Reduction of Frequency Oscillation of the Gas-Diesel Generator Units

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Abstract - **The problem of frequency oscillation of gas-diesel generator unit and optimisation of his PID-regulator have been discussed in this paper.**

Keywords - **modeling, control system, autonomous power system, optimization.**

I. INTRODUCTION

Dynamic model diesel generator's parameters are determined by methods of the identification and subsequent adjustment of the adequacy of the transient load set/reset and management [1]. The dynamic model of gas-diesel (GD) was implemented in Matlab with the established parameters, similar to considering physical machines.

II. FUNDAMENTAL INFORMATION EXPOSITION

The GD itself is actually three consistently connected elements with a sufficiently large gain. Element with a positive feedback detects the influence of the pipe`s compressor. GD is object of the regulation for PID-regulator. Dynamic parameters of the object of regulation by control and disturbance affection are characterized by transient curve that shows oscillatory of the processes with natural frequency $\omega_0$ and coefficient of oscillation $m_0$. Let`s analyze possible reductions in rate of oscillation with numerical values for the system for different parameters of PID regulator. The transfer function of closed – loop system with PI-regulator for $W_{FB} = 1$:

$$W = \frac{W_{\mathrm{PI}}(p).W_O(p)}{1 + W_{PI}(p)W_O(p)}$$

The characteristic equation for $p = m_c w \pm jw$:

$$1 + W_{\mathrm{PI}}(m_c, jw).W_O(m_c, jw) = 0$$

Following formulas could be obtained from the resulting complex equation:

$$k_p = \frac{1}{A_0}\left(wT_и\left(m_c^2 + 1\right)\sin j_0\right) = \frac{1}{A_0}\left(m_c \sin j_0 - \cos j_0\right)$$

from which we can find:

$$m_c = \frac{k_p A_0 + \cos j_0}{\sin j_0} = \sqrt{\frac{A_0 k_p}{wT_и \sin j_0} - 1}\cdot$$

Amplitude frequency characterization of the object:

$$A_0 = \sqrt{\left[\mathrm{Im}_0(m_0 w)_0\right]^2 + \left[\mathrm{Re}_0(m_0, w)\right]^2} - \frac{k_0}{\left(1 - w^2 T_0\right)^2 + \left(2xwT_0\right)^2}$$

Object`s phase-frequency characterization:

$$j_0 = \frac{\mathrm{arctg}\left(\mathrm{Im}_0(m_0 w)\right)^2}{\mathrm{Re}_0(m_0 w)}$$

Analysis of these expressions shows that the value of index of the oscillation m_c cannot be reduced comparison to m_0. It also can be found from the analysis of LAFC open-loop system (Fig.1).

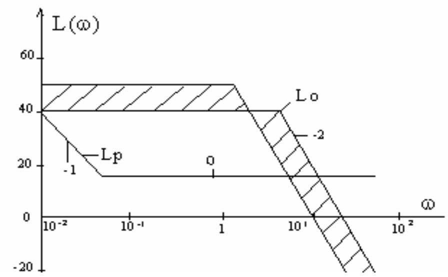

Fig.1 LAFC open-loop system

Let`s consider possibility of reducing of the oscillation degree of the system for an ideal PD controller with transfer function:

$$W_{\mathrm{PD}}(p) = k_p\left(1 + T_{\mathrm{D}} p\right),$$

T_D – time constant of the differentiator.

In this case the characteristic equation looks:

$$T_0^2 p^2 + \left(2xT_0 + k_0 k_p T_{\mathrm{D}}\right)p + k_0 k_p + 1 = 0$$

We can find the relation between the settings parameters T_D, k_p and m_c, m_0 from the previous equation:

$$m_c = \frac{\frac{T_д}{2xT_0} k_0 k_p + 1}{\left(\frac{m_0^2 + 1}{m_0^2}\left(k_0 k_p + 1\right) - \left(\frac{T_{\mathrm{D}}}{2x.T_0} k_0 k_p + 1\right)^2\right)^{1/2}}$$

To ensure aperiodic process, when $m_c = \infty$ from this equation, we need use expression:

$$\frac{m_0^2 + 1}{m_0^2}\left(k_0 k_p + 1\right) = \frac{T_{\mathrm{D}}}{2xT_0} k_0 k_p + 1$$

This allows finding necessary relation between the parameters of the regulator and object.

III. CONCLUSION

The optimal parameters of PID regulator are automatically calculated by equation method according to the object of control and selected criterion of optimality. User can select one of the following criteria of optimality when searching for the optimal parameters: aperiodic regulation, regulations with a 20% overshoot or minimize the mean square error.

REFERENCES

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