



Renewable Energy – Daily Program

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Day 1

Welcome and Presentation of:

- Electrical Energy (present situation and expectations), demand, production and consumption all over the world.
- The Units and physical laws related to the generation of Electrical Energy.
- Conversions of the various energies i.e. Chemical Energy into Thermal Energy, Thermal Energy into Mechanical Energy, and Mechanical Energy into Electrical Energy.
- Various means for the production of Electrical Energy (production sources).

Generator Principle

- a) Lubrication
- b) Excitation
- c) Outlet Voltage from the Generator
- d) Stator Cooling System (H_2 or H_2O)
- e) Bus Ducts
- f) Coupling Breaker
- g) Net work Synchronization
- h) Generator Protections
- i) AVR Automatic Voltage Regulation

Electrical Part into a Power Plant

- a) Transformer Area
- b) Transformer Principle
- c) Usefulness of the various transformers
- d) High voltage Connection to the grid
- e) Transport of the Electricity
- f) Middle Voltage Generation and Distribution
- g) Low Voltage Generation and distribution
- h) DC generation and distribution
- i) UPS (Uninterruptible Power System) Generation and Distribution
- j) Centralized Control System or Control Data System
- k) Control Room
- l) Metering
- m) Lighting (inside and outside)
- n) Telecommunications (Telephone, Interphone, Radio contact, HF link)
- o) Electrical Power disposal for starting the Power Plant

Balance of Plant (BOP)

- a) Auxiliary Buildings (Admin. Building, Ware House, Workshop, Garage)
- b) Various Tanks (Diesel oil, Fuel oil, Raw Water, Fire Fighting Water reserve, Demineralized Water, Potable Water)
- c) Water Treatment (Demineralization, Drinkability, Waste Water Treatment, Effluents Treatment)
- d) Raw water Distribution
- e) Drinking Water Distribution
- f) Demin. Water Feeding
- g) Fire Detection System
- h) Fire Fighting System



- i) Compressed Air Generation Systems (Service Air, Regulation air)
- j) Compressed Air Distribution System
- k) HVAC (Heat, Ventilation, Air conditioning) System
- l) Auxiliary Steam generation
- m) Auxiliary Steam Distribution
- n) Lightning Protection
- o) Emergency Diesel Generator

Day 2

Gas/Fuel oil-Fired Steam Turbine Power Plant

Coal Handling (Not Applicable)

Fuel Oil Handling

- a) Fuel Oil Unloading
- b) Fuel Oil Storage
- c) Fuel Oil Heating System
- d) Fuel Oil Transfer
- e) Fuel Oil Conditioning Skid

Gas Feeding

- a) Gas Conditioning Station

Steam Generator

Coal Cycle (Not Applicable)

Air Cycle

- a) Forced Draft Fan
- b) Air Heater
- c) Combustion Air Route to Wind Boxes
- d) Induced Draft Fan
- e) Flue Gas Route

Fuel oil Cycle

- a) Fuel Oil piping feeding from the Conditioning Skid to the Oil Burners

Gas Cycle

- a) Gas Piping Feeding from the Gas Station to the Gas Burners

Feed Water/Steam Cycle

- a) Same as Coal-Fired Power Plant

Ashes Cycle (Not Applicable)

Steam Turbine principle

- a) Same as Coal-Fired Power Plant

Generator Principle

- a) Same as Coal-Fired Power Plant



Electrical Part into the Power Plant

- a) Same as Coal-Fired Power Plant without the utilities for the Coal Handling and the Pulverized coal Cycle

Balance of Plant (BOP)

- a) Same as Coal-Fired Power Plant

Efficiency of a Gas/Fuel Oil-Fired Steam Turbine Power Plant

Auxiliary Utilities Consumption of a Gas/Fuel Oil-Fired Steam Turbine Power Plant

Availability of the Gas/Fuel oil-Fired Steam Turbine Power Plant

Gas/Fuel oil Turbine Single Cycle Power Plant

Fuel Oil Handling

- a) Fuel Oil Unloading
- b) Fuel Oil Storage
- c) Fuel Oil Heating System
- d) Fuel Oil Transfer
- e) Fuel Oil Conditioning Skid

