Maciej Bernatt, Wojciech Poprawski
BOBRME Komel, Katowice

SILNIKI WYSOKIEGO NAPIĘCIA DLA TRUDNYCH WARUNKÓW
EKSPLOATACYJNYCH.
(PROJEKTOWANIE I WYKOŃAWSTWO)

HIGH VOLTAGE AC MOTORS FOR HARD WORKING CONDITIONS
(DESIGN AND MANUFACTURE)

Abstract: High voltage (6000 and 10000 V) AC squirrel cage motors are started by switching direct on line. The inrush of starting current causes mechanical and thermal stresses in the motor structure, mainly in their rotor’s cage. Motors for hard working conditions, esp. for high frequency of starts, or for long lasting starts should be designed and manufactured especially. At Komel Centre several calculation and designing methods for motors exploited at hard working and starting conditions were elaborated. Many motors of this kind were designed by Komel and manufactured by polish manufacturers. The motors were exploited several years in various branches of industry without any breakdowns. In the paper three cause studies are presented: 550, 800, and 2000 kW motors, where redesigning and replacing only their rotors were full satisfactory.

Jan Zawilak, Tomasz Zawilak
Politechnika Wrocławska, Wrocław

SILNIKI ELEKTRYCZNE W NAPĘDACCH GÓRNICZYCH

ELECTRIC MOTORS IN MINE DRIVES

Abstract: This paper deals with electric drives in mine applications. Use of pole-changing induction motors enables reduction of energy consumption. Applications with fan type and constant torque-speed characteristics are shown. Parameters of induction and synchronous motors with permanent magnets are compared.

Paweł Zalas, Jan Zawilak
Politechnika Wrocławska, Wrocław

WPŁYW PRZEMIENNEGO NAPIĘCIA WZBUDZENIA
NA SYNCHRONIZACJĘ DWUBIEGOWEGO SILNIKA
SYNCHRONICZNEGO

INFLUENCE OF AC EXCITATION VOLTAGE ON
SYNCHRONIZATION OF TWO-SPEED SYNCHRONOUS MOTOR

Abstract: The paper presents the calculation results of synchronization processes through AC and DC excitation voltage for a selected model of two-speed synchronous motor with switchable armature and field magnet windings. The synchronous motor type GAe 1716/20t is used for driving the main fans type WPK 5.3 in deep underground mines. The effect of the instant of starting synchronization out of asynchronous operation and greater then nominal value of excitation voltage on the process’s effectiveness and the dynamic waveforms was presented. The influence of AC excitation voltage on armature current, field current, field-winding-terminal voltage, electromagnetic torque and rotational speed during synchronization processes has been demonstrated. The calculation results are presented as diagrams over time.
Abstract: The use of variable-frequency drives (VFDs) to control AC motors has increased dramatically in recent years. In addition to their low operating cost and high performance, they save energy. Today, the challenge facing system designers and engineers is to minimize damage to AC motors from shaft current. From its first minute of operation, a VFD induces destructive voltages that build up on the motor shaft until they find discharge paths to the frame (ground). In most cases, the motor bearings present the path of least resistance. Once voltage is sufficient to overcome the resistance of the oil film layer in the bearing, shaft current discharges, causing electrical discharge machining (EDM) pits and fusion craters in the race wall and ball bearings. This phenomenon continues until the bearings become so severely pitted that fluting, excessive noise, and failure occur. Mitigation of this damage is possible through various strategies. Some are narrow in application, and most are costly. Many are not technically feasible. However, a new technology employs a circumferential ring of conductive micro fibers to discharge harmful currents and provide a low-cost solution to the problem.

Bronisław Drak, Piotr Zientek, Roman Niestrój, Andrzej Boboń
Politechnika Śląska, Gliwice
Józef Kwak, Zabrzańskie Zakłady Mechaniczne, Zabrze

Abstract: The negative influence of bearing currents on the durability of rolling bearings in the alternating current electric motors are shown. The reasons of bearing current formation in electric motors are given. Examples of bearing races damages of cooperating rolling bearing elements are presented. Analysis of dents distribution in the roller, roll-neck and ball bearing races are made. Conclusions drawn from laboratory researches are presented in chapter 6.

