EXCITATION SYSTEM MODERNIZATION OF THERMAL POWER PLANT

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Abstract - Many power plants built 20-30 years ago are facing problems associated with the excitation system used for controlling generator output voltage. After years of reliable operation, generation is experiencing increased down time due to maintenance associated with the exciting excitation equipment. Reliability of the excitation system has become an issue, especially where many of these generation plants may be critical to the internal processes used for manufacturing. Wear out mechanisms such as those associated with the wire wound rheostat, the electromechanical voltage regulator, insulation failures of the rotating exciter and commutator deterioration have become real problems typical of many older installations. These are some of the issues that are affecting system reliability for older power plants. This paper will address typical problems associated with the old excitation systems and the justification for a replacement static excitation system used in many Paper Mills.

I. INTRODUCTION

As in any power plant, the aging factor has its affect on operating equipment. Continuous wearing of parts leads to increased maintenance and periodic part replacement to maintain reliable operation of the power plant. This paper will discuss an application where a retrofit from a rotating electromechanical excitation system to static exciter system has taken place. Various factors and considerations will be discussed that are involved in selecting and installing a static exciter system for use with a steam turbine generator.

II. SELECTION OF EXCITATION SYSTEM

A. Conventional Static Exciter

The following figure is a classical static exciter. This exciter consists of a synchronous generator and controller and converter. In this system, excitation power is supplied through a transformer from the generator terminals. This system has a very small inherent time constant. However, the maximum exciter output voltage is dependent on the input AC voltage. Then during system-fault conditions which causes a depressed generator terminal voltage, the available exciter ceiling voltage is reduced. In addition, the conventional static exciter is inexpensive and easily maintainable.

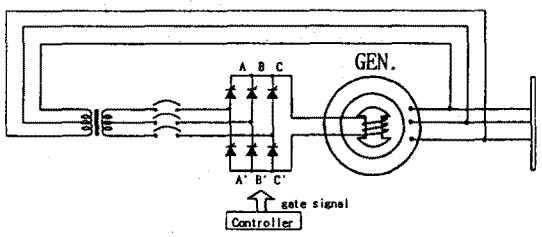


Fig. 1. Conventional static exciter.

B. Conventional AC Exciter

Fig. 2 shows an AC exciter that consists of a PMG(Permanent Magnet Generator) with controlled rectifier and exciter generator with non-controlled rectifier. In this system, the exciter is on the same shaft as the turbine generator. The ac output of exciter is rectified by either a controlled or non-controlled rectifier to produce the direct current needed for the generator field. The rectifiers may be stationary or rotating. In the view point of stability, this system is more stable than a static exciter because excitation power is not supplied from the generator terminals.

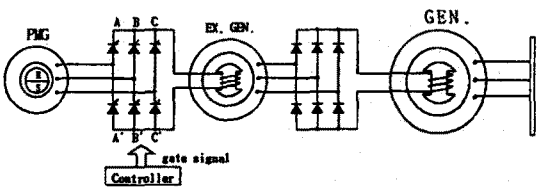


Fig. 2. Conventional AC exciter.

III. CONSTRUCTION OF A EXCITATION SYSTEM

The static exciter is equipped with typical features including:

1. Automatic Voltage Regulator
   a. Reactive Droop Compensation
   b. Volts/Hertz Limiting

2. Standby Manual Voltage Control
3. Minimum/Maximum Excitation Limiters
4. Manual Follow up Control for the Automatic Voltage Regulator (Autotracking)
5. Fault Transfer to Manual
6. AC to DC Power Rectifier Bridge
7. AC Field Contactor
8. Automatic Field Flash Control
9. Local/Remote Control

Basic Equipment
Power Potential Transformer
AC Field Shutdown Contactor
Field Flashing the Generator
Power Rectifier Bridge

Generator Size
The larger the machine, the greater the field power required maintain rated generator voltage at rated load.

The Rotational Speed
In a synchronous generator, this indicates that it takes less field excitation to excite a generator operating at high speed than is required on the same generator operating at lower speeds. The type of turbine used on a generator plays dominant role in determining the size of the excitation system. Hence, it is not surprising that a gas or steam turbine rotating at 3600rpm would require a much smaller excitation system compared to a hydro turbine rotating at 120rpm that has the same generator KW rating.

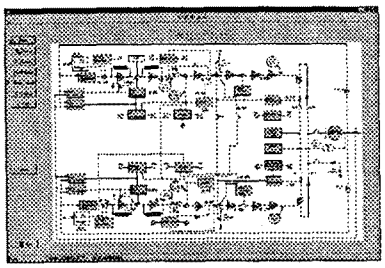
Choosing the Static Exciter
The procedure for selecting a static excitation system involves little more than the use of Ohm's Law to determine the rating of the static exciter appropriate for a given generator. in most applications, the excitation system is nominally sized to meet the generator continuous field rating requirement. This information is many times obtained from the machine nameplate located on the side of the generator. If the machine has been rewound, it is most important to obtain operating DC amperes and DC volts required by the field that represents the maximum continuous machine loading at rated power factor.

