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About Monitoring of Electric Drives Parameters of Off-Shore Drilling Installation

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Abstract

Spread of off-shore drilling and of high-depth drilling determined a strong necessity for performing of drilling systems. Being isolated systems off-shore drilling rig use the energy produced locally and this is reason that it must be used efficiently. The paper analyzes the possibilities for monitoring of parameters of electric drive systems of off-shore drilling installation, presenting the structure of an equipment that is capable to offer knowing at every moment of process parameters. There are analyzed the transducers, acquisition interface and it is presented program for monitoring of a F500-4DEC installation.

Key words: *monitoring, electric drives, off-shore drilling, data acquisition.*

Introduction

Drilling installation, which equip the off-shore drilling units, are generally similar with that for drilling at high-depth on the continent.
They are made for a drilling depth starting with 6100 m and can overtake 9100 m. As a consequence, the drilling units are heavy and have large installed powers, especially when mobile units are with auto propulsion. This tendency become generally at new installation, which are built for moving on large distances.

Requirements

Studies and analyses, which were realised, showed that indifferent by constructive principle and by adopted scheme, the electrical drive of off-shore drilling installation must fulfil the following conditions:

-safety in operation, especially in case of complications and drilling accidents;
-progressive regulation, in a large scale, of the speed of the main working systems;
-easiness of start-stopping commands, of inversion of rotation sense and speed changing;
-drilling equipment must give the necessary power to guarantee the efficiency of drilling in a large range of drilling depth;
-relative simplicity of installation, regarding operations and costs of exploitations;
-drilling equipment must be easy enough to not overload the platform.

Particular aspects of electric drive systems

Being isolated systems, without access to electrical energy network, energy source of drilling installation is represented by Diesel engines, having powers between 1,6MW and 2,7MW. A drilling platform has several this kinds of motors.
For satisfying the requirements, energy transmission between primarily engine and the working machine is made on electrical way.
It is considered that this modality is the most advantageous, taking in consideration some essential aspects like:
-eliminating intermediary mechanical devices which restrict some possibilities for locating of different elements of installation;
-eliminating intermediary couplings and reversing devices;
-allowing using of some driving motors with characteristics that are adapted to specific working mechanism;
-it can be permitted to compensate temporary non-operation of one power group by another one.
The electric drive systems which fulfil these conditions and which are used in off-shore drilling are Diesel-electric Ward Leonard (DEWL) and Diesel-electric mixed (DEC).
Diesel-electric Ward Leonard system is the classical solution for adjustable driving in continuous current. This solution has some advantages like:

- the possibility for continuing regulation, in a large scale, of the working rotations;
- a fast acceleration of large inertia masses;

a smooth but fast brake for the load.
The DEWL system has a great disadvantage: at one receiver must be allocated an integer number of generators. This can lead to great complexity of distribution and, many times, to a non-rationally using of generators.

