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Simulation for Protection of Huge Hydro Generator from Short Circuit Faults

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Abstract:—By taking mathematical model for excitation system of huge hydro generator is analyzed. The PID control mode is taken in automatic voltage regulator (AVR) for controlling the excitation system .The simulation model is constructed in matlab/simulink environment. Here the simulation results for the system short circuit faults LL, LLLG, LG are has a greater impact on hydro generator using self excitation method is analyzed. After remove the fault, adjusting generator excitation automatically contributes to hydro generator operation and power system.

I. INTRODUCTION

Hydro generator excitation system is having the two parts one part is used to supply DC current for excite the magnetic field windings of generator. It is called excitation power unit. Other part is to control the excitation current in normal and abnormal conditions, and it is called excitation control unit. In synchronous machine operation can control by controlling excitation and speed control ling, when load fluctuations or any faults happens at output side of machine. The adjustment of speed is not controllable instantaneously when fault happens, so other alternate to control the fault effects on system controlling of excitation system of generator. $E=4.44K_D K_P \Phi TF$
The induced emf (E) in the alternator is given by below equation. Where Φ is flux produced by excitation system. So we can observe the relation $E \alpha \Phi$
By adjusting flux i.e. excitation, induced emf i.e generated voltage, can controlled. It not only controls the terminal voltage, but also controls hydro generator reactive power.

The power of self-excitation system is supplied by generator's stator bus-bars and transported through the excitation transformer T to the silicon controlled rectifier U. The rectifier changes the AC excitation power into the DC excitation power. The automatic voltage regulator (AVR) takes PID algorithm. The inputs of AVR are the secondary side current of the two phase’s current transformer (TA) and the secondary side voltage of the three phase’s voltage transformer (TV). The output values of TA and TV are bound to change when the generator operating conditions change. By collecting these changes in time, AVR can change the value of excitation current by verifying the angle of SCR in order to achieve the purpose of regulating ultimately.

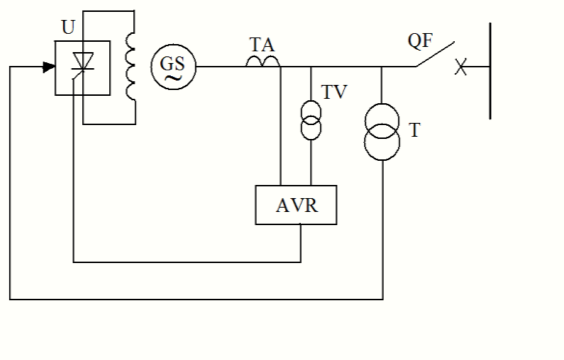


Fig 1. *Self-excitation system*

Self-excitation method using PID algorithm is studied in this paper. Self-excitation system is mainly composed of excitation transformer, silicon controlled rectifier and excitation controller. The model of infinite-bus system with single machine is constructed with Matlab/Simulink. The short-circuit fault to ground is simulated. Generator terminal voltage, excitation voltage, electromagnetic torque and speed variation have been presented and the simulation results are analyzed.

II. THE MATHEMATICAL MODEL FOR SELF- EXCITATION SYSTEM

- **Power unit**

The power unit of self-excitation system refers to the excitation transformers and thyristor devices. It is generally composed of a proportional component and a very small delay link. This time delay link may merge into AVR time delay Ta. The rectifier's output voltage is:

$E_{fb}=K_R U_t \cos\alpha$ (1)

Where, K_R is the product of the transformation ratio and rectifier coefficient of the rectifier transformer;

U_t is the generator stator voltage; α is the control angle of controlled rectifier. In this paper, analog regulator circuit uses the cosine phase shift, it is:

$\alpha= COS^{-1}$ UR/Ut (2)

where, U_R is the control voltage.

Taking (2) into (1), we have:

$E_{Fd} = K_R\ U_R$ (3)

The equation above explains when the control angle of controlled rectifier ranges within the specified regulation the excitation voltage E_{fd} can vary with the control linearly. When the control angle α is adjusted to the limit, the output of excitation voltage is proportional with the generator terminal voltage. The rectifier always works in external characteristic in region I. The commutating voltage $K_C I_{fd}$ can be transformated to the voltage less than the voltage limits. So the voltage limits can be expressed by $U_t u_{RMAX} - K_C i_{fd}$ and $U_t u_{RMAX} - K_C i_{fd}$.

