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Management of Power in Alternate /Direct Current Hybrid Micro Grids and Harmonic Analysis With and Without D-STATCOM with Different Load Condition

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Abstract **-** Renewable energy is the source of energy, and in the present situation, the electricity demand is increasing, similar to increasing the population, so the consumption of electricity is rising. There are many problems in solar energy due to fluctuations in the voltage, frequency, mismatch of load, and many stability issues in power generation. Therefore, that improves the power quality and ESS, fuel cell. In this paper, the alternate current /direct current micro grid to invent depend on the generator photovoltaic solar cell (PV) & the energy storage system (ESS). The help of with or without D -STATCOM in the alternate and direct current hybrid micro grid, controls the power demand. Ac-dc buses are interconnected with bidirectional converter. The (IC) interlinked converter is used when the alternate current /direct current flank is affected by the active power shortage. Specifically, the distributed static synchronous compensator (D-STATCOM) at work as the Alternate Current micro grid cannot deliver the reactive power response. A dc-dc boost converter is used to boost out the (I_V) input voltage from the photovoltaic, which is come from the Direct current bus. In this structure, the nonlinear load is examined with different loads, e.g., inductive pulse, which is connected to the alternate current side bus. The mat lab 2022b for the power management of two ac/dc under different conditions verifies the proposed scheme with highly efficiency, optimization, trustworthiness, & strength in the islanding mode.

Keywords**:** Photovoltaic, Hybrid micro grid, Energy Storage System, D-STATCOM, Total Harmonic Distortion.

1. Introduction

In the 21st century, electricity is an essential life need. The electricity generation in hydropower is very costly and has many issues. Using fossil fuel sources produces carbon emissions, environmental factors, and pollution. Renewable energy is the best source of energy. It is straightforward eco-friendly, pollution free, and cost-effective. Wind energy, solarcell & fuel cell are the sources of energy. They are used in the hybrid mode in the ac/dc with a distributed control scheme implemented to control the voltage, frequency, power, and energy[1] management with an energy storage system with different balance loads. The bidirectional converter is used for the interconnected in the ac-dc side to control the system's active and reactive power flow. Different method used for improve the efficiency of ac and dc micro grid for the constant power load [2].The coordinated voltage control methods with RPMS structure achieve the voltage and transient time response. The loads are increasing as per the requirement, minimizing the low cost and providing high-quality power without any line loss is needed. Then this power quality issue in the hybrid is modified by the STATCOM. The essential purpose of a hybrid micro grid [3] is to reduce the line losses in the multiple conversion & active and reactive power problems to overcome [4]. This proposal uses the shunt power active filter to improve the power quality. This is a new kindof invention with the help of power electronics converts [5] because they replace the extant inverter for the small-sized permanent magnetic wind machine ten kilo Watt to 20 kilo Watt that offers the volt ampere reactive control and power control in the dynamic manner that is called the D-STATCOM. This inverter provides the grid with Voltage ampere reactivepower control and power analysis rectification. The planned method depends on the line's voltage or power supply. The 3 phase D-STATCOM [6] used to improve the power quality in the phase with DGs that flow "Maximum available active power." The distributed system includes the nonlinear loads used as the transformer's computers, saturated coils, and power electronics devices [7]. The system creates nonlinear character tics, switching action, power electronics inverter & converterdevices, & unsolicited harmonics. The system affects the low power efficiency & power factor. The active shunt filter, D- STATCOM used to suppress the harmonics [8]. The proposed technique used to control the reactive power from the microgrid to improve the voltage quality reason of the active power from the hybrid micro grid. The D-STATCOM uses for the compress the harmonics disturbances comes from renewable energy sources, power generators, and integrate STATCOM [9]. ESS devices play a prominent role in improving the system's efficiency. The D-STATCOM has used the active power filter (APF) [10] to decrease the high-unwanted voltage in individually power switch. The control scheme used renewable energy sources to fulfil the power demand [11]. The controller is used in the alternate current /direct current micro grid. The planned power management system used energy storage devices in the hybrid micro grid. The exit ac/dc [12] micro grid can fulfil the power demand of the customer at a reasonable cost or high-quality power with minimum losses. The scheme shown a brief scheme for power management approaches designed for a hybrid Alternate Current/Direct Current micro grid [13], which encompasses different loading conditions. The paper is structured as follows: Section 1. Modelling of the hybrid micro grid 2. Configuration of the hybrid micro grid 3. Simulation of purposed hybrid ac/dc micro grid. 4. Effect of divergence of various loading situations micro grid 5. Discrepancy of loading situations with D-STATCOM 6. Variation of loading conditions with Three-phase fault 7. Variation of loading conditions with three-phase fault & D- STATCOM 8. Results and Discussion.

