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Analysis, Design and Instillation of Inverter based 6kW Solar Smart Water Purifier in the Ground water Polluted Areas of KAVITI Mandal - A DEATH ZONE of Srikakulam, Andhra Pradesh in India

[1]G. Suchitra, [2]K. Kiran Kumar
[1]PG Student ,[2]Professor
Department of Electrical and Electronics Engineering
Aditya Institute of Technology And Management
Tekkali,India.

***Abstract*:- This present work carries analysis, design and instillation of 6kW solar smart water purification plant in Chepalakapasakurdi in order to provide safe drinking water to the chronickidney patients in the most affected area and whatever excessive power is generated through solar power will be exported to the grid and while carrying the work we have also concentrated in designing the inverter which converts solar power to run the purification plant. The output power generated from the inverter is a constant and balanced three phase voltage (RMS value) is maintained during steady-state operation of water purification system which purifies the available effected ground water using desalination plant irrespective of solar intermittences and fed to reverse osmosis plant which is provided the motors and the compressor of water purification system. To assist the plant during night time or at low irradiance level or to feed the grid during excess PV power, grid interface is provided with a bidirectional net metering scheme. This paper gives an idea about the Reverse Osmosis Plant which is installed will purify the water using filters at five stages. One Hp pump used inRO plant to circulate the water within. Photovoltaic (PV) simulation system powering a reverse osmosis (RO) desalination unit.**

Keywords -water pollution; solar plant; inverter; grid; solar smart water purification plant.

I. INTRODUCTION

Uddanam (Udyanavanam) region is the part of south eastern Srikakulam ghat located 200 km from the city of Visakhapatnam. This region spread through an area of about 290 sq. km and is located between “18.56219 - 19.16563”N latitude and “84.30934 - 84.76844”E longitude[1,3].The climate is moderate to humid throughout the year with good seasonal rainfall and is influenced by both south –west and north –east monsoon rains. The population of people in Uddanam is 76,019 according to 2011 census [2] The life style of uddanam people are Agriculture and Fishing[4]. A number of researchers have proposed that groundwater contamination is one of the factors leading to the high prevalence of Chronic kidney disease in this region[22]. People in the Uddanam region believe they are cursed because of the high prevalence of CKD. The most horrible affected mandals in this area is Kaviti. Their performance is based on the belief that drinking water is the primary cause of chronic kidney disease in the area, and ground water is the only primary source of drinking water. Because of the high rainwater situation and proximity to the sea beach[17], the Uddanam area has less ground water residence and a narrow water table. As a result, ground water contains fewer minerals and is pure, but it may have additional problems due to the water recorded situation. Because of paddy agriculture, these waterlogged areas contain extremely high levels of fertilizer and chemicals. In many methods, the kidneys are unprotected from high fluoride (F) concentrations in drinking water[5,6,16] .

Chronic means "long-lasting," and CKD is defined as the presence of kidney damage and its structure, or decreased kidney function and diminished function that lasts more than three months [7,8,9]. Whenever kidneys’ functioning is slow, then level of Creatinine in life blood increases. CKD usually triggered by contaminations in food intake, ailments like hypertension, diabetes, etc., and rarely by intake of poisonous compounds[10].The albumin creatinine rate (ACR) can be used to determine kidney damage. In a timed urine collection, albuminuria is one of the observable identifiers of kidney function. One of the causes of CKD, i.e., proteinuria excretion, is a high protein intake or a kidney infection [11,18]. Basically, the ACR among young adults is ACR standard values, which are as follows: ACR 10–29 mg/g indicates high/normal risk, 300 mg/g high risk, >300 mg/g very high risk, and symptoms of nephrotic syndrome (low serum albumin, oedema, high serum cholesterol) appear when ACR is >200 mg/g.

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Reverse Osmosis Plant which is installed will purify the water using filters at five stages. One Hp pump used inRO plant to circulate the water within. Photovoltaic (PV) simulation system powering a reverse osmosis (RO) desalination unit[13]. The simulation is carried out using commercial software, MATLAB. The PV system consists of solar panels which connected in series parallel combination which acts as a source to a storage battery via DC-DC charge controller in integration with a three phase voltage source inverter (VSI) to supply the AC output to the water treatment plant. The load for this system is a pump, which provides the feed water to RO system. The RO unit comprises of one Filmtec spiral wound membrane. Due to the filtration the effect on the main parameters in desalinated water production capacity shows that with the increase of the raw water feed flow will increase the monthly fresh water production increases.