B. Excitation regulator (AVR)

Excitation regulator is the intelligent components of an excitation control system. Based on the changes of generator terminal voltage (and current), it has the ability of adjusting the excitation system to realize the automatic excitation regulation in normal and accidental conditions. The algorithm of Excitation controller is the core of excitation controller. It completes the excitation adjustment task under the support of hardware. In this paper, PID control algorithm is taken. In control system, PID control algorithm is very mature, easy to be implemented and easy to be set. The actual using is proved well. PID controller is a linear controller, when r (t) is the given value, and c (t) is the actual output parameter value, the control deviation is

$e(t) = r(t) - c(t)$ (4)

Through the linear combination, deviation's proportion (P), integral (I) and differential (D) constitute the control quantity.

$U(t)=K_P[e(t)+(1/T_i)\ T_d]$ (5)

Where, K_P is proportion coefficient; T_i is the integral time constant; T_d is the differential time constant.

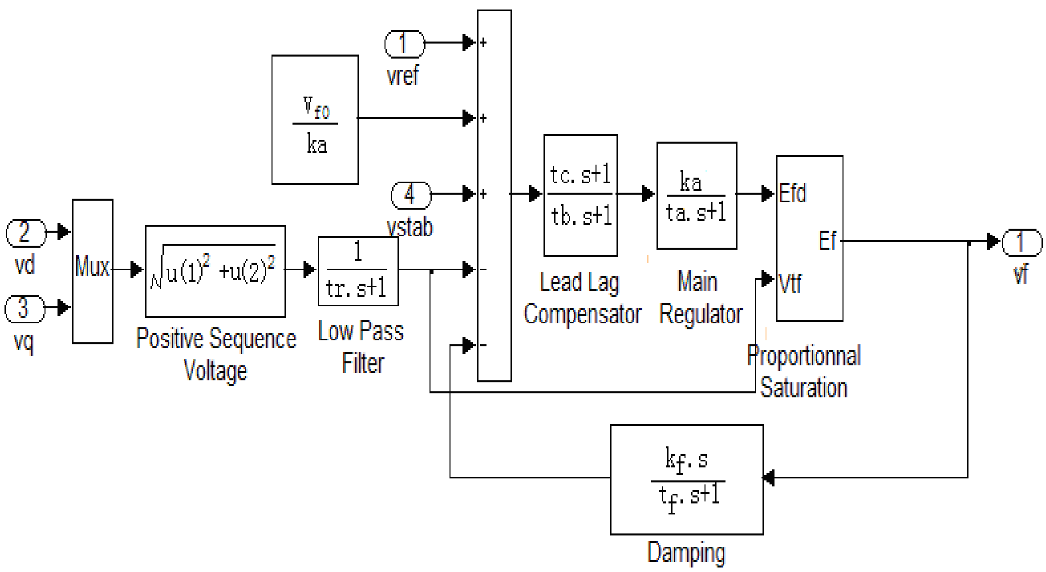
When

$K_i = k_p / T_i$, $K_d = K_P T_d$, the transfer function of the equation above may be represented as:

$G_c(s) = U(S)/E(S) = K_P + K_i/S + K_d S$ (6)

C. Self-excitation system simulation model

Excitation system simulation model is shown in figure 2:

