

Zaenab_Muslimin_2020_IOP_Conf..pdf

by

FILE	ZAENAB_MUSLIMIN_2020_IOP_CONF..PDF (1.12M)	WORD COUNT	3099
TIME SUBMITTED	27-JAN-2021 08:00PM (UTC+0700)	CHARACTER COUNT	15274
SUBMISSION ID	1495270303		

PAPER • OPEN ACCESS

10

Reactive power injection at the North Makassar distribution system with D-STATCOM

6

To cite this article: Z Muslimin *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **850** 012009

View the [article online](#) for updates and enhancements.

10

Reactive power injection at the North Makassar distribution system with D-STATCOM

Z Muslimin*, A Suyuti, E Palantei, I Indrabayu and I C Gunadin

Department of Electrical Engineering, Hasanuddin University, Indonesia

*zaenabandy@gmail.com

Abstract. The need for electrical energy is increasing in line with the growth of population. As consequences of high demand, electrical power network is also extended massively. A wider distance between the power generator to far load centers also consider as drawback in performances due to power loss along the transmission. The problem of power loss and voltage drop in the distribution system can be solved by installing DSTATCOM. This paper aims at finding the effect of DSTATCOM installation on real power losses and reactive power, as well as its effect on voltage profiles on the North Makassar Distribution System. The simulation results show that by installing DSTATCOM on 92 Bus North Makassar Distribution System on several buses, increasing of performances can be achieved. The average active power loss decreased by 2.5%, declining of the reactive power loss averaged 26.7% and the average voltage profile improved by 0.12% (2.5 kV).

1. Introduction

Electrical energy is one of the needs that cannot be separated from people's lives in the era of globalization. The dependence of electrical energy is very large in various activities of modern human life can be found in many sectors such as in the world of transportation (two-wheeled and four-wheeled vehicles such as motorcycles and cars) in the service sector and industry, government sector, and housing sector. The use of electrical energy increases as the demand for new pairs increases. The electrical energy produced by power plant centres is generally located far from load centres. The generated electricity will be channelled to load centres through transmission and distribution networks. A considerable distance in the delivery of power from the plant to the consumer will cause a decrease in voltage which results in a power loss. Voltage drop is one of the problems of electric power quality. There are many ways to reduce voltage drops in transmission and distribution systems. At present, various controllers are very flexible, utilizing power electronic components, providing fast and reliable control of transmission parameters such as voltage, channel impedance and phase angle between the sender and receiver ends known as FACTS.

FACTS is an electronic-based equipment that maintains the quality of electric power by maintaining better power flow by changing the parameters of voltage, impedance, and phase angle. On the other hand, special power equipment is used to improve power quality in the distribution system. This special power equipment functions are similar to FACTS, which includes special power equipment is D-SATCOM, UPQC, DVR including D-STATCOM which is most often used because it provides a low cost in compensating for reactive power [1]. D-STATCOM can handle a variety of functions, namely



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

minimizing active and reactive power losses, harmonics, and their size is relatively small and inexpensive [2,3].

The passive control of the STATCOM-level converter integrated with the distribution transformer has been carried out resulting in good performance integrated with D-STATCOM with reactive power compensation and financing functions [4,5]. D-STATCOM analysis and control under unbalanced voltage conditions, contribute when the voltage is not balanced between phases [6,7]. Then the D-STATCOM design uses high power based on the dual converter topology in an isolated system that has been carried out by Sreenivasarao et al. which aims to optimize the voltage using a converter. Gupta and friends have developed a variety of load models to determine the D-STATCOM allocation on the distribution network [8]. The optimal placement of D-STATCOM using sensitivity in the distribution system that is affected by varying load growth [9-10]. The reactive power compensation using DSTATCOM, giving results that conceptually are similar to STATCOM on transmission [11]. The control scheme must be such that it provides better compensation for reactive power and profile stress so as to improve power quality at the end of distribution [12].

Much research has been done before to reduce power losses and increase voltage profiles in distribution systems, besides using D-STATCOM also uses shunt capacitors, synchronous condensers. However, the results of the study show that shunt capacitors and synchronous condensers have disadvantages, that is, for shunt capacitors cannot supply variable reactive power while synchronous condensers are expensive and require routine maintenance [13]. For the northern Makassar distribution system, for now, it still uses shunt capacitors and has a network topology that is long enough to allow for considerable voltage drop and power losses when there is a dynamic load. Therefore this is very interesting to study which aims to improve the efficiency and quality of utilities on the distribution network.

