IMPLEMENTATION OF NETWORK RECONFIGURATION ALGORITHM IN ELECTRICAL DISTRIBUTION SYSTEMS

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Abstract — Network reconfiguration of a distribution system is an operation to alter the topological structure of distribution feeders by changing open /closed status of sectionalizing and tie switches. This paper presents an approach for distribution system reconfiguration to minimising losses. The proposed algorithm has been implemented on 6-bus distribution system in the MATLAB environment.

Keywords— Radial Distribution System, Distribution Load Flow, Network Reconfiguration.

I. INTRODUCTION

Currently a significant amount of electric energy produced by power plants is lost during transmission and distribution to consumers. About 40 percent of this total loss occurs on the distribution network [5]. The distribution network usually operates in a radial configuration, with tie switches between circuits to provide alternate feeds. Whenever components fail, some of the switches must be operated to restore power to as many customers as possible. As loads vary with time, switch operations may reduce losses in the system and transfer of loads from heavily loaded feeder. All of these are applications for DNR [2]. DNR is a process of changing the status of the network topology through opening or closing tie switches to optimize the network parameters.

Network reconfiguration is a process of altering the topological structures of the distribution feeders by changing the open/close status of the sectionalising and tie switches. During normal operating conditions, the networks are reconfigured to reduce system real power losses [3] and accomplish load balancing to relieve network overloads. Thus, under normal operating conditions the network is reconfigured to reduce the system's losses and/or to balance load in the feeders. Under conditions of permanent failure, the network is reconfigured to restore the service, minimizing the zones without power [1].

The algorithm implemented in this paper is a classic technique. The only input data of this algorithm is the conventional bus-branch oriented data used by most utilities. Two developed matrices, the bus-injection to branch-current matrix (BIBC) and the branch-current to bus-voltage matrix (BCBV), and a simple matrix multiplication are utilized to obtain load flow solutions [2].

II. PROPOSED ALGORITHM

A. Load Flow Analysis:

The formation of BIBC and BCBV matrices is explained in [2]. These matrices explore the topological structure of distribution systems. The BIBC matrix is responsible for the relations between the bus current injections and branch currents. The BCBV matrix is responsible for the relations between the branch currents and bus voltages. Combining the relation between the bus current injections and bus voltages can be expressed as Distribution Load Flow matrix (DLF):

The algorithm steps for load flow solution of distribution system are given below:

Step 1: Read the distribution system line data and load data.

Step 2: Form BIBC matrix. The relationship is given as

$$\left[I_B\right]=\left[BIBC\right]\left[I\right]$$

Step 3: Form BCBV matrix. The relationship is given as

$$\left[\Delta V\right]=\left[BCBV\right]\left[I_B\right]$$

Step 4: Form DLF matrix. The relationship will be

$$\left[DLF\right]=\left[BCBV\right]\left[BIBC\right]$$

$$\left[\Delta V\right]=\left[DLF\right]\left[I\right]$$

Step 5: Set Iteration k=0.

Step 6: Update voltages by using below equations

$$I_i^k=\frac{\left(P_i+jQ_i\right)}{V_i^k}$$

$$\left[\Delta V^{k+1}\right]=\left[DLF\right]\left[I^k\right]$$

$$\left[V^{k+1}\right]=\left[V^0\right]-\left[\Delta V^{k+1}\right]$$

Step 7: Iteration k=k+1.

Step 8: If max ((|I(k+1)|-|I(k)|) > tolerance) go to step 4.

Step 9: Calculate line flows, and losses from final bus voltages.

Step 10: Print bus voltages, line flows and losses.

Step 11: Stop.

B. Network Reconfiguration:

The reconfiguration algorithm considered to minimize losses in distribution network is shown in Flowchart [4] in Fig. 2.