1. Modeling Of Hybrid Micro Grid

A micro grid is a portable power grid that may run by itself or in collaboration with certain other micro power grids operation with a single controller. A single cell observed a single load and response within milliseconds as per the demand of the transmission line. To make the system reliable, robust and resilient, decrease the feeder losses and local support voltage [2]. The primary intention of this idea is to sharpen the esteem of the benefit presented by small-scale distribution, like contributing waste heat during need times [3]. The micro grid system is conventional compared to the other distribution network; if we use this system with proper coordination. Micro grid is eco-friendly and desirable output by connecting the distribution system.

2. Configuration of the Hybrid Micro Grid

The design of the hybrid alternate and direct current micro grid shown below the fig.1 their pulse load, nonlinear or alternate load connected with system. The alternate current bus connected with utility grid. Fig.2 show the STATCOM is connected on the alternate current side in the hybrid system. After that the system are given below the fig3&four. Alternate and direct current is connected with or without D-STATCOM 3-phase fault in the hybrid system. The structure of the alternate and direct current of the hybrid micro grid is achieved with 3 phase fault or FACT device is implementedin the STATCOM.

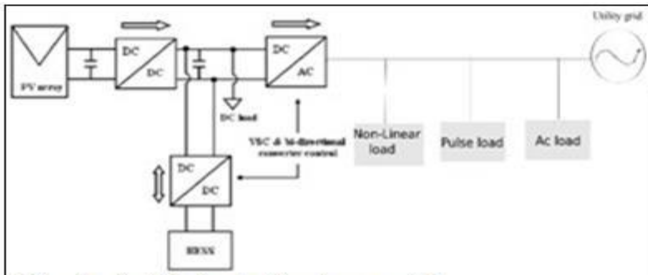

Fig.1 Ac/Dc hybrid micro grid

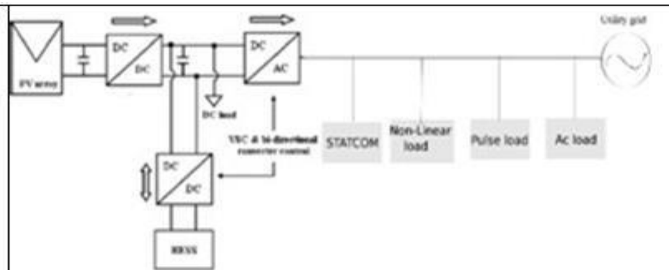

Fig.2 Hybrid ac/dc design with D-STATCOM controller