In this paper, D-STATCOM is used to increase the voltage profile and reduce power losses, with the following arrangement: in the first part the background is explained, the second part is the distribution system, the third part is the explanation of D-STATCOM, 4 simulation results and fifth conclusion.

2. Distribution systems

Distribution System of North Makassar (DSNM) is shown in Figure 1 which is used to analyse the system load especially the Mandai substation, having an average voltage value of 0.964 pu (graph of voltage profile shown in Figure 2.), total power losses of 195.94 kW and 68.36 kVar. This amount is before installation of DSTATCOM, by installing DSTATCOM, it will increase the voltage value and reduce the number of power losses.

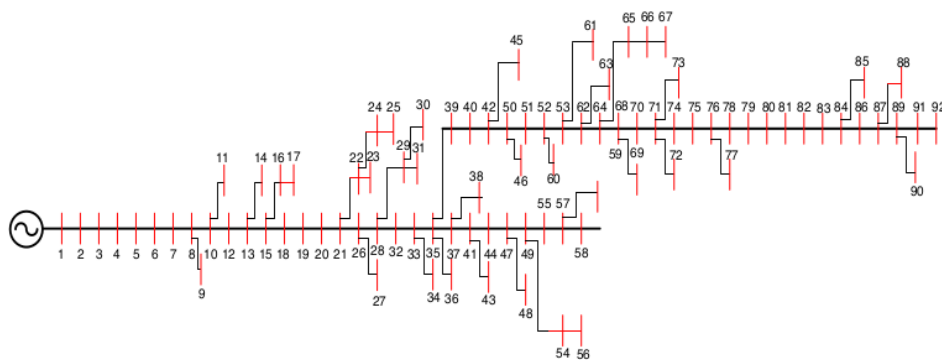


Figure 1. Distribution system of North Makassar.

To install DSTATCOM on the Distribution system of North Makassar in improving the voltage profile and reducing losses based on the load flow system using steps as shown in Figure 3.

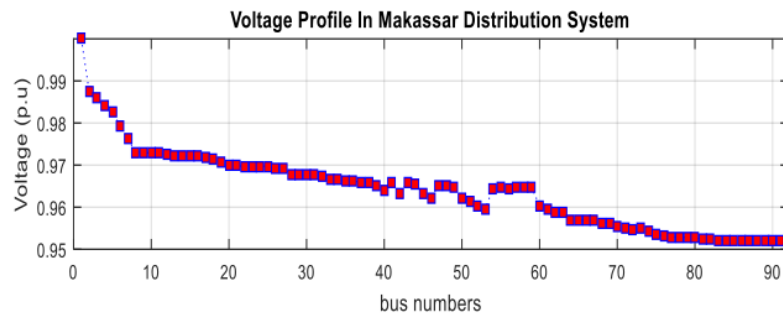


Figure 2. Voltage profile before D-STATCOM installation.