Whatever the power left after utilizing it for the purpose of RO plant and then it will be transferred to the grid using solar grid integration technologies[15]. Solar-Grid integration technology allows solar power produced in large scale from PV to integrate with the already existing power grid. This technology involves careful considerations within the areas involving manufacturing, installations and operation of solar component. The solar energy generated must be interconnected effectively onto the transmission grid[19].

In this paper I would like to present the observation which provides that more chronickidney disease patients are found in Chepalakapasakurdi. Therefore the establishment of solar water purification plant generating a 6KW is found to be very economical and ecofriendly. Whatever excessive power is generated through solar power will be exported to the grid and while carrying the work we have also concentrated in designing the inverter which converts solar power to run the purification plant.

II. METHODOLOGY

The solar Power generating system with net metering scheme is designed which has a total output voltage of 680V. The PV array consists of 20 panels of 250W have been connected in series parallel combination integrated to a three phase voltage source inverter (VSI) to feed the AC output to the water treatment plant. To assist the plant during night time or at low irradiance level or to feed the grid during excess PV power, grid interface is provided with a bidirectional net metering scheme. In continuous with the analysis on the water samples, to purify the water in affected areas, a solarpowered water treatment plant has been designed and the simulation has been carried out for theperformance analysis of the integrated system.

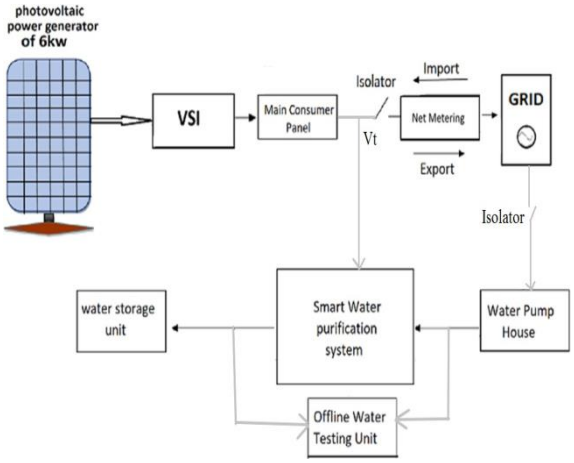

Fig1: Solar power generation for water treatment plant and grid interface through net metering

The simulation has been carried out for theperformance analysis of the integrated system. For instance, the terminal voltage (Vt),

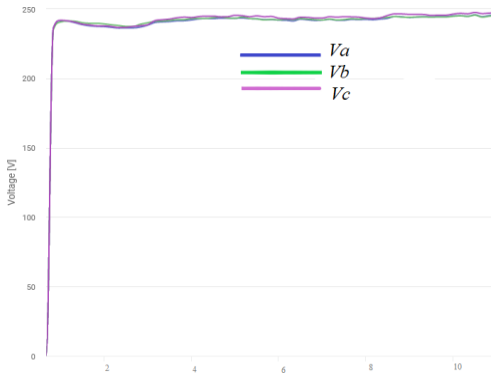

Fig. 2: Voltage at point of common

III. SIMULATION RESULT

It can be observed that a constant and balanced three phase voltage (RMS value) is maintained during steady-state operation of water purification system (a load of 2 kW) irrespective of solar intermittences. The resulting simulated waveforms of DC voltage from PV array to inverter, simulated load voltage waveform and load current waveforms are provided as shown in Fig.3.and Fig.4 respectively.

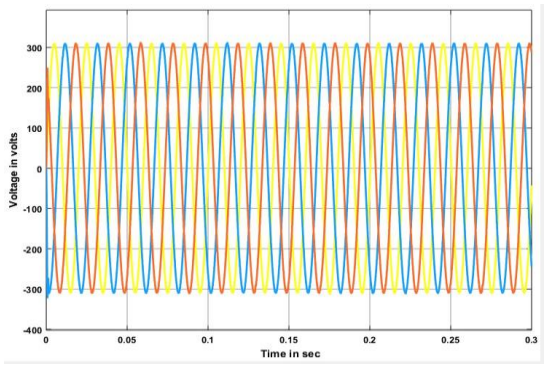

Fig 3.Output voltage waveform of solar PV -inverter for 2KW load water plant

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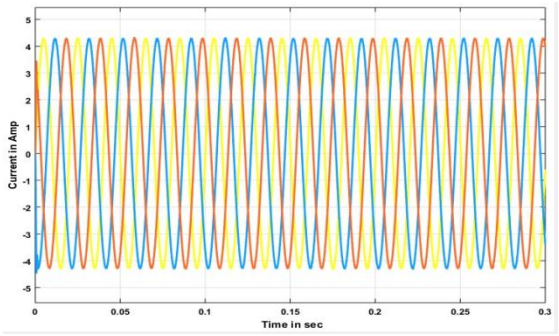

