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Well Water Filtration System

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Abstract: ***Water scarcity is an important issue nowadays. People are being forced to drink unsafe water. During a survey we found that people are consuming well water which is hard, turbid and muddy and there is no filter unit. Mostly people of southern Maharashtra and north eastern part of Madhya Pradesh mostly rely on well water for their livelihood and daily chores. So we design a filter unit taking their problem statement into our consideration and we made filter Unit of four stage i.e. Flocculation and sedimentation using Potassium based alum, Filtration using sand, silex, pebbles, and Activation Carbon and UV based Disinfect .And all the processes are automated by PLC associated with electric controlled solenoid valve and water level sensor which is powered by solar panel, here instead of using electric power we are using Solar Power. Solar power has become a source of renewable energy and solar energy application should be enhanced. The Dawning of water is carried out through gym based mechanisms with ratchet mechanisms.We able to remove mud, particles, given pleasant odour and virus, bacteria free water at low cost minimal maintain and negligible effort with the help of green energy. The Filtered water is enriched with minerals and have a minimal change in its TDS level. This system is design for rural area where the people can't afford the expensive system to filter the water. Since Nowadays people Health's were deteriorating due to new variant viruses and bacteria, So taking hygienic and safe water is need of today's world.***

Keyword: Flocculation, Filteration, Disinfect, TDS, PLC, Solar Power, Solenoid Valve, Sensor

I. INTRODUCTION

The effect and use of well water is investigated by referring the result obtained by experimentation and there is extremely large quantity of water, if all well water could be converted in usable forms, it would be more enough to supply the filtered water to people who depend on well water or people who can't afford purified water. Our Filtered unit is based on gravity technique and without any use of pressure pumps. Water is allowed to pass through three chambers i.e. Flocculation& Sedimentation, Filtration and Disinfection. This plant is designed in such a way that in dry drought zone where muddy water is compelled to consume should get clean filtered water without any more cost with less maintenance. The quantity of mud in water is removed with the help of Potassium based Alum and particulate matter is trapped by filtration chamber filled with fine sand, silex, coarse silex and pebbles and also with Activated Carbon to remove Arsenic based particulates and UV ray will kill viruses and bacteria in Disinfection Chamber.TO avoid handling and maintenance, this filter unit is automated by PLC powered by solar energy. For Drawning water from well, pulley Ratchet mechanisms along with gym equipment is consolidated. Following there is a short information about Filter Media

Filter media used in this project consists of fine sand, fine silex, Coarse, silex, pebbles and activated carbon.This is a gravity sand filter in which filter media are arranged in a vertical order.Gravity sand filter have flocculant agent at the top to remove pathogens as well as mud contents of water.As this is gravity based, sedimentation occur by itself,no need of any pressure pump.Combine sand media consist of pebbles,coarse silex,fine silex and fine sand arranged in a given sequence in order to remove particulate matter.Odour and Arsenic based particulate matter is removed by Activated Carbon.And viruses and bacteria is being killed by a UV based disinfect.

Following are the properties of given filter media

1) *Fine Sand:* A loose aggregate of sand of size 125 to 250 µm capable to adsorb particulate matter of size more than 250 µm.It is easily accessible from river bed.And it is best alternative for synthetic filter.
2) *Fine Silex:* A Particulate size of 2-3 mm made from pure quartz ground. This high quality silex is used in water filtration and water treatment applications. Our silex is white and clear of any impurities and matches the highest standards.
3) *Coarse Silex:* A class of hard rock ,pure form of silica capable to filter water by adsorbing particles on a surface.
4) *Pebbles:* Small usually rounded stone of small size used to trap particulate matter.
5) *Activated Carbon:* Form of Carbon refined to have a small ,low -volume pores that increase the surface area available for adsorption.It adsorb Arsenic based particulate matter and it add taste to water because of its micro porosity properties.