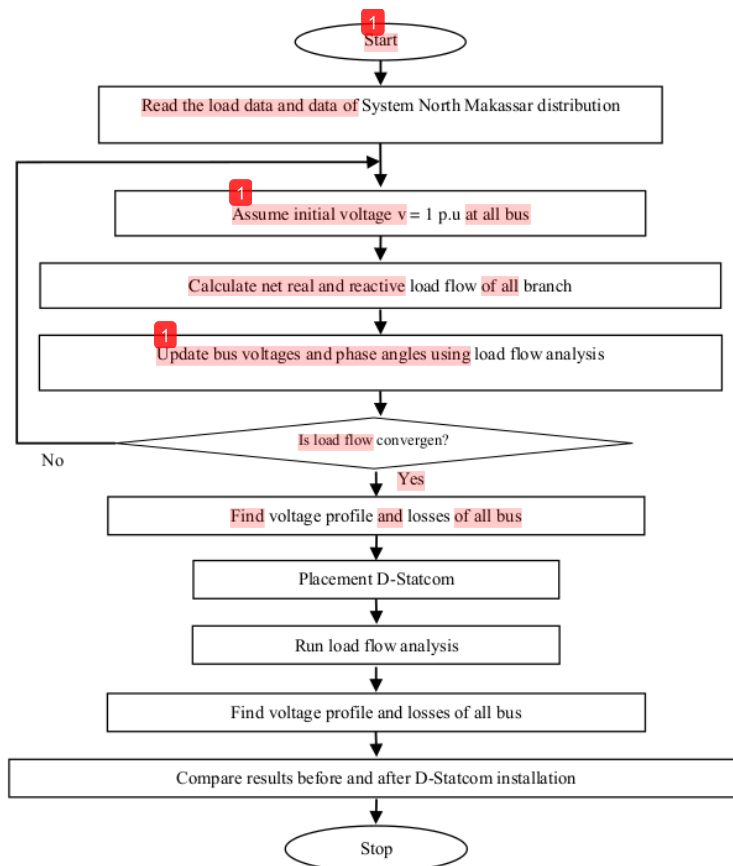


Figure 3. Flow chart to determine the voltage and amount of losses.

26 **3. Distribution static compensator (D-STATCOM)** **19**

To analyze the Distribution System of North Makassar, the equivalent circuit of the distribution system is modeled in Figure 4, which is a simplification of Figure 1.

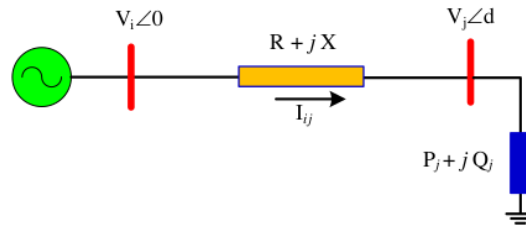


Figure 4. Equivalent circuit model of Distribution System of North Makassar.

D-STATCOM is an inverter-based voltage source which is a special power device, connected in parallel to the power system and can supply reactive power to increase the voltage profile and reduce power losses on the channel [14]. The main components of D-STATCOM include VSC (Voltage Source Converter), energy storage equipment, transformers, and a controller. For more details, the basic structure of D-STATCOM can be seen in Figure 5. The basic principle of D-STATCOM installed in a distribution system will produce an ac voltage source that can be controlled by a voltage source converter (VSC). The output voltage of D-STATCOM can control the exchange of active and reactive power between D-STATCOM and the distribution network system. Very flexible output voltage control from VSC is utilizing high frequency switching with pulse width modulation (PWM) technique at constant dc voltage source, then the average of the output voltage waveform is obtained to get the fundamental voltage component that can be adjusted by its magnet. The PWM technique provides advantages in which low-order harmonics are reduced so that it will reduce the number of harmonics and harmonic filters. The higher the frequency ratio of transmission to the fundamental frequency, the lower the low-order harmonics that appear, but this can cause additional loss.

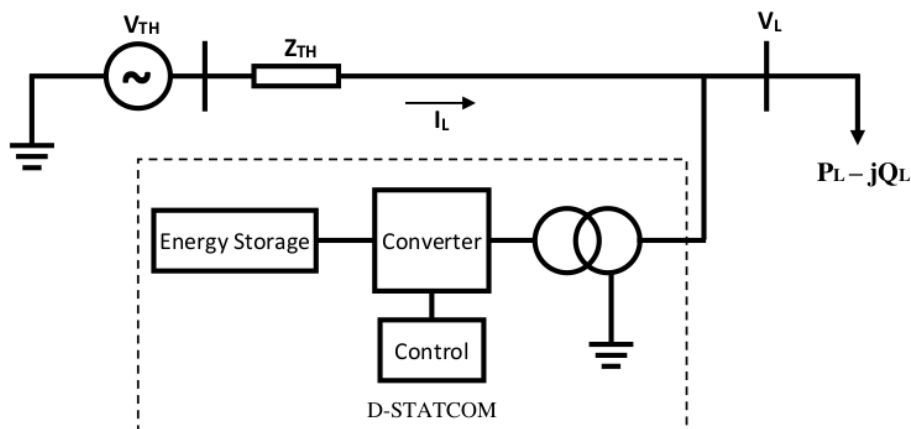


Figure 5. D-STATCOM Basic structure in distribution system.