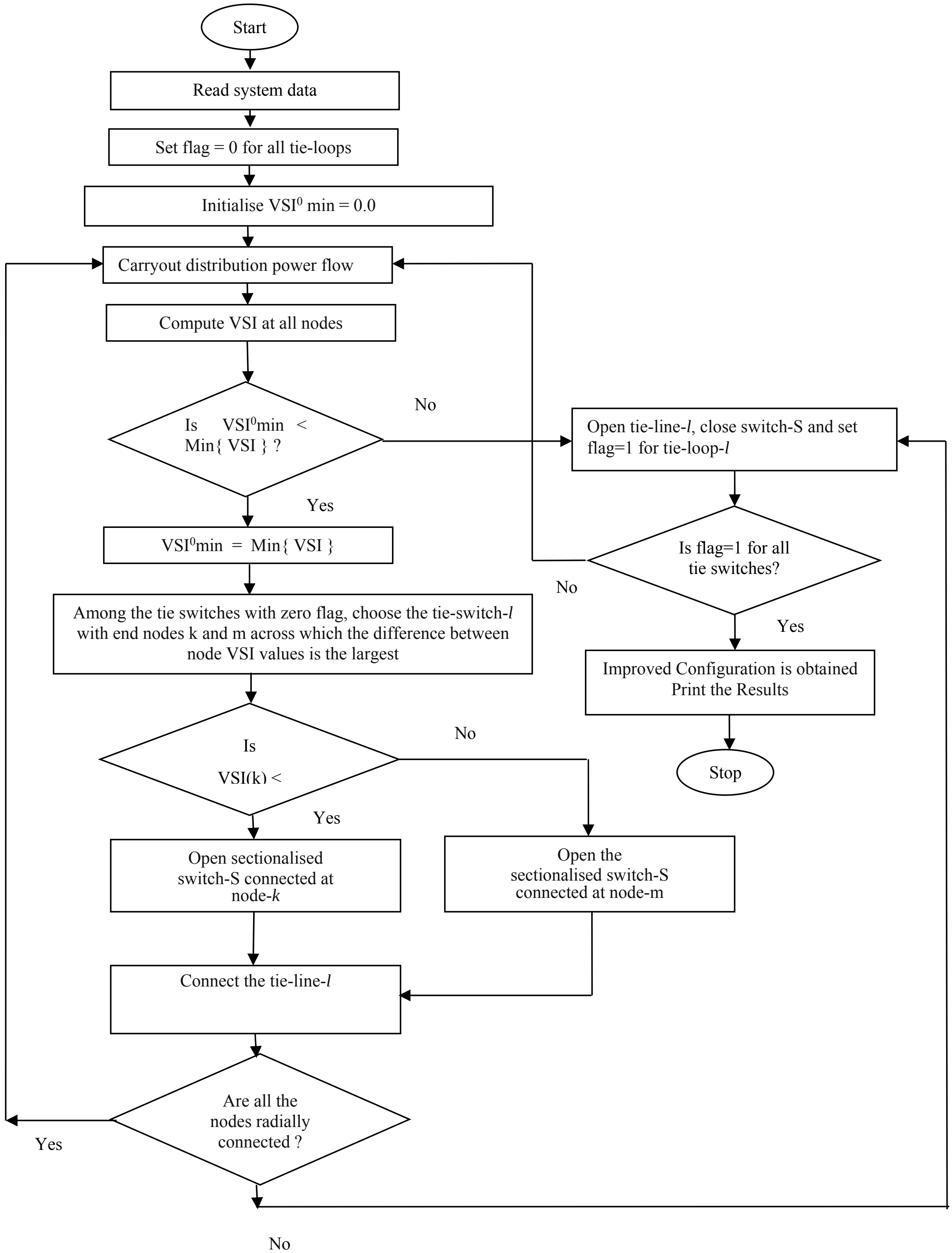
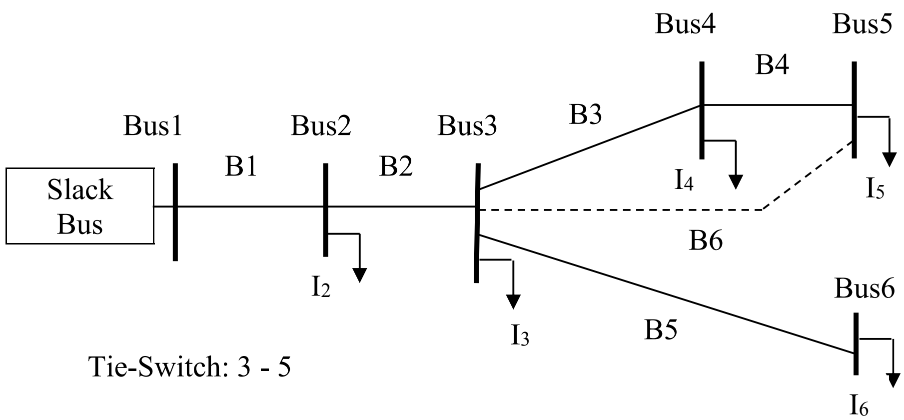


