a clean reputation with consumers. Companies should regularly evaluate and update their crisis management plan to ensure it remains effective in the current environment.

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COMPARISON OF THE INDICATORS OF THE TECHNICAL LEVEL OF OPTIONS OF TRANSFORMERS AND REACTORS WITH TOROID AND RADIAL MAGNETIC WIRE FOR THEIR INSTALLATION IN CYLINDRICAL TUBULAR SHELLS OF LIMITED DIAMETER OF SUBMERSIBLE PUMPS

(ПОРІВНЯННЯ ПОКАЗНИКІВ ТЕХНІЧНОГО РІВНЯ ВАРІАНТІВ ТРАНСФОРМАТОРІВ І РЕАКТОРІВ З ТОРОЇДНИМ І РАДІАЛЬНИМ МАГНІТОПРОВОДАМИ ДЛЯ ВСТАНОВЛЕННЯ ЇХ У ЦИЛІНДРИЧНІ ТРУБЧАСТІ ОБОЛОНКИ ОБМЕЖЕНОГО ДІАМЕТРА ЗАГЛИБЛЕНИХ НАСОСІВ)

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Виконано числовий порівняльний аналіз показників технічного рівня планарних стрижневий, броньовий і просторової броньовий електромагнітних систем з крученими і шихтованими магнітопроводами.

Ключові слова: *однофазний трансформатор, кручений, шихтований, планарний, просторовий, магнітопровід, оптимізація, порівняльний аналіз.*

A numerical comparative analysis of technical level indicators of planar rod, armor and spatial armor electromagnetic systems with twisted and layered magnetic conductors was performed.

Key words: *single-phase transformer, twisted, stacked, planar, spatial, magnet wire, optimization, comparative analysis.*

In modern developments in the field of automation of technological processes, electrical equipment protection control systems, instrument building, radio electronics, electrical systems, and complexes, energy saving systems, as well as underwater (underground) technological and aerospace applications, single-phase transformers are one of the dimensional and material-intensive elements of modern electrical engineering equipment and reactors. Most often, traditional design solutions are used in ESPs, for example, planar (rod, armored) and spatial (toroidal) EMC with rectangular forming contours, which have a number of disadvantages.

In devices and complexes for underwater search and underwater technical purposes, as well as in ship diving devices and elements of aerospace equipment, there are strong spherical or cylindrical tubular shells in which the equipment is embedded. Three-phase groups of three toroidal single-phase transformers are installed in cylindrical tubular shells of limited diameter. Traditional toroidal EMCs with continuous magnetic conductors made of electrical steel (ETS) or the magneto-dielectric of most ESPs for instrument-making and radio-electronic industry products have a central technological hole. Such a hole ensures the winding of the winding "shuttle" machine and significantly reduces the filling of the internal circuit with the active material of the winding. This leads to a deterioration of the technical level indicators (PTR) of toroidal ESPs.

In accordance with the heuristic direction of improvement of electrical machines and devices, an unconventional three-rod spatial radial structure of single- and three-phase EMFs (Fig. 2.b) is proposed, which is analogous to the shape formation of the above-mentioned toroidal EMFs. The purpose of the work is to determine, increase and compare the technical level indicators (TPR) of EMCOT options and reactors with toroidal and radial magnetic cores for their installation in cylindrical tubular shells of limited diameter.

The main research material is focused on the possibility of improving the power supply system of the electric drive of submersible pumps. The modernization is carried out by replacing the design of single-phase toroidal transformers, which make up the group transformer, with spatial single-phase transformers with a radial electromagnetic system. The radial electromagnetic system is characterized by the convenience of embedding in shells of a limited diameter, a shorter average length of the coil, as well as the absence of winding stacking disadvantages.

The main task is the definition and comparative analysis of indicators of the technical level of variants of spatial twisted electromagnetic systems. To solve the task, the method of optimizing the objective function is used, which contains dimensionless indicators of the technical condition, as well as relative geometric controlled variables. The extremum of the relative components of the target function is a function of the winding window of the current-conducting material of the winding and three universal identical geometric controlled variables, which are used for any of the existing variants of electromagnetic systems. According to the principle of electromagnetic equivalence, the same materials used, the average values of the amplitudes of magnetic flux induction in rods and yokes, the filling factor of the muzdram theater with steel, as well as the execution and methods of cooling electromagnetic static devices, are used accordingly.

Conclusions:

The results of a comparative analysis of the technical level indicators (minimum mass, cost of active materials, and losses of active power) showed that the design of a twisted radial electromagnetic system with a rectangular cross-section of rods provides, on average, a significantly reduced level of mass, cost, and losses compared to an equivalent analog from a toroidal electromagnetic system.

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