Govt. Engineering College of Thalawar

B.Tech II year 4th Sem.

Electrical Engineering

Subject : Generation of electrical Power

Subject Teacher
Pramod Patidar

Model Test paper I with Solution

Q.1 A thermal power plant spends ₹ 40 lakhs per annum for coal used in the station. The coal has a Calorific value of 600 Kcal/Kg and costs ₹ 400 per tonne. If the station has thermal efficiency of 35%, find the average load on the station. and electrical efficiency 80%

Solution :

Overall efficiency = Thermal efficiency × electrical efficiency

$= 0.35 \times 0.8 = 0.28$

Coal used /annum $= 40 \times 10^5 / 400 = 10^4$ tonnes $= 10^7$ Kg

Heat of Combustion = Coal used /annum × Calorific value

$= 10^7 \times 6000 = 6 \times 10^{10}$ Kcal

$$\text{overall efficiency} = \frac{\text{Heat output}}{\text{Heat of Combustion}}$$

Heat output $= \eta_{overall} \times$ Heat of combustion

$= (0.28) \times (6 \times 10^{10}) = 1680 \times 10^7$ Kcal

units generated /annum $= 1680 \times 10^7 / 860$ KWh

Pramod Patidar
31/01/19 018

Average load on station = $\frac{\text{units generated / annum}}{\text{Hours in a year}}$

$= \frac{1680 \times 10^7}{860 \times 8760} = 2230$ KW Ans.

Q.9 Discuss the economic feasibility of a pumped storage scheme of an hydro power plant.

Solution :- An economic analysis of a pumped storage plant requires the determination of following components of the total system cost :

(a) Capital Cost of System :- It is directly dependent on the basic characteristics viz r and h. A certain portion of the cost is dependent on h, a certain portion is dependent on r while third portion is constant. The specific capital cost i.e. capital per KW can be written as :

$$C_r = a + (r) C_p + (h) C_e \text{ Rs/KW}$$

Where C_r is total specific cost
a is constant
r C_p is the portion of cost independent of h (i.e stored energy)
h C_e is the portion of cost which is depent on stored energy.

(b) The risk cost of a System :- It is directly related to the reliability and, therefore, to the power duty. This duty consists of making the plant capacity available at the time of any contigency. The lack of reliability is expressed by the risk index i.e. yearly averaged energy which has the following two components :

31/01/2018

① Power risk i.e. the inability to meet the load requirement because of lack of capacity resulting from forced and scheduled outage of generating units. It is independent of h.

② Energy risk i.e. the inability to meet the load due to the lack of stored energy in the reservoirs. The higher the percentage of storage plants of storage plants and the smaller the value h, the more important is the energy risk component.

The value of power duty is obtained by expressing the yearly curtailed energy of the system in economic terms by unit cost. Regarding the choice of the unit cost to be described to the risk index (Power risk + energy risk) a widely accepted value in foreign countries is 1 $ per Kwh.

(C) Running cost of System :- It is directly related to the energy transfer duty. It is known that the amount of corresponding benefits depend on the system composition, particularly on the percentage of low incremental cost energy in the system. Moreover it is worth mentioning that energy transfer duty can be performed only when it does not affect the power duty, that is, when the overall system is safe. It is necessary to avoid using energy for energy transfer duty when it should be better utilized for power duty because the former may lead to greater energy shortage and a higher risk level. Therefore, it is necessary to select the proper situation when the energy transfer duty should be performed. The value of the energy by the stored energy can be taken as the difference of the total running cost of the system with and without energy transfer.

Pramod Patidar
31/01/2018

Q.3 What are fissile & fertile materials? Give example of each.

Solution: Fissile material can sustain a chain reaction with neutrons of any energy. Fissile material can be used to fuel thermal neutron reactors, fast neutron reactors and nuclear explosives.

Fissile is distinct from fissionable. A nuclide capable of undergoing fission after capturing a high energy neutron is referred to as fissionable. A fissionable nuclide that can be induced to fission with low energy thermal neutrons with a high probability is referred as fissile. Fissile material are subset of fissionable materials.

Example: Uranium-235 fission with low energy thermal neutrons, because the binding energy resulting from the absorption of a neutron is greater than the critical energy required for fission therefore Uranium^{235} is a fissile material.

Fertile Materials: It is a material that although not itself fissionable by thermal neutrons, can be converted into a fissile material by neutron absorption and subsequent nuclei conversion.

Example: Thorium-232, uranium-235, Uranium-238.

Naturally occuring fertile materials that can be converted into a fissile materials by irradiation in a reactor include:

Thorium-232 which converts into Uranium-233
Uranium-234 which converts into Uranium-235
Uranium-238 which converts into plutonium-239

Q.4 Derive the efficiency of various power plant. Which one is most efficient & why?

Solution: Efficiency of various power plants:

Ramkrishna
31/01/2018

Thermal Power plant :- Thermal Power plant or coal fired Power accounts for almost 41% of the World's electricity generation. coal fired Power plants operate on the modified rankine thermodynamic cycle. The efficiency is dictates by the parameter of this thermodynamic cycle. The overall plant efficiency is ranges from 32% to 42%. This is mainly dictate by the superheat and reheat steam temperature and superheat pressure

Super critical power plant can achieve a efficiency 42% ultra super critical pressure power plant can achieve efficiency in the range of 45% to 48%.

Natural Gas Fired Power plants

It account for almost 20% of the World's electricity generation. These power plants use gas turbines or gas turbine based combined cycles. Gas turbines in the simple cycle mode only gas turbine running. have an efficiency of 32% to 38%.

The latest gas turbine with technological advances in material and aerodynamics have efficiency upto 38%

Renewables

Hydro turbine, the oldest and most commonly wed renewable energy source have the highest

Pramod Patidar
31/01/2018

efficiency

Hydro plant efficiency - 85% to 90%.
wind turbine efficiency - 30% to 45%

Solar thermal plant can achieve efficiency up to 20%
Geothermal system can achive efficiency in the range of 35%.

Nuclear Power plant -

The efficiency of nuclear is little differant. since the energy release rate in nuclear fission in extremely high the energy transferred to steam is a very small percentage only around 0.7%. This makes overall plant efficiency only around 27%

Diesel Engines - Diesel engines large capacity industrial engines deliver efficiencies in the range of 35% to 42%.

Hydrothermal plant have the highest efficiency of all power conversion process. The potential head of water is available right next to turbine so there are no energy conversion losses. only the machanical and copper losses in the turbine and generator and the tail end loss. The efficiency is in the range 85% to 95%.

Pramod Dhiman
31/01/2018