OPTIMIZATION TECHNIQUE OPTIMAL ALLOCATION OF DSTATCOM IN THE DISTRIBUTION NETWORK

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Abstract: The extension of force framework has provoked the increment of Distributed Generation to fulfill the heap interest; because of the advancement of force matrix the productive usage of power is generally significant. Since the massive cost for development and advancement of force organizations, relief mitigation of existing issues that are extreme power misfortunes, voltage profile issues, voltage hazards, dependability issues. To upset this multitude of issues Distribution Synchronous Static Compensator D-STATCOM can be associated as a shunt gadget to give receptive power remuneration in the low voltage circulation organization. It is vital to sort out dependent on unwavering quality, financial utilization, accessibility. This paper gives a state-of-the-art review of the writing on the ideal assignment of D-STATCOM in dissemination organizations.

Keywords: D-STATCOM, Distribution networks, FACTS devices, Artificial Neural Network, Power loss index

1. INTRODUCTION

With the increment in stacking and the necessity for the efficiency of electric power networks affected associations to use transmission and appropriation networks at the most raised possible efficiency and stacking [1]. A couple of difficulties related with these organizations join strength issues, over the top voltage and high misfortunes in transports [2–4]. It is generally happen when there is an unpredictable increment of non-straight loads [5]. The drop in voltage in the appropriation organization may be brought by high impedance or fostering the heaps in three-stage which are known as unequal burdens. The present progressed circulation networks take on an inexorably current construction on account of the carried out of the dispersed age units which redirect the current by the lines [6]. Nowadays, there is a typical understanding with regards to drive gadgets and furthermore about the techniques which are more sensible than old and conventional strategies [7]. Using the adaptable AC transmission framework the FACTS gadgets are inevitable for ideal use of current [8,9]. The regulators dependent on Power hardware in the power conveyance framework will serve to giveaway the energy [10–13]. As a rule, custom power gadgets which are practically like FACTS gadgets, are exceptionally useful answer for address the issue of obstructions and helpless power quality in power networks [14]. Disregarding FACTS and custom power gadgets share a commonplace specific and specialized base; they have different execution targets [15]. Dispersion Static compensator D-STATCOM is a shunt kind of custom power gadget which will use in the appropriation organizations. used to further develop power quality [16].

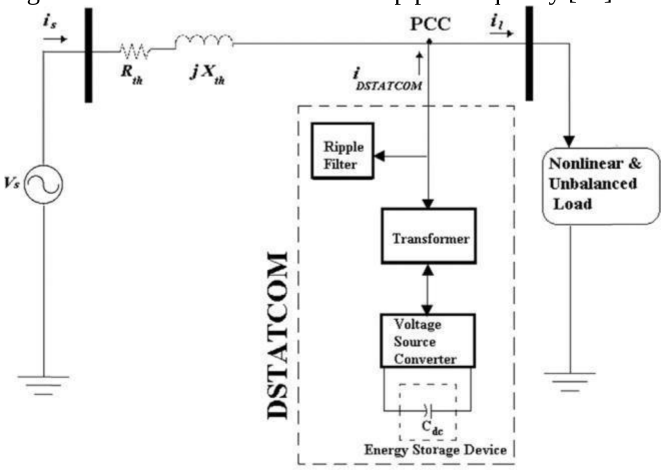


Fig. 1. D-STATCOM with the configuration in the distribution network.

The capacity to infuse as well as absorb the reactive power with exceptionally quick, the wide rang application inside the field was made possible by the dynamical responses [17]. The review which demonstrates about the potential applications of D-STATCOM [18], voltage control with precise voltage support [19], the excess power is circulating within the phases [20]

1. Review on allocation of addressing in D-STATCOM

Every single existing strategy for optimal allocation of D-STATCOM's in distribution can be separated into five methods: analytical methods, artificial neural network-based methods, met heuristic methods, sensitivity approaches, and a combination of sensitivity approaches and met heuristics.

1.1. Analytical methods

The logical methods comprising basic algorithms that have been proposed in privation of powerful computing resources. The requirement of proposing analytical methods in optimal allocation of D-STATCOM, is to recognize the optimum solutions without considering nonlinearity and unpredictability in the problem. In [36], an analytical method has been produced for determining the optimum position of DSATATCOM in a distribution network. The proposed technique was tested in a 33 bus radial distribution system. In the results, voltage regulation and the number of buses that have an under/over voltage problem were analysed and compared.

1.2. Artificial Neural Network based methods

The Artificial Neural Networks (ANN) are utilized for modeling online nonlinear systems with utilized inputs and outputs. Some of the applications of ANN-based approaches fault detection, voltage control, reactive power control and detection of voltage disturbances, can be seen in the literature [37]. These methodologies can able to the optimal place of D- STATCOM in the distribution network under faults. However, they are not applicable for optimal D-STATCOM sizing. In [37].

