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ELECTRIC ENGINES DIAGNOSTICS AFTER IMPEDANCE ANALYZING

ABSTRACT *There is proposed to estimate the engine state after it's impedance parameter measuring results obtaining. The vague pole engine replacement scheme and the measuring procedure are analyzed. The measuring parameters deviations from the corresponding parameters of the basic engine-models contain the information about the engine characteristics behavior. It makes possible to forecast the intensive working in harmony on-the-fly.*

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1. INTRODUCTION

The engines of different types (evident pole, vague pole, jet) – are objects with definite resource of working mill. At first separate elements and knots work in harmony gradually during all period of their operation, and then the period of "intensive working in harmony" of engine comes on the whole [1]. It causes mainly sudden worsening as technical, so and economic indices of engines. Such objects become exponents of dangerous situations and technogenic disasters in many cases. Traditional means of diagnosing not always are able to find out various defects in materials, constructive changes in the process of work timely and so on, and so forth, that makes prevision of regimen's deepening of engine intensive working in harmony impossible. Distinguishing of control means don't allow put into practice complex valuation of control object mill and means themselves because of their high cost and small quantity are not enough available for customer at the same time. That's why the search of the new ways of control development means of electric engine's parameters with taking into account mentioned above is actual task nowadays.

2. SETTING OF THE TASK

One of the directions of the construction means for electric engines diagnosing can be control of electric models parameters, with the help of which electric engines for engineering calculations are given in author's view [2]. The general method of construction such schemes of electric engine replacement for different regimens its work is engine equation analysis that contains complex variables. The models are two-poles with many elements of inductive character mainly. Each of the elements such two-poles contains information about definite engine character. Among known schemes of engine replacement are known as very complicated, and also essentially simplified. It is caused by different approaches concerning their construction.

Let's examine the scheme of replacement, which is used in the practice of engineering calculations with using of single approach to the analysis of synchronous vague pole engine's work (Fig. 1) [3].

As was mentioned, each of the elements of the replacement scheme (Fig. 1) reflects corresponding character of engine, specifically: R_1 and L_1 – – active resistance and induction of winding, correspondingly; R_2 -– resistance

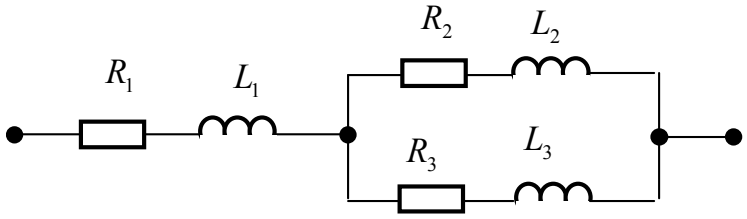

Fig. 1. The replacement scheme of synchronous vague pole electric engine

that characterize losses in the constant; L_2 – induction that determine current of no-load running course; R_3 – active resistance that depends on loading; L_3 - induction that determine invariable inductive resistance, which is proportional to the inductive resistance of the armature reaction in the longitudinal axle.

Let's analyze from the theoretical and practical point of view one from the possible variants of means construction for diagnosing the mill of electric engine with using measuring parameters of impedance of the two-pole which has a lot of elements.

3. THEORETICAL REALIZATION OF MEASUREMENTS

For determination of the parameters of much measuring control object is reasonably to use the known method of parameter's measurement of two-poles, which have many elements, namely: measurement constituents of many-pole impedance in the fixed frequencies. It decreases quantity of frequencies twice from quantity of measured parameters as is generally known.

In our case, the impedance of two-pole which has many elements (Fig. 1) in the frequency w is described by expression

$$Z = R_1 + j\omega L_1 + \frac{(R_2 + j\omega L_2)(R_3 + j\omega L_3)}{R_2 + R_3 + j\omega L_2 + j\omega L_3} \quad (1)$$

From which after simple mathematical operations with complex quantities we will distinguish active $\mathrm{Re}(Z)$ and reactive $\mathrm{Im}(Z)$ constituents, namely:

$$\mathrm{Re}(Z)=\frac{R_2R_3(R_2+R_3)+R_1(R_2+R_3)^2+\omega^2R_1(L_2+L_3)^2+\omega^2L_2^2R_3+\omega^2L_3^2R_2}{(R_2+R_3)^2+\omega^2(L_2+L_3)^2} \quad (2)$$

$$\mathrm{Im}(Z)=\frac{(R_2+R_3)(R_2L_3+R_3L_2)+(L_2+L_3)(\omega^2L_2L_3-R_2R_3)+L_1(R_2+R_3)^2+\omega L_1R_3(L_2+L_3)^2}{(R_2+R_3)^2+\omega^2(L_2+L_3)^2} \quad (3)$$

So, having measured active $\mathrm{Re}(Z)_{\omega_1}$, $\mathrm{Re}(Z)_{\omega 2}$, $\mathrm{Re}(Z)_{\omega_3}$ and reactive $\mathrm{Im}(Z)_{\omega_1}$, $\mathrm{Im}(Z)_{\omega_2}$, $\mathrm{Im}(Z)_{\omega 3}$ constituents of impedance in the fixed frequencies ω_1, ω_2 and ω_3 we will have six equations with six unknown quantities. Common solution of the received equations gives the meaning of the parameters R_1, R_2, R_3, L_1, L_2, L_3.

