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Reconfiguration Of An Unbalanced Distribution System For Loss Reduction By Software Simulation

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Abstract

An Electrical Distribution System topology can be suitably modified to minimize the losses. This can be done by reconfiguration of the network to minimise the losses. This work proposes reconfiguration of distribution network system for minimizing the real power losses based on CYMEDIST, which is an efficient analysis software. Through this technique we can calculate the losses, reactive, apparent power and power factor (%). The reconfiguration problem has been formulated and effectively tested on 19 node unbalanced radial distribution system.

***Keywords**: Distribution system, Network Reconfiguration, Loss Minimisation*

1. INTRODUCTION

Distribution companies are constantly in search for new technologies that enhance power delivery performance. One of several significant issues is the manage power losses. A number of strategies can be employed to minimize power losses in a distribution network including inclusion of capacitor banks, phase balancing and reconfiguration of distribution feeders. The distribution feeder reconfiguration consists of changing the system topology by opening and closing switches with the objective of minimizing system losses or minimizing service restoration time in the event of contingencies.

In developing countries distribution systems cause a loss of about 5–13% of the total power generated [2]. A lot of research work has been carried out to solve Distribution network reconfiguration problems. These research efforts can be broadly classified into traditional approaches and AI based approaches. The traditional approaches include heuristic optimization techniques and classical optimization techniques. A branch exchange method was used in which approximate formulae

Provide the change in loss due to feeder reconfiguration in [3]-[4]. In another technique the switches were opened one by one beginning from a fully meshed system, based on an optimal power flow pattern by Shirmohammadi and Hong [5]. Another algorithm based on optimal flow pattern, of a single loop, formed by closing a normally open switch, and the switch with minimum current was opened by Goswami and Basu [6]. Sarfi et al. [7] developed a method based on partitioning the distribution system into group of load buses, such that the line section losses between groups of nodes were minimized. But in [8]–[9], solution strategies have been proposed for feeder reconfiguration using simulated annealing. In [10] based on approaches in [4, 5] a heuristic method for three-phase unbalanced systems was proposed. According to another reference an algorithm has been proposed to minimize losses and load balancing for a large-scale unbalanced system using network reconfiguration Wang et al. [11]. Thus there are many ways to reduce losses in distribution system, one of the simple and cheap way of reducing losses is reconfiguration/changing the status of the sectionalizing switching operation. There are many objectives for reconfiguration of unbalanced distribution system such as:-

A) To reduce the real losses
B) To increase stability of voltage profile
C) Network is the reliable
D) Reduce the power factor

The method proposed in this paper is tested on 19 bus unbalanced radial distribution system.

2) MATHEMATIC MODEL OF DISTRIBUTION NETWORK RECONFIGURATION

A) Minimum losses model-

The minimum losses formulation for reconfiguration problem, it expressed mathematically as:

$$\min f = \sum_{i=1}^{n} k_i r_i \frac{P_i^2 + Q_i^2}{V_i^2}$$

Where

- n total no of branches
- r_i branch of resistance i ;
- q_i branch of reactive power i ;
- p_i branch of active power i ;
- v_i voltage on head node of branch i ;
- k_i switch on branch i ,1 can equal to closed, 0 can equal to open ;

B) Representation of two substations in a simple distribution system

Figure represents two substations in a simple distribution system. A, B shows the branch on left-hand side feeder and right hand side feeder respectively Nanjung [12]. In this system n no. of nodes are taken in between the two feeders where K is the tie switch and (S1,S2,S3,S4,S5,S6) are sectionalizing switches in this two feeder distribution system.

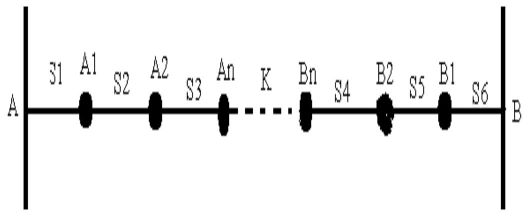

Fig 1: A simple distribution system with two substations with n nodes

The tie switches are closed to form a loop, and then choosing a sectionalising switch we open the loop to get back the radial topology. All the tie switches in the network should be searched and calculated during reconfiguration process as proposed by Baran [13] and Zhang [14]. The sectionalizing switches are basically used for protection in secondary distribution system [15][16]. An efficient power load flow in computational time has been proposed by Shirmohammadi [5] and a formula for loss reduction in on /off condition by Civanlar [17].

