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Optimization of SVC size & site for reducing loss in transmitsion networks

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Abstract- this article is about optimized locating and optimized determination of SVC size by two algorithms (BGA- binary generic algorithm and BF-bactrial foraging) in order to reducing loss and improving voltage profile on three IEEE bus networks (5 and 6 and 30). precision, accessibility and quick response are advantages of these algorithms in comparison to other classic ones. in this research we try to make a comparison between intelligent algorithms and find effective factors (such as optimized size and location) in order to loss reduction in two modes (with one and two SVCs).

***Keywords**:* voltage profile, reactive and active losss, binary generic algorithm. bacteria algorithm, SVC

1. Introduction

Electricity industry always faced with network stability problems and so many scenarios are evaluated and hereby problems are solved temporarily, but electricity network is always improving and saving this energy is not feasible with low costs. instability and energy consumption which is caused by network failure are inevitable.voltage instability in electrical systems is mentioned frequently in related literature(1-2) . this effect starts by voltage drop in one point and it can spread in all over the network and hereby the whole voltage would be gone. voltage instability happens when the network is not able to deliver sufficient power toload reactive. instability voltage process which can have different forms, is related to main load characteristics and voltage controlling dynamics.

the presence of some loads in specific situations can cause voltage drop(2-3). in(4) generic algorithm is used to handle SVC controlling parameters in order to improve voltage profile for SCIM loads after short circuit removal. (5) is about loss reduction and security margin with respect to TTC and(6) is about loss reduction and its effects on SVC localizing and (7) is about loss reduction and voltage stability for optimized locating and optimized size determination of SVC and STATCOM.

We can mention to broad operating range, quick response and high reliability with using these elements. with respect to IEEE standard, FACTS instruments utilize systems with one or more abilities which are mentioned in these references(8-9-10).

The main SVC applications are listed below:

- voltage stability in weak networks.
- reducing transmission losss.
- power transmission capability improvement.
- more attenuation of little turbulences.
- improvement of voltage stability
- power fluctuation elimination.

If we want to fully utilize FACTS elements we must choose the best place for doing this. in this regard authors introduced some methods. for example in (11) they used optimized load part to improve loading levels or reduce losss. in (12) a hybrid TS/SA method is used for production cost minimization. in (13) genetic algorithm is used for FACTS localization in order to reducing production and investment costs, moreover with bringing in loss issues, they tried to improve loading levels.

parallel-serial FACTS elements: these elements are a set of two previous categories and the most important member is UPFC which is so powerful inperformance and the only limitation of this member is its high costs. in (14) loss reduction and improvement of voltage bias is a target which is tried by PSO algorithm for choosing the right location. ref (15) recommended FACTS elements for loss reduction and voltage stability. in (16) some applications of DF algorithm for improvement of voltage stable margin and loss reduction by SVC and TCSC localizations are mentioned. in (17) gravity algorithm is used for localization of FACTS elements.

2. SVC model

SVC is one the most important FACTS elements which is used over the years because of its technical and economical advantages in resolving voltage dynamic problem.

SVC is made of one TCR (reactive impedance with the size of X_L and with a two-way (value tisistor) which is parallel to a capacitor X_C , and in the circuit it operates as a varying reactance. its main function is fast reactive power supplying and voltage support. this device enables Firing angle control SVC to approximately respond instantly. X_V

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is the controllable part of TCR reactance, which can be calculated by eq1:

$$X_V = \frac{\pi}{2\pi - 2\alpha + Sin2\alpha} \quad (1)$$

in which a is Firing angle Tyrystvr. effectivesusceptance in TCR can be calculated by:

$$I = \int_a^b x.f(x)dx \quad 2)$$

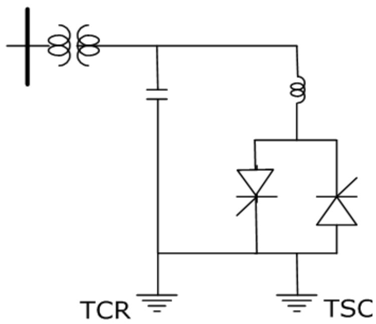

Fig.1. internal schematic view of SVC

3. problem formulation (loss, voltage bias and objective function)

active and reactive power loss reduction and improvement of voltage bias in a transmission system for effective and correct performance is necessary. objective function can be formulated as:

$$FitnessFunction = Minimize(w1.\frac{P_L}{P_{L,Normal}} + w2.\sum_{i=1}^{N}(\frac{(1-V_i)}{(1-V_i)_{Normal}}) + w3\frac{Q_L}{Q_{L,Normal}}) \quad (3)$$

in which fist and 3th terms are about active and reactive loss and can be calculated by eq7 and eq8 respectively:

$$P_L = \sum_{k=1}^{N} Loss_k \quad 4(4)$$

$$Q_L = \sum_{k=1}^{N} Loss_k \quad 5)$$

the second term in qe3 is voltage bias. voltage and current constraints can be written as ieq9 and ieq10 respectively:

$$|V_i|^{\min} \le |V_i| \le |V_i|^{\max} \quad (6)$$

$$|I_{ij}| \le |I_{ij}|^{\max} \quad (7)$$

in which Vi is the voltage of ith bus and
Iij is the current between i and j

a. 4. BF algorithm

if we want to study different strategies of finding food, we just have to study haunter behaviors for haunting food. at first, for haunting food, a haunter must look for the food and find its location. at the next step, haunter must haunt the victim and finally use it as the food. the importance of different food finding behaviors is related to the relation between victim and haunter. if the victim is bigger that the haunter, then haunting and attacking becomes more important but if victim is smaller that haunter, then searching becomes more important.

at first we must determine primary value such as:
algorithm implementation

first step: initial valuing of parameters
s: number of bacteria which are used in the search.
p: number of parameters which must be optimized.
Ns: swim number.
C(i): swim pace length.
Nc: number of movement levels.
Nre: number of generations.
Ned: number of disposal and scatter events.
P(p,S,l): bacteria position and location.
Jcc(θ,P(j,k,l)) : evaluates bacteria location with respect to the target (if we have swarming)
(i) : random generation vector

5. simulation results

in this article for active and reactive loss reduction and improvement of voltage profile in SVC localizing systems on three IEEE bus networks (5 and 6 and 30) we used two algorithms and the best location and the best size are determined by these algorithms. we used MATLAB software for running the simulation and for load spread, we used Newton Raphson. in the appendix you can review IEEE bus 5,6 and 30 diagrams.

table(1) is the results of localizing and determining of optimized size and loss reduction percentage in our networks. after using BGA, active and reactive loss in 5 bus network(with one SVC - 20 MVAR) are respectively 9.6815 Mw and 3.8579 MVAR that is better in comparison with BF and normal state. with entering two new SVCs (one in the bus 4 and the other in the bus 5) those amounts reduced more and became 9.4233Mw and 19.2375 MVAR respectively.

in 6 bus network, the loss amount with BGA method and one SVC (19.8631) in bus 4, the loss amount reduced from 0.146 to 0.1137 Mw and similarly in BF algorithm this amount is reduced to 0.1409 which is not so good in comparison with BGA. in this network with two SVCs active and reactive loss, reduced to 0.0927 Mw and 0.5131 MVAR respectively that is better in comparison to BF with

0.1075 Mw and 6.2535 loss amounts. BGA algorithm results in 30 bus network is better than BF: with one SVC with the amount of 16.1877 MVAR in bus 15,active loss reduced to 17.5527 Mw and reactive loss reduced to 21.5533 which is better than BF method and for two SVCs in bus 3 and bus 20 with the amount of 19.9472 MVAR and 10.2444 MVAR, loss amounts reduced to 17.4683 Mw and 21.3278 MVAR which is better that BF in which similar amount are respectively 17.5173 Mw and 21.5039 MVAR. as we can see in table(1) size determination and localization of BGA is better than BF. the results for voltage bias improvement by BGA and BF are shown in figs 4 - 30.

6. 6. conclusion

Wrong localization has undesirable effects such as more loss, less reliability, voltage instability and voltage breakdown, less loading ability and etc on the network. for optimized localizing and optimized size determination of SVC, in this article we used BGA and BF methods. the results show us that BGA method is more exact that BF method.

network	Algorithm	Utilization level	Installation location(bus) SVC1	Q_SVC1	Installation location(bas)SVC2	Q_SVC2	Ploss (MW)	Qloss (MVAR)	%losses	
									Active %	Reactive %
5 bus		Normal					9.8789	4.917		
	BGA	SVC1	5	20			9.6815	3.8579	1.999	21.539
	BF	SVC1	4	4.9861			9.8076	4.5972	0.721	6.5
	BGA	SVC2	4	9.4233	5	19.2375	9.6781	3.6544	2.032	25.678
	BF	SVC2	4	13.7171	5	11.2967	9.6797	3.7473	2.016	23.788

