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Experimental Model for the Operation Improvement of the Revolving Excitation Assembly for the Syncronous Motors of 5100 and 4650 kW

By this study we aim the achievement of a reliable constructive model of revolving excitation assembly which should ensure the start in good conditions of the compressors.

Key words: *synchronous motor, revolving excitation, reactive power, power factor, exciter.*

1. Introduction

The choice of the excitation system is done according to the concrete operation conditions of the syncronous motor in different services imposed by the technologic process.

This is why, some researches are required regarding the size of real solicitation which appear in the most unfavourable starting conditions and in the same time researches regarding the improvement of the electric scheme of the rotoric winding connection of the synchronous motor at the rectified voltage supplied by the assembly of revolving excitation.

In figure 1, we present the main services of the syncronous motor operation.

Regime I has a short duration (0,02 - 0,04)sec and it corresponds to the supertransitory processes of direct connection to the network. The stator current in this regime has the character of shock current and it can reach (10 – 15)In.

Regime II refers to **the operation in asynchronous short-circuit** during the acceleration of the motor up to the nominal revolutions. During the start (2-3)sec, the stator current remains at a value of (4 – 5)In. In this regime in the stator winding we will induce an alternating voltage whose value depends on the value of the start resistance.

Regime III refers to the asynchronous, unexcited empty running. The input current of this regime is around the nominal value.

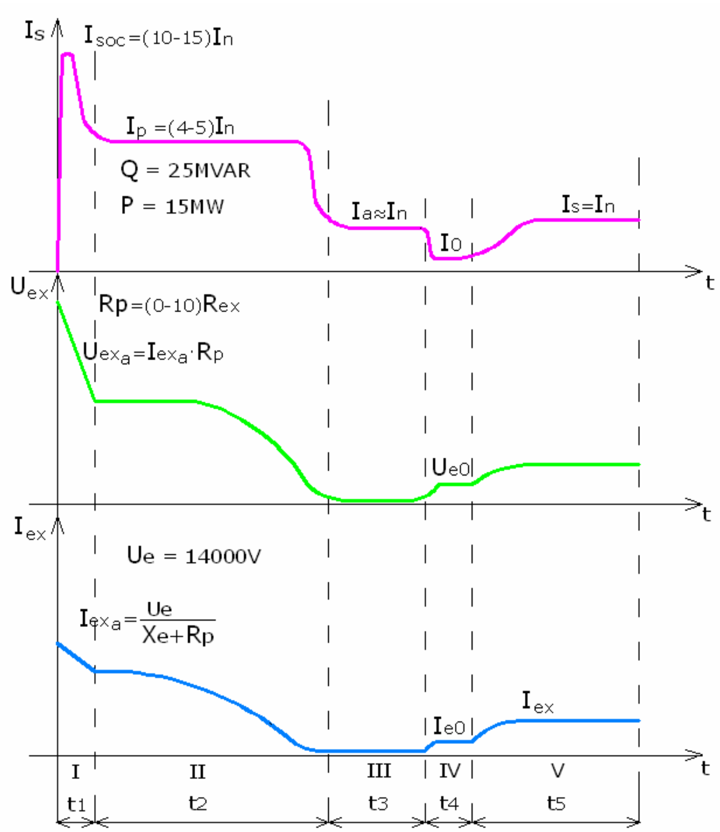

Figure 1. The main operation services of the synchronous motor

Regime IV is obtained the moment when the excitation current is introduced in the rotor winding of the synchronous motor obtaining the synchronization of the motor with the supply network. In this service, the stator current will drop to a minimal value corresponding to the effective output at the shaft.

Regime V corresponds to the loaded operation of the compressor. The excitation current will be modified according to the reactive power needed in the supply network, respectively according to the power factor which is required for the operation of the motor.

We notice the fact that in all the operation services it is required the monitoring of the excitation current and its keeping at the values imposed by the respective service.

In the first two services which correspond to the process of starting the motor, the value of the excitation current is null.

