LOAD FREQUENCY CONTROL

The following basic requirements are to be fulfilled for successful operation of the system:

1. The generation must be adequate to meet all the load demand

2. The system frequency must be maintained within narrow and rigid limits.

3. The system voltage profile must be maintained within reasonable limits and

4. In case of interconnected operation, the tie line power flows must be maintained at the specified values.

- When real power balance between generation and demand is achieved the frequency specification is automatically satisfied.
- Similarly, with a balance between reactive power generation and demand, voltage profile is also maintained within the prescribed limits.
- Under steady state conditions, the total real power generation in the system equals the total MW demand plus real power losses.
- Any difference is immediately indicated by a change in speed or frequency
- Generators are fitted with speed governors which will have varying characteristics: different sensitivities, dead bands response times and droops.
- They adjust the input to match the demand within their limits.
- Any change in local demand within permissible limits is absorbed by generators in the system in a random fashion.
- An independent aim of the automatic generation control is to reschedule the generation changes to preselected machines in the system after the governors have accommodated the load change in a random manner.
- Thus, additional or supplementary regulation devices are needed along with governors for proper regulation.
- The control of generation in this manner is termed load-frequency control.
- For interconnected operation, the last of the four requirements mentioned earlier is fulfilled by deriving an error signal from the deviations in the specified tie-line power flows to the neighboring utilities and adding this signal to the control signal of the load-frequency control system.
- Should the generation be not adequate to balance the load demand, it is imperative that one of the following alternatives be considered for keeping the system in operating condition:

I. Starting fast peaking units.

2. Load shedding for unimportant loads, and

3. Generation rescheduling.

- It is apparent from the above that since the voltage specifications are not stringent. Load frequency control is by far the most important in power system control.
- In order to understand the mechanism of frequency control, consider a small step increase in load. The initial distribution of the load increment is determined by the system impedance; and the instantaneous relative generator rotor positions. The energy required to supply the load increment is drawn from the kinetic energy of the rotating machines. As a result, the system frequency drops. The distribution of load during this period among the various machines is determined by the inertias of the rotors of the generators partaking in the process. This problem is studied in stability analysis of the system.
- After the speed or frequency fall due to reduction in stored energy in the rotors has taken place, the drop is sensed by the governors and they divide the load increment between the machines as determined by the droops of the respective governor characteristics. Subsequently, secondary control restores the system frequency to its normal value by readjusting the governor characteristics.

AUTOMATIC LOAD FREQUENCY CONTROL

- The ALFC is to control the frequency deviation by maintaining the real power balance in the system.
- The main functions of the ALFC are to i) to maintain the steady frequency; ii) control the tie-line flows; and iii) distribute the load among the participating generating units.
- The control (input) signals are the tie-line deviation ΔPtie (measured from the tie- line flows), and the frequency deviation Δf (obtained by measuring the angle deviation Δδ).
- These error signals Δf and ΔPtie are amplified, mixed and transformed to a real power signal, which then controls the valve position. Depending on the valve position, the turbine (prime mover) changes its output power to establish the real power balance.
- The complete control schematic is shown in Fig For the analysis, the models for each of the blocks in Fig2 are required.

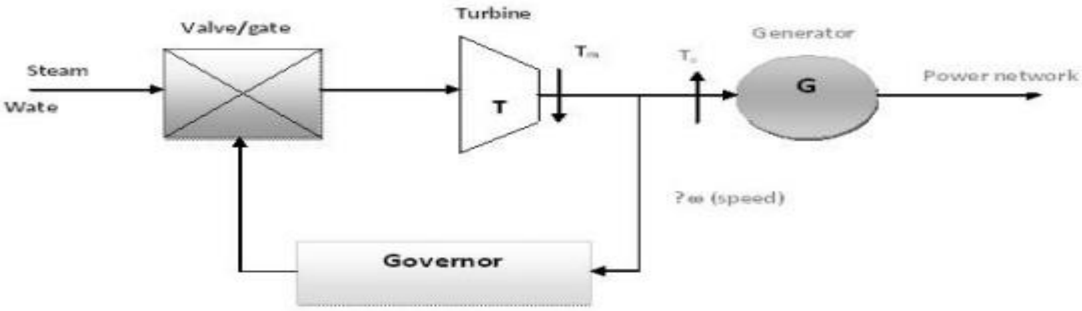


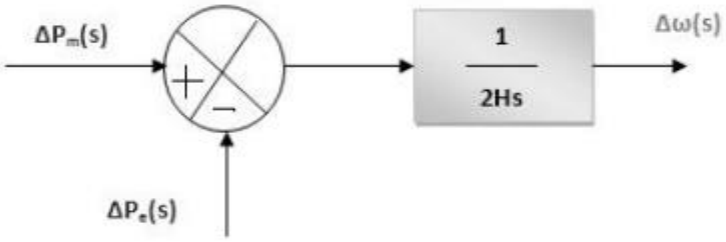
Fig 2.3The Schematic representation of ALFC system

- The generator and the electrical load constitute the power system. The valve and the hydraulic amplifier represent the speed governing system. Using the swing equation, the generator can be Using the swing equation, the generator can be modeled by Block Diagram Representation Of The Generator The load on the system is composite consisting of a frequency independent component and a frequency dependent component. The load can be written as

$$Pe = P0 + Pf$$

$$e \quad {}^{2}\,\Delta\delta = \Delta Pm - \Delta Pe$$

$$\overset{g}{\underset{1}{}}\ \Delta Pm - \Delta Pe$$



Pe is the change in the load;
P0 - is the frequency independent load component;
Pf - is the frequency dependent load component.

$$Pf = D$$

where,

- D is called frequency characteristic of the load (also called as damping constant) expressed in percent change in load for 1% change in frequency.
- If D=1.5%, then a 1% change in frequency causes 1.5% change in load. The combined generator and the load (constituting the power system) can then be represented as shown in Fig.
- The turbine can be modeled as a first order lag as shown in the Fig.

- Gt(s) is the TF of the turbine; ΔPV(s) is the change in valve output (due to action). Pm(s) is the change in the turbine output.
- The governor can similarly modeled as shown Fig. The output of the governor is by
- Where ΔPref is the reference set power, and Δw/R is the power given by governor speed characteristic.
- The hydraulic amplifier transforms this signal Pg into valve/gate position corresponding to a power PV.

Thus

$$PV(s) = (Kg/ (1+sTg)) \_Pg(s).$$