1.3. Metaheuristic methods

Metaheuristics are the most generally utilized methodologies for solving D-STATCOM allotment issues. They are stochastic, population based improvement algorithms[38,39]. In [40], Taher & Afsari used immune algorithm (IA) to find optimal location and setting of D- STATCOM in distribution networks. Metaheuristics are the most generally utilized objective

function is introduced, which includes installation cost of D-STATCOM and the cost of energy loss. Compared to GA, IA gives lower objective function value, in light, medium and peak load levels, in both IEEE 33 and 69-bus distribution systems. In 2014, Devi & Geethanjali [41] used particle swarm optimization (PSO) to find the location and the size of distributed generation (DG) and D-STATCOM in order to reduce copper losses and improve the voltage profile.

1.4. Sensitivity approaches and their combinations with metaheuristic methods

In affectability-based D-STATCOM allocation strategies, first a is characterized is defined and computed for different potential locations of D-STATCOM and then the optimal location is determined based on the computed indices. The two common indices used for D- STATCOM allocation issue are as per the following.

2.VOLTAGE SENSITIVITY INDEX

The suitable location for installing D-STATCOM can be decided by finding the voltage stability index (VSI) for different buses [47]. Jain et al. [48] proposed a voltage affectability- based method to improve the voltage profile and reduce ohmic losses by D-STATCOM. At first, the voltage stability of all buses was determined by calculating the voltage stability index values. Finally, the outcomes have been presented for IEEE 33-bus distribution system. Hussain and Visali [49] utilized voltage sensitivity index for deciding the most fragile bus of distribution network.

3. POWER LOSS INDEX

The power loss index (PLI) approach is a procedure for choosing the appropriate location for D-STATCOM's [50]. In [32], the following sensitivity indices were used for optimal placement of D-STATCOM's: fast voltage stability index, the combined power loss sensitivity index, voltage stability index, voltage sensitivity index and proposed stability index. The ideal size of D-STATCOM was found in summer and winter seasons, considering load growth. The efficiency of different sensitivity-based methodologies in ideal allocation of D-STATCOM's were thought about, and the effect of the optimal placement of D- STATCOM's to improve the edge of voltage dependability, decrease energy losses and increase energy cost savings were examined. In [3], a voltage stability index has been used for optimal allocation of D-STATCOM devices in unbalanced radial distribution systems. In [33], loss sensitivity factor (LSF) and bacterial rummaging optimization algorithm have been hybridized and utilized for ideal allocation of D-STATCOM's and DG's so as to limit of influence of power loss and improve the voltage profile of distribution systems.

4. D-STATCOM ALLOCATION OBJECTIVES AND CONSTRAINTS

The following objectives have been considered in the examination of solutions for the problem of D-STATCOM allocation:

- Cost reduction
- Reliability improvement
- Voltage profile improvement
- Voltage stability improvement
- Load balance improvement
- Power loss mitigation
- Total harmonic distortion reduction,

Besides, the following were considered as equality or inequality constraints of the problem:

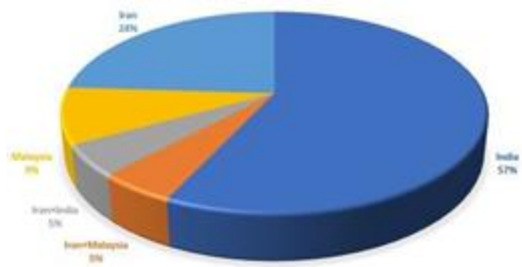
- reactive power compensation,
- power balance,
- current limit,
- voltage deviation limit,

D-STATCOM
- capacity limits
- cost limitations.

In [41], during the optimal allocation of DSTATCOM and DG units by PSO, power loss was minimized. In [42], optimal size and location of DSTATCOM's along with optimal configuration of distribution system has been determined. In [26], optimal allocation of DG and DSTATCOM's have been done. Akbari-Zadeh et al. [46] also used power losses and voltage violations as the objectives of optimization problem. In [48], power losses and voltage violations have been included in the objectives of optimization problem. Gupta and Kumar [33] found the optimum place and rate of the D-STATCOM in radial distribution systems to reduce losses and voltage deviation while limiting the total energy savings. In [34], the proposed work provided an objective function to minimize total power dissipation, voltage fluctuation and the operation cost.