In this service, in the rotor winding an Ue electromotor alternating voltage is induced, which is very high, around 13000V.

This is why, the rotor winding must be protected during the starting process. The protection is achieved by means of the excitation installation.

Thus, the improvement of the excitation system supposes first of all the choice of the optimal starting scheme.

1. The experimental model

2.1.The proposed principle scheme for the experimental model

The proposed principle scheme for the experimental model is presented in figure 2.

The scheme of the revolving excitation assembly presents 3 component parts which are to be studied on the experimental model:

- The rectified force circuit formed of the diodes assembly D_1-D_6 ;
- Quenching force circuit composed of the controlled rectifier diodes T1-T2;
- Electronic control circuit of controlled rectifier diodes Mcc.

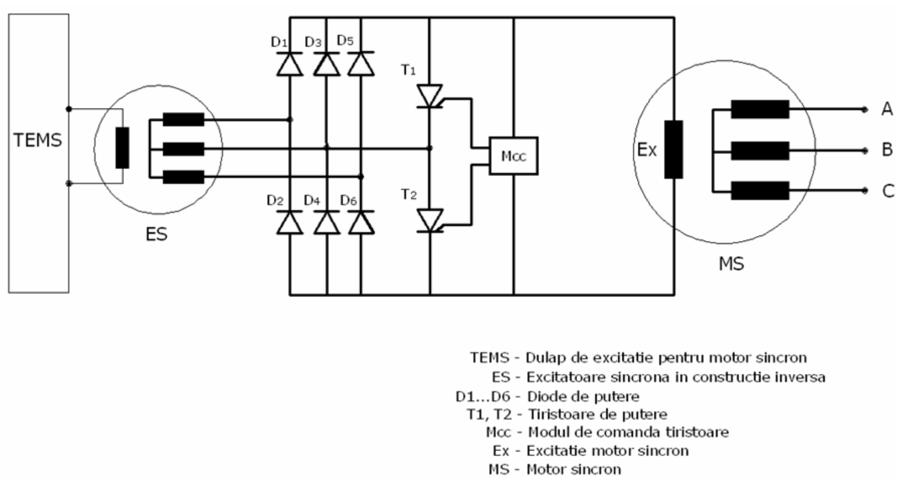

Figure 2. The principle scheme for the Experimental Model Revolving Assembly

The rectified assembly D_1-D_6 is connected in the circuit of alternating current of the synchronous generator ES which operates in drivers service.

The excitation winding of the synchronous generator is supplied from a continuous adjustable voltage source (CAVS) similar to those used for the synchronous motors at the Compressors Station Butimanu.

In this way there is the possibility of studying the electromagnetic services which appear on the occasion of transitory processes at the start in asynchronous service of the synchronous motors of compressors tripping.

The rectified tension of the assembly of revolving excitation is connected to the excitation winding of a synchronous motor SM.

Paralleled with the excitation winding we connect the quenching circuit built by 2 controlled rectifier diodes serial T1-T2, through the means of which we achieved putting in short-circuit the excitation winding.

The control of the conduction entrance of the controlled rectifier diodes T1-T2 respectively the control of their blocking is achieved through the agecy of the electronic block Mcc.

2.2. The electric operation scheme for the experimental model

The scheme of the control circuit of the controlled rectifier diodes is given in figure 3.