Ⅳ. DATA ACQUISITION SYSTEM

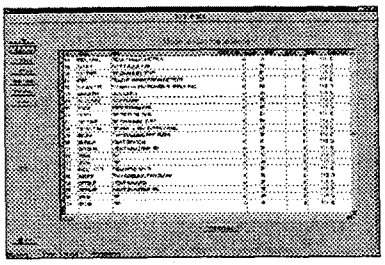
In this system, DAS(Data Acquisition System) is installed in order to monitor a system state of excitation system. Hardware of DAS is following as :

- Central Processing Module
- Central Communication Module
- Backup Module
- Digital Input Module
- Analog Input Module
- Power Supply Module

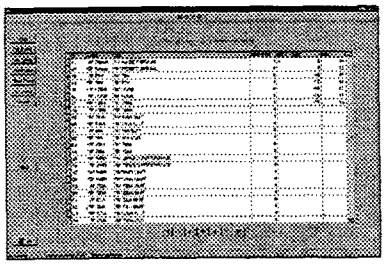
Also menu of DAS is following as :
- FLOW, which indicates signal values in system.
- DI_CONFIG, which shows the configuration for a digital point.
- AI_CONFIG, which shows the configuration for a analog point.
- REAL VALUE, which monitors all analog points.
- DI STATUS, which monitors normal or trouble operation
- EVENT, which display a summarized alarm events signal



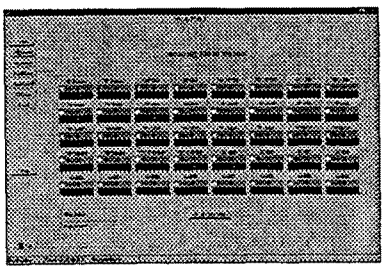
a) FLOW



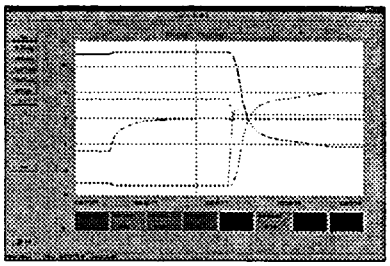
b) DI_CONFIG



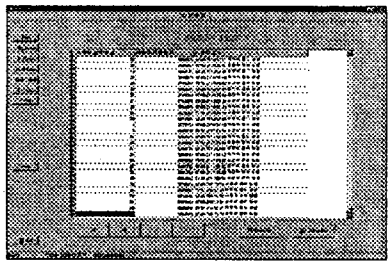
c) AI_CONFIG



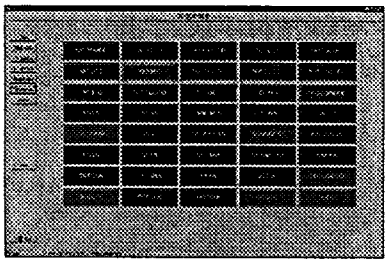
d) REAL VALUE



e) REAL TREND



f) DI STATUS



g) EVENT

VI. CONCLUSION

Static excitation systems provide valuable solutions to problems with equipment obsolescence. The benefits of retrofit to static excitation is far beyond the savings in maintenance. They also provides excellent system performance for faster motor starting. Additionally, they provide high operating efficiency, as compared to a rotating exciter, hence, consuming less power. High operating efficiency translates into lower operating cost and fast return upon intimal investment. The detail design methods and experimental results including field test results will be presented in the final paper.

REFERENCE

1. "A Development of Automatic Voltage Regulator for the Power Plant(I)". KEPRI KRC-91I-J01, 1994
2. Lennart Ljung, *"System Identification : Theory for the User"*, P. T. R. Prentice Hall, Englewood Cliffs, New Jersey 07632. 1987
3. J. A. Cadzow and H. R. Martens, *"Discrete - Time and Computer Control System"*. Prentice Hall Inc., 1970.
4. IEEE Power Generation Committee, "IEEE Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control systems". IEEE Std. 421A - 1978
5. ANSI C50.13-1965 Cylindrical Rotor Synchronous Generators.
6. JIEE 421.4-1990 Guide Specification for Excitation Systems.
7. NEMA MGI-22.16, July 1982.
8. Schaefer, R. C., "Performance Consideration for Selecting a Static Excitation System". Presented at Waterpower 85.
9. Schaefer, R. C., "Steam turbine Generator Excitation System Modernization". Presented at IEEE Pulp & Paper Conference in Vancouver, Canada, June 1995.
10. ANSI C37.18-1979 IEEE Standard Enclosed Field Discharge Breaker for Rotating Machinery. Rev C, January 1996.