Gas Feeding

- b) Gas Conditioning Station

How a Gas/Fuel oil Turbine Works

Generator Principle

- a) Same as Coal-Fired Power Plant

Electrical Part into the Power Plant

- a) Transformer Area Simplified
- b) High voltage Connection to the grid
- c) Transport of the Electricity
- d) Middle Voltage Simplified Generation and Distribution
- e) Low Voltage Generation and distribution
- f) DC generation and distribution
- g) UPS (Uninterruptible Power System) Generation and Distribution
- h) Centralized Control System or Control Data System
- i) Control Room
- j) Metering
- k) Lighting (inside and outside)
- l) Telecommunications (Telephone, Interphone, Radio contact, HF link)
- m) Electrical Power disposal for starting the Power Plant

Balance of Plant BOP (adapted to a single Cycle)

- a) Auxiliary Buildings (Admin. Building, Ware House, Workshop, Garage)
- b) Various Tanks (Diesel oil, Fuel oil, Raw Water, Fire Fighting Water reserve, Potable Water)
- c) Water Treatment Drinkability, Waste Water Treatment, Effluents Treatment)
- d) Raw water Distribution
- e) Drinking Water Distribution
- f) Fire Detection System



- g) Fire Fighting System
- h) Compressed Air Generation Systems (Service Air, Regulation air)
- i) Compressed Air Distribution System
- j) HVAC (Heat, Ventilation, Air conditioning) System
- k) Lightning Protection
- l) Emergency Diesel Generator
- m) Black Start System

Environmental effects of a Gas/Fuel Oil Turbine Single Cycle Power Plant

Efficiency of a Gas/Fuel Oil Turbine Single Cycle Power Plant

Auxiliary Utilities Consumption of a Gas/Fuel Oil Turbine Single Cycle Power Plant

Availability of a Gas/Fuel Oil Turbine Single Cycle Power Plant

Gas/Fuel oil Turbine Combined Cycle (GTCC One Shaft)

Fuel Oil Handling

- a) Fuel Oil Unloading
- b) Fuel Oil Storage
- c) Fuel Oil Heating System
- d) Fuel Oil Transfer
- e) Fuel Oil Conditioning Skid

Gas Feeding

- c) Gas Conditioning Station

How a Gas/Fuel oil Turbine Works

- a) Same as the Single Cycle
- b) Fuel Oil/Gas System Same as Single Cycle

HRSR Heat Recovery Steam Generation

- a) Gas Turbine Exhaust
- b) Supplemental Duct Burners (if any)
- c) Economizer Surface
- d) Evaporator surface
- e) Super heater Surface
- f) Steam Drum

Feed Water/Steam Cycle

- a) De-aerator Feed Water Tank
- b) Low pressure feed Water Heater
- c) Feed Water Pumps
- d) High Pressure Feed Water Heater
- e) Feed water Inlet Economizer
- f) Feed Water Outlet Economizer to Drum
- g) Feed Water From Drum to Evaporator
- h) Mixture Steam/Water From Evaporator to drum
- i) Steam from drum to Super Heater
- j) Steam from Super Heater to control Valve of Steam Turbine High Pressure Body



Steam Turbine principle

- a) Same as Coal-Fired Power Plant

Condensing System

- a) Same as Coal-Fired Power Plant

Generator Principle

Same as Coal-Fired Power Plant

Electrical Part into the Power Plant

- a) Transformer Area
- b) High voltage Connection to the grid
- c) Transport of the Electricity
- d) Middle Voltage Generation and Distribution
- e) Low Voltage Generation and distribution
- f) DC generation and distribution
- g) UPS (Uninterruptible Power System) Generation and Distribution
- h) Centralized Control System or Control Data System
- i) Control Room
- j) Metering
- k) Lighting (inside and outside)
- l) Telecommunications (Telephone, Interphone, Radio contact, HF link)
- m) Electrical Power disposal for starting the Power Plant

Balance of Plant (BOP)

