Research report

Theme:
Investigation of the influence of quasicrystalline Al Cu Fe powder on the operating characteristics of the reducer 1ts2u-160

Base:
Decision of the working meeting of representatives of BPD PJSC Inter RAO, LLC CCT “Energy without Borders” on the need to confirm the potential economic effect for Inter RAO Group from the introduction of new generation plastic additives to lubricants

Place of work:
Pilot production of LLC "CCT" Energy without Borders "on the territory of the Kostroma State District Power Plant

Purpose of the study:
Assessment of the positive effect of the introduction of a quasicrystal into the lubricant composition of the most common gearboxes in the Inter RAO Group

Tasks:
Test bench creation
Production of a laboratory batch of a quasicrystal
Creation of repair plastic composition
Determination of the nominal characteristics of the stand
Determination of the characteristics of the stand after the introduction of the repair plastic composition Analysis of the results
Determination of the purpose and objectives of subsequent research

Test bench composition:
The test bench consists of a 1ts2u-160 gearbox and an AIR80V4 electric motor (1.5 kW, 1500 rpm), mounted on a common frame. To create a continuous cantilever load of 1000N (maximum permissible), a lever clamp is installed on the bed, transmitting the force to the driven shaft through the brake shoe and the flywheel.

Control devices:
Household weather station Avidsen - control of the ambient temperature and oil in the gearbox housing with an accuracy of 0.1 ° C.
Sound level meter RFE-EM 882 - noise control with an accuracy of 0.1 dB
FLUKE 365 current clamp for measuring electrical load with an accuracy of 0.01 A. Voltmeter for measuring the voltage at the terminals of an electric motor with an accuracy of 1 V. Electronic scales QC-Pass 500 for weighing a quasicrystal with an accuracy of 0.1 g.

Production of a laboratory batch of a quasicrystal
A laboratory batch of a quasicrystal of the Al-Cu-Fe system with a fraction of up to 100 microns was prepared and submitted for testing. The weight of the laboratory batch was 98 g.

Creation of repair plastic composition
The repair plastic composition was obtained by introducing a quasicrystal into industrial grade oil I-40A (specific gravity 8.83 g / cm3 at a temperature of 20 ° C). The weight of the quasicrystal introduced into the repair compound is 32.6 g, which corresponds to 1% of the total weight of the oil in the gearbox.

Determination of the nominal characteristics of the stand

The voltage at the terminals of the electric motor was monitored at each measurement. The voltage magnitude was constant and was 400 V between all phases.
The ambient temperature during the testing period changed insignificantly and ranged from 9.5 to 14.3 ° C.
Other controlled parameters and their values, taken as the initial data for the study, are presented in Table 1.

Table 1 - Initial data

	Idling	Work under load
T oil, ºC	12,3	23,1
Noisiness, dB	97,0	100,3
Load, A	5,0	5,55

Determination of the characteristics of the stand after the introduction of the repair plastic compositionThe values of the controlled parameters obtained as a result of three-fold repetition of the experiment are presented in Tables 2, 3 and 4.

Table 2 - Results of experiment 1

	Idling	Work under load
T oil, ºC	12,3	19,0
Noisiness, dB	97,0	97,0
Load, A	4,88	5,1

Table 3 - Results of experiment 2

	Idling	Work under load
T oil, ºC	18,0	21,5
Noisiness, dB	97,0	97,0
Load, A	4,88	5,0

Table 4 - Results of experiment 3

	Idling	Work under load
T oil, ºC	26,2	26,3
Noisiness, dB	97	97,0
Load, A	4,88	4,88

Additional research
The contact surface area between the flywheel and the brake shoe increased with time, which created a variable load on the driven shaft of the gearbox. To eliminate the load from the friction of the flywheel on the surface of the shoe, I-40A oil was fed directly onto it. Additional studies were carried out to determine the effect of the cantilever load on the performance characteristics of the 1ts2u-160 gearbox, the results are shown in Table 5.

Table 5 - Results of additional studies

	Full load operation	Cantilever Load Operation
T oil, ºC	27,3	26,5
Noisiness, dB	97	97
Load, A	6,0	4,9

Analysis of results

As a result of a study of the performance characteristics of the gearbox 1ts2u-160 after the introduction of a quasicrystal of the Al-Cu-Fe system in the amount of 1% by weight into its lubricant, it was found that:

1. The change in the temperature of the oil in the gearbox occurs mainly due to its heating from the heat generated at the point of contact between the flywheel and the brake shoe. Therefore, the change in oil temperature cannot be regarded as a quality parameter.
2. Within 30 minutes, the noise level decreased by 3%. Subsequently, the noise level did not increase. However, a decrease in noise can be caused by an increase in the viscosity of the oil as a result of the introduction of a quasicrystal into its composition. The change in oil viscosity has not been quantified.
3. The power consumption of the stand, operating without load, did not change after the introduction of a quasicrystal into the oil.
4. The power consumption of the stand operating under load during 2 hours decreased by 8%, and during the next 6 hours by 4% more. Thus, during one work shift, energy consumption has decreased by 12%.

Determination of the purpose and objectives of subsequent research

Target:

Investigation of the positive effect of the use of quasicrystals in the lubrication system of the gearboxes of auxiliary equipment most common in the Inter RAO Group.

Tasks:

Development of technical requirements for the research stand and its design documentation.

Development of a list of controlled parameters, purchase of instrumentation and automation.

Purchase of components, installation of a research stand.

Development of laboratory methods for testing repair compositions.

Testing: Determination of the numerical values of the operating parameters of the tested gearboxes and the investigated repair compositions.

Development of a list of technological equipment for the production site of repair compositions for gearboxes of generation facilities.

Economic evaluation of the production of repair compounds.

Assessment of the economic effect for Inter RAO Group from the use of quasicrystals in lubrication systems.