

## PARAMETERS OF THE SYNCHRONOUS GENERATOR AND THE FACTORS INFLUENCING THEM

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### Abstract:

Synchronous generators are one of the important electromechanical devices, and their normal operation can be influenced by certain factors. This article will analyze the operating modes of synchronous generator in Almalyk thermal power plant, important parameters and factors affecting them.

**Keywords:** thermal power plant, turbo generator, power factor, cooling air, overload, normal operation, apparent power.

### Introduction

For the generation of electricity in the world, mainly in all power plants, synchronous generators are used, and synchronous motors are used for electric drives with a constant speed [1].

A synchronous brushless excitation generator T-12-2Y3 is installed in the Almalyk MMC thermal power plant [2]. We will consider the operating modes and parameters of this generator

### Normal operating modes

The normal operation mode of the generator is such a mode in which the generator can operate for a long time with deviations of the main parameters (voltage and current, frequency, power factor, temperature and pressure of the cooling medium) from the nominal value within the limits permissible by state standards and technical requirements. These modes will be indicated in the factory instructions or in the generator data sheet. The operating mode of the generator at the nominal values indicated on the factory label and passport is called the nominal operating mode.

### Acceptable modes

The operating modes when the mains voltage deviates from the nominal value are shown in the table below.

**Table 1.** Changes in the total power of the synchronous generator, stator current and power factor at different voltage values

Voltage (from nominal), %	110	105	100	95
Apparent power (from nominal), %	90	100	100	100
Current of stator (from nominal), %	82	95	100	105
$\cos\varphi$	0,89	0,8	0,8	0,8

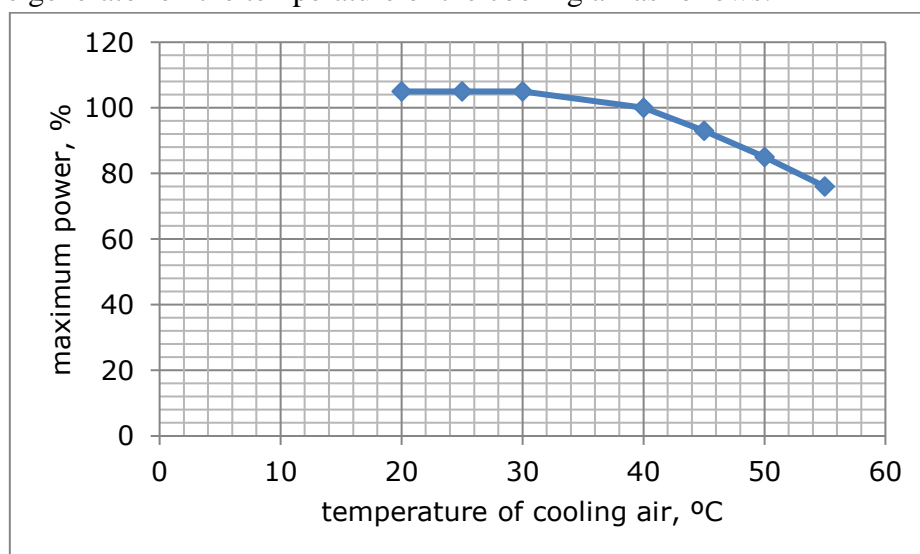
It cannot operate with a voltage greater than 110% of the rated voltage. The turbo generator retains its rated power when the AC frequency deviates from the nominal value by  $\pm 2.5\%$ . If the frequency of the alternating current deviates more than  $\pm 2.5\%$  from the nominal, the operation of the turbo generator is impossible. The turbo generator retains its rated power with simultaneous deviations of the AC frequency within  $\pm 2.5\%$  of the nominal and  $\pm 5\%$  of the output voltage. In this case, the sum of the absolute values of the excess voltage over the nominal value and the decrease in frequency over the nominal value should not exceed 6%.

Current of stator can be measured in non-contact method. Measurement of currents in a non-contact manner is divided into electromagnetic and remote in turn [3].