- a) Auxiliary Buildings (Admin. Building, Ware House, Workshop, Garage)
- b) Various Tanks (Diesel oil, Fuel oil, Raw Water, Fire Fighting Water reserve, Demineralized Water, Potable Water)
- c) Water Treatment (Demineralization, drinkability, Waste Water Treatment, Effluents Treatment)
- d) Raw water Distribution
- e) Drinking Water Distribution
- f) Demin. Water Feeding
- g) Fire Detection System
- h) Fire Fighting System
- i) Compressed Air Generation Systems (Service Air, Regulation air)
- j) Compressed Air Distribution System
- k) HVAC (Heat, Ventilation, Air conditioning) System
- l) Auxiliary Steam generation
- m) Auxiliary Steam Distribution
- n) Lightning Protection
- o) Emergency Diesel Generator
- p) Black Start System



Environmental effects of a Gas/Fuel Oil Turbine GTCC One Shaft Power Plant

Efficiency of a Gas/Fuel Oil Turbine GTCC One Shaft Power Plant

Auxiliary Utilities Consumption of a Gas/Fuel Oil Turbine GTCC One Shaft Power Plant

Availability of a Gas/Fuel Oil Turbine GTCC One Shaft Power Plant

Gas/Fuel Oil Turbine GTCC One Shaft Power Plant means that Gas Turbine, Steam Turbine and the Electric Generator are on the same shaft

Gas/oil Turbine Combined Cycle (double shaft)

The difference between a GTCC One-Shaft and a Two-shaft is that each turbine is coupled separately with its own generator

This mean more equipment and more investment than for a one shaft GTCC. We can consider that this kind of power Plant has been abandoned

Diesel Oil Power Plant

Fuel Oil Handling

- a) Diesel Oil Unloading
- b) Diesel Oil Storage
- c) Diesel Oil Transfer

Diesel Engine Generator

- a) Starting System

Electrical Part into the Power Plant

- a) Middle or Low Voltage to the grid
- b) Low Voltage Generation and distribution
- c) DC generation and distribution
- d) AVR
- e) Metering
- f) Lighting
- g) telecommunication

Nuclear Power Plant

Fission Principle

Reactor Containment

Reactor Vessel

Fuel

Rod Control

- a) Full Length Rod control System
- b) Part length Rod Control System
- c) Air Cooling of Rod Control System



Primary loop

- a) Charging Pump
- b) Pressurizer
- c) Steam Generator (155 bars, Inlet 296 °C outlet 327 °C, 60 000 to/h)

Secondary Loop

- a) Low pressure Heater System
- b) Feed Water Motor-Pump
- c) Feed Water Steam Turbine-Pump
- d) High Pressure Heater System
- e) Steam Generator (55 bars, 270 °C, 7000 to/h)
- f) Turbine
- g) Condenser
- h) Main Water Cooling (Sea, River, Cooling Tower)
- i) Electric Generator

Day 3

Environmental effects of a Nuclear Power Plant

Efficiency of a Nuclear Power Plant

Auxiliary Utilities Consumption of a Nuclear Power Plant

Availability of a Nuclear Power Plant

Comparing Elementary Systems between the different Power Plant processes:

Coal-Fired Power Plant 146 Elementary Systems

GTCC One Shaft 189 Elementary Systems

Nuclear Power Plant 197 Elementary Systems

Renewable Energies

Hydroelectric Energy

- a) Hydroelectric Energy from Falling Water (Dam, Pressure Pipeline)
- b) Hydroelectric Energy from the River Stream
- c) Pumped Storage reservoirs
- d) Maritime Wave Electrical Energy
- e) Maritime Tidal Electrical Energy

Solar Energy

- a) Solar Resources
- b) Passive Solar Energy (Water Heating)
- c) Photovoltaic Solar Energy
- d) Thermal Solar Energy (Solar Furnace)

Aeolian Energy

- a) How it Works
- b) Wind Turbine Farm on Shore
- c) Wind Farm Turbine of shore



- d) Wind Turbine on Building

Geothermal

- a) How it Works
- b) Pumping Depth Hot Water
- c) Heat Pump

Biomass

- a) How it Works
- b) Biomass Power Plant

How to store Electric Energy

Fossil fuels Power Plant, Nuclear Power Plant and Renewable Energies - Advantages and disadvantages

Conclusion, Questions and Answers session