According to the paper CYMDIST Software has been used for to analyse the network for reconfiguration. The 11 kV, 19 node unbalanced radial distribution system with base reconfiguration is based on 1 MVA. The line, load and tie switch data are given in [1]. The normally opened switches are s19 and s20. When s19 and s20 are in open condition the power supply goes to nodes (1,2,4,6,8,9,10,11,13,14,18,17,12,16,15,19,7,5,3).

The main aim of this study is to minimize the active loss.

In the proposed system data related electrical condition of feeder, line length, properties of cable and so on are required. Voltage profile and summary of test results of 19 node unbalanced radial distribution system before and after network reconfiguration are given table 1 and 2 respectively in [1]. The active power loss in phase A, B and C is 4.45, 4.45 and 4.56 KW to 0.10,0.10 and 0.18 KW.

3) NETWORK DEVELOPED IN THE SOFTWARE ENVIORMENT

The network has been created to calculate the losses before and after reconfiguration. The complete network when the sectionalising and tie switches are in closed position is shown in fig 2.

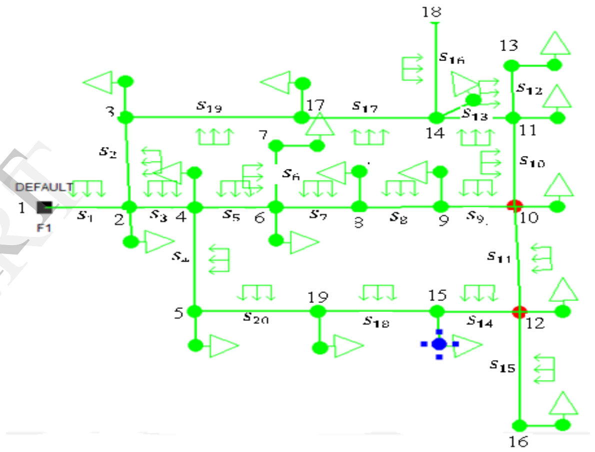

Fig 2: Unbalanced Radial Distribution System

The two cases of network reconfiguration in distribution system are discussed below:

A) Before reconfiguration case:

Normally switch s_{19} and s_{20} are in open condition [1], and the active power loss in each phase A, B and C is 4.45, 4.45 and 4.56 KW. After the network reconfiguration the losses reduces to 0.10, 0.10 and 0.18 KW. In the paper the switch position of s_{19} and s_{20} has been changed to s_9 and s_{11} as seen in fig 3.

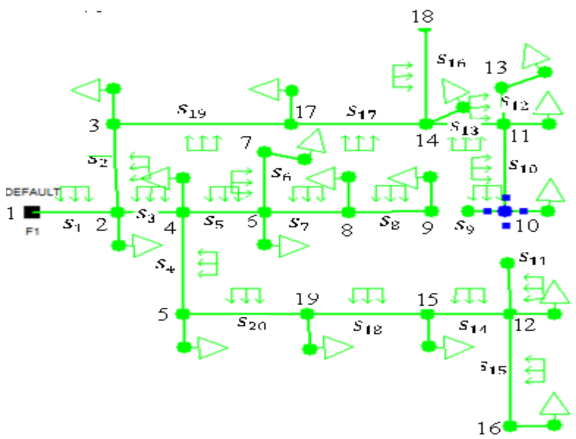

Fig 3: Switching positions (s_9 and s_{11}) open

Table shows the total losses in KW, total losses in KVAR.

S.No.	Description	Switching position	Phase A	Phase B	Phase C
1.	Total active power loss(KW)	s_{19} and s_{20}	4.45	4.45	4.56
2.	Total reactive power loss (KVAR)	s_{19} and s_{20}	1.94	1.89	1.95
After reconfiguration	-	-	-	-	-
3.	Total active power loss(KW)	s_9 and s_{11}	0.10	0.10	0.0.18
4.	Total reactive power loss (KVAR)	s_9 and s_{11}	0.05	0.04	0.06

Table 1: Loss reduction before reconfiguration case

During network reconfiguration by opening and closing 2 suitable switches i.e (s_9 and s_{11}) and (s_{19} and s_{20}) respectively, same load would be on feeder A , and losses will be reduced a small fraction. Similarly by opening switch (s_9 and s_{11}) and closing (s_{19} and s_{20}) losses will be reduced to 0.10 kW. The graphs depict the voltage profile, reactive and apparent power