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II. METHODOLOGY

A. Designing The Basic Prototype

The prototype design consists of following parts:

1) *Storage Tank and Sedimentation Tank:* Well water is stored in storage tank then flow of well water is controlled from one tank to another by programmable logic control (PLC), timing valve and solenoid valve. And there is three water sensor one sensor is in sedimentation tank and second sensor is in filtration tank and the third sensor is in the storage tank which stores filtered water. A switch mode power supply (SMPS) is used to convert 240V AC into 24V DC which is connected to PLC (programmable logic control) and PLC (Programmable logic control) is connected to the solenoid valve which open and closes automatically with PLC (Programmable logic control) and water sensor. Again a Switch mode power supply (SMPS) which convert 24V DC to 12V DC, then this is connected to solenoid valve through a relay. From storage tank well water comes in sedimentation tank through solenoid valve (SV1) after sedimentation tank is filled with well water when it touches water sensor, it send signals to solenoid valve(SV1) and it get closed according to the program. Sedimentation tank consist of alum which is hanged in the tank such that sedimentation process is done by alum. By which coagulation and flocculation process occurs and impurities settle down, which is cleaned afterwards. Alum (aluminum sulphate) is a non-toxic liquid that is commonly used in water treatment plants to clarify drinking water. Its use in lakes began in the early 1970's and is used to reduce the amount of phosphorous in the water.
2) *Filtration and Activated Carbon Tank:* When well water touches water sensor(X1) it wait for some time given to program then it opens solenoid valve 2(SV2) , well water with sedimentation and flocculation enters in filtration and activated carbon tank it passes through layer of bed, it is a 4-stage filtration consist of fine sand , fine silex, coarse silex and pebble/gravels These four stages remove different sizes of physical impurities and suspended matter to make water suitable for use it have high purification capacity. The gravel and pebble form the under drain. It's the fine sand that does the filtering. So, the combination forms layer with the fine sand on top. As water flows down through the layers, dirt and particulates matter collect on the top of the fine sand. And then activated carbon is below the layer of bed of sand filter from that filtered water drops on activated carbon, activated carbon remove contaminants, odour and bad taste of well water and certain organic such as chlorine, fluorine and radon.
3) *UV chamber and Storage Tank:* From filtration and activated carbon tank filtered water passes through UV, it is the most effective method for disinfecting bacteria from the water. Ultraviolet(UV) rays penetrates harmful pathogens in water and destroy microorganisms by attacking their genetic core(DNA). This is extremely efficient in eliminating their ability to reproduce. and it is powered by solar panel. UV is powered by solar panel, the term solar panel is used colloquially for a photo-voltaic(PV) module. A PV module is an assembly of photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV module is called a PV panel, and a system of panels is an arrays of photovoltaic system supply solar electricity to electrical equipment. Solar panel collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge). Solar panels absorb the photons and in doing so initiate an electric current. The resulting energy generated from photons striking the surface of the solar panel allow electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a directional current. The entire process is known as the photovoltaic effect. From UV filtered water comes in storage tank which can be used for drinking and other purposes. There is a water sensor3(X3) in this when filtered water reach water sensor it send signal to close solenoid valve1 (SV1).

III. DESIGN OBJECTIVE

The basic objectives of the projects are: -

A. To provide clean well water which will be free from contaminants like Muds, Particulates matter, Viruses and bacteria.
B. To provide pure water drinking system at low cost to the rural area.
C. To furnish a system that doesn't require any external power source with less initial setup cost.
D. To make water free from water borne diseases which includes Bacteria, protozoa, virus and microbes which causes diarrhea, gastrointestinal illness, cholera, fever and typhoid etc.
E. To make water alkaline.
F. To remove suspended particle.6. To remove hardness of water.

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IV. COMPONENT FUNCTIONAND SPECIFICATION

A. Component For Filter Unit Electric Automation

Solenoid Valve It is used to control the flow of liquids or gases in a positive, fully-closed or fully-open mode. The valve is commonly used to replace a manual valve or where remote control is desirable. In our Project Solenoid valve is operate or control by PLC (programmable logic controller).