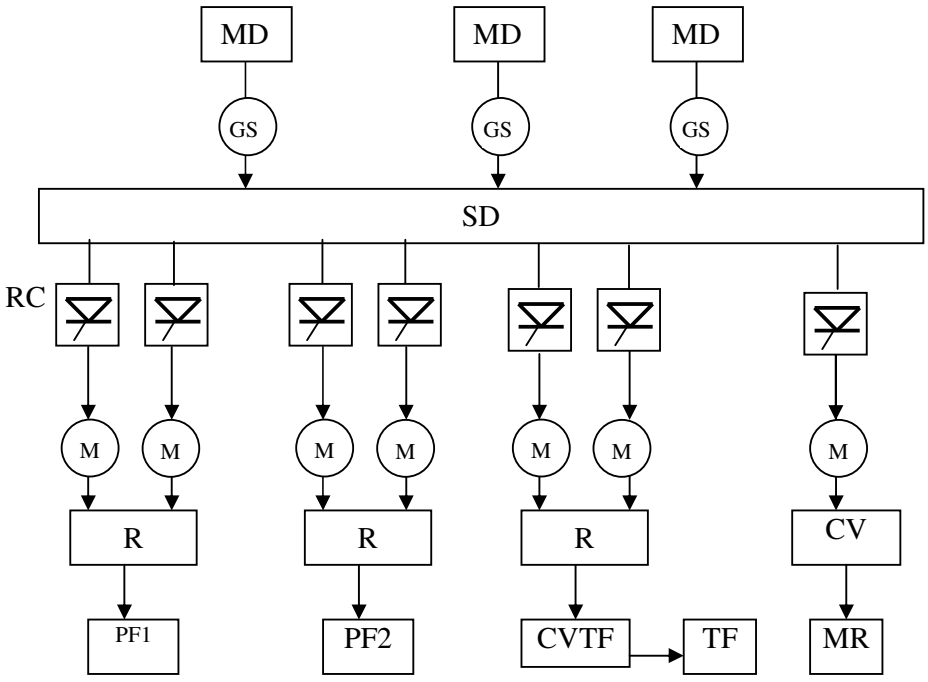

Fig 1 - Structural scheme of energetic fluxes at a F400-3DEC drilling installation .
MD – Diesel motor; GS- synchronous generator; SD – distribution-rectifying system;
PF -fluid pump; CVTF-draw works driving group; TF draw works; MR - rotary table;
CV- rotary table driving group, RC- commanded rectify.

The mixed Diesel-electric system (DEC) can eliminate these inconvenient. It contains synchronous generators which deliver on a common bare.

A distribution and rectifying system supplies the electric machines, which drive the working machines.

In figure 1 is presented a principle scheme of the transmission modality of energetic fluxes to a F400-3DE installation. Every continuous current motor has the own rectifying block and it is connected separately to the common bare of alternative current. By this way it is simplified the assembly and the power given by Diesel engines is used more efficiently.

Analysing the general technical characteristics of electric driven installation it can be observed that, at the same type of drilling installation, the installed power for a DEC installation is with 30% smaller than at a DEWL installation.

Another particularity of electric drive system of an off-shore drilling installation is that besides the classical working machines (draw works, rotary table and mud pumps) it must be driven the specific working machines for platform moving (that means two propellers) and for its anchoration (four draw works of the anchors).

So, the number of electric drive machines is almost double by comparison with a similar drilling installation which drills on the continent.

It can be noted that they are not working in the same time, so that the power deliver at a moment by synchronous generators is smaller than sum of nominal powers of electric drive machines. At each Timer interruption, all the programmed channels are sampled consecutively, based on the EOC interrupt

Structure of a electric drive system of a drilling off-shore

Figure 2, which presents the electrical scheme of a F500-4DEC drilling installation, can give the image of what means such an electric drive system for an off-shore drilling installation.

It can be observed the four groups made from Diesel motors (1) by 1,6 MW and synchronous generators (2) by 1,9 MVA which deliver on a common bare at a tension by 600 V, parallel connection being made by some automated interrupters.

It can be noted that, besides of working mechanisms of a classical drilling installation (one draw work driven by three continuous current motors, each of them having 600 KW, a rotary table driven by continuous current motor having 600 KW, mud pumps driven by two continuous current motors, each of them having 600 KW) the electric drive system contains working machines that are specifically for off-shore drilling platforms.

There is another thing that must be observed: the specific working machines don't work all in the same time with the machines specifically for platform moving. So, the electric machines which drive them are supplied by the same group of commanded rectifies. In this manner is realized an economy of equipments and space.

Structure of monitoring system

Monitoring system of electric drive parameters contains, in principal(fig.3):

- transducers for acquisition of parameters of electric drive machines and of working machines;
- data acquisition interface;
- computer or process equipment where is working programs, which are specifically for the considered application.