4. Simulation results

The distribution system of north Makassar consisting of 92 buses has been modeled using the following scenario: case 1 is the condition before the installation of D-STATCOM, cases 2, 3, 4 and 5 are to add D-STATCOM to each bus on bus 20, bus 35, bus 51 and bus 81.

The simulation results from the North Makassar Distribution System with several scenarios result in a significant increase in voltage and a reduction in losses shown in Table 1 and Table 2. Table 1 is the voltage on the bus and Table 2 is the total active and reactive power losses of the simulation results by installing D- STATCOM is 250 KV.

Table 1. Voltage on the bus.

Scenario	Voltage (pu)			
	Bus 20	Bus 35	Bus 51	Bus 81
Case 1	0.97000	0.96616	0.96132	0.95249
Case 2	0.97101	0.96718	0.96233	0.95351
Case 3	0.97101	0.96742	0.96258	0.95375
Case 4	0.97101	0.96742	0.96301	0.95418
Case 5	0.97101	0.96742	0.96301	0.95548

11

Table 2. Total active and reactive power losses.

Total Losses	Case 1	Case 2	Case 3	Case 4	Case 5
Aktif Power (kW)	195.94	192.49	191.44	190.79	189.60
Reaktif Power (kVar)	-68.36	-53.68	-51.82	-49.50	-45.38

9

Tables 1 and 2 show that the installation of D-STATCOM on a bus will increase the voltage profile and reduce active power losses and reactive power losses. Of the five scenarios, the most effective D-STATCOM installation is in case 5, namely bus 81, resulting in an increase in voltage profile of 3.24% and reduction in a reactive power loss of 33.6% and active power loss of 3.2%.

17

The graph of the comparison of active power losses and reactive power losses for various scenarios on the 92 buses system is shown in Figure 6., Figure 7., and Figure 8.



15

Figure 6. Comparison of Active power loss for different cases DSNM in 92 bus.

4

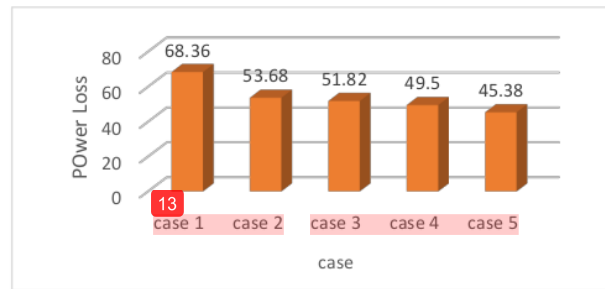


Figure 7. Comparison of Reactive power loss for different cases DSNM in 92 bus.

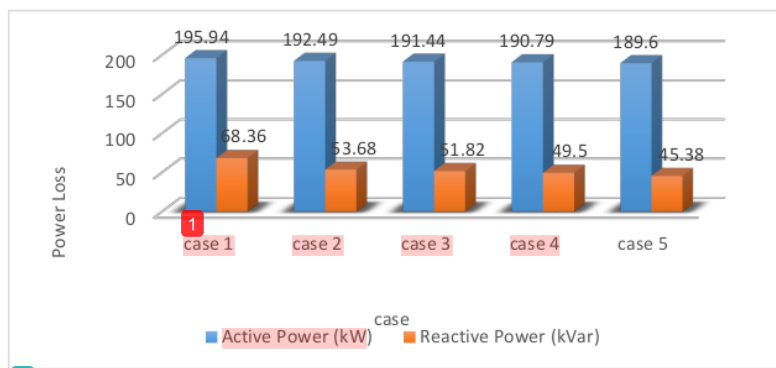


Figure 8. Comparison of Active power and Reactive power loss for different cases DSNM in 92 bus.

For voltage profiles on each bus on the Distribution System of North Makassar 92 buses are shown in Figure 9, Figure 10, Figure11, and Figure12. Figure 9, D-STATCOM installation on bus 20, in Figure 10, D-STATCOM installation on bus 35, in Figure 11 is an installation D-STATCOM on bus 51 and Figure 12 mounting D-STATCOM on bus 81.