1) Specification

- Rated Operating Voltage 12V DC
- Rated Current 0.6a
- Operation Mode: NC (Normally Closed)
- Pressure: 0.02 -0.8Mpa
- Max Fluid Temperature: 100^0C

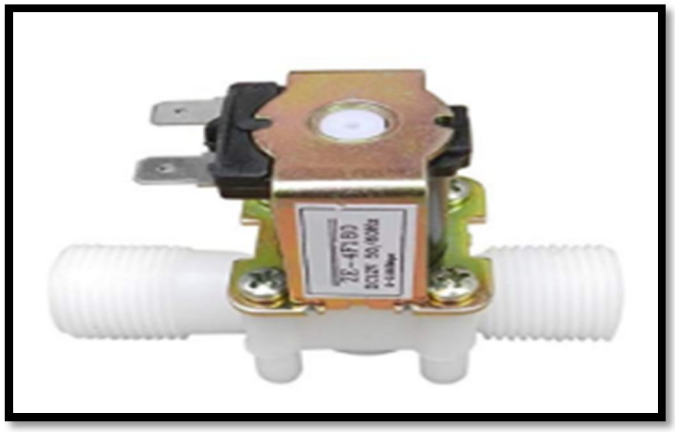

Fig.1Solenoid Valve

B. Water Sensor

It is an electronic device that is designed to detect the presence of water for purposes such as to provide an alert in time to allow the prevention of Water wastage

1) Specification

- Operating voltage: DC3-5V
- Operating Current: Less than 20mA
- Sensor Type: Analogy
- Operating temperature: 10^0 C – 30^0C

Fig.2 Sensor

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C. SMPS(Switched mode Power Supply)

SMPS is the Switched Mode Power Supply circuit which is designed for obtaining the regulated DC output voltage from an unregulated DC or AC voltage

1) Specification

- Output Voltage: 24V
- Output Current: 2.5A
- Approx. Wottage: 60W
- Input Voltage: 180-270V AC
- Single Phase Input
- Built in Transient protector & EMI filter
- Cooling by free air convection
- Efficiency : 80-85 @ full load & Nominal input voltage
- Overload Protection: 105% ~130% of rated load
- Line & Load Regulation: Better than 0.5%
- Hold Up Time: > 20ms at rated input voltage and load
- Operating Ambient: 0 50^0C, 95% RH
- Storage Ambient: -20^0C to 85^0C
- Isolation: Input – Output : 3KVAC, 1 minute
- Input – Earth: 2KVAC, 1 minute
- Output – Earth: 0.5KVAC, 1 minute

Fig.3 SMPS

D. PLC (Programmable logic Controller)

A programmable logic controller (PLC) or programmable controller is an industrial digital computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, robotic devices, or any activity that requires high reliability, ease of programming, and process fault diagnosis.

Here we use Renu FL004 0806P model PLC which have 8 Input and Output

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1) Specification

- DIN rail / Back panel mounted slim PLC
- Transistor or Relay Outputs
- 32 Bit RISC processor DC Inputs, DC Outputs
- Support for High Speed Counters(8 Channels Up-to10kHz or 2 channels Up-to 25kHz) / Quadrature (2 pairs Up-to 10kHz or 4 pairs Up-to 5KHz) and Timers
- High Speed 3 PWM Outputs (Up-to10khz)
- Up-to 2 Serial Ports, 1 RS232, 1 RS485
- 1 USB Device Port
- DC powered units (24VDC) & Output voltage 24V
- IEC61131-3 programming environment and Native Ladder programming environment support CE approved

Fig.4 PLC

E. Linear voltage Convertor(24V to 12V Convertor)

It is use to operate the solenoid valve, because we use 12V Solenoid Valve whereas the output of PLC is 24V

1) Specification

- Input Voltage: 3-40V
- Output Voltage: 1.5-35V (Adjustable)
- Output current: Rated current is 2A, maximum 3A
- Switching Frequency: 150 KHz
- Operating temperature: Industrial grade (-40 to +85)
- Conversion efficiency: 92 %(highest)

