INFLUENCE OF BIOGAS POWER PLANT ON ACTIVE POWER LOSSES IN DISTRIBUTION NETWORK

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ABSTRACT

This article discusses about influence of biogas power plant on active power losses. With decreasing active power losses we can save energy that occurs in the transmission of power in the network. For this purpose we use biogas power plant. With optimization process we determined active power losses before and after connecting biogas power plant into distribution network. All simulations were performed in Matlab tool. We used optimization method called Particle Swarm Optimization.

1. INTRODUCTION

Today we are witnesses of continuous increase in electricity demand. This fact causes problems with management of power systems, increasing active power losses in power systems and problems with reliability of supply. As a result, operators of power systems are forced to search new source of energy. This source of energy should be decentralized in power systems and also if it is possible should be close to customers for minimizing active power losses.
In this article we supposed small biogas power plant with install power 2 MG. This power plant is working into distribution network on 22 kV level. Biogas is renewable resource (consisting mainly of methane and carbon dioxide). Biogas is produced during anaerobic micro bacterial degradation processes of organic material (all microbiological degradable substrates can be used for production of biogas). The produced biogas is a mixture of about 50 – 70 % methane and 30 – 40 % carbon dioxide. This gas can be used in many ways. The most common alternative is the utilisation in a gas engine for the production of electricity and heat [2].

2. OPTIMIZATION METHOD

Particle swarm optimization (PSO) is a population based stochastic optimization technique inspired by the social behaviour of flocks of birds or school of fish. PSO shares many similarities with evolutionary computation techniques such as genetic algorithms. The system is initialized with a population of random feasible solutions and searches for optima by updating generations. However unlike genetic algorithm, PSO has no evolution operators such as crossover and mutations.
The whole calculation process can be summarized into the following steps [1]:

1. Initialization – generate random *n* particles. Each particle is considered to be a solution for the problem.
2. Counter updating
3. Compute the objective function
4. Velocity updating – using the global best and individual best.
5. Position updating – based on the updated velocity.
6. Individual best updating – Each particle is evaluated and updated according to the update position.
7. Search for the minimum value in the individual best where its solution has ever been reached in every iteration and considered it as the minimum.
8. Stop criteria – If one of the stopping criteria is satisfied, then stop, otherwise go to step 2.

3. PROBLEM FORMULATION AND RESULTS

We considered 23 nodes power system. The first sixteen nodes are on 110 kV level, other are on 23 kV level. We assumed that all transformers 110/23 kV are regulation transformers (110 ± 8x2%/23 kV). In first case we did not consider the use of biogas power plant. In this case the controlled variables are only transformer tap ratio. In second case we considered use of biogas power plant. In this case are not only transformers tap ration regulations variables. Also place (node) and amount of power is necessary determine.
In optimization process main constraints are:

1. Voltage limit
2. Max./min. position on transformer tap changer
3. Max. permissible current flow though the line
4. Max. active power generated by biogas power plant.

All simulation results are shown in the following graphs. In second case (red colour) optimization process determined that the best location (from side of decreasing active power losses) for install biogas power plant is node 21. Changes of transformers taps (voltage on primary side) for both cases are in table 1.

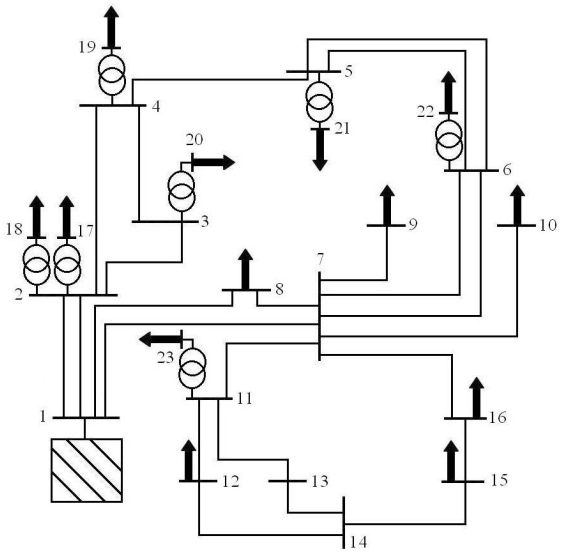

Figure 1 – 23 nodes distribution network.

Table 1 – Loads in nodes

Node [-]	Load [MVA]	Node [-]	Load [MVA]
1	0	13	0
2	0	14	0
3	0	15	3+1i
4	0	16	3+1i
5	0	17	1+0,5i
6	0	18	2+1i
7	0	19	3+1i
8	3+1i	20	1+0,5i
9	2+1i	21	3+1i
10	1+0,5i	22	2+i1
11	0	23	1+0,5i
12	2+1i		

Table 2 – Changes of transformers taps

Transformer		Voltage on secondary side [kV]	
from node [-]	to node [-]	Case 1	Case 2
2	17	105,6	105,6
2	18	105,6	105,6
4	19	105,6	105,6
3	20	110	110
5	21	105,6	105,6
11	23	107,8	105,6
6	22	105,6	105,6