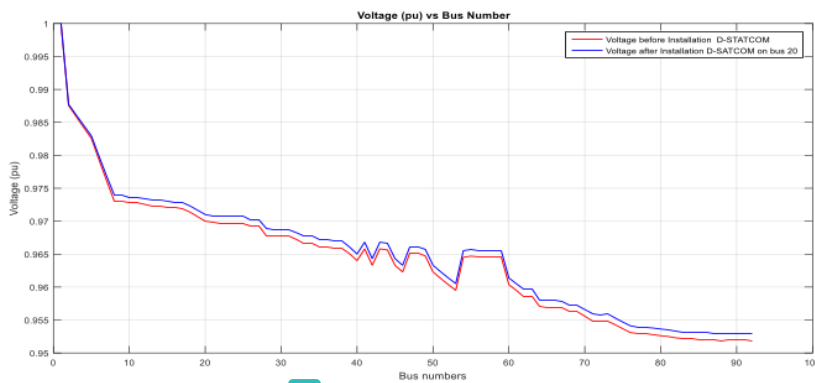


Figure 9. Installation of D-STATCOM in bus 20.

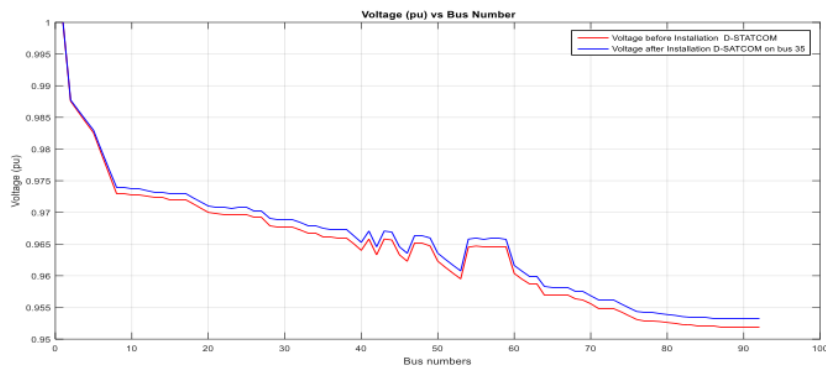


Figure 10. Installation of D-STATCOM in bus 35.

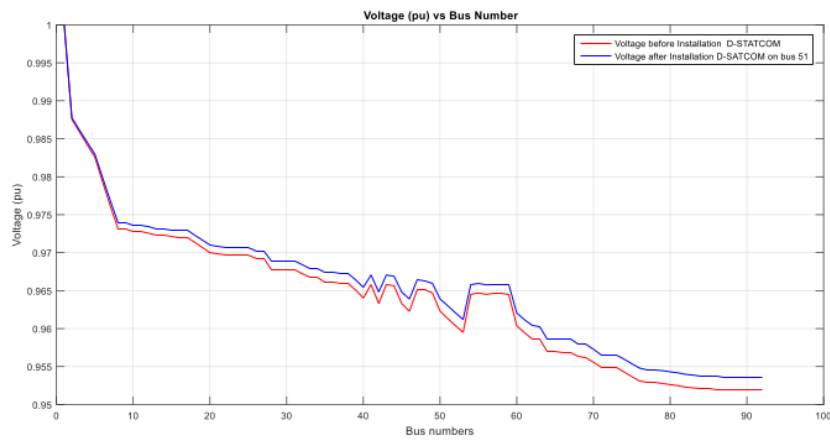


Figure 11. Installation of D-STATCOM on bus 51.

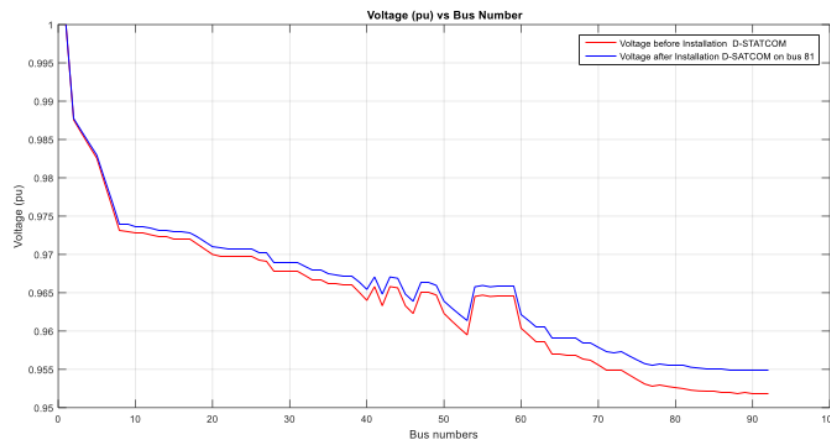


Figure 12. Installation of D-STATCOM on bus 81

The graph in Figure 13 illustrates the comparison of the stress profile of each bus in five scenarios.