Władysław Przytocki
Energotest Sp. z o.o., Gliwice

ENERGOTEST - GLIWICE
DZIAŁ UKŁADÓW ENERGOELEKTRONICZNYCH
PRODUKTY I USŁUGI

ENERGOTEST - GLIWICE
POWER ENGINEERING DEPARTMENT - PRODUCTS AND SERVICES
Abstract: This document describes products and services of the Power Engineering Department of Energotest Gliwice. There are static excitation systems, automatic voltage regulators, excitation and starting systems for synchronous and synchronized asynchronous motors, start-up system for slip-ring induction motors, excitation, start-up and speed control system for large DC motors, digital voltage regulator for tap transformers, power diode and thyristor rectifiers, and industrial control systems.

Józef Dwojak, Ireneusz Struzik
PGE Elektrownia OPOLE S.A., Opole

EXPLOATIONAL DIAGNOSTICS OF ELECTRIC MOTORS BASED ON THE AUTHORS OWN EXPERIMENTS

Abstract: The paper’s aim is to explain that the exploitative diagnosis of electric engines is the least expensive method of exploitation. The authors will give specific examples of solutions to major technical problems of the machines’ drives in the electric plant, from the moment they were put into operation. The record of their work, wear degree, etc. is registered. Over 20 years of experience in the assessment of the dynamic electric engines, allowed the authors to advance a conclusion that the majority of engines’ damage is mechanical in nature, and is caused by the improper conditions of working (setting, drivers, shafts’ non-concentricity, clutch, fan’s imbalance, bearings). Therefore, it was concluded that during the study of exploitative electric engines in industrial conditions, the drive engine cannot be omitted. What is more, a person conducting diagnosis ought to know the structure and the dynamics of the whole unit. Based on the above examples of the solutions to specific problems resulting from the exploitation of machines’ drives, it can be stated that the proper handling, organization, flow of information and successive exploitative diagnostics of electric engines guarantees long-lasting and failure-free exploitation.

Kazimierz Kużaj, Jerzy Kolloch, Paweł Mościbroda, Witold Brzózka, Wojciech Rumiński
Polski Koncern Naftowy ORLEN S.A., Płock

BASIC ISSUES OF EXPLOITATION OF ELECTRICAL EQUIPMENT IN EXPLOSION-PROOF EXECUTION AND HAZARDOUS AREA DOCUMENTATION, ON EXAMPLE OF MAIN PRODUCTION UNIT OF PKN ORLEN S.A., PŁOCKU

Abstract: Effective resolving issues met in exploitation of electrical equipment in explosion-proof execution is one of the most important items in maintenance process. This paper presents basic questions of exploitation of electrical equipment in explosion-proof execution in collation with some aspects of hazardous area documentation. Based on experiences obtained during the implementation Directives of European Parliament and the Council, mainly ATEX 137 in correlation with ATEX 95, WEEE and their transposition into polish law rules, the paper describes selected concerns of electrical equipment accessibility or some questions of detailed engineering, erection, installation and commissioning processes in interaction with maintenance process, expressed on example of the Main Production Unit of PKN ORLEN S.A., located in Plock. Correlated with
mentioned directives, selected technical standards published by Polish Committee for Standardization are the background to present the effects, in aspects of maintenance of electrical equipment in explosion-proof execution, business effectiveness and care for safe, unpolluted environment.

Wojciech Kandora
TurboCare Poland S.A., Lubliniec

WYSOKONAPIĘCIOWA METODA IMPULSOWA OCENĄ STANU IZOLACJI ZWOJOWEJ MASZYN WIRUJĄCYCH

HIGH VOLTAGE IMPULSE METHOD FOR DIAGNOSTIC OF ROTATING MACHINES TURN TO TURN INSULATION

Abstract: The paper presents high voltage insulation method for testing turn to turn insulation. Paper contain surge test theory and describes comparative character of this method. In the article has been presented test result from stators with damage turn to turn insulation as well from high voltage motors. The paper describes influence of the tester storage capacitor capacitance on the test results, base on turbo generator rotor tests.