Table 1-Review of different research works on D-STATCOM allocation

Reference	Objectives	Constraints	Remarks
[26]	power loss reduction, Voltage profile improvement	Power balance, Voltage deviation limit, Real power compensation, Reactive power compensation, Branch Current Limit, Radiality Constraint, System Compensation Limit	Allocation of both D-STACOM and DG has been done. Three different load levels (light, medium and peak) with three corresponding load durations have been considered
[23]	Power loss reduction, Voltage profile improvement, Load balance Improvement	Power balance, Voltage deviation limit, Branch Current Limit, Radiality Constraint	Network reconfiguration and DG (PV)/D-STATCOM allocation has been done in three different load levels (light, medium and peak)
[28]	Power loss reduction	Power balance, Voltage deviation limit, Reactive power compensation	Uncertainties of loads have been modeled and considered
[29]	Power loss reduction	Power balance, Voltage deviation limit, Reactive power compensation	Placement of both DG and DSTACOM
[30]	Power loss reduction, Voltage profile improvement	Power balance, Voltage deviation limit, Reactive power compensation, Current limits	Allocation D-STACOM has been done for three different load levels (light, medium and peak)
[31]	Power loss reduction, Voltage stability enhancement	Power balance, Voltage deviation limit, Reactive power compensation, Cost of D-STATCOM Power balance	Instead of radial distribution system, meshed distribution system has been used as case study and the results reported for seasonal load growth
[32]	loss mitigation, Voltage profile improvement, cost reduction and energy saving increment	Power balance	Placement of multiple DG and DSTACOM in different power factors
[33]	loss mitigation, Voltage profile improvement, Cost reduction	Power balance, Voltage deviation limit, Real power	Placement of DTATCOM when DGs are already existed
[34]	Voltage stability enhancement, Cost reduction	compensation, Reactive power compensation	
[35]	Voltage stability enhancement, Cost reduction	Power balance, Voltage deviation limit, Real power compensation, Reactive power compensation, Branch	
[36]	loss mitigation, Voltage profile improvement	Current Limit	
[40]	loss mitigation, Voltage profile improvement, Cost reduction	Power balance	Three different load levels (light, medium and peak)
[41]	loss mitigation, Voltage profile improvement	Voltage deviation limit, Reactive power compensation	Placement of both DG and DSTACOM
[42]	loss mitigation, Voltage profile improvement	Power balance, Voltage deviation limit, Reactive power compensation, Current limits	Network reconfiguration and D-STATCOM allocation
[43]	Reliability improvement, Voltage sag reduction	Voltage deviation limit, Current limits	Short circuit analysis and reliability evaluation have been done
[44]	Reducing the THD of voltage, Voltage profile improvement, Cost reduction	Power balance, Voltage deviation limit, Current limits	A distribution system with some source of harmonics has been used as case study
[37]	Voltage sag reduction	Power balance, Voltage deviation limit, Real power compensation, Reactive power compensation, D-STATCOM capacity limits, Cost limitations Power balance	Short circuit analyses for different types of faults, Placement of DVR / D-STATCOM
[45]	Power loss reduction, Voltage profile improvement, Cost reduction and system efficiency increment	Power balance	
[46]	Power loss reduction, Voltage profile improvement	Power balance, Voltage deviation limit, Reactive power compensation	Uncertainties of loads have been modeled and considered
[48]	Power loss reduction, Voltage profile improvement	Power balance	The load flow is carried out by implementing the compensating values for constant power, constant current and constant impedance.
[49]	Power loss reduction, Voltage stability enhancement	Power balance	The results have been presented for one load level.
[70]	voltage stability under different conditions in distribution networks	the fault oscillation is reduced and the ability to ride through faults is improved	allows automated sharing of the power between the storage units which could be used as a powerful tool in real time application
[71]	voltage stability	Loss reduction	Reliable system
[72]	To reduce the total power losses and the voltage profile improvement.	Loss reduction and voltage magnitude improved	Improved efficiency
[73]	reduction of line losses as well as Total Harmonic Distortion	load flow and harmonic load flow	the voltage profile of the network and reduce the system losses as well as harmonic distortion
[74]	provide reactive power compensation in the low voltage	harmonics compensation, and it will be coupled with one of the power systems	feeder voltage profile and reactive power losses



In [31] the aim of D-STATCOM placement in radial distribution system was to minimize the overall power losses while maintaining the equal and unequal constraints. In [35], D- STATCOM placement has been solved for IEEE 30-bus radial test system.

5. CONCLUSION

Voltage profile improvement, structure reliability and power misfortune improvement are the main goals for the specialists to involve D-STATCOM gadgets in influence frameworks. A broad examination should be endeavored all together recognize the best region and size of D-STACOMs in electric conveyance organizations. Notwithstanding, In perspective on the directed survey it will in general be surmised that there has been next to no improvement in streamlining techniques used for D-STATCOM position and estimating. There is a prerequisite for a near report on the use of different progression methodologies as far as exactness and speed to deal with this issue in different conditions. It can moreover be assumed that most examinations just utilized a solitary D-STATCOM in the conveyance networks for minimization of force misfortune and neglected to consider various D-STATCOMs in the outspread dissemination organizations. Also, it is assumed that ideal designation of D-STATCOM's for unequal dissemination networks has not been done and is proposed for future exploration.

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