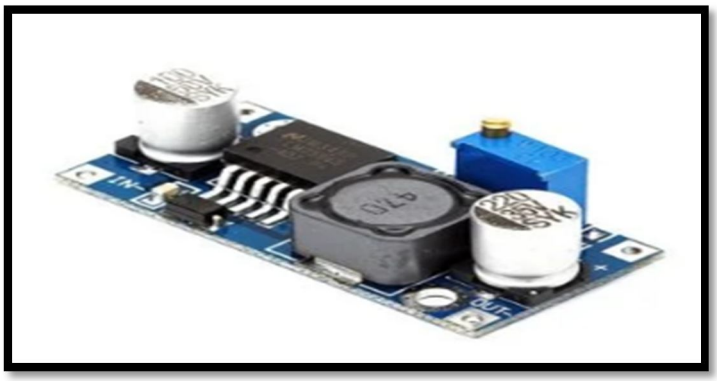

Fig.5 Linear voltage converter

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F. Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

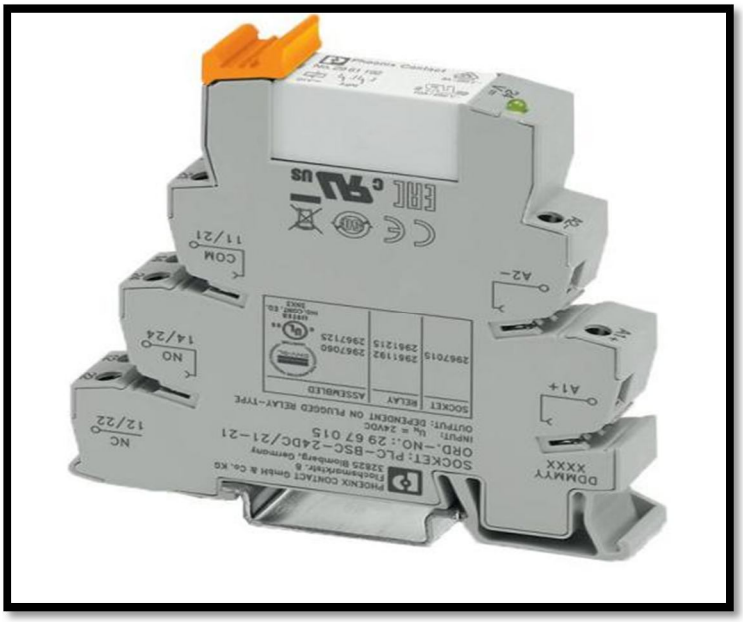