4. TECHNICAL REALIZATION OF MEASUREMENTS

Structural scheme of measuring means of the impedance parameters that realizes the method of direct transformation “impedance-tension” represented in the Fig. 2.

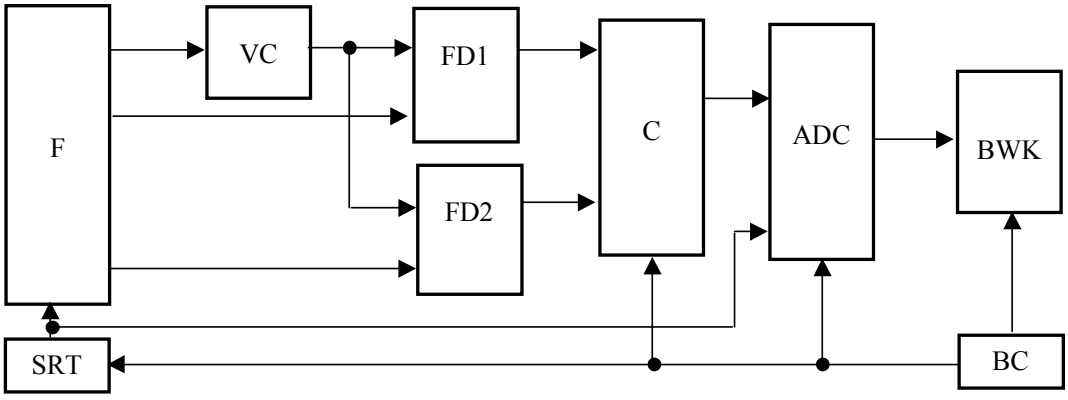

Fig. 2. Structural scheme of impedance parameters measurer of the two-pole that has many elements

The structure contains former F, source of resistant tension SRT, vector converter VC, phase-sensitive detectors FD1, FD2, switch C, analog-to-digital converter ADC, block of working up results BWR and block of control BC. The

converter F forms test signal of sine wave tension of definite level and three fixed frequencies for present case of measurement, and also signals of control FD1 and FD2 (in-phase component and quadrature component with test signal).

VC puts into practice transformation of two-pole impedance into complex tension, active and reactive constituents of which are proportional to corresponding impedance constituents:

$$\dot{U}_x = aU_m\left[\mathrm{Re}(Z) + \mathrm{Im}(Z)\right]$$

where a - factor of transformation VC; U_m – amplitude of test signal.

With the help of FD1 from the complex tension distinguishes active $\mathrm{Re}(Z)$, and with the help of FD2 – reactive $\mathrm{Im}(Z)$ constituents of complex tension $\dot{U}_x$. Through the switch on the information input ADC are given target tensions of detectors in the every frequency, and on the resistant input – tension of the resistant source of tension. With the help of it is provided invariance of result to amplitude meaning of test signal. BWR works up the results of ADC replacement:

$$N_1' = F\left[Re(Z)_{\omega_1}\right];\ N_2' = F\left[\mathrm{Re}(Z)_{\omega_2}\right];\ N_3' = F\left[\mathrm{Re}(Z)_{\omega_3}\right]$$

$$N_1'' = F\left[\mathrm{Re}(Z)_{\omega_1}\right];\ N_2'' = F\left[\mathrm{Re}(Z)_{\omega_1}\right];\ N_3'' = F\left[\mathrm{Re}(Z)_{\omega_1}\right]$$

BC controls the work of device and synchronize its work for given program.

5. CONCLUSIONS

For appreciation of engine quality by differential method that is used in quality control it is necessary to measure the mentioned parameters of two-pole that has many elements and compare their meanings with corresponding meanings of basic sample. In given case is suggested as indices of basic sample to use the results of measuring the elements of engine replacement scheme to operation. It is necessary to measure the same parameters this engine after putting into operation in definite intervals of time.

We can appreciate deflection of electric parameters by comparisons of measurement current results with basic.

We can appreciate the period during which the engine can work in secure regimen by absolute changes of the indices relation and known tendency or character of such changes in a relation to the corresponding engine characters.

That is why, we can foresee the mill of control object by results of measuring parameters of impedance of two-pole that has many elements.

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DIAGNOSTYKA SILNIKÓW ELEKTRYCZNYCH NA PODSTAWIE WYNIKÓW POMIARÓW IMPEDANCJI

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Jewhen POCHODYLO

STRESZCZENIE *W artykule omówiono ocenę stanu silnika na podstawie wyników pomiaru impedancji. Przeanalizowano schemat zastępczy niejawnobiegunowego silnika oraz metody pomiarowe. Odchylenia zmierzonych parametrów od odpowiadających im parametrów podstawowych modeli silnika zawierają informację o przebiegach charakterystyk silnika. W oparciu o omawianą metodę możliwe jest możliwe prognozowanie obciążeń silników*.

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