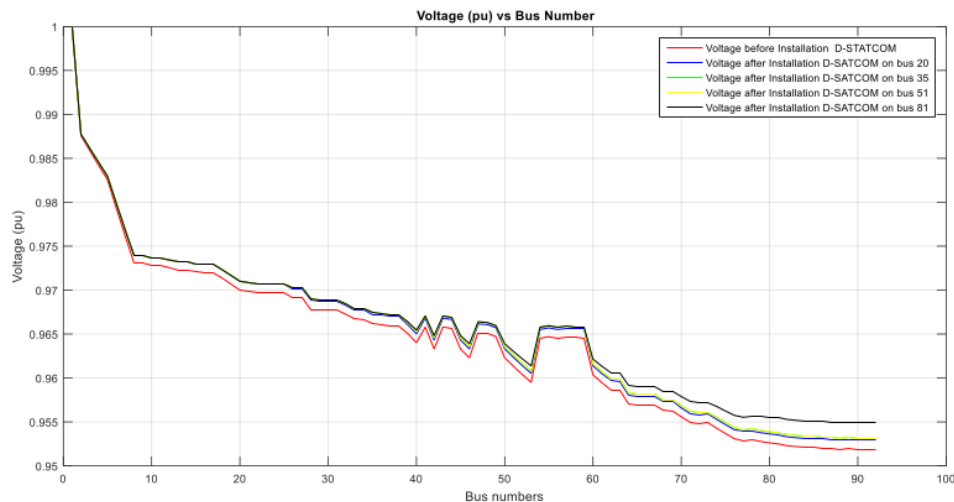


Figure 13. Comparison of voltage profiles in five scenarios on DSNM 92 bus.

5. Conclusion

Simulations are carried out on Distribution System of North Makassar 92 buses, especially Mandai Substation with several scenarios. With the installation of D-STATCOM in several scenarios, the simulation results show an increase in voltage profile and active and reactive power losses. Case 1 (without D-STATCOM) shows a voltage value of 0.970pu on bus 20, bus 35: 0.966pu, bus 51: 0.961pu and bus 81: 0.952pu while the total active power loss is 195.94kW and total reactive power loss is 68.36 kVar. Case 2 (installation of D-STATCOM on bus 20) shows a voltage value of 0.971pu on bus 20, bus 35: 0.967pu, bus 51: 0.962pu and bus 81: 0.953pu while total active power loss is 192.49kW and total reactive power loss is 53.68 kVar. Case 3 (installation of D-STATCOM on bus 35) shows a voltage value of 0.971pu on bus 20, bus 35: 0.967pu, bus 51: 0.963pu and bus 81: 0.953pu while total active power loss is 191.44kW and total reactive power loss is 51.82 kVar. Case 4 (installation of D-STATCOM on bus 51) shows a voltage value of 0.971pu on bus 20, bus 35: 0.967pu, bus 51: 0.963pu and bus 81: 0.954pu while total active power loss is 192.49kW and total reactive power loss is 53.68 kVar. Case 5 (installation of D-STATCOM on bus 81) shows a voltage value of 0.971pu on bus 20, bus 35: 0.967pu, bus 51: 0.963pu and bus 81: 0.955pu while total active power loss is 189.60kW and total reactive power loss is 45.38 kVar.

The simulation results show that the conclusion of this paper with the installation of D-STATCOM on the Makassar North 92 Distribution System can increase the average profile of 0.12% (2.5 kV) and the reduction in active power losses by an average of 2.5% and reactive power losses 26.7%. The most effective installation of the five scenarios is case 5, namely on bus 81 with an increase in voltage profile of 0.16% (3.2kV) and a reduction in an active power loss of 3.24% and reactive power loss of 33.61%.