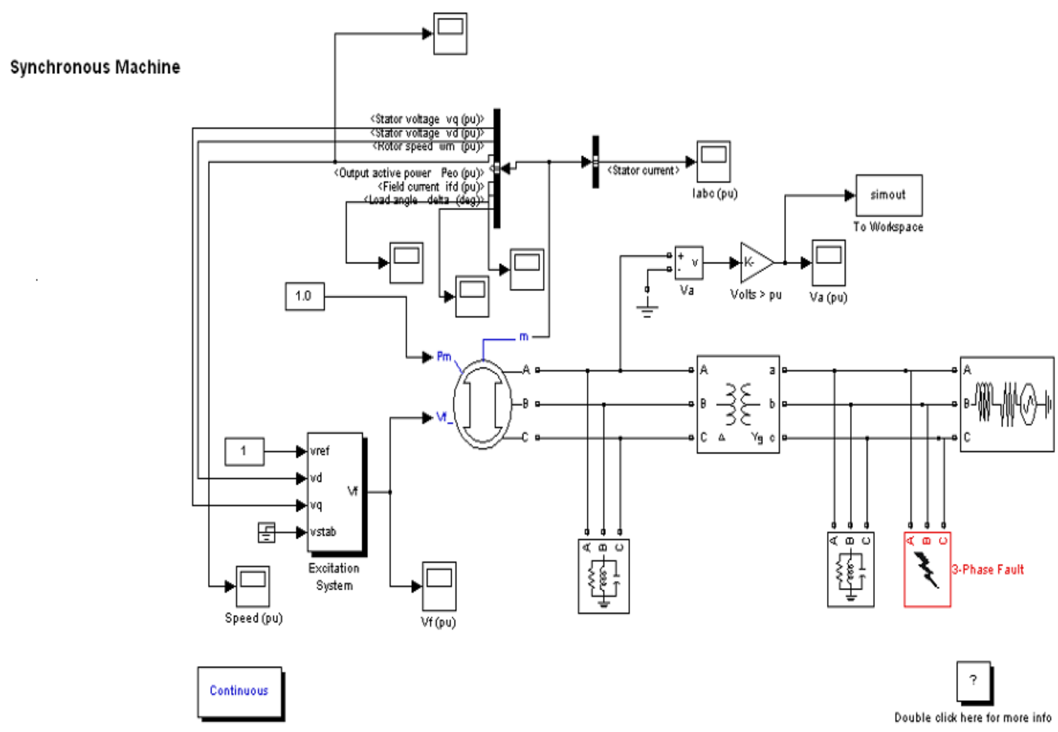


III. ESTABLISHING THE SIMULATION MODEL OF SINGLE MACHINE INFINITE-BUS SYSTEM

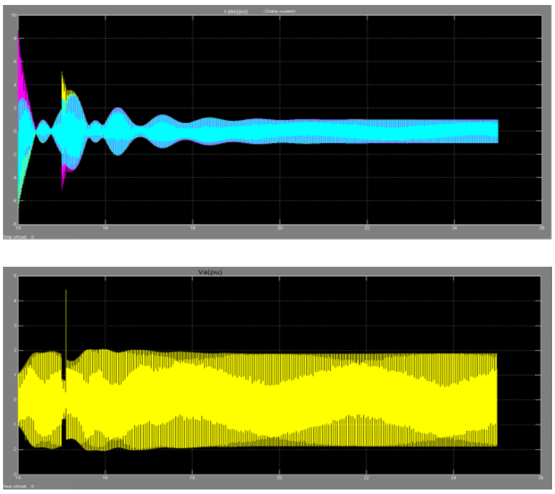
The simulation model of single machine infinite-bus system is established by simulation.
It is shown in Figure 3.
Hydro-generator with two 20MVA loads is connected to infinite-bus system through step-up transformer. The generator terminal voltage, speed and power angle are measured by Measurement module.

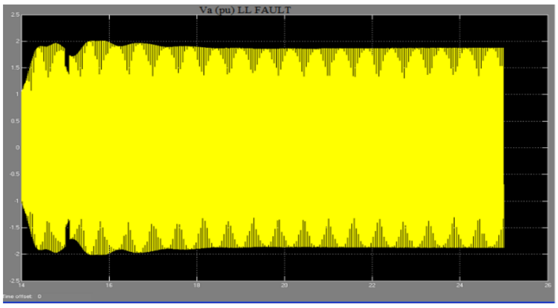
IV. SIMULATIONS AND ANALYSIS

When the generator with loads runs till 15s, we artificially cause the generator near-end transmission line to have three relatively short faults, and remove the breakdown 0.1s later.
The simulation waveforms are shown in the figure (by p. u.)The system has three phases to ground short-circuit fault at 15s.

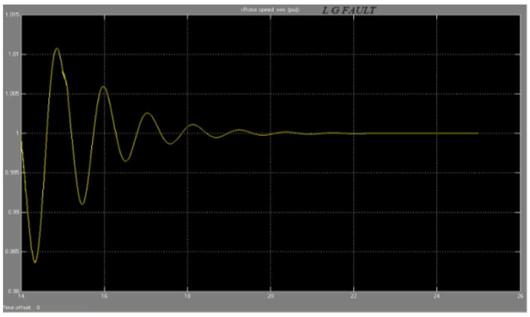


Results for LL FAULTS

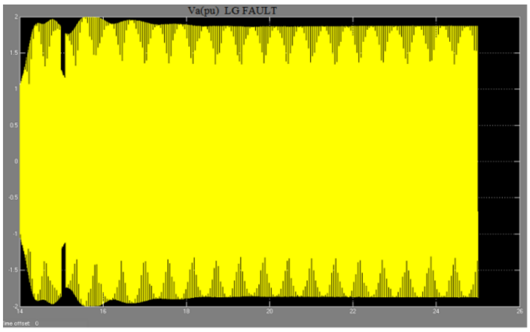


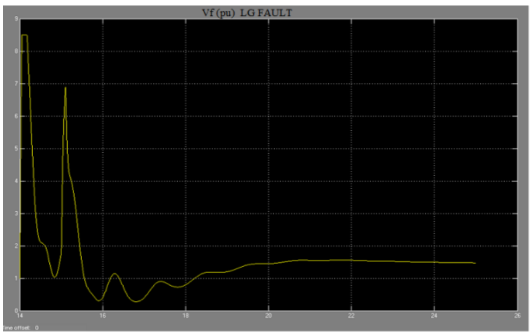


Because of the short-circuit fault in lines, the terminal voltage of generator suddenly drops to 37% of the rated voltage within 0.1s. shown in the figureS, when the short-circuit fault occurs, the fall of generator voltage results in the fall of excitation voltage; at the same time, drive torque is greater than the electromagnetic torque, which makes the generator speed change. This is a great impact on the stability of the generator and the grid. Thus the failure must be promptly removed. When the failure is removed in 0.1s later, it’s shown in figure 4 that generator terminal voltage rapidly comes back to rated voltage in 5s which is due to the join of the excitation regulator.