**Table 2.** The maximum power of the generator at different values of the cooling air temperature

The temperature of the incoming air, °C	55	50	45	40	30...20
Maximum power, % ( $\cos\varphi=0,8$ )	76	85	93	100	105

Based on the data in Table 2, it is possible to graphically express the dependence of the total power of the generator on the temperature of the cooling air as follows:



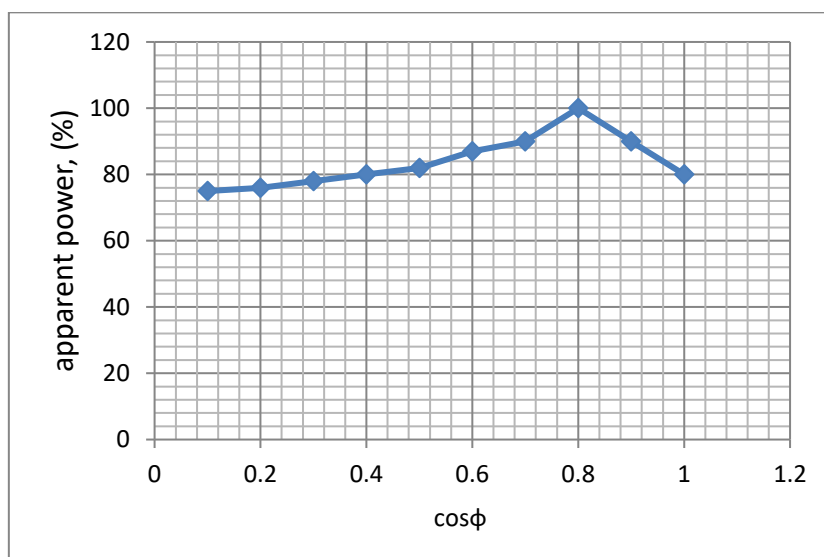
**Figure 1.** Dependence of the apparent power of the generator on the temperature of the cooling air

The lower limit of the cooling air temperature should not be less than 20 °C.

Operation with  $\cos\varphi$  less than the nominal value is allowed provided that the rotor current does not exceed the nominal value. In this case, the total power is changed according to Table 3.

**Table 3.** Dependence of the total power of the generator on the active power factor

$\cos\varphi$	1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1
Apparent power, %	80	90	100	90	87	82	80	78	76	75



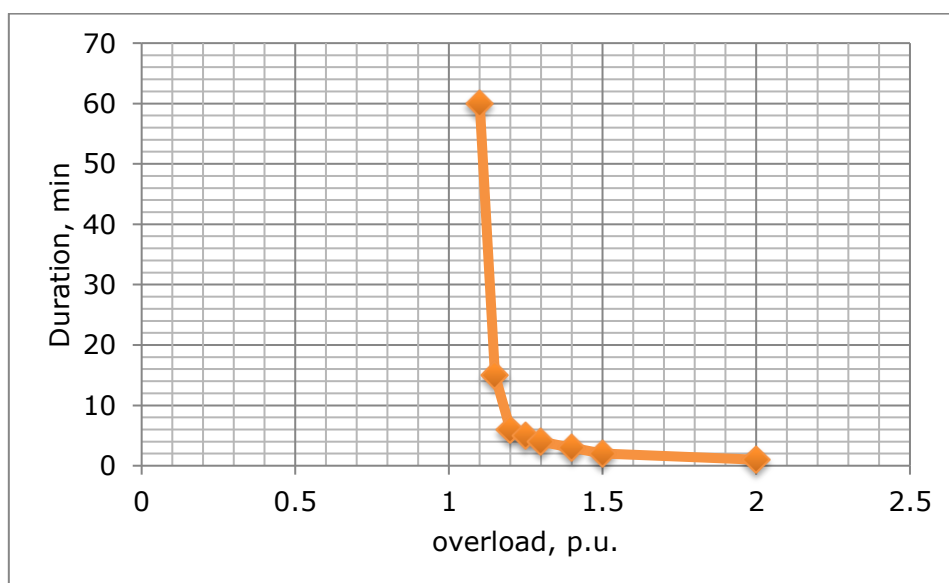
**Figure 2.** Dependence of the apparent power of a synchronous generator on its active power factor  $\cos\phi$

**Acceptable short-term overloads**

In emergency conditions, the turbogenerator can operate under short-term overloads by multiples of the stator current relative to the nominal value shown in Table 4.

**Table 4.** Acceptable overload duration

The multiplicity of overload, p.u.	1,1	1,15	1,2	1,25	1,3	1,4	1,5	2,0
Overload duration, min	60	15	6	5	4	3	2	1



**Figure 3.** Permissible operating time when the generator is overloaded

**References**

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