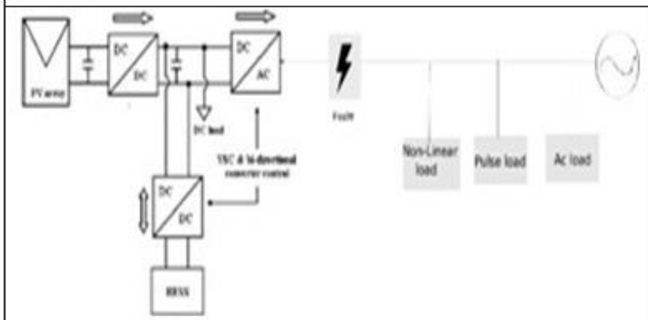

Fig.3 The hybrid ac/dc system with 3 phase fault

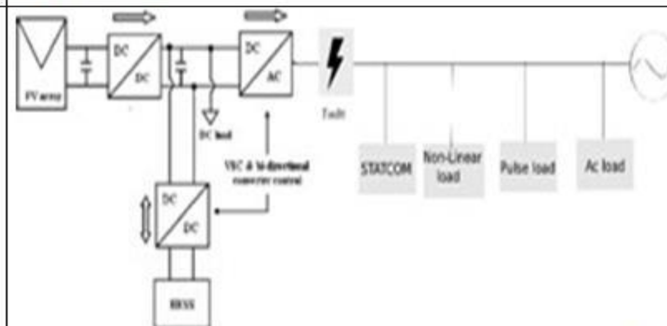

Fig.4 The hybrid ac/dc system with 3 phase fault with D-STATCOM

Detail and symbol	Significance
Solar panel capacitor (C_{PV})	100 micro farad
Inductor for solar panel boost converter (L_{PV})	5 mili Henery
DC bus capacitor (C_d)	6000.0 microfarad
AC filter inductor (L_{ac})	1.2mH
Inverter equivalent resistance (R_{ac})	0.3 ohm
Battery converter inductor (L_b)	3.3 milli henery
Resistance of Lb (R_b)	0.5 ohm
Rated AC grid frequency (F)	50hertz
Rated DC bus voltage (V_d)	300 volt
Rated AC bus p-p voltage (rms)(V_m)	208.0 volt
Transformer ratio(n_1/n_2)	1:1

Table 1

3. Simulink Purposed Model of Alternate Current /Direct Current HybridMicro Grid:-

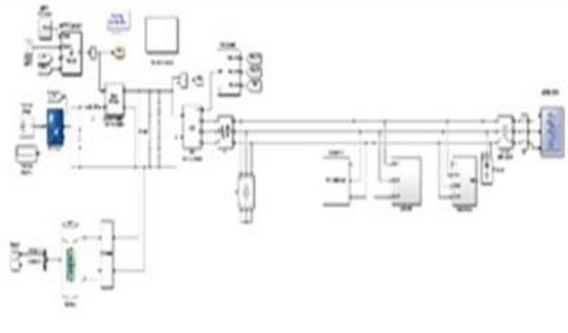

Fig.5 Ac/Dc hybrid micro grid with different load conditions in simple mode operation

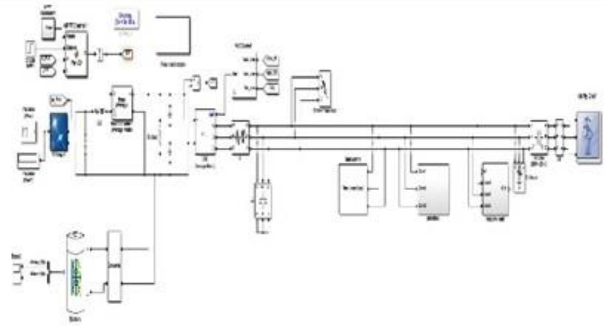

Fig.6 ac/dc hybrid micro grid with different load conditions in simple mode operation with fault system

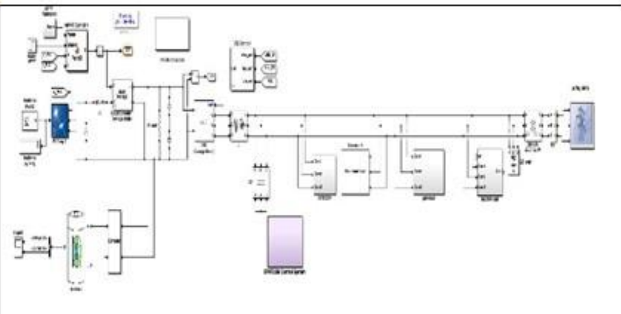

Fig.7. The AC/DC Hybrid micro grid with different load conditions atsimple operating mode with STATCOM.

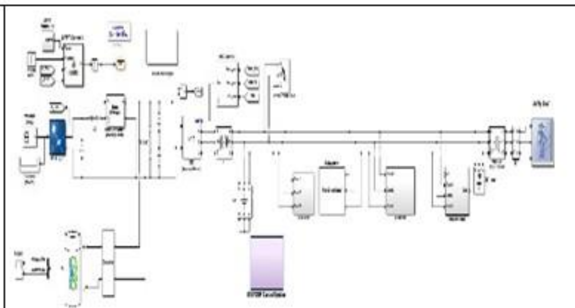

Fig.8. The AC/DC Hybrid micro grid with different load conditions faults with a simple operating mode with STATCOM.

4. Effectof Divergence Of Various Loading Situations Micro Grid

In this model when add the different type of loads are attached in ac/dc micro grid or observed the power quality and balancing without STATCOM of the system.