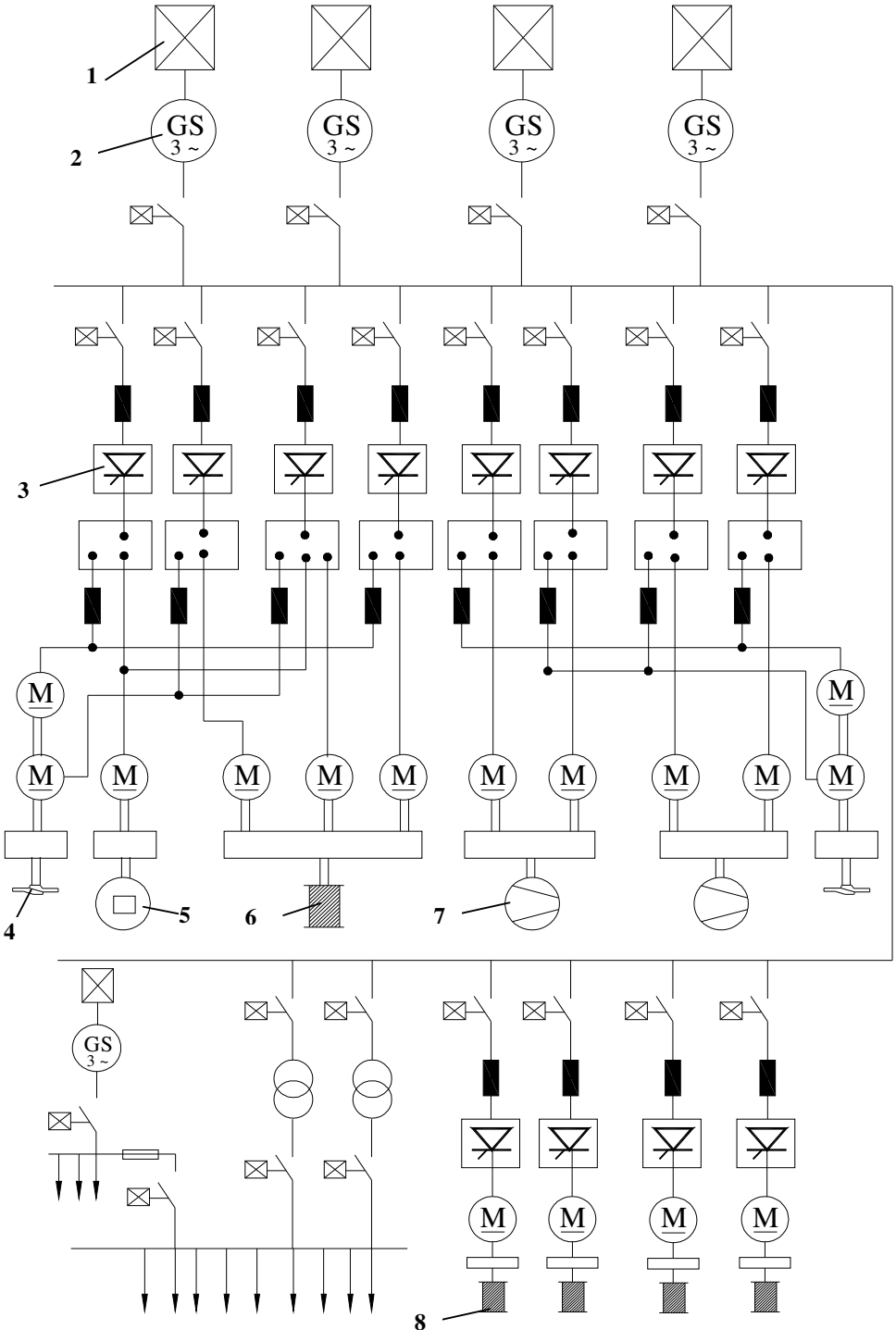

Fig 2- Sample scheme of a DEC driving system with generation of alternative current and rectifying.1- Diesel motor; 2- synchronous generators; 3 –rectifiers; 4 – propeller for platform moving; 5-rotary table; 6-drilling draw works; 7-mud pumps; 8-draw works of anchors