Tadeusz Glinka, Artur Polak
BOBRME Komel, Katowice

MONITOROWANIE STANU TECHNICZNEGO UKŁADU IZOLACYJNEGO GENERATORÓW SYNCHRONICZNYCH

THE CONDITION OF SYNCHRONOUS GENERATOR INSULATION SYSTEM MONITORING

Abstract: High power synchronous generators (turbo and hydro generators) are very expensive electrical machines. The manufacturer must be sure that his product will not be failure during warranty period. The user wants to operate with minimized costs of maintenances and repairs. Tests of insulation should be satisfied for the manufacturer and the user. The article refers to range of diagnostic tests of generators insulation by “Ramowa Instrukcja Eksplatacji Generatorów Sychronicznych” published by one of the firm making tests of electrical machines in energetic.

Adam Decner, Artur Polak
BOBRME Komel, Katowice

KRYTERIA OCENY STANU TECHNICZNEGO IZOLACJI ZWOJOWEJ METODĄ ROZMYТЕJ FALI NAPIĘCIOWEJ

WEAR ESTIMATION CRITERIA OF TURN TO TURN INSULATION WITH FUZZY VOLTAGE WAVE METHOD

Abstract: Condition diagnostic of turn-to-turn insulation, using the method of fuzzy wave is based on breaking the passage of current in the circuit with tested coil or winding what generate a voltage wave. This voltage is exactly the same on each turn. The frequency of generated voltage depends solely on the parameters of the winding, not on the supply and parameters of insulation, what is described in [1] and [3]. Described method is a supplement of diagnostic method of main insulation with DC voltage, named method of prof. Glinka.
IGNACY MOŚCICKI (1867 - 1946) CHEMIK CZY ELEKTRYK?

IGNACY MOŚCICKI (1867-1946) - CHEMIST OR ELECTRICIAN?

Abstract: The paper presents the curriculum vitae of Ignacy Moscicki, starting with his education in high school in Plock and chemical studies at the Technical University in Riga. It briefly presents his revolutionary activities in the country and the necessity of his departure to London. His stay in Switzerland at the University of Freiburg is also described. There, in 1901, he began his research on the acquisition of nitrogen from the air. He discovered that the intensity of obtaining the product increases in the arc of high voltage and high frequency. These studies led to the necessity of building a high-voltage installations which had never been constructed before. In this area he also showed his inventiveness, as well as his skills as a constructor and technologist (Moscicki capacitors), he also proved to be a talented businessman. He would eventually become a wealthy man with great scientific authority. In 1912 he was invited to take the chair at the State Polytechnic University of Lvov. His reasons and motivation that led to leaving Switzerland and moving to Lvov are presented. The paper also describes his activities in the domestic industry, which began during the First World War, and which greatly expanded (Chorzow, Moscice etc.) after Poland regained independence. A list of his most important publications and patents is attached.

Andrzej Bytnar, Instytut Energetyki, Warszawa
Adam Biernat, Wojciech Urbański, Politechnika Warszawska, Warszawa

WYBRANE PROBLEMY KONSTRUKCYJNE I TECHNOLOGICZNE W MASZYNACH ELEKTRYCZNYCH W ASPEKCIE DIAGNOSTYKI

SELECTED PROBLEMS OF ELECTRICAL MACHINES’ CONSTRUCTION AND TECHNOLOGY: THE ASPECT OF DIAGNOSTICS

Abstract: The article is a summary of dozen-year experience of workers researching at Institute of Electrical Machines of Warsaw University of Technology and at Institute of Power Engineering. The professional experience has been related to technical diagnosis of engines, generators and energetic transformers. The authors form postulates to constructors and electrical machine creators. The aim of these statements is to prepare the devices suitably to be able to conduct efficient diagnostics offline as well as online. Even though the diagnostics has been taken into consideration what has succeeded in an improvement, services of motion maintenance and technical supervision have still been encountering numerous problems connected with receiving signals needed in the process of creating the right diagnosis. Crucial difficulties appear every time when the examined machine junctions are tried to be reached or appropriate sensors are installed, etc. The analysis has been done with the connection of types of signals listed below: vibration, electromagnetic, thermal.
MAINTENANCE AND DIAGNOSTIC OF ELECTRIC MACHINES IN CEMENT INDUSTRY

Abstrakt: This short document describes represents question about maintenance and diagnostic of electric drive system. Industrial plant which they work in continuous system they require different way of repairs. Preventive working are important element in work of plant. Qualification of technical state of machines lies out the directions of repairs and observation. Every element of driving system should possess supervisory apparatus. Author represents his working for assurance of correct work of devices. The task of maintenance was introduced for online and offline.

