IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor 6.252

Volume 2, Issue 2, July 2022

Power Quality Enhancement for Small-Scale Hydropower Plant using SVC

Varun Shrivastva[1], **Prof. Upendra Singh Tomar**[2], **Aishwarya Singh**[3]
PG Student, Department of Electrical Engineering[1]
Assistant Professor, Department of Electrical Engineering[2]
Assistant Professor, Department of Electronics Engineering[3]
Vikrant Institute of Technology & Management, Gwalior, India

Abstract: *Unlike the generators in large hydro power stations, which operate in voltage control mode, the generators in small hydro power stations (SHPs) are forced to operate in power factor control mode due to their limited reactive power support. In fixed power factor operation, smaller variations of voltage at the evacuation bus are managed by on load tap changing at the generator transformers. One of the biggest challenges facing the world today is to provide access to a safe and affordable electricity supply. Depending on the river flow, small-hydropower is often a cost-effective source of renewable energy. This research shows the voltage compensation & reactive power incorporation for the micro hydro power plant using the facts device SVC. This paper pertinent for enhancing power quality by control of voltage what's more, recurrence of a confined smaller scale hydropower era. The complete electromechanical framework is displayed and reproduced in MATLAB utilizing Simulink and Sim-power framework piece set.*

Keywords: SVC, Small hydro power plants (SHP), power quality improvement

I. INTRODUCTION

Hydropower is a method of generating electricity that uses moving water (kinetic energy) to produce electricity. Small-scale hydropower has been used as a common way of generating electricity in isolated regions since end of 19th century [1,2]. Small-scale hydropower systems can be installed in small rivers, streams or in the existing water supply networks, such as drinking water or wastewater networks. As the demand grows indefinitely, the available resources of the utility remain overstressed all the while. To overcome various disadvantages of large-scale hydro plants, it is proposed in the literature [3,4] to install SHPs in the regions that have potential for generating hydro-electricity. Clean energy at a competitive cost, less affected by rehabilitation and resettlement (R&R) problems vis-a-vis large hydro power plants, meeting power requirements of remote and isolated areas and availability of mature and largely indigenous technology, small hydro power plants (SHP) are growing at a faster rate all over the world. However grid connected SHPs faces challenges in maintaining continuous evacuation of power during the peak seasons where plenty of water is available in the river stream [5]. The utilities and the local governments have devised various policies so as to encourage private and public entrepreneurs for setting up of their own small hydro power generating units in order to supplement their generation to the grids. As a result of this, many firms have gone a long way in setting such units with the help of schemes and technical support available with them.

II. SMALL HYDROPOWER PLANTS CLASSIFICATIONS

Small hydro plants are basically "run-of-river" type. They generate electricity ranging from few kilowatts to few megawatts [6,7]. A detail classification of SHP units categorized as Micro, Mini and Small Hydro projects is presented below:

1. Mini hydro-10 KW to 99 KW;
2. Micro hydro-100 KW to 999 KW;
3. Small hydro- 1 MW to 25 MW.

The low utilization rate of the world's SHP potential could be attributed by several factors such as (i) challenges faced in setting up plants in remote terrain; (ii) delays in acquiring land and obtaining statutory clearances; (iii) inadequate grid

DOI 10.48175/568

connectivity; (iv) high wheeling and open access charges in some States; and (v) preliminary survey and review for the technical aspects.

III. POWER QUALITY IMPROVEMENT

Power Quality is a combination of Voltage profile, Frequency profile, Harmonics contain and reliability of power supply. The Power Quality is defined as the degree to which the power supply approaches the ideal case of stable, uninterrupted, zero distortion and disturbance free supply. Power Quality is characterized as any force issue showed in voltage, current, or recurrence deviations that outcome in disappointment or mis-operation of utility or end client gear [9-11]. With huge modern organizations including new advancements and touchy electronic gear to their operations, PQ issues have turned out to be more vital than any other time in recent memory.

3.1 Static VAR Compensator

The static VAR compensator is a shunt connected device, using thyristor switches and controllers, is already firmly established equipment for transmission line compensation. The static VAR compensator (SVC) is usually composed of thyristor-switched capacitors and thyristor - controlled reactors. The VAR output of an SVC can be varied continuously and rapidly between the capacitive and inductive ratings of the equipment[6] . SVC is normally used to regulate the voltage of the transmission system at a selected terminal, often with a priority option to provide damping if power oscillation is detected [12,13]. However, SVCs control only one of the three important parameters determining the power flow in AC power systems: the amplitude of the voltage at selected terminals of the transmission line.