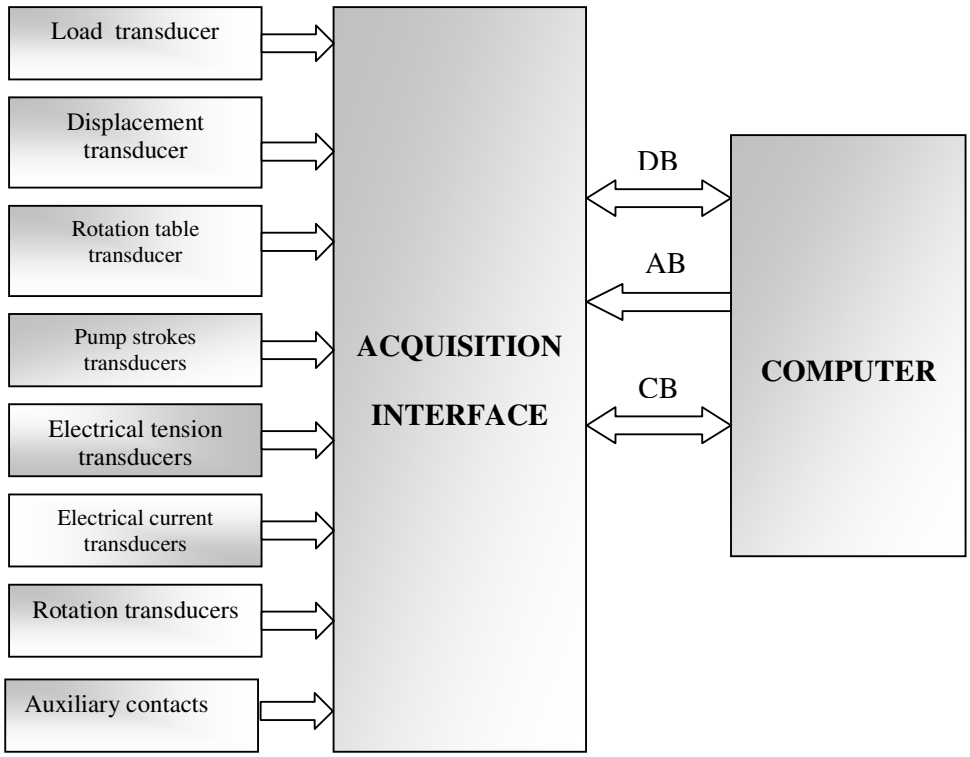

Fig. 3- Structural scheme of acquisition system of process parameters.

Transducers set

The type, the range and the number of the transducers depends on parameters that must be monitored.

So, for a Diesel – electric group it will be monitored intensity of delivered current, apparent given power and speed rotation of the generator. For the common bare on which deliver the generators, it is measured electrical tension; also, for electric drives machines it is measured intensity of the absorbed current and speed rotation.

Having in view the working machines, parameters that must be measured are:

- cable displacement and hook crane load for the drilling draw work and for handling system;
- mud pump strokes frequency;
- speed of rotary table.

For getting information about status of the interrupters, there are used auxiliary contacts of them.

Acquisition Interface

Data received from the transducers must be adapted so that it can be acquired by computer. In this case, this is the role of the interface.

The transducer set presented above can give following types of signals:

- analogical signal in current (current and electrical tension transducers and the load transducer);
- signals in tension impulses (rotation transducer, displacement transducer and transducer for pump strokes);
- inputs by electrical contact type.

Each of these signals is processed properly. So, analogical signals are selected by a multiplexer, they are adapted by an amplifier to be applied at the input of an analogical-numerical converter. This will transform in a numerical form and put the information on data bus of the computer, at its request.
Signals in tension impulses are processed properly to be applied to the counting-timing circuits. These put on computer data bus, at its request, numerical information about number of impulses that were received from the last reading until present.
Information by contact type is received as words, after galvanic separation using optical couplers.

Monitoring programs

Monitoring programs realize the following functions:
-the acquisition and selection of analogical parameters;
-selection and acquisition of parameters that use transducers with output signals in impulses;
-selection and acquisition of data received from electrical contact transducers;
-numerical processing of acquired parameters, which assumes filtering, engineering units conversion, testing of framing on the proper limits and correction of the systematically errors;
-graphical display of acquisition results.
On the monitor are displayed the results of data acquisition, messages for the operator and other necessary information. An important factor in design of the interface was the modality of displaying so that this be suggestively and friendly for the persons who watch the process.

