

# Research of Self-Contained Induction Generator Characteristics During Direct Current Consumers Supply

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**Abstract** The operating conditions of the induction generator – capacitor bank – rectifier load system have been researched. A harmonic analysis has been performed for currents and voltages of a self-contained induction generator with capacitor excitation when direct current consumers are connected to it. It has been demonstrated that the evaluation of the overload capacity of a self-contained power supply with an induction generator operating for a direct current consumer is to be made on the basis of the balance of active and reactive powers of all the electromechanical system elements.

**Keywords** Induction generator, rectifier, DC motor, nonlinear model simulations, power system harmonics.

## I. INTRODUCTION

Low-power electric power plants can make up for the absence of centralized power supply under the condition of energy instability, also in remote and economically undeveloped areas. Self-excited induction generators (SEIG) are widely used in small wind-power- and hydroelectric stations [1]-[3], in individual power supply systems and domestic heating as a power supply.

The analysis [1]-[3] demonstrated that problems of researching power processes in the systems of self-contained power supply (SPS) with SEIG at direct current consumers supply are insufficiently investigated. In this case SEIG operates for a frequency converter (FC) or a rectifier (RC).

Taking the above said into consideration, the paper is aimed at the research of physical phenomena in SEIG – RC – consumer system by means of the analysis of energy conversion processes in all the SPS elements, using mathematical modeling.

## II. THEORETICAL RESEARCH

SEIG – RC electromechanical system properties study, choice of the algorithm of SEIG output parameters (generated voltage amplitude and frequency) control determine the necessity of creating a mathematical model of a system adequately reflecting electromagnetic and electromechanical processes.

An electric balance equation for all the circuits and a rotor motion equation were formulated for description transient processes in SEIG. SEIG itself is presented by a system of magnetically connected windings situated on the stator and rotor. Switching functions method was used to create RC model.

Direct current consumers were presented as mathematical models of actively inductive load and direct current motor (DCM).

Transient processes in the system were analyzed by means of computer modeling in MATLAB application package.

It has been determined that the start is possible when a certain relation between generator power  $P_{AG}$  and motive load power  $P_{DCM}$  is observed:

$$P_{DCM} / P_{AG} = 0.35 \div 0.4. \quad (1)$$

If static-load consumers (lighting units, ovens, etc.) are

connected, this relation increases to:

$$P_c / P_{AG} \leq 0.5 \div 0.6 \quad (2)$$

where  $P_c$  – power of static-load consumers.

## III. EXPERIMENTAL RESEARCH

An experimental laboratory complex researching SPS with SEIG has been created to confirm the obtained results and verify the adequacy of the developed mathematical model. Short circuit induction motors (SCIM) of type AIR120A4, 1.2 kW, were used as a generator. The capacity of excitation capacitors for each SEIG phase was  $C = 30 \mu\text{F}$ . The installation provides the possibility of connecting the following to SEIG:

active load – lighting units of various power;  
motive load – SCIM1 and SCIM2 with an active and a fan-type, respectively, moments of load on the shaft;  
rectifying load – lighting units of various power and a resistor with variable resistance, which are connected through RC.

When the research was carried out, there was a possibility to regulate the generator rotor rotation speed, to change parameters and connection scheme (star- or triangle-form) of excitation capacitors.

A comparison of mathematical modeling results and experimental researches showed that relative error does not exceed 6%, which certifies the adequacy of the offered SEIG – RC system mathematical model.

## IV. CONCLUSION

The limits of steady operation of a self-contained induction generator providing direct current consumers have been determined. It has been proved that an uncontrolled rectifier is an active capacity load for an induction generator, which contributes to the rigidity of its external characteristic and overload capacity.

## REFERENCES

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