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Minimization of Power Loss in Distribution Networks by Different Techniques

Mr.Rudresh.B.Magadum, Mr.Tejaswi.M.Timsani

Abstract— This paper proposes accurate loss minimization is the critical component for efficient electrical distribution power flow. The contribution of this work presents loss minimization in power distribution system through network reconfiguration, DTC relocation, voltage regulator placement, express feeders and building new substation.

Index Terms— Distribution system, Network Reconfiguration, Express Feeder, Automatic Voltage Regulator (AVR) placement,

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1. INTRODUCTION

The distribution system is the most visible part of the supply chain, and as such the most exposed to the critical observation of its users. It is, in many cases, the largest investment, maintenance and operation expense, and the object of interest to government, financial agencies, and associations of concerned citizens. About 30 to 40 % of total investments in the electrical sector go to distribution systems [3], but nevertheless, they have not received the technological impact in the same manner as the generation and transmission systems.

Ideally, losses in an electric system should be around 3 to 6%. In developed countries, it is not greater than 10%.However, in developing countries, the percentage of active power losses is around 20%; therefore, utilities in the electric sector are currently interested in reducing it in order to be more competitive, since the electricity prices in deregulated markets are related to the system losses. In India, collective of all states, in 2008 the technical and non technical losses are accounted as 23% of the total input energy [2]. To manage a loss reduction program in a distribution system it is necessary to use effective and efficient computational tools that allow quantifying the loss in each different network element for system losses reduction. Various authors have discussed loss minimization in different aspects.

India's transmission and distribution losses are among the highest in the world. When non-technical losses such as energy theft are included in the total, losses go as high as 65% in some states and average about 35- 40%. The financial loss has been estimate at 1.5% of the national GDP.

TABLE.1 COMPARISON OF LOSSES IN DIFFERENT STATES OF INDIA [2]

Less than 20%	Between 20-30%	Between 30-40%	Above 40%
Goa	Andra Pradesh	karnataka	Delhi
Tamilnadu	Gujarat	kerala	Uttar Pradesh
	West Bengal	Assam	Bihar
	Himachal Pradesh	Haryana	Jharkhand
	Maharastra	Rajstan	Madhya Pradesh
	Tripuar	Meghalaya	Arunachal Pradesh
	Punjab	Mizam	Manipal
	Uttaranchal	Chattisgarh	Nagaland

2. LOSS REDUCTION AND VOLTAGE IMPROVEMENT TECHNIQUES.

Technical losses can be reduced by up-gradation of the existing network using.

- Network reconfiguration
- DTC relocation (Change of feed)

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- Network re-conduct ring
- Voltage regulator placement
- Use of express feeder
- Adoption of High voltage distribution system (HVDS)
- Building new substation

2.1 Network Reconfiguration

Optimal distribution planning involves network reconfiguration for distribution loss minimization, load balancing under normal operating conditions and fast service restoration minimizing the zones without power under failure conditions. Network Reconfiguration is the process of operating switches to change the circuit topology so that operating costs are reduced while satisfying the specified constraints.

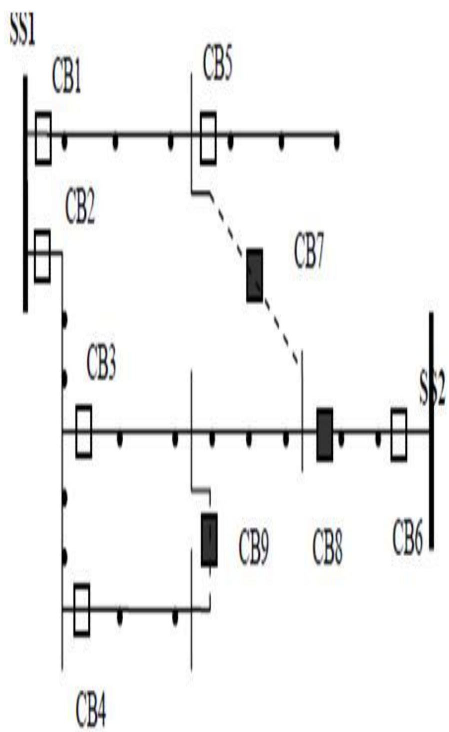

Fig.1 Simple example for network reconfiguration

2.2 Distribution Transformer (DTC) Relocation

DTC relocation involves the change of feed point. This scheme is adopted as an immediate solution. The new point of connection can be determined by feasibility study.