DIAGNOSTYKA TRANSFORMATORA PIECO-KADZI PO USUNIĘCIU AWARII

DIAGNOSTICS OF A LADLE FURNACE TRANSFORMER AFTER DAMAGE REPAIR

Abstract: The paper presents results of diagnostic tests of a ladle furnace transformer conducted after damage repair, before putting the ladle to operation. In the tests, the waveforms of voltages and currents were recorded digitally on the primary and secondary side of the transformer in no-load as well as in under-load state. Additional temperature measurements of the transformer casing during its operation, conducted with an infrared camera, are also presented. The recorded data were numerically processed. The results made it possible to assess condition of the transformer components (core, windings and casing), indicate hazards and formulate operation recommendations.

CZUJNIKI I PRZYRZĄDY DO POMIARÓW WYŁADOWAŃ NIEZUPEŁNYCH MASZYN ELEKTRYCZNYCH

DETECTORS AND DEVICES FOR MEASUREMENTS OF PARTIAL DISCHARGES IN ELECTRIC MACHINES

Abstract: Operation of electric machines is accompanied by partial discharges. Partial discharges have a very complex nature. Together with progressing use of machines, there is a change in the intensity of partial discharges with typical phase-resolved distributions. The diagnostics can be carried out using available partial charge detectors, in particular based on factory Pt100 thermoresistors equipped additionally in antenna assemblies. The author’s solutions regarding detectors for measurements of partial discharges in electric machines in industrial conditions have proved to be successful. Results of measurements of partial discharges in motors depend on: the condition of their insulation, motor load, temperature of windings, humidity, level of external interference, and characteristics of partial discharge detectors and partial discharge analysing devices.
USE OF THE CORRELATION FUNCTION IN ON-LINE MEASUREMENTS OF PARTIAL DISCHARGES OF ELECTRIC MOTORS

Abstract: Partial discharges accompanying operation of electric motors have a very complex nature. On-line measurements require specialist partial discharge detectors and partial discharge analysing devices. The analysis of signals for diagnostic purposes should be conducted taking into account phase-resolved distributions and mutual correlations between partial discharges and load, temperature and humidity. Together with progressing use of motors, there is a change in the intensity of partial discharges with typical phase-resolved distributions and typical types of correlations. The paper presents results of measurements of partial discharges in industrial motors, including the correlation function, in particular the Pearson’s linear correlation coefficient for parameters of partial discharges as well as load, temperature and humidity. Further research in this respect is necessary.

Włodzimierz Koczara, Zbigniew Szulc, Politechnika Warszawska, Warszawa
Tomasz Kubera, PKN Orlen, Płock

THE RULES OF DRIVE SYSTEM'S SELECTION WITH MEDIUM VOLTAGE’S FREQUENCY CONVERTER AND INDUCTION CAGE MOTOR WITH NOMINAL PARAMETERS OF: POWER 3150 kW, VOLTAGE 6 kV, FREQUENCY 72,5 Hz FOR A WATER SUPPLY PUMPS

Abstract: In this paper, the criteria for the selection elements of the drive system water supply pump are presented. Currently, drive system with fluid coupling is used, which make a base for creating a new type of drive systems. Considered drive systems consists of squirrel-cage motor medium voltatge and medium voltage inverter. The selection was dependent on qualitative and quantitative criteria, which describe technical, operating and economic properties. There were described three types of drive systems with medium voltatge inverter. Moreover, application of new drive system with fluid coupling VORECON was considered. Based on characteristics of selected pump and predicted working point, calculated power input of drive systems, energy efficiency and distortion factor of input current. Obtained results allowed to quantify of mentioned drive systems. Further evaluation could be made based on propertis of drive system not inclued in this study. Presented method of drive system selection could be useful in practice design.

Adam Pozowski, Siemens, Katowice
Henryk Krawiec, Akademia Górniczo-Hutnicza, Kraków
INFLUENCE OF DIFFERENT TYPE OF OUTPUT FILTER FOR FREQUENCY CONVERTERS ON OPERATION OF INDUCTION SQUIRREL CAGE MOTORS

Abstract: The article describes matching of frequency converters and fed from it induction squirrel cage motors in scope of different shapes of voltage and current generated for different types of output filter for converters and different motor constructions. The article includes both theoretical aspects of this issue and describes experiences of motors exploitation in different branches of the industry.