References

- [1] Pinapatrumi K K and Krishna Mohan L 2012 DQ based Control of DSTATCOM for Power Quality Improvement *VSRD International Journal of Electrical, Electronics & Communication Engineering* **2**(5) 207-227
- [2] Awasth V M and Huchche V A 2012 Reactive Power Compensation using D-STATCOM *IEEE* **8** 583-585

- [3] Das P 2015 Optimal Sizing And Placement of Distributed Generation in A Radial Distribution System Using Loss Sensitivity Factor And Firefly Algorithm *Int. J. Sci. Res. Manage (IJSRM)* **3**(4) 2611–2618
- [4] Iqbal F, Khan M T and Siddiqui A S 2017 Optimal Placement of DG and D-Statcom for Loss Reduction and Voltage Profile Improvement *Alexandria Engineering Journal* **57**(2) 755-765
- [5] Chen Y, Wen M, Lei E, Yin X, Lai J and Wang Z 2018 Passivity-Based Control of Cascaded Multilevel Converter Based D-Statcom Integrated with Distribution Transformer *Electric Power Systems Research* **154** 1-12
- [6] Choudhury S, Bhowmik P and Rout P K 2018 Economic load sharing in a D-STATCOM Integrated Islanded Microgrid based on Fuzzy Logic and Seeker Optimization Approach *Sustainable Cities and Society* **37** 57-69
- [7] Wang Y, Tang J and Qiu X 2011 Analysis and Control of D-Statcom under Unbalanced Voltage Condition *International Conference on Mechatronic Science Electric Engineering and Computer (MEC)* **1** 1623-1625
- [8] Sreenivasarao D, Agarwal P and Das B 2013 Performance Enhancement of A Reduced Rating Hybrid D-Statcom for Three-Phase, Four-Wire System *Electric Power Systems Research* **97** 158-171
- [9] Mehrouachi I, Abbes M and Chebbi S 2019 Design of A High Power D-Statcom Based on The Isolated Dual-Converter Topology *International Journal of Electrical Power & Energy Systems* **106** 401-410
- [10] Gupta A R and Kumar A 2018 Optimal Placement of D-Statcom Using Sensitivity Approaches in Mesh Distribution System with Time Variant Load Models under Load Growth *Ain Shams Engineering Journal* **9**(4) 783-799
- [11] Reddy S S K, Babu A V, Suman S and Manasa K D 2011 Reactive Power Compensation Using D-Statcom *International Journal of Engineering Research and Applications (IJERA)* **2** 1-6
- [12] Gupta A R and Kumar A 2016 Energy Saving Using D-STATCOM Placement in Radial Distribution System under Reconfigured Network *Energy Procedia* **90** 124-136
- [13] Sreejith S, Bose U, Vachana K M D S and Jyothi V 2014 Application of D-STATCOM as Load Compensator for Power Factor Correction *International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT)* **2** 595-600
- [14] Gunadin I C, Muslimin Z and Siswanto A 2017 Transient Stability Improvement Using Allocation Power Generation Methods Based on Moment Inertia *International Conference on Electrical Engineering and Informatics (ICELTICs)* **5** 147-152

ORIGINALITY REPORT

% **19**
SIMILARITY INDEX

% **10**
INTERNET SOURCES

% **18**
PUBLICATIONS

% **4**
STUDENT PAPERS

PRIMARY SOURCES

1 pt.scribd.com Internet Source %**2**

2 Andrii Kravets, Vitaliy Vlasovets, rii Yevtushenko, Yevgen Romanovych, Anna Kravets. "Study on the prospects for the use of lubricants produced by Fuchs Lubritech GmbH on the Ukrainian railways in "wheel of rolling stock-rail" tribocoupling", IOP Conference Series: Materials Science and Engineering, 2021
Publication %**2**

3 www.er-c.org Internet Source %**2**

4 www.elsevier.es Internet Source %**1**

5 Vinay M. Awasth, V. A. Huchche. "Reactive power compensation using D-STATCOM", 2016 International Conference on Energy Efficient Technologies for Sustainability (ICEETS), 2016
Publication %**1**

6

Submitted to Universitas Negeri Surabaya The State University of Surabaya

Student Paper

% 1

7

Zaenab Muslimin, Agus Siswanto, Indar Chaerah Gunadin, Muhammad Anshar. "Real Time Monitoring of Salinity Gradient and Solar Pond Temperatures", MATEC Web of Conferences, 2020