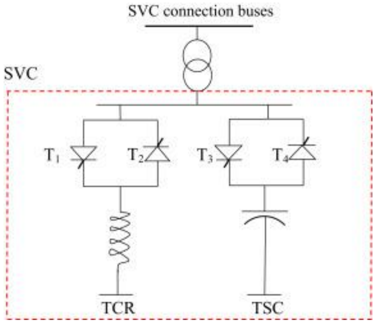

Fig 1: SVC connection Bus

IV. MICROHYDRO POWER GENERATION MATHEMATICAL MODEL

Mathematical model of hydro power units, especially the governor system model for different operating conditions [14-16]. Distributed generating systems are coming out to be into one of the most promising ways to cater the electrification requirements of isolated consumers all over the world [17,18].The Hydro power yield, as the turbine model depends on conditions for enduring state operation, is given by,

$Pt = \rho\times g\times Qt\times He$(1)

Where, P_t = turbine power,

ρ = water thickness,

Q_t= water stream,

He = viable head. If there should be an occurrence of Pelton turbine, it gets to be:

$P_t = \rho\times Q_t\times V_t\times(V_1 - V_2)\ (1 + m\cos\beta)$ (2)

Where, V_t = drive pace of the turbine,

V_1 = water speed in the contact of the plane with the basins,

m = report of V_1 and V_2,

β = edge amongst V_1 and V_2.

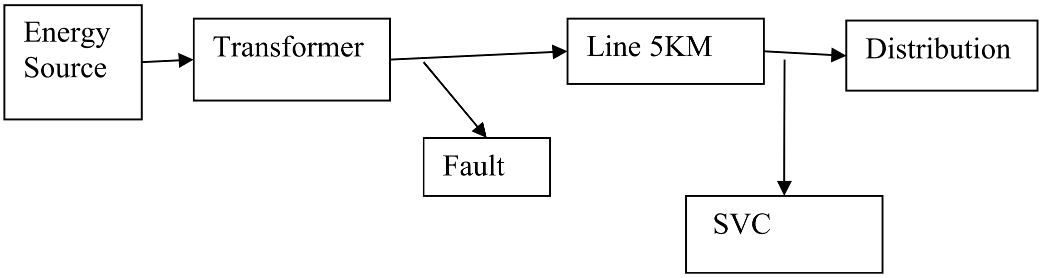

Fig 2 Proposed Methodologies for the Simulation of Work

Table I Parameters used in simulation for smaller scale hydro power framework

S. No.	PARAMETER	RATING
1	Power	40 KVA
2	Frequency	50HZ
3	Transmission line	11/33 KV LINE
4	Rotor Speed	1200RPM
5	R_s	0.03
6	X_d	2.9
7	$X_{d'}$	0.2
8	$X_{d''}$	0.1
9	X_q	2.5
10	$x_{q''}$	0.4
11	X_l	0.1
12	$T_{d'}$	0.07
13	$T_{d''}$	0.02
14	$T_{q''}$	0.02

V. RESULTS & DISCUSSION

The parallel operation of disengaged offbeat generators execution is exhibited with adjusted/lopsided, direct and non-straight loads. The capacity of battery is accomplished for burden leveling and a consistent force is kept up at generator terminals. The proposed system is modeled and simulated using MATLAB environment. The configuration includes the micro-hydro turbine, synchronous generator, a back-to-back AC-DC-AC converter, SG (42.5kVA), power quality analyzer, RL-load with SVC 200e6 connected through it. The linear load applied for simulation time 10 sec, then the load observed high power requirement so the battery supplies additional power required by consumer loads. The function of battery is achieved for load levelling and a constant power is maintained at generator terminals.