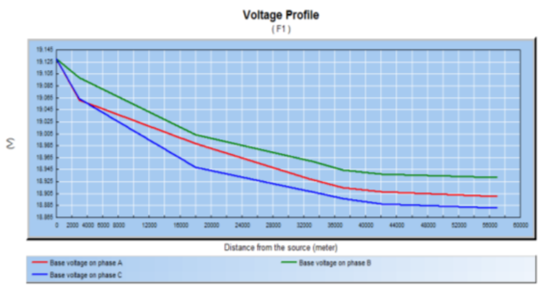

Fig 4: Voltage profile of the test system

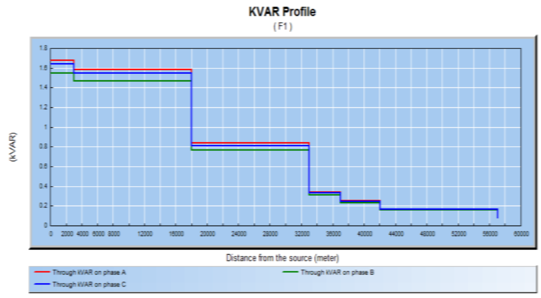

Fig 5: KVAR profile of test system

B) After reconfiguration case:

Switches S_{10} and S_{11} are opened in the unbalanced radial distribution system after reconfiguration. The active power loss in each phase A, B and C is 2.83, 2.53 and 2.86 KW which have reduced to 0.10, 0.09 and 0.11 KW with the proposed system. After reconfiguration the switch position is shown in fig 6.

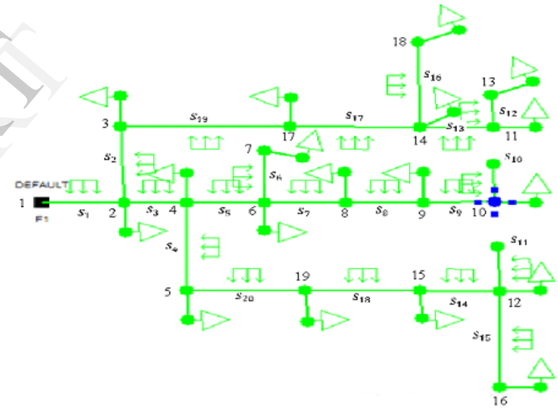

Fig 6: Switch position (S_{10} and S_{11}) open after reconfiguration

Table shows the total losses in KW, total losses in KVAR.

S.No.	Description	Switching position	Phase A	Phase B	Phase C
1.	Total active power loss(KW)	s_{10} and s_{11}	2.83	2.53	2.86
2.	Total reactive power loss (KVAR)	s_{10} and s_{11}	1.27	1.10	1.16
After reconfiguration	-	-	-	-	-
3.	Total active power loss(KW)	s_{10} and s_{11}	0.10	0.09	0.11
4.	Total reactive power loss (KVAR)	s_{10} and s_{11}	0.05	0.04	0.08

Table 2 After system reconfiguration.

The graphs show voltage and reactive power profiles.

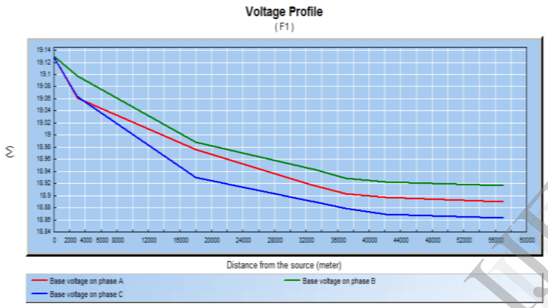

Fig7:Voltage profile of test system

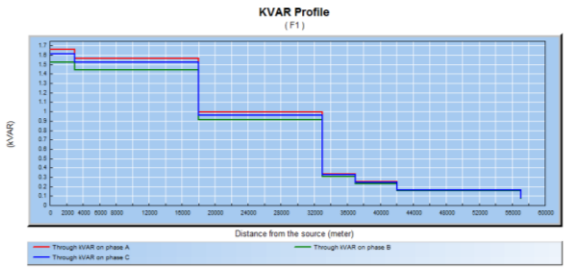

Fig 8: KVAR profile of test system

4. CONCLUSION:

In the proposed system, by shifting the tie switches on the lines the losses have been reduced significantly in the unbalanced radial distribution system by minimizing the switching time and thus reducing the losses on the donor. CYMDIST performs per phase voltage drop calculations unbalanced systems, fault calculations (fault flows and fault voltages). The system offers a very powerful graphic editor to enter or modify feeder data and to perform line switching. It also offers a wide variety of graphical reports including voltage profile and short-circuits current profiles along the feeder.