Publication

% 1

8

Ashutosh Kumar Tagore, Atma Ram Gupta. "Impact of DG and D-STATCOM allocation in radial distribution system for reducing harmonics", 2017 8th International Conference on Computing, Communication and Networking Technologies (ICCCNT), 2017

Publication

% 1

9

Atma Ram Gupta, Ashwani Kumar. "Reactive power deployment and cost benefit analysis in DNO operated distribution electricity markets with D-STATCOM", Frontiers in Energy, 2017

Publication

% 1

10

sinta3.ristekdikti.go.id

Internet Source

% 1

11

Bushra Weqar, Mohd Tauseef Khan, Anwar Shahzad Siddiqui. "Optimal Placement of Distributed Generation and D-STATCOM in Radial Distribution Network", Smart Science,

% 1

2017

Publication

12

Piyushkumar M. Saradva, Ketan T. Kadivar, Mahesh H. Pandya, Abhayrajsinh J. Rana. "Reactive and real power compensation in distribution line using D-STATCOM with energy storage", 2016 International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC), 2016

Publication

% 1

13

T. Yuvaraj, K. R. Devabalaji, Sudhakar Babu Thanikanti. "Simultaneous Allocation of DG and DSTATCOM Using Whale Optimization Algorithm", Iranian Journal of Science and Technology, Transactions of Electrical Engineering, 2019

Publication

<% 1

14

Yu Chen, Minghao Wen, Ertao Lei, Xianggen Yin, Jinmu Lai, Zhen Wang. "Passivity-based control of cascaded multilevel converter based D-STATCOM integrated with distribution transformer", Electric Power Systems Research, 2018

Publication

<% 1

15

www.mdpi.com

Internet Source

<% 1

16

Ganesh Selvaraj, Kanimozhi Rajangam. "Multi-

objective grey wolf optimizer algorithm for combination of network reconfiguration and D-STATCOM allocation in distribution system", International Transactions on Electrical Energy Systems, 2019

Publication

<% 1

17

Adel A. Abou El-Ela, Sohir M. Allam, Nermine K. Shehata. "Optimal Allocation of a Hybrid Wind Energy-Fuel Cell System Using Different Optimization Techniques in the Egyptian Distribution Network", Energy and Power Engineering, 2021

Publication

<% 1

18

eprints.uthm.edu.my

Internet Source

<% 1

19

Alladi Pranay Kumar, Ganjikutta Siva Kumar, Dharmavarapu Sreenivasarao. "Three-phase four switch DSTATCOM topologies with special transformers for neutral current compensation and power quality improvement", IET Generation, Transmission & Distribution, 2019

Publication

<% 1

20

Bazilah Ismail, Noor Izzri Abd Wahab, Mohammad Lutfi Othman, Mohd Amran Mohd Radzi et al. "A Comprehensive Review on Optimal Location and Sizing of Reactive Power Compensation Using Hybrid-Based Approaches

<% 1

for Power Loss Reduction, Voltage Stability Improvement, Voltage Profile Enhancement and Loadability Enhancement", IEEE Access, 2020

Publication

21

www.samlexamerica.com

Internet Source

<% 1

22

www.ijert.org

Internet Source

<% 1

23

bdigital.unal.edu.co

Internet Source

<% 1

24

Jinmu Lai, Xianggen Yin, Zhe Zhang, Zhen Wang, Yu Chen, Xin Yin. "System modeling and cascaded passivity based control for distribution transformer integrated with static synchronous compensator", International Journal of Electrical Power & Energy Systems, 2019

Publication

<% 1

25

"Applications of Artificial Intelligence Techniques in Engineering", Springer Science and Business Media LLC, 2019

Publication

<% 1

26

Veera Venkata Satya Narayana Murty, Ashwani Kumar. "Impact of D-STATCOM in distribution systems with load growth on stability margin enhancement and energy savings using PSO and GAMS", International Transactions on

<% 1

Electrical Energy Systems, 2018

Publication

27

Khyati D. Mistry, Ranjit Roy. "Impact of demand response program in wind integrated distribution network", Electric Power Systems Research, 2014

Publication

<% 1

EXCLUDE QUOTES ON

EXCLUDE
BIBLIOGRAPHY ON

EXCLUDE MATCHES < 5
WORDS