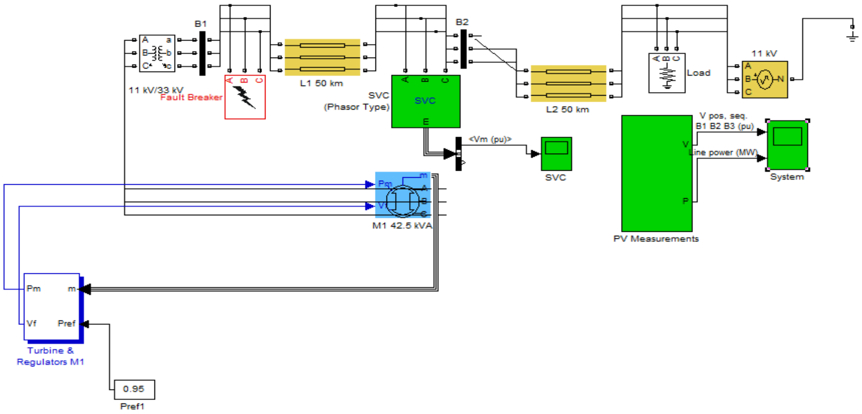

Fig 3. Simulink Model for Small-Scale Hydro Power plant

DOI 10.48175/568

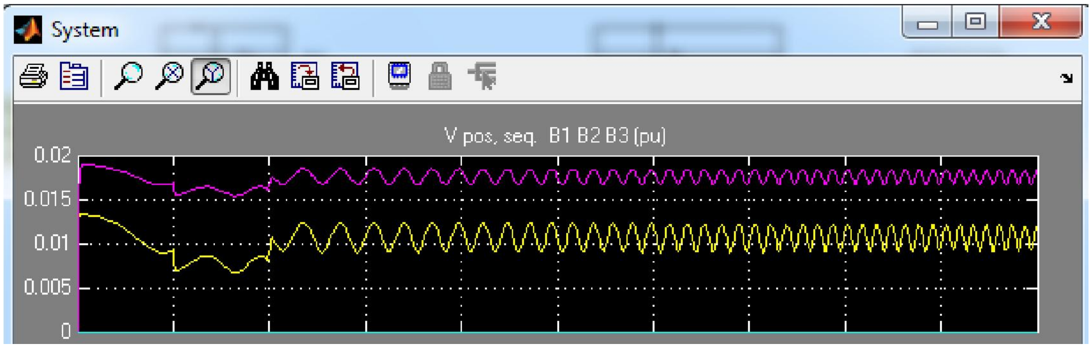

Fig 4 Bus Voltage V_{abc} of hydro plant utilizing SVC

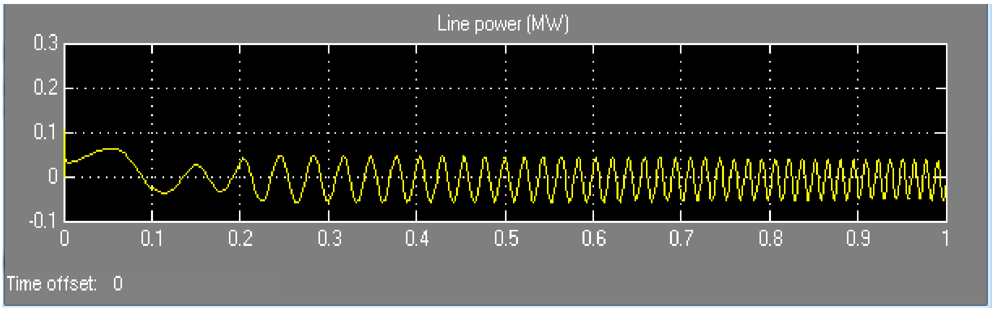

Fig 4 Line Power of micro hydro system

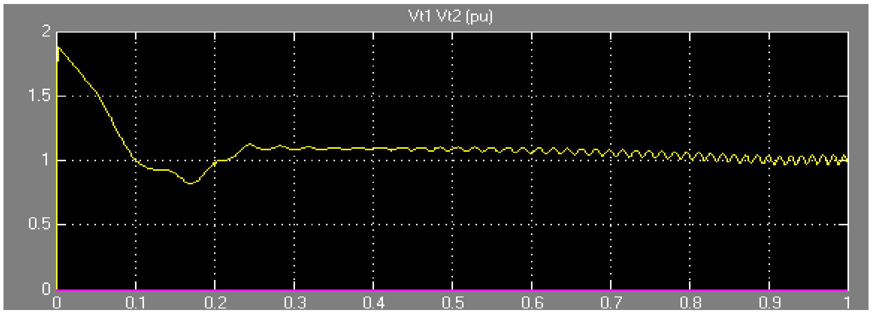

Fig 5Voltage of the turbine

VI. CONCLUSION

The main focus of this paper is to ensure smooth evacuation of real power generated by SHP units to the neighboring grid. While dealing such issues, the practical limitations faced by such units have been considered carefully in this work.A SVC is proposed in a position of a customary which depends on vector control plan including synchronously reference. As SVC is intended for solidarity power. A battery is associated on the dc side which is charged and released by the bidirectional movement of SVC. The SVC likewise performs different capacities like voltage direction &provide better result for the voltage compensation. This paper revealing the micro-hydro system to reached at steady state by use of facts device SVC at the simulated scale 0.75 sec for the under simulated time 1 sec.