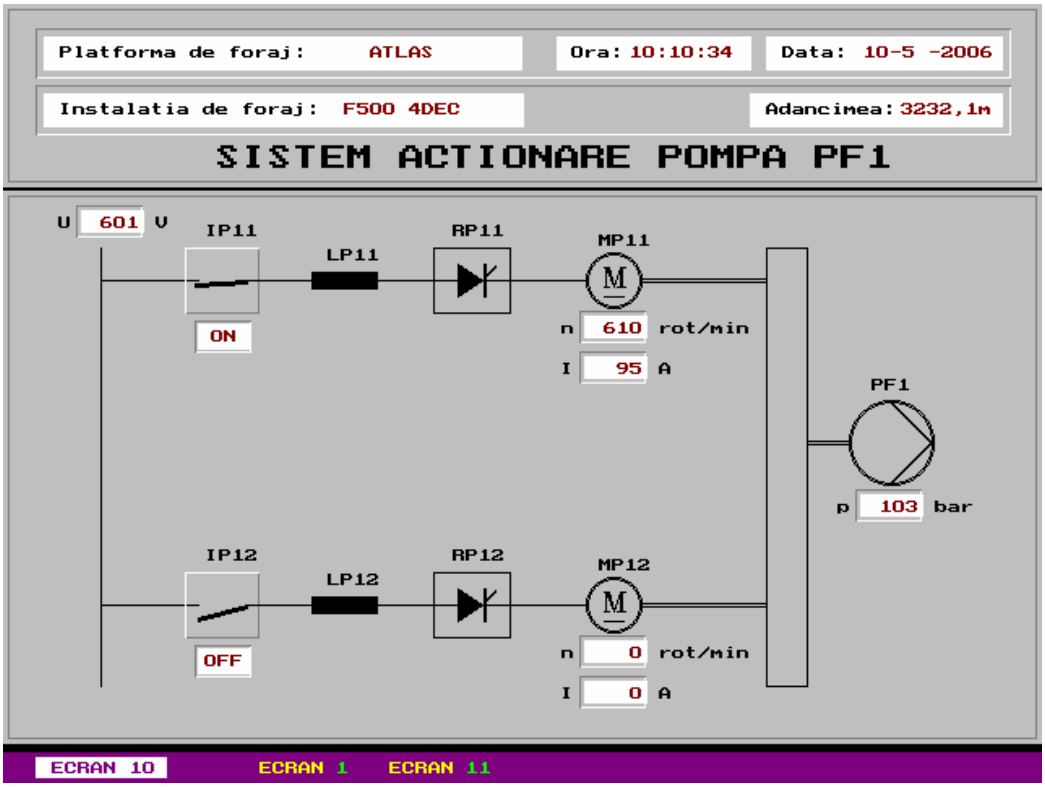

Fig. 4. The screen for displaying of electrical driving systems parameters of mud pump PF1

Having in view the number of the acquired parameters it was chosen a solution in which the results are displayed in several screens.
The main subsystems used in monitoring activity are:

- generators groups;
- driving of drilling draw work;
- driving of mud pumps;
- driving of rotary table;
- driving of propeller for platform moving;
- driving of anchors mechanisms.

In figure 4 is presented for sampling the screen for displaying of electrical driving systems parameters of mud pump PF1.
The programs have a modular structure so that it can be added new specific modules.

Conclusions

Because their high daily operation costs, the electric drive systems of off-shore drilling must assure:

- safety in operation, especially in case of complications and drilling accidents;
- progressive regulation, in a large scale, of the speed of the main working systems;
- easiness of commands, reversion of rotation sense and speed changing;
- efficiency of drilling process in a large range of drilling depth.

A factor that can contribute to fulfil these objectives is monitoring of parameters of electric drive system and of other parameters of drilling process.

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Asupra monitorizării parametrilor sistemelor de acţionare electrică a unei instalaţii de foraj marin

Rezumat

Odată cu extinderea forajului marin şi a celui de mare adâncime a apărut necesitatea perfecţionării sistemelor de forare sub aspectul performanţelor tehnice. Fiind sisteme izolate, instalaţiile de foraj marin utilizează energia produsă local, motiv pentru care ea trebuie utilizată eficient. Lucrarea analizează posibilităţile de monitorizare a parametrilor sistemului de acţionare electrică a acestor instalaţii, prezentând structura unui echipament capabil să ofere cunoaşterea în orice moment a parametrilor procesului. Sunt analizate traductoarele, structura interfeţei de achiziţie şi prezentat programul de monitorizare cu o exemplificare la o instalaţie F500-4DEC.