.

References

1. ICPE ACTEL, Prospectus – *Electric drives systems for offshore and onshore drilling,* rev. 2008.

Soluții moderne pentru acționările electrice din cadrul echipamentelor de foraj marin şi terestru, furnizate de ICPE ACTEL

Rezumat

Această lucrare prezintă soluția în curent alternativ a sistemelor de acționări electrice utilizate pe platformele de foraj marin şi terestru. Soluția numerică de acționare în curent alternativ, ca parte principală a sistemului, reprezintă un echipament de ultimă generație, care conduce la o serie de beneficii pentru procesul de foraj. Soluția prezintă principiile de bază şi descrie echipamentul, subliniind avantajele soluției în sine, dar şi comparativ cu soluția în curent continuu. Se prezintă un studiu de caz, relevându-se economiile făcute după criterii de eficiență energetică.