Fig.4. Output current waveform of solar PV –inverter for 2KWwater plant

Thehardwarecomponentsrequiredforfulfillingthedesiredoutputareillustrated:

Fig.5. a) Solar Photovoltaic Panels, b) Power conditioning unit, c) DC Cable for interconnectingPanel to Panel, d) DC Cable for Inter connecting String Combiner Box with Inverter, e) RS 485cableforinterconnectingSCBtoSCADAandotherequipment's,f)ModuleMountingstructure, g) String Combiner Boxes, h) Lightning Arrestors for Solar Fields, i) Earthing ,j) AC DC SafetyDevices Arrangement ofsolar panels

a) Solar Photovoltaic Panels:

PV panels use solar energy from the Sun to generate electricity based on the photovoltaic effect. This use thin-film cells which are made up of silicon. Cells are to be protected from mechanical damage and moisture to produce adequate energy. The cells are connected with one to another electrically in series to get the desired voltage, and then in parallel to increase amperage. The power rating of the module is the mathematical product of the voltage and current output of the module[21].

b) Power conditioning unit:

A solar power conditioning unit is a system component that includes a solar charge controller, an inverter, and a grid charger. It allows you to charge the battery bank from solar to grid and vice versa.

c) String Combiner Box:

String Combiner Box combines the multiple DC inputs coming from the panel terminals in the system. The overall function of this box is to bring the output of several solar strings together connects the box to the inverter. Here in this paper we have used it for combining the outputs of 20 PV Cells.

d) ModuleMountingstructure :

Module mounting structures are made of three types of metals. They are Hot Dip Galvanized Iron, Aluminium and Mild Steel (MS). Dip Galvanized Iron, the name itself represent the galvanizing of iron, zinc coating is applied to iron or steel to prevent it from rusting.

IV. DESCRIPTION OFWATER FILTRATIONPLANT

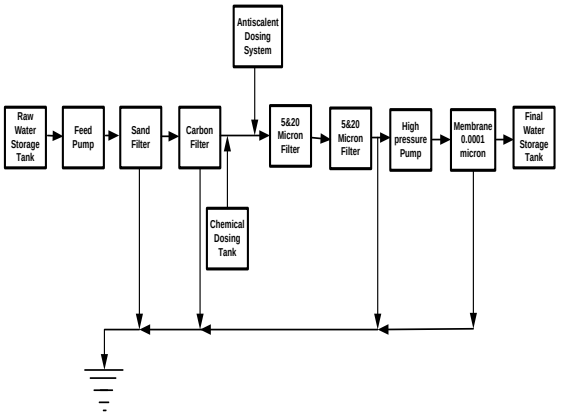

Fig.6.BlockDiagramofwater filtrationplant

The output power generated from the aforementioned setup is fed to reverse osmosis plant whichis utilized bythe motorsand the compressor ofwaterpurification system.

Most of the residents in this affected area are illiterates and their standard of living is below the povertyline .The challenge faced here is theft of power .Inorderto overcome this problem and providesecurity to the solar power generation an intelligent solar power theft detection technology usingWi-Fi notification is used Intelligent Solar Power Theft Detection is providing utility data servicewhich includes a receiving meter for measured solar power data consumed and delivered solarpower data that delivered to the load. The invented technology determined a difference betweenmeterdataandthedeliveredsolarpowerdatagreaterthanapredeterminedamount,andindicateadiscrepancyifthedifferenceexist betweenbothanddisplaytheamount.Theinventedtechnologyalso provides that discrepancy varies over time by a pre-determined amount and providing adiscrepancynotificationsuchaWI-FIviathesolarpowerline.Theinventedtechnologyalsolooksthe solar power traversing through the utility meter is metered to determine the utility fees to bebilled to the customer of given premises. The tapping into the power line upstream of the solarpower meter to supply solar power to premises or diverse is illegal and is solar power theft. It isestimated that approximately11.4% of thesolar power.

The Reverse Osmosis Plant is installed to purify the water in five stages. One Hp pump used inRO plant to circulate the water within. The RO Plant is drawing around 4000 KWhs per annum.TheBlock illustrated inFig.6 shows the processof purification of water.

a) RAW WATER SUPPLY PUMP:

With a flow rate of 4 m^3 per hour, a centrifugal pump made of Cast Iron (C.I) is required to feed raw water from an underground raw water storage tank to a Pressure Sand Filter (PSF), then to an Activated Carbon Filter (ACF), and finally to a Micron Cartridge Filter (MCF). Suction and discharge pipework are installed on the pump.