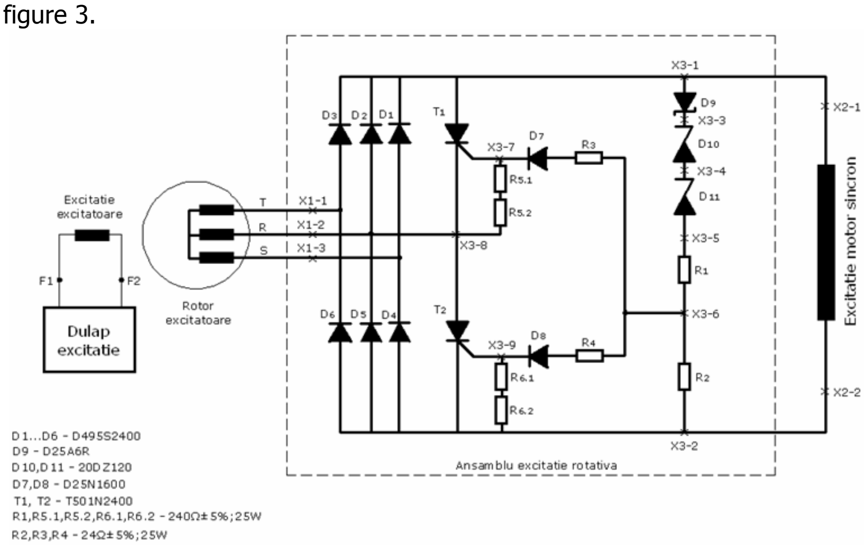

Figure 3. The electric scheme of the Experimental Model of the Revolving Assembly in the proposed variant

The direct start at network of the synchronous motor determines in the rotor winding an electromotor voltage alternatively induced which is applied on the diodes marked with the R_1 and R_2 resistances.

The moment when the electromotor voltage surpasses a certain value the controlled avalanche diode D_9 enters conduction and the Zener diodes D_{10},D_{11} , establish the voltage at a certain value corresponding to the voltage necessary for the operation of the control scheme.

By potentiometer mount the resistances R_3, R_{5-1}, R_{5-2} , respectively R_4, R_{6-1}, R_{6-2} , ensure a potential corresponding for the control grids of the controlled rectifier diodes T_1, T_2.

The electromotive voltage induced in the rotor reaches a maximal value of the controlled rectifier diodes T_1 and T_2 enter conduction, connecting the rotor winding in shortcircuit.

When the transitory service which characterises the start of the motor finishes, the electromotive voltage induced in the rotor winding is practically cancelled but the controlled rectifier diodes T_1, T_2 stay in conduction until the excitation current is established in the stator winding of the exciter.

The voltage induced in the rotor winding of the exciter is applied to the rectified bridge D_1, D_6 and in the same time the tension on the R phase determines the blocking of the controlled rectifier diodes T_1, T_2 which leads to the disconnection of the shortcircuit of the rotor winding.

In this way, the proposed scheme ensures the start of the synchronous motor in asynchronous service by shortcircuiting the winding of the excitation and the connection of the current supplied by the revolving synchronous exciter in the moment of the stop of the transitory process in asynchronous service.

We have to notice the fact that the electromagnetic process which takes place in the rotor winding of the exciter, respectively in the excitation winding of the synchronous motor depends on the position of the rotor against the stator respectively the angle between the axes of the windings in the stator and rotor.

The scheme adopted for the experimental model ensures the protection of both the rotor winding of the exciter and of the excitation winding of the synchronous motor.

3. Conclusions

Due to the fact that the synchronous motors can operate both in capacitive service and in inductive service we need a permanent control of the power factor aiming that the operation point should be in the superexcited area, with a capacitive power factor.

There are situations such as in the case of the synchronous motors of 4650KW and 5100KW in the compression station of natural gases in Butimanu when by their operation service we can influence the voltage on the supply rod of the station 110/6KV.

The excitation system being the main factor which determines the operation service of the synchronous motors, its improvement is a requirement which is imposed in order to obtain a good operation at minimum energetic costs.

This paper highlighted a constructivist solution which is to be adopted for the revolving excitation system with the purpose of improving the operation performances of this one in all the operation services.

In the same time, we need a design and achievement of a monitoring installation and control of the reactive powers afferent to the synchronous motors of 810KW, 4650KW, 5100KW and the asynchronous motors of 900KW.

In this way we create the possibility of maintaining under control the reactive power circulation, respectively the voltage on the shafts of 6KV, in the conditions of a minimum consumption of active power.

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