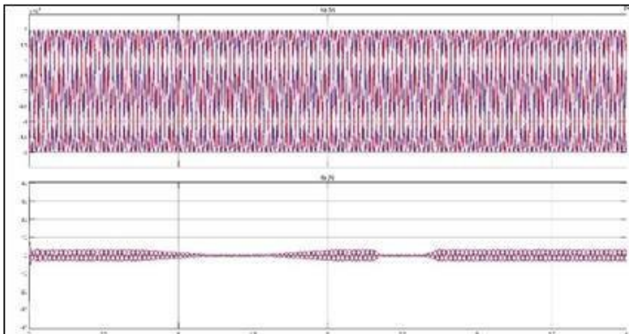

Fig.9 No-Load condition grid output voltage or current

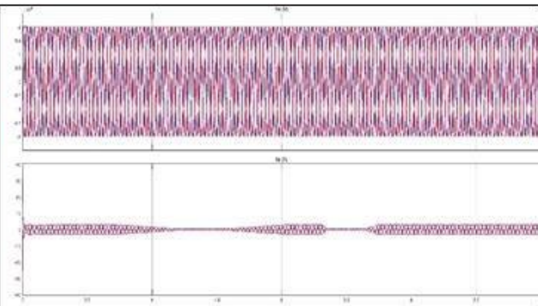

Fig.10 Inductive load condition grid output voltage or current

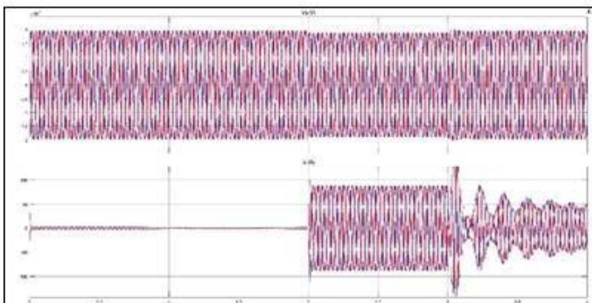

Fig.11 Inductive & Pulse load condition grid output voltage and current

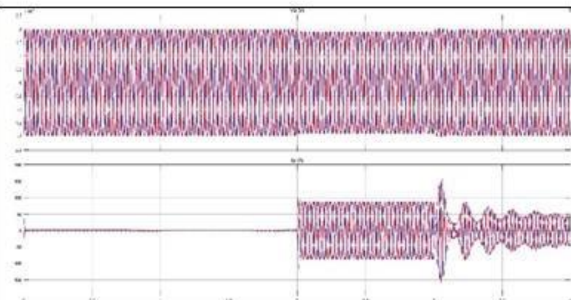

Fig.12 Inductive, Pulse, Non-linear load condition grid output voltage and current

Loads	A_P (ACTIVE POWER)	R_P (REACTIVE POWER)	Parentage total harmonic distortion (Volt)	Parentage total harmonic distortion (Volt)
Without load	9.0e+04	-41.8	0.82	100.14
Inductive load	9.0e+04	-58.5	0.83	141.09
Inductive load and pulse load	-1.2e+06	4.94e+05	1.93	82.93
Inductive load , pulse load and Nonlinear load	-1.2e+06	4.89e+05	0.98	148.08

Table 2

5. Discrepancy of Loading Situations With D-STATCOM

After that add the various loads in the alternate and direct current with in the STATCOM and supply the power quality without any disturbance.

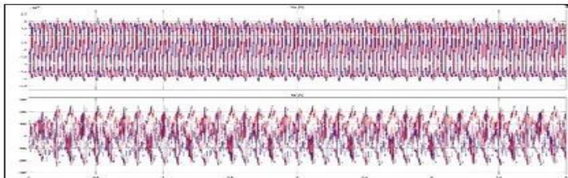

Fig.13 No-Load condition grid output voltage and current with D-STATCOM

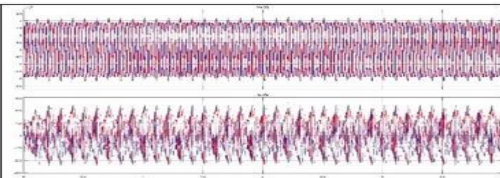

Fig.14 Inductive load condition grid output voltage and current with D-STATCOM

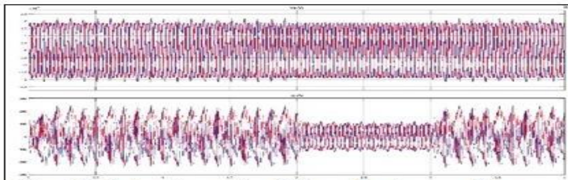

Fig.15 Inductive & Pulse load condition grid output voltage and current with D-STATCOM