REFERENCES

[1]. Xu, J., Ni, T, Zheng, B. 2015. Hydropower development trends from a technological paradigm perspective. Energy Convers.Manag. 90, 195–206.

[2]. Sachdev, H.S.; Akella, A.K.; Kumar, N. 2015 Analysis and evaluation of small hydropower plants: Abibliographical survey. Renew. Sustain. Energy Rev. 51, 1013–1022.

[3]. Manzano-Agugliaro, F.; Taher, M.; Zapata-Sierra, A.; Juaidi, A. 2017, Montoya, F.G. An overview of research and energy evolution for small hydropower in Europe. Renew. Sustain. Energy Rev. 75, 476–489.

[4]. Yildiz, V.; Vrugt, J.A. 2019, A toolbox for the optimal design of run-of-river hydropower plants. Environ. Model.Softw. 111, 134–152.

[5]. Karady, G. G. and Holbert, K. E. 2013. Electric Generating Stations, in Electrical Energy Conversion and Transport: An Interactive Computer -Based Approach, Second Edition, John Wiley & Sons, Inc.

[6]. Naghizadeh, R.A., Jazebi, S. and Vahidi, B. 2012 .Modelling Hydro Power Plants and Tuning Hydro Governors as an Educational Guideline. International Review on Modelling and Simulations (I.RE.MO.S), Vol. 5, No.4.

[7]. IEEE Committee. 1973. Dynamic models for steam and hydro turbines in power system studies. IEEE Trans on Power ApparSyst; 92:1904 –15.

[8]. IEEE Working Group. 1992. Hydraulic turbine and turbine control models for system dynamic studies. IEEE Trans on Power Syst;7:167–79

[9]. Vournas CD. Second order hydraulic turbine models for multimachine stability studies. IEEE Trans Energy Conv 1990;5.

[10]. Qijuan C, Zhihuai Xiao. 2000. Dynamic modeling of hydroturbine generating set. In: IEEE International Conferenc e on Systems, Man and Cybernetics, pp. 3427 – 3430.

[11]. Singh, M., and Chandra, A. 2010. Modeling and Control of Isolated Micro -Hydro Power Plant with Battery Storage System. National Power Electronic Conference, Roorkee, India

[12]. Malik, O.P., Hope, G. S., Hancock,G., Zhaohui, L., Luqing, Y. E. and Shouping, W. E. I. 1991. Frequency measurement for use with a microprocessor-based water turbine governor. IEEE Trans Energy Conv, 6:361–6.

[13]. Ramey, D. G. and Skooglund, J. W. 1970. Detailed hydro governor representation for system stability studies. IEEE Trans on Power Apparatus and Systems, 89:106–12.

[14]. Bhaskar, M. A. 2010. Non Linear Control of SVC.IEEEInternaltional Conference on Recent Trends in Information Telecommunication and Computing, pp. 190-195.

[15]. Luqing, Y. E., Shouping, W. E. I., Malik, O. P. and Hope, G. S. 1989. Variable and time varying parameter control for hydroelectric generating unit. IEEE Trans Energy Conv, 4:293–9, Wozniak.

[16]. Fuchs, E. F. and Masoum, M.A.S. 2011. Power Conversion of Renewable Energy Systems, Springer, ISBN 978-1-4419-7978-0.

[17]. Xu, F., Li, Y. and Qijuan, C. 1995. Study of the Modelling of Hydroturbine Generating Set. In: International IEEE/IAS Conference on Industrial Automation and Control: Emerging Technologies, 22-27, pp. 644-647.

[18]. Casey L, Lasher S, Rhoades S, Schauder C, Semenov B 2010, A faster, smarter, controllable, greener, distributed Grid - the keys to an advanced Grid that yields higher power quality," in Innovative Technologies for an Efficient and Reliable Electricity Supply (CiTRES), IEEE Conference on pp. 1-7.