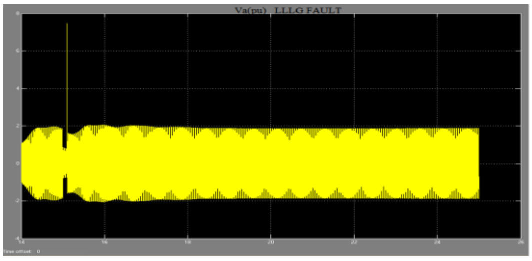


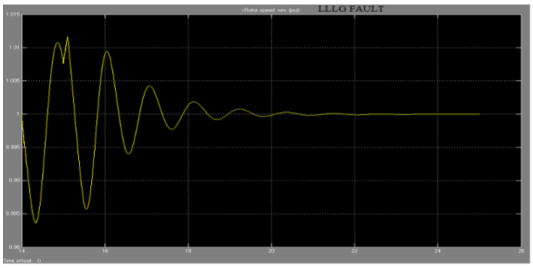
RESULTS FOR LG FAULT



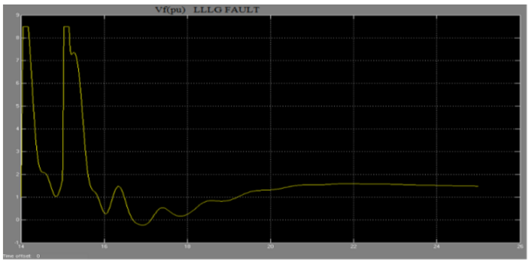


As shown in figure 5 and figure 7, the rotor speed and excitation voltage return to the steady-state once again after the failure is removed in 7s later





RESULTS FOR LLLG FAULT



V. CONCLUSIONS

In this paper, generator excitation system with self-excitation mode is analyzed. On the basis, the simulation model of single machine infinite-bus system is established.

The fault of three phases to ground, L-L, L-G short-circuit in transmission lines is simulated. From the simulation results, the system short-circuit failure has a great Impact on the excitation voltage of the Generator using PID excitation way. This will affect the stable operation of generators. After the failure is removed, excitation regulator can make the generator restore stability rapidly, and the generator runs within the static stability limit in the whole process. And the stability of the system is ensured. This is vital to the stable operation of generators and power grid.

REFERENCE

[1]. GE Baojun, XIN Peng, LV Yanling"The Excitation System Simulation of Huge Hydro-generator"978-1-4244-4813-5/10/ ©2010 IEEE

[2]. Han Yingduo, Xie Xiaorong, Cui Wenjin. "The status and future trend in research on synchronous generator excitation control [J]." Journal of Tsinghua University(Science and technloogy). 2001.Vol. 41, no. (4 / 5), pp. 142 -146. (In Chinese).

[3]. Mu Deshi, Sun Fuchen. "Choice of exciting system and optimal adjusting law of large generator." Large electric machine and hydraulic turbine. 2000, no. 4, pp. 50-56. (In Chinese).

[4]. Liu Qu. "Power system stability and generator excitation control." 2007. 2 China Electric Power Press . (In Chinese).

[5]. Li Jicheng. "Synchronous generator excitation system design and application." 2002.3 China Electric Power Press. (In Chinese).

[6]. Richard C Schaefer. "Excitation control of the synchronous generator [J]." IEEE Transactions on Industry Applications1999Vol. 35, no. 3, pp. 694-702.

[7]. Wu Jie, Liu Yongqiang, Chen Wei. "The application of modern control Proceedings of the Csee. 1998, techniques in power system control()."Vol. 18, no. 6, pp. 377-382. (In Chinese).

[8]. Huang Yaoqun. "Self tuning PID excitation regulator for synchronous generators." Journal of Tsinghua University(Science and Technology). 1993, pp. 17-25. (In Chinese).

[9]. Zhou Shuangxi, Zhang Heng. "A new self-tuning PID regulator of excitation [J]." Journal of Tsinghua University (Natural Science Edition), 1997, Vol. 37, no. l, pp. 31-34. (In Chinese).

[10]. Chen Xin Qi, Chen Hao, Zhu Shizhang. "Parameter settings for power system voltage regulator" Electric Power, 2004, Vol. 37, no. 7, pp. 12-15. (In Chinese).