OBJECTIVE

Load sharing between two interconnected power system including transmission losses component.

SOFTWARE USED

MATLAB

THEORY

If we consider how a load is distributed between the different plants that are joined by transmission lines, then the line losses have to be explicitly included in the economic dispatch problem. When the transmission losses are included in the economic dispatch problem we can write

$$P_T = P_1 + P_2 + \cdots + P_N - P_{LOSS} \tag{1}$$

where P_{LOSS} is the total line loss. Since P_T is assumed to be constant, we have

$$0 = dP_1 + dP_2 + \cdots + dP_N - dP_{LOSS}$$

In the above equation dP_{LOSS} includes the power loss due to every generator, i.e., $\qquad$ (2)

$$dP_{LOSS} = \frac{\partial P_{LOSS}}{\partial P_1} dP_1 + \frac{\partial P_{LOSS}}{\partial P_2} dP_2 + \cdots + \frac{\partial P_{LOSS}}{\partial P_N} dP_N \tag{3}$$

Also minimum generation cost implies $df_T = 0$. Multiplying both (2) and (3) by λ and combining we get

$$0 = \left(\lambda \frac{\partial P_{LOSS}}{\partial P_1} - \lambda \right) dP_1 + \left(\lambda \frac{\partial P_{LOSS}}{\partial P_2} - \lambda \right) dP_2 + \cdots + \left(\lambda \frac{\partial P_{LOSS}}{\partial P_N} - \lambda \right) dP_N \tag{4}$$

Adding (4) with (5) we obtain

$$0 = \sum_{i=1}^{N} \left(\frac{\partial f_T}{\partial P_i} + \lambda \frac{\partial P_{LOSS}}{\partial P_i} - \lambda \right) dP_i \tag{5}$$

The above equation satisfies when

$$\frac{\partial f_T}{\partial P_i} + \lambda \frac{\partial P_{Loss}}{\partial P_i} - \lambda = 0, \quad i = 1, \ldots, N$$

(6)

Again since

$$\frac{\partial f_T}{\partial P_i} = \frac{df_T}{dP_i}, \quad i = 1, \ldots, N$$

from (6) we get

(7)

$$\lambda = \frac{df_1}{dP_i} L_1 = \frac{df_2}{dP_2} L_2 = \cdots = \frac{df_N}{dP_N} L_N$$

where L_i is called the **penalty factor** of load- i and is given by

$$L_i = \frac{1}{1 - \partial P_{Loss} / \partial P_i}, \quad i = 1, \ldots, N$$

PROBLEM STATEMENT

A two-bus system is shown in figure below. If 100 Mw is transmitted from plant1 to the load, a transmission loss of 10 MW is incurred. Find the required generation for each plant and the power received by load when the system λ is Rs 25/MWh. The incremental fuel costs of the two plants are given below

$$\frac{dC_1}{dP_{G_1}} = 0.020 P_{G_1} + 16 \text{ Rs/MWh}$$

$$\frac{dC_2}{dP_{G_2}} = 0.04 P_{G_2} + 20 \text{ Rs/MWh}$$

A two-bus system

CONCLUSION

The MATLAB code for the above problem is run and executed. It can be interpreted that the minimum fuel cost is obtained, when the incremental fuel cost of each plant multiplied by its penalty factor is the same for all the plants. Also when one generator is far away connected through transmission line there is some loss component involved in that.

REFERENCES

[1]. Stevenson Jr, W. D. (1982). *Elements of Power System Analysis*, (4th), Mc-Graw Hill Higher Education.
[2]. Hadi Saadat, "*Power System Analysis*", Milwaukee School of Engineering, McGraw Hill, 1999.
[3]. Kothari D. P., Nagrath I. J., *"Modern Power System Analysis"*, Mc-Graw Hill Higher Education.

APPENDIX

MATLAB CODE

```
clear
% MATLAB Program for optimum loading of generators
% This program finds the optimal loading of generators including
% penalty factors

% n is no of generators
n=2
% Pd stands for I oad demand
% alpha and beta arrays denote alpha beta coefficients for given
% generators
Pd = 237.04;
alpha=[ 0.020
     0.04];
beta=[16
    20];
lamda=20;
lamdaprev =lamda;
% tolerance is eps and increment in lamda is deltalamda
eps=1;
deltalamda = O.25;
% the minimum and maximum limits of each generating unit
% are stored in arrays Pgmin and Pgmax.
% In actual large scale problems,we can first initialise the Pgmax array
% to inf using for loop
% and Pgmin array to zero using Pgmin=zeros(n,1) command
PGmax=[200 200]:
Pgmin=[0 0] ;
B=[0.001 0
   0    0] ;
Pg = zeros(n,1) ;
noofiter=0;
PL=0;
Pg = zeros(n,1);
while abs(sum(Pg)-PD-PL)>eps
   for i=1:n
      sigma=B(i,:)*Pg-B(i,i)*Pg(i) ;
      Pg(i) =( 1-beta(i)/lamda-(2*sigma))/(alpha(i)/lamda+2*B(i,i));
      PL=Pg'*B*Pg;
if Pg(i) > Pgmax(i)
Pg(i) =Pgmax(i) ;
end
if Pg(i) < Pgmin(i)
   Pg(i) = Pgmin(i)
end
```

```matlab
    end
PL=Pg'*B*Pg;
if (sum(Pg)-Pd-PL) < 0
    lamdaprev = lamda;
    lamda=lamda+deltalamda;
else
    lamdaprev=lamda;
    lamda=lamda-deltalamda;
end
noofiter=noofiter+1 ;
Pg;
end
disp('The number of iterations required are')
noofiter
disp('The final value of lamda is')
lamdaprev
disp('The optimal loading of generators including penalty factors is')
Pg
disp('The losses are')
PL
```