Andrzej Jedut, Marek Stańczyk
PGE Elektrociepłownia Lublin-Wrotków Sp. z o.o., Lublin

RESULTS ESTIMATION OF THE CIRCULATING WATER PUMPING STATION’S MODERNIZATION AT THE PGE LUBLIN WROTKOW COMBINED HEAT & POWER PLANT

Abstract: The article contains general information about the modernization process of the circulating water pumping station at the PGE Lublin-Wrotków CHP Plant, in which the most important part was the modernization of the PWS6 pump drive, finished in December 2007. The two-year long operation of the modernized pumping station let us estimate the achieved savings in electricity consumption, just as the financial and environmental effects. The achieved results were estimated in comparison to the values which were supposed before the ultimate decision of the modernization.

Andrzej Rusek, Andrzej Popenda, Janusz Flasza
Politechnika Częstochowska, Częstochowa
Piotr Dziubałtowski, ZM Elektro Sp. z o.o., Katowice

SELECTION OF PARAMETERS FOR NEW PUMPS IN MATCH MODERNIZED SYSTEM IN THE EC TYCHY LTD.

Abstract: The paper presents a methodology for the selection of the parameters of the drive pumps in EC TYCHY SA. Are presented on selected aspects of a series of tests and comparisons designed to reduce electricity consumption on own account and allow the reimbursement of costs for a period not exceeding 48 months.

Adam Bartoszek, Du Pont Polska, Warszawa
Roland Menzel, Du Pont de Nemours, Deutschland GmbH
Steven Lee, Du Pont R&D and Management Co. Ltd, Korea Południowa

PRÓBY STARZENIA MATERIAŁÓW IZOLACYJNYCH DLA SILNIKÓW ZASILANYCH Z FAŁOWNIKA
MOTORETTE AGING TEST FOR INSULATION MATERIALS OF INVERTER-FED MOTORS

Abstrakt: Inverter Driven Motors (IDM) with high speed switching and advanced Pulse Width Modulation (PWM) techniques have been widely used for variable speed applications. Adjustable Speed Drives (ASD) with high speed switching devices provide very accurate control of speed and torque to a system. However, ASD give electrical stress such as high peak voltage, fast rate of voltage change (dV/dt) and extremely high carrier frequency to the insulation materials of a motor. The degradation of electrical insulation used in Inverter Driven Motors can lead to premature failure of motors sometimes days or months after startup. This paper presents the evaluation process of insulating materials used for IDM. Thermal aging tests were carried out on motorettes with enameled wires, impregnating resin and different insulating materials. Partial Discharge Inception Voltage (PDIV) measurement and Diagnosis test, based on IEC 60034-18-41 TS, were conducted on the motorettes. It could be demonstrated that the PDIV of the motorette decreased during aging and was very much dependent on the types of insulating materials being used.

Roman Serafin, JSW S. A. KWK Budryk, Chorzów
Tadeusz Jędrus, Dariusz Macierzyński, ELGÓR+ HANSEN Sp. z o. o., Chorzów

ZASILANIE I STEROWANIE PRZENOŚNIKÓW TAŚMOWYCH W ZAKŁADACH GÓRNICZYCH WYDOBYWĄCYCH WĘGIEL KAMIENNY Z WYKORZYSTANIEM NOWEJ GENERACJI ŁĄCZNIKÓW

POWER SUPPLY AND CONTROL OF BELT CONVEYORS THAT USE NEW GENERATION OF SWITCHING EQUIPMENT AND ARE OPERATED AT MINING ENTERPRISES THAT DEAL WITH EXTRACTION OF HARD COAL

Abstract: This paper presents a new generation of thiristor-based starters of explosion-proof design along with operation experience gained by the Hard Coal Colliery ‘Budryk’ where such thiristor-based starters have been being applied to the haulage systems.

Kazimierz Gatnar, Grzegorz Kuś
Jastrzębska Spółka Węglowa S.A., Jastrzębie Zdrój

KOGENERACYJNE ZESPOŁY PRĄDOTWÓRCZE Z SILNIKAMI GAZOWYMI NA GAZ Z ODMETANOWANIA – PRACA GENERATORÓW W UKŁADACH ELEKTROENERGETYCZNYCH KOPALŃ JASTRZĘBSKIEJ SPÓŁKI WĘGŁOWEJ S.A.

