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TRENDS TO INCREASE THE QUALITY OF ELECTRICITY ON BOARD

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Abstract *: The quality indicators of electricity must meet the next conditions: universality with the purpose of using them in exploitation and for realization of acontrol methodology using simple and cheap measuring means and with the needed precision; perfectibility, precisely defined and few for characterization of distinctive properties of energy in stable conditions of the naval electro-energetic system functionality.The deviation of voltage and frequency, the voltage asymmetry and deviation from the sinusoidal form are the main indicators of quality of electricity with a practical importance. In the S.E.N., when permanent conditions is set, the sign of voltage deviations is the same for all electrical parts and can be different from the voltage sign. Voltage and frequency deviation depending on the nominal value can be positive or negative. Frequency and voltage decrease on electrical appliances electrical terminals leads to rotation moment decrease and for a constant load, the current value increases. The frequency decrease rises the currents value towards the consumer on account of increasing the magnetization current of transformers and inductive reactance decreases in circuits. The maxim allowed limits of voltage deviation are+/– 10% for permanent conditions and +/– 20% for 1,5 seconds or+/– 30% for 5 seconds for short period conditions.Voltage asymmetry of ships appears in three-phasic systems because of connecting mono-phasic consumers and lead to occurrence in S.E.N. to consumers of harmonic components with frequencies of over 50Hz, components that increase power losses and lead to heating the generators, engines and cables.The deviation from the sinusoidal form is generated by generators (up to 20%) or by consumers (up to 5%). When naval generator terminals are connected to nonlinear resistances, the consumed current has an asinusoidal form, and voltage drops of the superior harmonics of the current changes for tension curve in S.E.N.. Energy static converters represent the main nonlinear load of a naval electrical network. Under the rules of international maritime registers, the deviation from the sinusoidal form mustn't exceed 5% out of the peak value.The changing in form of the voltage curve in S.E.N. happens because of energy static converters depends on: the nature of the load; parameters of energetic sources on ships; adjustment depth; the ratio between the sources power onboard and the static converters used. As advert effects we find generator and appliances heating, precise reduction of automatic adjustment systems and command of generators.*
Keywords:*, electro-energetic system , voltage, frequency*

Introduction

The maritime ship is a conglomerate that includes elements from many fields and requires interdisciplinary research for increasing safety in supplying electricity to consumers,for increasing energetic efficiency in producing and distributing it. The naval scientific research targets the establishing of constructive solutions and equipping is meant to improve the nautical qualities of ships, a complete automation of compartments, at the same time with fuel economy, reducing transport costs, using shorter routes, achieving an optimization of equipment operation and reducing the crew.In projecting, constructing and exploitation of ships, new principles are used to combine theoretical elements and experimental results. It aims at finding solutions for technical and economic and scientific activity on board a new standard of profitability and quality. The elaborated study completes the necessary material for analysis and solving complex problems that occur to the activity of the engineer onboard, and the one that leads the electromechanical compartment[1,2,3,4].

The electric supply quality is determined by the next factors: safety in installation functionality; the electricity quality at the point of delimitation between consumer and supplier; the electromagnetic compatibility of installations in the environment that they are working.

The main factors that influence the continuity in alimentation of consumers are: reliability of every element that enters in the electrical supply installation; the configuration of the electrical scheme; safety characteristics (sensibility, selectivity, fastness, functioning safety); automated systems existence; exploitation quality.

The requirements for naval installations: economy and security; consuming items of equipment, installations and equipment should be standardized, minimum mass and volume, easy access for inspection and repair; entire naval equipment must comply with international conventions and shipping registry under the supervision which is built and operated; can be operated locally orfrom the bridge; have maximum operation and ease of maintenance, installation and operating stability [5,6] and maintenance.