Fig. 2 Flow chart for network reconfiguration of radial distribution system

III. RESULTS AND ANALYSIS

The algorithms given in section II is applied to a 6-bus distribution system using MATLAB programming and the obtained results are analysed. Load flow for a 6-bus distribution system shown in Fig. 3 is carried out as follows. Line and load data of 6-Bus distribution system is given in the Table 1 and 2.



g. 3 6-bus Distribution system

Table 1: Line and reliability data of 6-bus distribution system

Base kV =12.66kV, Base MVA =100MVA

Line Number	Sending end Node	Receiving end Node	R (Ω)	X(Ω)
1	1	2	0.0922	0.047
2	2	3	0.493	0.2511
3	3	4	0.366	0.1864
4	4	5	0.3811	0.1941
5	3	6	0.819	0.707
6	3	5	0.5	0.5

Table 2: Load data of 6-bus distribution system

Bus No.	Active power (kW)	Reactive power (kVAr)
1	0	0
2	100	60
3	90	40
4	120	80
5	60	30
6	60	20

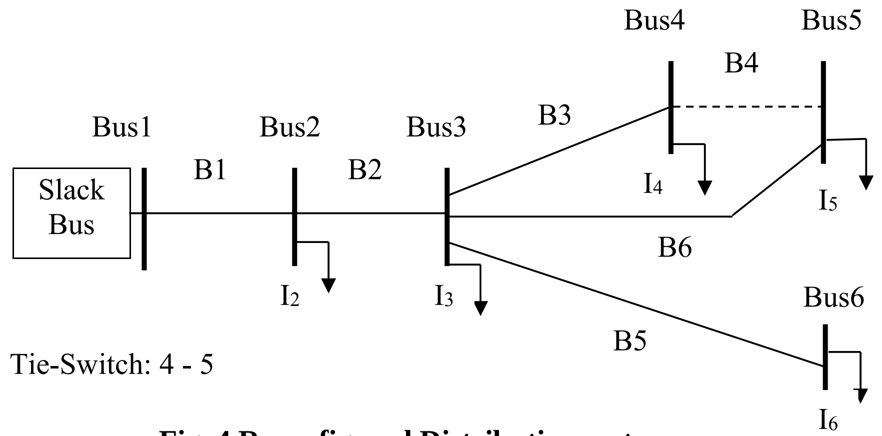


Fig. 4 Reconfigured Distribution system

Table 3. Comparison of Power Loss values

Parameter	Before NR	After NR
Real Power Loss	0.6961	0.6450
Reactive Power Loss	0.3602	0.3419
Total Power Loss	0.7838	0.7300

IV. CONCLUSIONS

A reconfiguration scheme for reducing losses in radial distribution systems is implemented. This algorithm reduces the system power losses without any additional equipment cost. The proposed algorithm is applied on a 6-bus radial distribution system and the obtained results from MATLAB are analyzed.

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