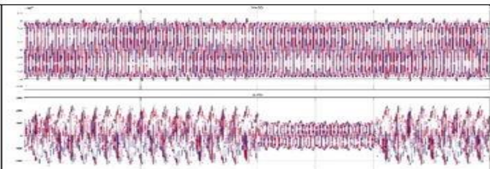

Fig.16 Inductive, Pulse, Non-linear load condition grid output voltage and current with D-STATCOM

Loads	A_P (ACTIVE POWER)	R_P (REACTIVE POWER)	Parentage total harmonic distortion (Volt)	Parentage total harmonic distortion (Volt)
Without load	4.4e+06	-1.5e+06	0.61	9.05
Inductive load	-5.5e+06	-1.6e+06	0.59	8.08
Inductive load or pulse load	-4.4e+06	-1.3e+06	0.47	9.21
Inductive load , pulse load or Nonlinear load	-4.5e+06	-1.3e+06	0.47	9.12

Table 3

6. Variation Of Loading Conditions With Three-Phase Fault:

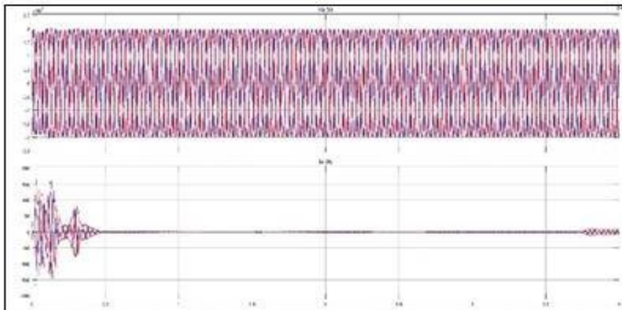

Fig.17 No-Load condition grid output voltage and currentwith Three-phase fault

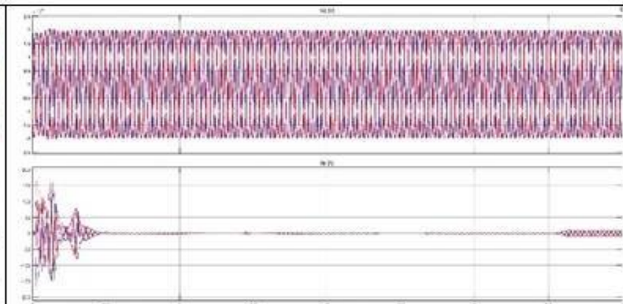

Fig.18 Inductive load condition grid output voltage andcurrent with Three-phase fault

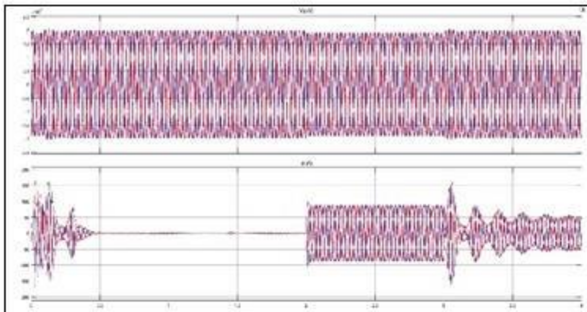

Fig.19 Inductive & Pulse load condition grid outputvoltage and current with Three-phase fault

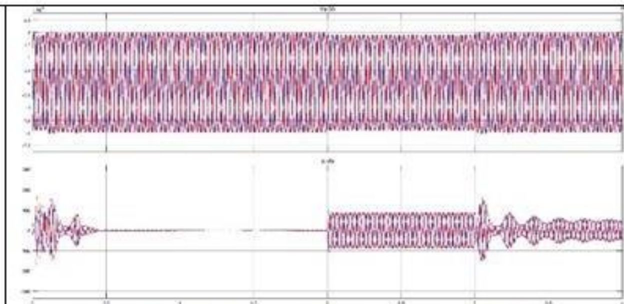

Fig.20 Inductive, Pulse, Non-linear load condition grid output voltage and current with Three-phase fault