COGENERATIVE GENERATOR SET WITH GAS ENGINE USING GAS FROM DEMETHANIZATION - OPERATION OF GENERATORS IN POWER SYSTEMS OF COAL MINES OF JSW S.A.

Abstract: The article presents basic information about Jastrzębska Spółka Węglowa S.A. (Jastrzębie Coal Mine Company) as well as investments connected with building up cogenerative generator sets with gas engines using gas from demethanization of coal mines. The detailed data of generator sets – with special attention to generators – that works in “Borynia”, “Budryk”, “Krupiński” and “Pniówek” coal mines as well as their location at medium voltage grid of the mines power systems were provided. Cooperation with medium voltage grid (active and passive energy), the amount and way of utilization of the produced electrical energy and the share in satisfying mines demand were discussed. The attempt was made to motive evaluate of generators.
work in regard of source of satisfying mines power demand, influence of power system on medium voltage grid work, supply station restoration as well as way of power removal from generator sets.

Jan Anuszczyk, Adam Wawrzyniak
Politechnika Łódzka, Łódź

NAPĘDY TRAKCYJNE Z SILNIKAMI SYNCHRONICZNYMI O MAGNESACH TRWAŁYCH W TRANSPORCIE SZYNOWYM

TRACTION DRIVE WITH PERMANENT MAGNET SYNCHRONOUS MOTORS IN RAILWAY TRANSPORTATION

Abstract: Permanent Magnet Synchronous Motors (PMSM), due to the simple structure and property are becoming more widely used in the traction drives. The paper contains a review of existing solutions ranging from mine engines, by trams, to high-speed trains. The domestic and foreign solutions has been analyzed. Additionally, the paper presents the results of research of PMSM drive conducted in the laboratory of Division of Transport and Energy Conversion, Technical University of Lodz. Mechanical and efficiency characteristics are the results of the researches.

Jerzy Podhajecki, Sławomir Szymaniec
Politechnika Opolska, Opole

WYZNACZANIE DRGAŃ WŁASNYCH WIRNIKA W BEZSZCZOTKOWYM SILNIKU PRĄDU STAŁEGO Z MAGNESAMI TRWAŁYMI

ROTOR NATURAL FREQUENCY DETERMINATION OF THE BRUSHLESS DIRECT CURRENT MOTOR WITH PERMANENT MAGNETS

Abstract: The Brushless Direct Current Motors with Permanent Magnets are become more and more popular in many uses because of high efficiency, the high ratio between electromagnetic torque to mass of the magnetic circuit and higher reliability. Their uses in high speed applications often for which the particularly important determination of natural frequencies of rotor due to possibility of damage machine.

The problem of determination of natural frequencies in article is presented for rotor for BLDC machine. Finite Element Program ANSYS was used to calculate natural frequencies of BLDC machine. In aim of qualification of influence selected parts of rotor (magnets, bearings, end shields) on natural frequencies of rotor numerical calculations were done for different models. Numerical results was compared with experimental results from Hammer test with good agreement.

Marek Trajdos, Jarosław Małkiewicz
Partner Serwis Sp. z o.o., Łódź, Kwidzyn

KOMPLEKSOWE UTRZYMANIE RUCHU OSI NAPĘDU ELEKTRYCZNEGO W WARUNKACH PRZEMYSŁOWYCH - ZASADY I MODEL

TOTAL ELECTRICAL DRIVE MANAGEMENT UNDER INDUSTRIAL CONDITIONS – PRINCIPLES AND MODEL

Abstract: This short document describes the principle and the model of the modern strategy of the management which the complex management of dependability of the driving axis is.
The attention was paid in the work to ways and advantages resulting from emission of the service of driving axises to the service through the external firm. They are this advantage both dependability (the accessibility of driving axises), how and fuel-efficient. The notion of the cycle of the life of the article which in this incident the electric drive is about the regulated rotational speed was considered in model.

Zbigniew Hilary Žurek, Politechnika Śląska, Gliwice
Mariusz Śladowski, BOBRME Komel, Katowice

Abstract: In the paper it is shown that material’s magnetic parameters largely depends on mechanical stresses. The paper discusses these problem and the example of frame of electrical motor and the stator sheet is given. The stress from the interference joint between frame and stator sheet influence on parameters of electric motor.