- Merits
  1. Supports further reconfiguration
  2. Investment required is less
- Demerits
  1. The extent of voltage improvement is limited
  2. For further improvement of voltage profile we have to adopt for other methodologies which involves extra investment.

2.3 Network Re-conductoring

Replacement of the existing conductor on the feeder with an optimal conductor size for optimal length of the feeder since, size of the conductor is the parameter that decides current density and resistance. This scheme is applied when Network reconfiguration is not possible

The existing conductor is no more optimal due to rapid load growth Re-conductoring depends on Load expected to serve and capacity required in future.

- Merits
  1. Increases the capability to handle load growth
- Demerits
  1. Additional investment is required

2.4 Voltage Regulator Placement

The capability of a voltage regulator to maintain smooth voltages is an attractive solution. The optimal location of the placement can be determined by conducting feasibility study.

- Merits
  1. Smooth variation of voltage is possible.
- Demerits
  1. The extent of voltage improvement is limited
  2. Extensive use will further deteriorate the network.

2.5 Use of Express Feeder

Express feeder is the feeder running from the source to any load point with no tapping intermediately. The use of express feeder is recommended when Reconfiguration or Re-conductoring is not possible. The point of connection depends upon the quotient of voltage difference.

- Merits
  1. More effective in improving the voltage profile
  2. Supports more load growth compared to reconfiguration and re-conductoring schemes
  3. Further reconfiguration is made possible
- Demerits
  1. Additional investment is required

2.6 Adoption of High voltage distribution

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System (HVDS)

Conversion of existing LVDS to HVDS reduces the technical losses effectively

Example: For a 100 KVA load the current for 11kV system is 5.2 A whereas for 415 V it is 140 A.

- Merits
  1. Reduced losses and improved voltage profile
- Demerits
  1. Additional investment is required
  2. Regular maintenance is required

2.7. Building new substation

This involves addition of new substation in addition to the existing. Location of the installation is determined by feasibility study. This scheme has to be adopted as the last option.

- Merits
  1. More reliable
  2. Reduction in losses and improved voltage profile
- Demerits
  1. Additional investment for building new substation

3. ORDER OF PRECEDENCE FOR ADOPTION OF METHODOLOGIES

- Network reconfiguration
- DTC relocation (Change of feed)
- Line re-conductoring
- Voltage regulator placement
- Use of express feeder
- Adoption of HVDS
- Building new substation