Parameter	A_P (ACTIVE POWER)	R_P (REACTIVE POWER)	Parentage total harmonic distortion (Volt)	Parentage total harmonic distortion (current
Without load	-4.7e+05	-1.6+05	0.82	2.31
Inductive load	-4.5e+05	-1.5e+05	0.59	8.35
Inductive load or pulse load	-4.6e+05	-1.4e+05	0.47	9.21
Inductive load, pulse load or nonlinear load	-4.5e+05	-1.4e+05	0.47	9.12

TABLE 4

7. Variation of loading conditions with three-phase fault and D-STATCOM

The ac/dc micro grid with D-STATCOM in the fault 3 phase for the observation in the power quality issue

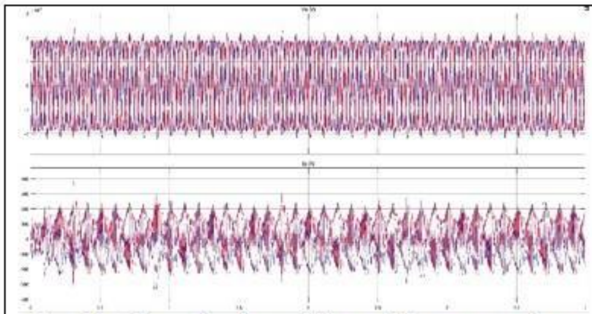

Fig.21without load condition grid output voltage and current with Three- fault and D-STATCOM

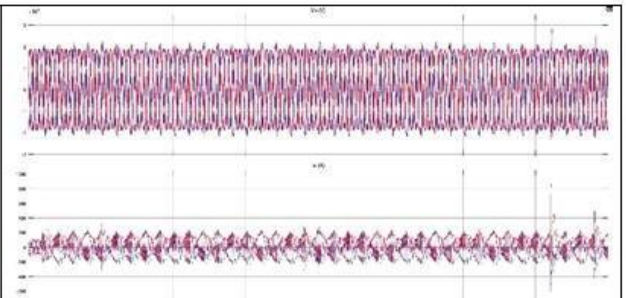

Fig.22 Inductive load condition grid output voltage and current with Three-phase fault and D-STATCOM

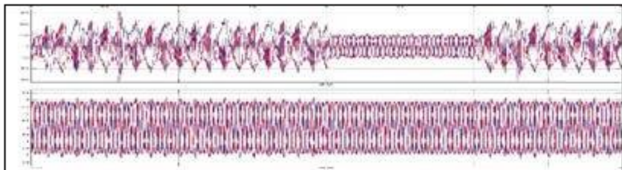

Fig.23 Inductive & Pulse load condition grid output voltage and current with Three-phase fault and D- STATCOM

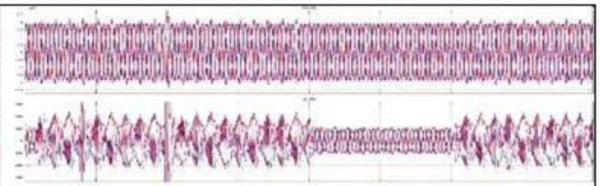

Fig.24 Inductive, Pulse, Non-linear load condition grid output voltage and current with Three-phase fault and D-STATCOM

Loads	A_P (ACTIVE POWER)	R_P (REACTIVE POWER)	Parentage total harmonic distortion (Volt)	Parentage total harmonic distortion (current)
Without load	-1.2e+05	4.3e+04	3.47	110.18
Inductive	-1.1e+05	4.2e+04	0.88	141.10
Inductive &pulse	-1.2e+05	4.5e+04	2.22	158.76
Inductive, pulse& nonlinear	-1.2e+05	4.4e+04	0.91	167.65

8. Results and Discussion

This paper shows the power flow between alternate current /direct current is proposed in the direct current side voltage is connected and boosting with the P&O algorithm in MPPT control. THD (HARMONIC DISTROTION) is determined vale is reduced from the 118.05to8.870. Another side the bidirectional converter is used for voltage and frequency control with different load conditions. The Facts control device is used for the control the active and reactive power compensate with STATCOM in ac/dc micro grid. From the table 2 shown that the load demand is increasing then the active power is decreasing or the reactive power vice versa. The analysis has studied by the various load conditions displayed above result. The system is used for the power quality without STATCOM and the % of THD is determined or decreased from the 144.45% to7.20%.

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