Fig.6 Relay

G. Filter Media

Fig.7 Filter media

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V. WORKING PRINCIPLE

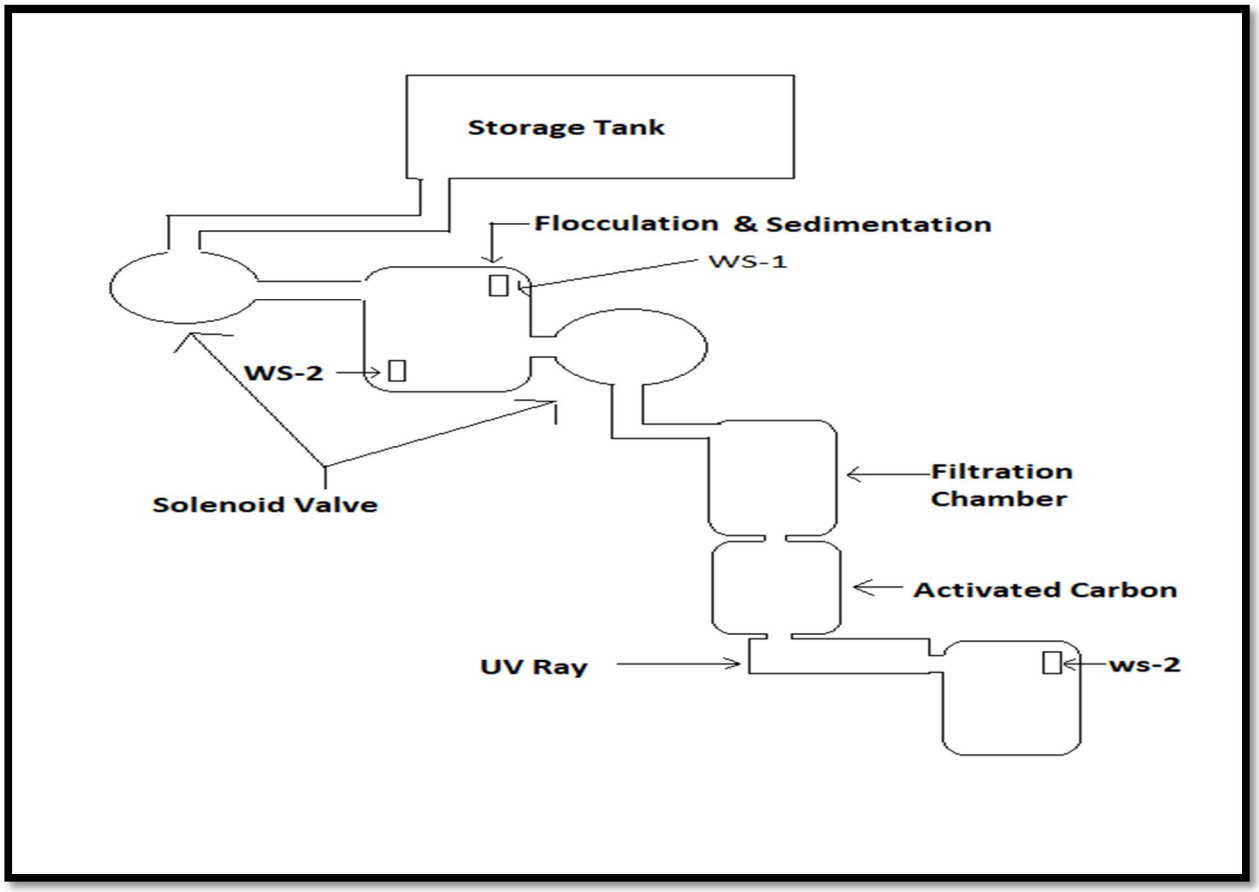

Fig.8 Assembly of Filter Unit(2d)