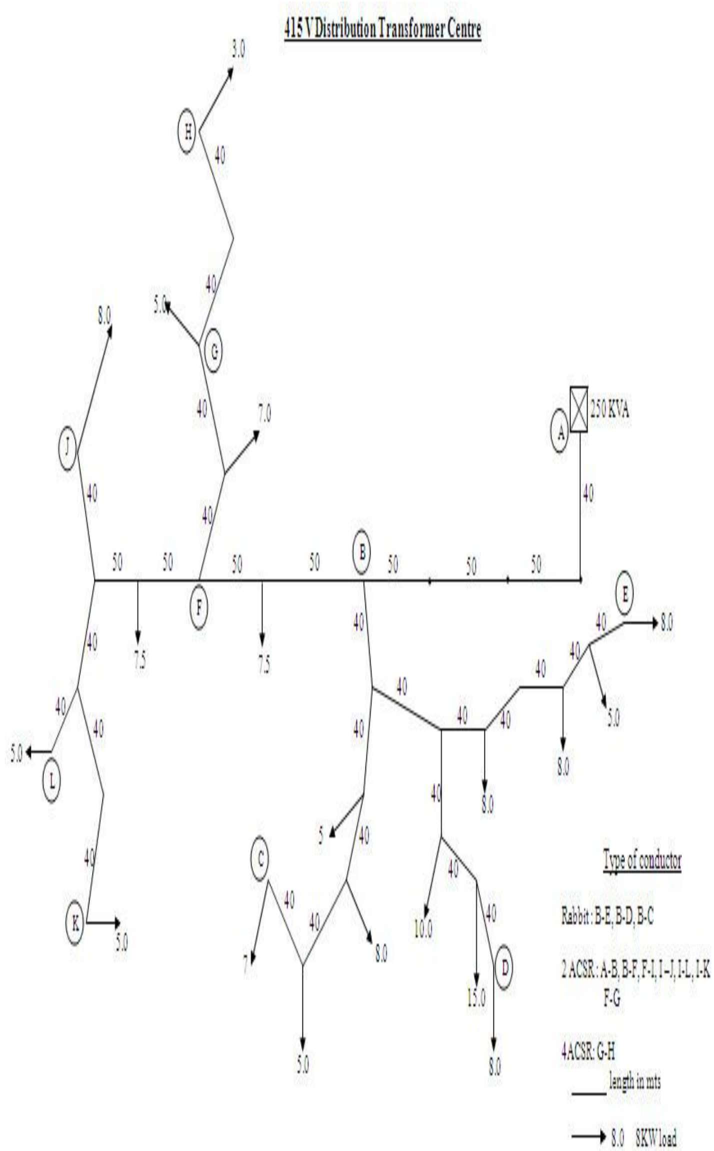

Fig.2 Single line diagram of 415 volt distribution centre drawn in MiPower software package

4. SIMULATION RESULTS OBTAINED FROM MIPOWER SOFTWARE PACKAGE.

MiPower is a highly interactive, user-friendly windows based Power System Analysis package. It includes a set of modules for performing a wide range of power system design and analysis study. MiPower features include Windows GUI with centralized database. Steady state, transient and electro-magnetic transient analysis can be performed with more accuracy and tolerance.

TABLE.2 SIMULATION RESULTS

Topology	Loss(in kw)
Original	58.9786
Network reconfigration	34.3152
DTC Relocation	30.3047
Network reconductoring	21.0285
Expree feeder	19.5944
HVDS	15.8442

Applying cost benefit analysis considering MiPower software package the network reconfiguration no additional investments are required hence it is considered feasible. The building of new substation is carried out only in unavoidable situations where no further augmentation is possible. So, four topologies DTC relocation, network re-conductoring, Express feeder and HVDS are considered. A cost benefit is analysis is performed for the fore-mentioned topologies and the results are furnished the necessary inputs required are listed and are taken as specified.

TABLE.3 OTHER INVESTMENTS PARAMETER CONSIDERED.

Input	Value considered
Interest	12 %
O & M charges	3 %
Project life	20 years
Unit charges	Rs. 2.5/-
Load factor	0.6
Constant A (for computing LLF)	0.3

TABLE.4 OTHER INPUTS TAKEN FOR COST BENEFIT ANALYSIS

Topology	Benefit to Investment ratio	Payback period (in years)
DTC relocation	20.0389	Less than one year
Network re-conductoring	13.185	Less than one year
Express feeder	5.34224	Between 1-2
HVDS	2.82409	Between 3-4

5. RESULTS OBTAINED FROM COST BENEFIT ANALYSIS

The Benefit to Investment ratio and payback periods of the projects considered are as tabulated below.

Table.5 cost benefit analysis results

Topology	Investment (in Rs)
DTC relocation	1,00,000
Network re-conductoring	2,00,000
Express feeder	5,00,000
HVDS	10,00,000

6. CONCLUSION

In this paper, the cost benefit calculation is done using MiPower software results. From cost benefit calculation it is clear that DTC relocation having benefit to investment ratio 20.038, it clears that the DTC relocation having less payback period hence which helps in distribution loss reduction in very easy way.

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BIOGRAPHY

Rudresh.B.Magadum was born in Karnataka, India on 09 July 1987. He obtained B.E (Electrical and Electronics) from Vishveswaraya Technological University, Belgaum, and Karnataka, India. He is currently pursuing M.Tech Degree in Power and Energy Systems in Electrical and Electronics Engineering, Basaveshwar Engineering College, Bagalkot, India.

Tejaswi.M.Timsani was born in Karnataka, India on 14 April 1986. He obtained B.E (Electrical and Electronics) from Vishveswaraya Technological University, Belgaum, and Karnataka, India. He is currently pursuing M.Tech Degree in Power and Energy Systems in Electrical and Electronics Engineering, Basaveshwar Engineering College, Bagalkot, India. His areas of interest are Distribution Generation, Renewable energy, FACTS.