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6. REFERENCES:

[1] Ganesh. Valasala, Sivanagaraj,Sirigiri, Ramana. Triruveedula "Feeder reconfiguration for loss reduction in Distribution system using genetic algorithm," International Journal of Electrical and Electronics Engineering, 2009.

[2] Asian Development Bank, "Power systems efficiency through loss reduction and load management," Proceedings of the Regional Conference on Power Systems Efficiency through Loss Reduction and Load Management, 1985.

[3] S. Civanlar, J.J. Grainger, H. Yin and S.H. Lee "Distribution feeder reconfiguration for loss reduction," IEEE Trans. Power Deliv. 3, (3), pp.1217–1223,1988.

[4] M.E. Baran, and F.F. Wu "Network reconfiguration in distribution for loss reduction and load balancing," IEEE Trans. Power Syst., 4, (3), pp.1401–1407, 1989.

[5] D. Shirmohammadi and H.W. Hong "Reconfiguration of electric distribution networks for resistive line loss reduction," IEEE Trans. Power Deliv., 4, (2), pp. 1492–1498,1989.

[6] S.K. Goswami and S.K. Basu " new algorithm for the reconfiguration of distribution feeders for loss minimization," IEEE Trans. Power Deliv. 7, (3), pp. 1484–1491, 1992.

[7] R.J. Sarfi, M.M.A. Salama and A.Y. Chikhani "Distribution system reconfiguration for loss reduction: an algorithm based on network partitioning theory," IEEE Trans. Power Syst., 11, (1), pp. 504–510,1996.

[8] H.D. Chiang and R.M. Jean-Jameau "Optimal network reconfiguration in distribution systems, Part 1: a new formulation and a solution methodology," IEEE Trans. Power

Deliv., 5, (4), pp. 1902–1909, 1990.

[9] Y.J. Jeaon, J.C. Kim, J.O. Kim, J.R. Shin and K.Y. Lee "An efficient simulated annealing algorithm for network reconfiguration in large-scale distribution systems," IEEE Trans.Power Deliv., 17, (4), pp. 10701078, 2002.

[10] V. Borozan, D. Rajicic and R. Ackovski "Minimum loss reconfiguration of unbalanced Distribution networks," IEEE Trans. Power Deliv., 12, (1), pp. 435–442, 1997.

[11] J.C. Wang, H.D. Chiang and G.R. Darling "An efficient algorithm for real time network reconfiguration in large scale unbalanced distribution systems," IEEE Trans. Power Syst.,11, (1), pp. 511 517, 1996.

[12] Jianming Yu "Distribution network reconfiguration based on minimum cost of power supply," Internal conference on suitable power generation and suppl, 2009, ISBN: 978-1-4244-4934-7.

[13] Baran M.E.,Wu F.F. Network reconfiguration in distribution systems for loss reduction and load balancing [J]. IEEE Transactions on Power Delivery, 1989,4(2): 1401-1407.

[14] Zhang Dong, Zhang Liu-chun, Fu Zheng-cai, A Quick Branch-Exchange Algorithm for Reconfiguration of Distribution Networks [J]. Power System Technology,2005,29(9):82,85.

[15] H. Bagheri Tolabi ,. Gandomkar and M. Bahreyni Borujeni. ''Reconfiguration and Load balancing by software simulation in a real distribution network for loss reduction''. Canadian Journal on Electrical and Electronics Engineering Vol. 2 No. 8, August 2011.

[16] Prof. P. M. Sonwane, Prof. D. P. Kadam, Prof. Dr. B.E. Kushare, Member IEEE'' Distribution System Reliability Through Reconfiguration, Fault Location, isolation and Restoration''

[17] S. Civanlar and J. J. Grainger, ''Distribution feeder reconfiguration for loss reduction,'' IEEE Trans. Power Del., vol. 3,pp. 1217-122, Jul.1988.