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b) PRESSURE SAND FILTER:

Sand filtration is a popular and effective method for removing suspended solids from water. The filtration medium is made up of multiple layers of sand with varying sizes and specific gravity. Sand filters are available in a variety of sizes and materials, and can be operated manually or automatically.

c) ACTIVATED CARBON FILTER:

The raw water from its source will be passed directly through the ACF to remove chlorine, colour, and odor. For efficient filtration, the Charcoal Filter will be designed with a filtration velocity of 19 - 20 m/hr.

d) MICRON CARTRIDGE FILTER:

A MCF is provided to remove fine suspended solids, which may escape from upstream units. 5 Micron cartridge filter is provided which will remove fine suspended solids up to 5 micron, which if not trapped may clog the RO membrane. This would also eliminate problems caused by particulate matter in high-pressure pumps.

e) CHEMICAL DOSING PUMP:

A dosing pump draws a predetermined amount of liquid into its chamber and injects the chemical into a tank or pipe containing the fluid to be dosed. It is powered by an electric motor or an air actuator and has a controller that controls the flow rate and turns the pump on and off. Some models have more advanced control systems.

f) HIGH PRESSURE PUMP:

Vertically mounted multistage centrifugal high pressure pump made of stainless steel. The High Pressure Pump delivers raw water at pressures ranging from 10 to 15 kg/cm2 to the RO Membranes, where permeate is separated. Instruments such as a high and low pressure switch, a pressure monitor, and the necessary isolation valves are provided.

g) DESALINIZATION BY REVERSE OSMOSIS SYSTEM:

The principle of the 'Reverse Osmosis Process' removes 90-95 percent of Total Dissolved Solids from a Reverse Osmosis System. This system is made up of a Stainless Steel Skid for mounting high pressure tubes in FRP with a 150 PSI resistance for pressure housing spiral wound TFC. Under specified operating conditions, High Pressure Pump instruments provide membrane elements with necessary control valves to feed, product, and reject pipe. For pressure indication and control of the entire R.O. System, a pressure monitor is provided. An online flow indicator is provided at the product and brine pipe work to control the desired flow rate and recovery.

h) PRODUCT WATER STORAGE TANK:

This is a vertical storage tank that is required for storing R.O processed water. Inlet/outlet pipework with appropriate isolation valves, level indicator.

OVERALL SPECIFICATIONS OF WATERFILTRATIONPLANT:

The Raw water pump has technical specification with capacity of 10.0 M3/hr, discharge head of35manddriveof1.5HP.Thesandfilterusedhasamaximumandminimumtreatmentflowof15.0M3/hr, 3.0 M3/hr respectively .The maximum operating pressure 3.5 kg/cm2 andminimumoperatingpressure2.0kg/cm2withunitdiameterof16" andheightonstraightis65"withfilter media of Quartz sand. For the carbon filter the maximum treatment flow is15.0 M3/hr andminimum treatment flow is 3.0 M3/hr with maximum and minimum operating pressure of 3.5kg/cm2 and 2.0 kg/cm2 respectively. The unit diameter is 16", height on straight is 65", FilterMedia- Activated carbon, Frontal Pipe work is 40 NB with multi-Port Valve. TheDosing pumphas the capacity of maximum5 litres per hour andStorage tank of 100 litres, The Micron filterhas the capacity of 15000 litres per hour, size of cartridge is 20" long jumbo, the cartridge ratingis 5/10 µ, the operating pressure is 2.5 to 3.0 kg/sq cm. For membrane model the feed flow rate is4000 LPH and treated water flow rate is 2000 LPH, the type ofMembrane used isSpiral woundand the size of the membrane is8" dia x 40" long. For high pressure pumpVertical Multi stagewithSSImpellerstypeusedwithratingofmotoris4HP.Theaccessories requiredinadditionare rota meters pressure gauges and electronic control panel.

V. ESTABLISHMENT OF SMART SOLAR WATER PURIFIER

In the view of providing safe drinking water to the area Chepalakapasakurdi which has featured with highly affected chronic kidney disease due to contaminated underground water which has harmful ions. With this project we have established desalination plant based on smart solar water purifier which utilizes solar energy from PV panels economically. This is designed in such a way that the process of desalination of underground water will run 24*7 with interconnection to grid.

Fig.7.Photograph ofhardwaresetup of water purification plant

VI. CONCLUSION

Thus, by integrated solar system to water purification plant the objective like eliminating harmful ions from the water is fulfilled. There by reducing the effect of dissolved harmful ions on human body.

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