Generation, transmission, distribution, and consumption of electricity on board

It is necessary to maintain a high level of power quality to achieve high efficiency in the operation of installations, equipment and electrical appliances.Using power electronics within electrical equipment and installations lead to disruptions in power quality.Resolving power quality is a complex process that is performed by monitoring the voltage and current and disturbances introduced by consumers. Thespecific indicators from which is assessedthe level of power quality are: frequency deviations; variations in actual values of voltages (voltage fluctuations - the flicker effect, surges, dips); deviations from the sinusoidal shape deviations of the instantaneous values of voltage and current: deforming regime, harmonics, interharmonics, voltage pulses; deviations from symmetry of the phase of a system voltages or currents. [7,8].The electricity produced on board a ship should have a symmetrical sinusoidal alternative voltage of a certain effective value and frequency , maintained within well determined limits

The improving quality of electricity supply is a complex process requiring organizational, technical and economic actions. Costs increase with increasing quality. Equipment, electrical devices and electric handsets will be more expensive as they have by design and manufacture a higher level of immunity to electromagnetic interference [9].

By monitoring the power consumption it is checked:

-the voltage level for meeting the quality parameters of electricity;

-the phase imbalance;

-thetotal harmonic distortion;

-theactive and reactive power, power factor and the energy absorbed.

When the parameters in real time exceed the benchmarks, the alarms start[10]. A low power factor has a number of negative consequences for the operation of the power grid:

-oversizing power distribution facilities, increased investment - sizing is based on the electric current so that the same active power, the active power increases, the current increases;

-increasing active power losses so that they vary in direct proportion to the square of reactive power and inversely proportional to the square of the power factor;

-decreasein load capacity of active power plants. With the increase of reactive power the active power decreases for a given apparent power. Consumers who have high inductance coils require a high reactive power, so the

phase shift angle increasesand the power factor of the source decreases and therefore less active power. Hence the interest of having a high power factor for consumers;

-increasing losses in the network voltage. The reactive power transport producesadditional power loss in addition to those produced by the active power and hence the network oversizing of the conductor cross-section;

-decreased number of receptors connected on CEN.

The power quality refers to product technical parameters: amplitude, frequency, harmonic content, the symmetry of the three-phase system.Voltage control is mainly done by controlling the production, consumption and reactive power flow at different levels of naval power system (transport, distribution).Medium voltage network specific to the transport system is strongly interconneted and consumers are not directly connected to it.In addition the majority of consumers in the network have their own system of voltage-reactive power control. In the case ofthe distribution network, the objective is to minimize power/energy loss and maintaining the voltage between the allowed limits.

To be able to monitor power quality is implemented in naval power system (SEN)an automated multivariable system based on data acquisition programs, processing, monitoring, analyzing, recording and data forwarding to help the officer onboard in following necessary sizes for the operation of all equipment and installations on board after processing it. [12]

For being used on board ships, the naval equipment must correspond in terms of functionality and structure according to authorized naval records which are meant to show compliance with international conventions and supervises and classifies shipbuilding.

Power quality depends on: a number of factors that interfere with each other, the way they produce,the physics characteristics, the disturbances that arise from production to the consumer.

The main factors that determine the quality of electricity are: safe operation of equipment and installations SEN; characteristics of electricity between production and consumption;

electromagnetic compatibility of installations N.P.S.. with the environment.The quality of electricity depends on voltage and frequency quality and continuity of supply.The proposed system provides the following functions: measurement of analog data (voltage, current, etc.) and numerical (status of switchgear and protection for SEN);processing numerical data to determine energetic parameters and performance indicators;storage and display of consumption and consumers to determine the deviations of parameters from predefined quality factors;monitoring the current energy consumers; fault detection; detection and warning when values are exceeded for quality indices of energy. All these features ensure the qualitative and quantitative efficiency of electricity consumption on board. Data processing allows the definition of active power, reactive power and deforming in time domain, in frequency, and the definition of quality indicators of electricity.

Given the nature of electricity consumers, which can be resistive, inductive or capacitive, we seekto obtain as much data about consumers who may induce disturbances in the supply - lowering power factor, apparition and amplification of voltage harmonics in higher class current, deficiency in power circulation in N.P.S.. –the aim is to have a uniform system of automatic control of power quality. [11]

The main sources of harmonic distortion are the receivers that contain power electronic converters: rectifiers, static frequency converter. An application of power electronics is the actuation of drive motors using static frequency converters that enable precise control of speed and torque. [9.10]

Effects of deforming regime (electricity disruptive effects of harmonics):

a. overheating conducting elements travelled by harmonic currentsmay cause insulation piercing and short circuits;

b. increased power losses (energy) on network elements (cables, transformers) because of additional circulation currents (harmonics);

c. the distortion of waveform electric current affects fuses / breakers which are more sensitive to heat and can cause unexpected operation;

d. the presence of tension deforming forces to supplying bars may cause additional loss of power (energy) in magnetic materials in transformers in electric appliances, in the occurrence of swirling current;

e. reducing the power factor increases reactive energy.