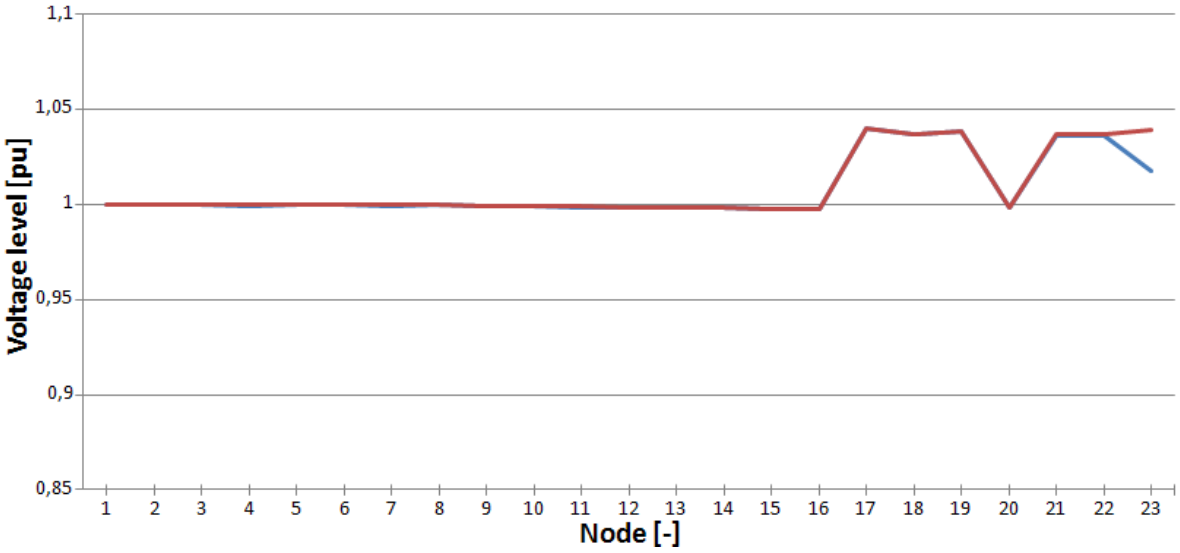

Figure 2 – Voltage profile

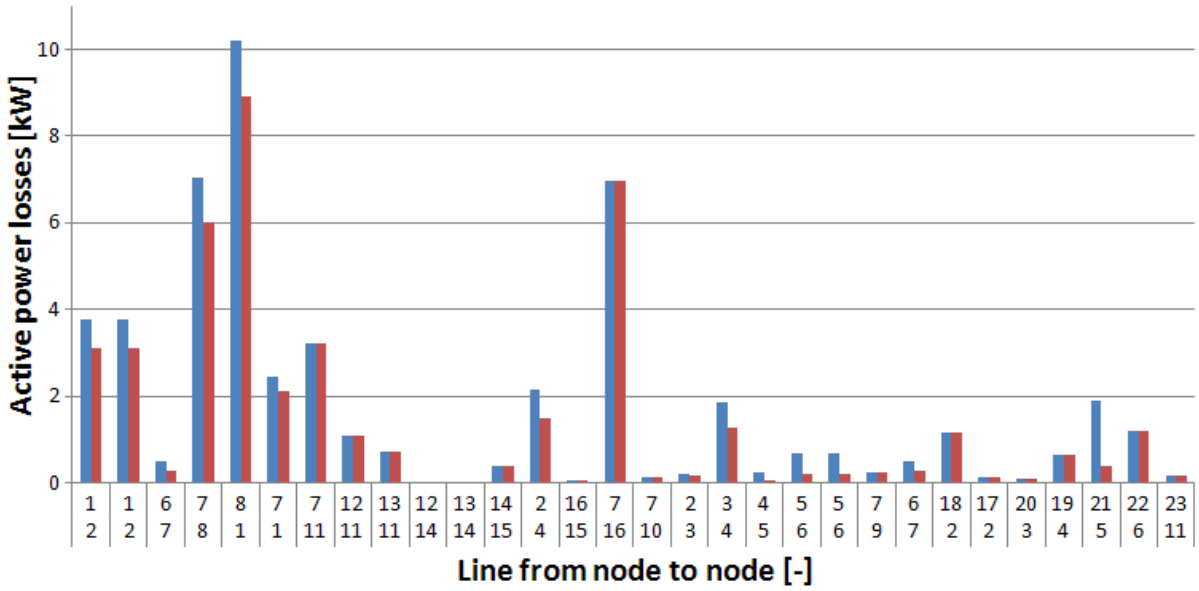

Figure 3 – Active power losses in all lines

In fig. 2 we can see voltage changes for all nodes in both cases. On 110 kV level is voltage without significant change only on 22 kV level occur to change of voltage. In fig. 3 we can see active power losses in all lines. As we can see not in all lines with installing biogas power plant are active power losses lower. But total active power losses are lower compared to the first case. In case without installing biogas power plant after optimization process were total active power losses 52,06 kW. After optimization with installing biogas power plant were total active power losses 43,7 kW. This is decrease about 16,06 %.

4. CONCLUSIONS

This article deals with influence of biogas power plant on active power losses in distribution networks. The aim was to show that installing biogas power plant into distribution networks offers not only new source of energy in power system, but if this source is installed in suitable place (node) this source can decrease active power losses in this network.

REFERENCES

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