References

[1] R.L.Hauth, S.A.Miske, F.Nozari, "the role and benefits of static V Ar systems in high voltage system applications, IEEE trans. Vol. PAS-101", No. 10, October 2002, PP. 3761-3770
[2] C.W.Taylor, "power system voltage stability", Mac Graw-hill, U.S.A, 1993.
[3] North American electric reliability council report: "survey of the voltage collapse phenomenon", published by north American electric reliability council, 1990
[4] P.Ju.E.Handschin, F.Reyer, "genetic algorithm aildedcontorller design with application to SVC", IEE Proc. Generation. Transmission & distribution", Vol. 143, No. 3, May 1996, PP. 258-262.
[5] Radu D, Besanger Y. Blackout "prevention by optimal insertion of FACTS devices in power systems" In: Proceeding of the IEEE international conference on future power systems 2005; November 2005, p. 1–6.
[6] Huang JS, Jiang ZH, Negnevitsky. " Loadability of power systems and optimal SVC placement" Int J Electr Power Energy Syst 2013;45(1):167–74.
[7] Sode-Yome A, Mithulananthan N. "Comparison of shunt capacitor, SVC and STATCOM in static voltage stability margin enhancement" Int J ElectrEng Educ,2004;41(2):158–71.
[8] N. G. Hingurani, L. Gyugyi; "Understanding FACTS: Concept and Technology of Flexible AC transmission System", IEEE Press, New York, 2000.
[9] M. Noroozian, L. Angquist, M.ghandhari, G. Anderson; "Improving Power System Dynamic by Series-connected FACTS Devices" IEEE Trans on Power Delivery, Vol.12, No. 4, October 1997
[10] M. Noroozian, L. Angquist, M. Ghandhari, G. Anderson; "Use of UPFC for Optimal Power Flow Control", IEEE Trans on Power Delivery, Vol. 12, No. 4, October 1997.
[11] J. A. Momoh, J. Z. Zhu; "A new Approach to Optimal Power Flow with Phase Shifter", IEEE International Conference on systems, Man, and Cybernetics, Vol. 5, pp. 4794-4799,1998.
[12] P. Bhasaputra, W. Ongaskul; "Optimal Placement of Multi-Type FACTS Devices by Hybrid TS/SA Approach", Industrial Technology, IEEE ICIT'02. IEEE International Conference, Vol. 1, 11-14 Dec.2002.
[13]L.J.Cai, I.Erlich, "optimal Choice and Allocation of FACTS Devices Using Genetic Algorithms", ISAP Conference, Lemnos, Greece, August 31-Sept3, 2003
[14] R. Benabida, M. Boudourb, M.A. Abidoc "Optimal location and setting of SVC and TCSC devices using non-dominated sorting particle swarm optimization" Electric Power Systems Research 79 (2009) 1668–1677.
[15] J.R. Shin, B.S. Kim, J.B. Park, K.Y. Lee, " A new optimal routing algorithm for loss minimization and voltage stability improvement in radial power systems" IEEE Transactions on Power Systems 22 (May (2)) (2007) 648–657.
[16] L.Jebaraj1, C.ChristoberAsir Rajan2, S.Sakthivel3 "Real Power Loss and Voltage Stability Limit Optimization Incorporating TCSC and SVC through DE Algorithm under Different Operating Conditions of a Power System" IOSR Journal of Electrical and Electronics Engineering (IOSRJEEE) ISSN: 2278-1676 Volume 1, Issue 5 (July-Aug. 2012), PP 16-25.
[17] Mahdi Mozaffari Legha,;"Optimal Conductor Selection of Radial Distribution Networks Using GA Method" CIRED Regional – Iran, Tehran, 13-14 Jan 2013; Paper No: 12-F-500-0320.
[18] [16] Mahdi Mozaffari Legha, Hassan Javaheri, Mohammad Mozaffari Legha, "Optimal Conductor Selection in Radial Distribution Systems for Productivity Improvement Using Genetic Algorithm "Iraqi Journal for Electrical and Electronic Engineering (IJEEE), Vol.9 No.1 , 2013, 29-36.
[19] Mahdi Mozaffari Legha, Rouhollah Abdollahzadeh, Ardalan Zargar, Mostafa Shadfar. "Effective method for optimal allocation of distributed generation units in radial electric power systems by genetic algorithm and imperialist competitive algorithm", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 15, Vol. 5, No. 2, pp. 70-74, June 2013.
[20] Mahdi Mozaffari Legha Majid Gandomkar, "Reconfiguration of MV network for balancing and reducing losses to by CYMEDIST software in Khorramabad", 16th Electric Power Distribution Conference (EPDC16), pp. 25-32, 2012.
[21] Mahdi Mozaffari Legha, Mohammad Mohammadi; Aging Analysis and Reconductoring of Overhead Conductors for Radial Distribution Systems Using Genetic Algorithm; Journal of Electrical Engineering & Technology (JEET); pp. 1-8, 2014.
[22] M. Mozaffari Legha; ''Determination of exhaustion and junction of in distribution network and its loss maximum, due to geographical condition''; MS.c Thesis; Islamic Azad University, Saveh Branch, Markazi Province, Iran (2011).

appendix