The limitation of harmonics in the nearest disruptivesource leads toreducing active power losses in non-sinusoidal electrical circuits. For filtering are used active or passive filters (harmonic filtering is due to repeated failures of electrical equipment malfunction or because malfunctions in the parameters of naval equipment). The automatic trigger of the liner in case of interruption of power supply voltage or use of stabilizers in case ofsensitive equipment is very important.

Frequency/ variable converters for revolutions (RPM) can reduce electricity consumption by 30-50%, allowing control / speed variation of engines, extend the life of electric motors, is the most efficient method of protection of electric motors; energy-saving tool in the automation of processes.

The variable speed exhaust driven fans lead to significant savings in electricity and increasing the life of electric motors using frequency converters (variable speed) and adjusting fans speed to air demand. There is a reduction in engine power absorbed by the network board. Using a specific function reduces the amplitude of voltage up to the required load torque.

Another advantage in using frequency converters to eliminate problems at startup. Absorbed current at startup exceeds (several times) rated current and overheat the engine. The inverter enables smooth start and maintain inrush current below nominal value.

The program will enable us to: record analog measured quantities and their harmonic analysis (voltage, current); display electrical parameters (voltage, current, frequency, power factor, power) weight display harmonic voltage and current; refer to the system unbalance three phase currents and voltages; store the measured values and their operation on demand; detect faults and root cause analysis; optical and audible warning the exceeding of value limits.

Research and achievements to increase power quality

We studied some of maritime literature and we can include some of the results [12,13,14,15,16,17]. The impact of Intelligent Transport Systems (ITS) and ship architecture (based on the calculation of drag) is done through Ford algorithm to determine the optimal path of the vessel and economic speed depending on weather conditions and latitude. For a transportation network, represented by graphs, values arcs (representing the cost of transit that arc - cost includes time to walk the distance, fuel consumption, additional costs for crew and materials) changes depending on a number of factors - weather, events, equipmentand the character of the ship. External factors that determine the values arcs have a constant influence over time, which can lead to changes in these values (the value of the arc is the transit cost of the arc) and can be obtained dynamic networks (graphs change in terms of quality and not of structure) . I.T.S. systems arcs can change the values, modifying the optimal solution on the route - can change a graph associated with a transmission by modifying the arcs (can be done statically or dynamically with the implementation of systems by modifying the arcs). Ford algorithm is sequentially applied and generates the optimal route based on the run-ship and cargo.

S & P Aurora Corporation - the largest designer, manufacturer and supplier of automatic control systems for ships, by making CSCES (Complex Control Systems for Engineering Systems), left the following principles: integrating subsystems CSCES based on a common set of components; increasing the control or the prediction warning actions in advance of damage control maneuvers; development of computer assisted safety systems; increase the level of automation; shift from the concept of operator - the principle of technical control station management of engineering systems; connection to an

integrated information space of the vessel; technology implementation C.A.L.C.S. (Continuous Acquisition and Life Cycle Support) product development and reliability for all stages of service.

The implementation of these postulates will provide a qualitatively new level of ship equipment control systems, increase efficiency, reliability and safety of airborne systems. It aims to develop a base ship coordinating the control hardware systems responsible for handling the ship safely, taking into account certain factors (wind, wave) and systems that control the position, transverse, and speed plus the propulsion. Within the integrated control system (CSCES) an essential component is a control system for IBC (Integrated Bridge Control). I.B.C. consists of modular workstations for the master, the officer of the watch and the helmsman. These modules are used for: technical data acquisition, analysis and operation; safe navigation of the ship; ship position and speed control; remote monitoring of Naval Power Plant (CEN) with all related components; road safety control and navigation of the ship; monitoring parameters of the power plant and unsinkable systems, maneuverability and stability.

