

## CHAPTER- 9

### HYDRO GENERATOR, CHARACTERISTICS AND PERFORMANCE

#### 9.1 GENERAL

The electric generator converts the mechanical energy of the turbine into electrical energy. The two major components of the generator are the rotor and the stator. The rotor is the rotating assembly to which the mechanical torque of the turbine shaft is applied. By magnetizing or "exciting" the rotor, a voltage is induced in the stationary component, the stator. The principal control mechanism of the generator is the exciter-regulator which sets and stabilizes the output voltage. The speed of the generator is determined by the turbine selection, except when geared with a speed increaser. In general, for a fixed value of power, a decrease in speed will increase the physical size and cost of the generator.

The location and orientation of the generator is influenced by factors such as turbine type and turbine orientation. For example, the generator for a bulb type turbine is located within the bulb itself. A horizontal generator is usually required for small turbine e.g. tube turbine and a vertical shaft generator with a thrust bearing is appropriate for vertical turbine installations.

Conventional cooling on a generator is accomplished by passing air through the stator and rotor coils. Fan blades on the rotating rotor assist in the air flow. For larger generator (above 5 MVA capacity) and depending on the temperature rise limitations of the winding insulation of the machine, the cooling is assisted by passing air through surface air coolers, which have circulated water as the cooling medium.

Large Generators interconnected with the grid should meet grid standards issued by Central Electricity Authority (CEA) (relevant extracts are enclosed as annexure-1).

#### 9.2 Hydro Generators Early Designs

##### 9.2.1 Large Hydro

Large salient pole hydro generators specified for installation up to 1970 were constrained by following considerations.

Insulation Systems for Stator and Rotor was Class B insulation with organic binding material which permitted lower temperature rises.

Material for rotor rim punching etc. required limiting the diameter of the rotor so as to permit operation at runaway speed.

Bearing arrangements: Top thrust and guide bearing supported on heavy brackets, capable of supporting total generator weight was provided with a bottom guide bearing to all hydro generators including slow speed large generator which constitutes majority of large hydro generators. This resulted in high cost of machine and building.

Shaft mounted excitation systems were slow and unable to meet the requirements of quick response required from large generators feeding large modern grid systems.

Stability requirements for long distance transmission lines required to feed distant load centre/grids was achieved by manipulating reactances, excitation response ratio and Dywheel effect. This resulted in larger size of the machine.

Grids were small and there was no stringent requirement for voltage and frequency variation.

Typical section arrangement for Bhakra Left bank machines (100 MVA; 166.7 RPM) with top thrust and guide bearing and bottom guide bearing is shown in figure 9.1 and the capability curve is shown in figure 9.2.

# Chapter 9 Hydro Generator Characteristics And Performance

**Xiaolong Qi**



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### **Table of Contents Chapter 9 Hydro Generator Characteristics And Performance**

1. Understanding the eBook Chapter 9 Hydro Generator Characteristics And Performance
  - The Rise of Digital Reading Chapter 9 Hydro Generator Characteristics And Performance
  - Advantages of eBooks Over Traditional Books
2. Identifying Chapter 9 Hydro Generator Characteristics And Performance
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Chapter 9 Hydro Generator Characteristics And Performance
  - User-Friendly Interface
4. Exploring eBook Recommendations from Chapter 9 Hydro Generator Characteristics And Performance
  - Personalized Recommendations
  - Chapter 9 Hydro Generator Characteristics And Performance User Reviews and Ratings
  - Chapter 9 Hydro Generator Characteristics And Performance and Bestseller Lists
5. Accessing Chapter 9 Hydro Generator Characteristics And Performance Free and Paid eBooks
  - Chapter 9 Hydro Generator Characteristics And Performance Public Domain eBooks
  - Chapter 9 Hydro Generator Characteristics And Performance eBook Subscription Services

- Chapter 9 Hydro Generator Characteristics And Performance Budget-Friendly Options
- 6. Navigating Chapter 9 Hydro Generator Characteristics And Performance eBook Formats
  - ePub, PDF, MOBI, and More
  - Chapter 9 Hydro Generator Characteristics And Performance Compatibility with Devices
  - Chapter 9 Hydro Generator Characteristics And Performance Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Chapter 9 Hydro Generator Characteristics And Performance
  - Highlighting and Note-Taking Chapter 9 Hydro Generator Characteristics And Performance
  - Interactive Elements Chapter 9 Hydro Generator Characteristics And Performance
- 8. Staying Engaged with Chapter 9 Hydro Generator Characteristics And Performance
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Chapter 9 Hydro Generator Characteristics And Performance
- 9. Balancing eBooks and Physical Books Chapter 9 Hydro Generator Characteristics And Performance
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Chapter 9 Hydro Generator Characteristics And Performance
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Chapter 9 Hydro Generator Characteristics And Performance
  - Setting Reading Goals Chapter 9 Hydro Generator Characteristics And Performance
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Chapter 9 Hydro Generator Characteristics And Performance
  - Fact-Checking eBook Content of Chapter 9 Hydro Generator Characteristics And Performance
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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