Implementation of Condition Based Maintenance System (CBM) to reduce costs on board is a modern way to streamline the transport ships. Existing automation systems on ships are designed for safety crews, cargo and vessel. They provide large amounts of data reliability monitoring equipment in order to transform them into information used effectively on the maintenance of the ship. The software named "DEXTER" allows monitoring equipment reliability through automated data acquisition and crew alerting in case of detecting a fault or the existence of potential malfunctions for the near future. The system monitors the reliability of existing equipment on board and performs data acquisition, performance analysis of electromechanical equipment and facilities, evaluation of the operation, fault diagnosis and their isolation (enter the reserve), verification issues and actions for maintenance and repair, reducing the role of the human factor checking and corrective action after a problem has been identified by the program. The "DEXTER" system uses neural networks for diagnosis and prognosis of failure for the equipment and facilities. The network software automatically learns the model associated with equipment failure alarm condition. Corrosion, ship vibrations, poor quality of electricity due to its parameters, power outages (blackout), environmental factors can damage many electronic and electromechanical equipment. The "DEXTER"server is directly connected to existing systems and alarm monitoring via an "Ethernet" which allows real-time data acquisition, archiving and analysis by diagnostic software. Workstation modules which incorporate the "DEXTER" are distributed on the vessel. The server is connected to the data bus of ship power quality indexes. With the introduction of Power Electronic Building Blocks (P.E.B.B) can reconfigure the power flow paths in response to different load priority task in real time. While power generating systems integration offers many benefits, introduction of new technologies (advanced electronic power systems, intelligent control and energy storage technologies) increases the need for real-time energy management and system reconfiguration to intervene in case of failure of electrical equipment.

4. Operating conditions and exploitation of naval electro-energetic equipment

The essential characteristic of electrical installations on ships is complex. Today, no matter how small a vessel is, it's unthinkable the absence of the electrical installation. Each ship must carry with it its own source of electricity. On the ship there is an electricity distribution network, power consumers of various kinds, lighting, heating, household equipment, automation and signaling systems of various mechanisms and devices, radio installations and other facilities for special purposes (demagnetization installation, cathodic protection system, radioactivitysignal system roll stabilizer system etc.). This complex electrical installations require the construction and the exploitation of ships by a large number of specialists. In shipyards and researchand design institutes is possible a specialization on types of installations. Onboard where there are fewelectromechanicalofficers, they must know all the problems relating to the operation of the electrical system on board.

Naval power system (N.P.S.) must provide:

1. independent and parallel operation of generators;
2. interconnection block sections of the main switchboard;
3. disconnect and reconnect automatically the aggregates in stand-by;
4. Protection of generators, motors and other consumers in occurrence of abnormal operating regimes;
5. automatically disconnected nonessential consumer;
6. operation and measuring equipment for overload, short circuit, under frequency value and over frequency value, reverse power, etc.

In terms of operating principles and components, the networks on board don't differ from those from the shore. Electrical installations on board vessels must have a high robustness and increased safety in operation, due to climatic conditions and technical on board and that during the voyage the ship becomes an isolated system, a system that can not be helped when malfunction occurs only with great difficulty.

The power quality with functional safety and electromagnetic compatibility of installations with the environment in which it operates defines and determines the quality of the electrical supply service.

The supervision of power quality indicators and measures for maintaining the permissible limits may be made only in connection with the supervision of disturbances introduced into the supply network by some consumers. In this sense, power quality indicators refer to:

- Product quality: frequency; voltage amplitude; temporary and transient surges (limited and controlled overvoltage protection systems); voltage dips (limited by relay protection systems);
- quality of service (power supply).

The power system of quality indicators relates in particular to disturbances caused by the operation of consumers harmonics and inter-harmonics (harmonic modes); fast voltage fluctuations; slow voltage fluctuations (flicker effect); unbalances. The harmonic and inter-harmonics disturbances, voltage fluctuations, fast and slow and unbalance deteriorates power quality to consumers, proper operation of the equipment being affected.

To maintain the sufficient quality of electricity is needed the establishment of clear and measurable limits of permissible deviations.

The power quality indicators must ensure the measurement of value parameters in a certain point in the network and at well established moments, comparing the values obtained with the optimum level demanded by consumers. [18]

Conclusions

The quality indicators of electricity must meet the next conditions: universality with the purpose of using them in exploitation and for realization of a control methodology using simple and cheap measuring means and with the needed precision; perfectibility, precisely defined and few for characterization of distinctive properties of energy in stable conditions of the naval electro-energetic system functionality.

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