A. Ladder Diagram of PlC

Explanation of Ladder Diagram

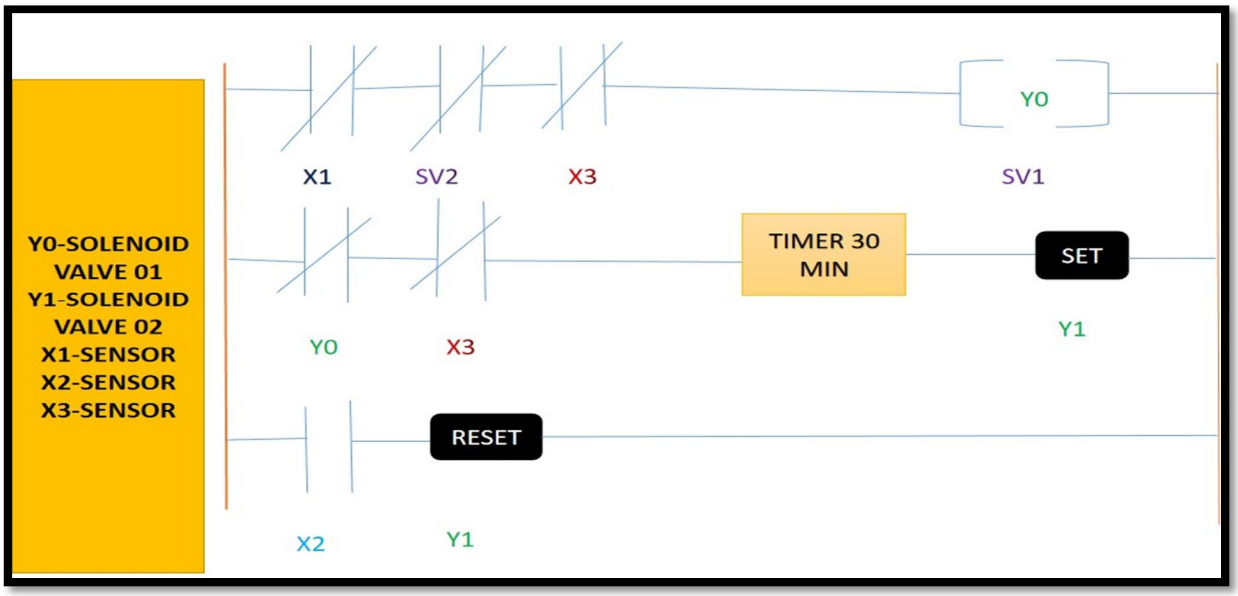

Fig 9.Ladder diagram of PLC

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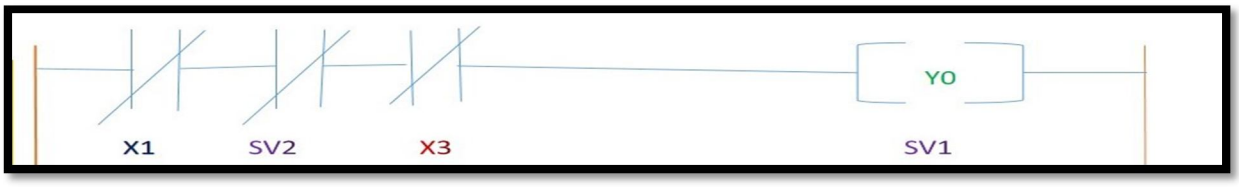
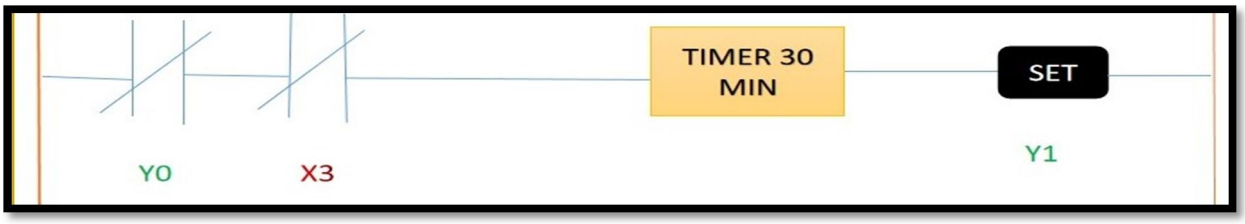
1) Line 1



Sensor 1(X1),solenoid valve 2(Y1),sensor 3(X3) are normally closed and solenoid valve (Y0) is open)Solenoid valve1 will be open until X1,Y1,X3 will closed, if anyone of them get open then solenoid valve1 will get closed.

2) Line 2



(Solenoid valve (Yo) and sensor(X3) are normally closed and timer (30 min) and set button for solenoid valve)Solenoid valve2 will get open for 30 min when solenoid valve 1 and sensor X3 are closed After 30 min SV 2 will get closed.

3) Line 3

Solenoid valve2 will closed when sensor X2 will open

B. Advantages

1) To provide pure water drinking system at low cost to the rural area.
2) To furnish a system that doesn't require any external power source with less initial setup cost.
3) To make water free from water borne diseases which includes Bacteria, protozoa, virus and microbes which causes diarrhoea, gastrointestinal illness, cholera, fever and typhoid etc
4) To make water alkaline
5) To remove suspended particle.6. To remove hardness of water.

C. Limitations

1) Cannot make large differences in TDS level.
2) Flow rate is low.
3) Cannot be commercialized to a certain extent.
4) Pressure Pump is required to get a high flow rate.

D. Applications

1) To purify well water.
2) Commercialized filter plant.
3) Can treat waste water after certain modification

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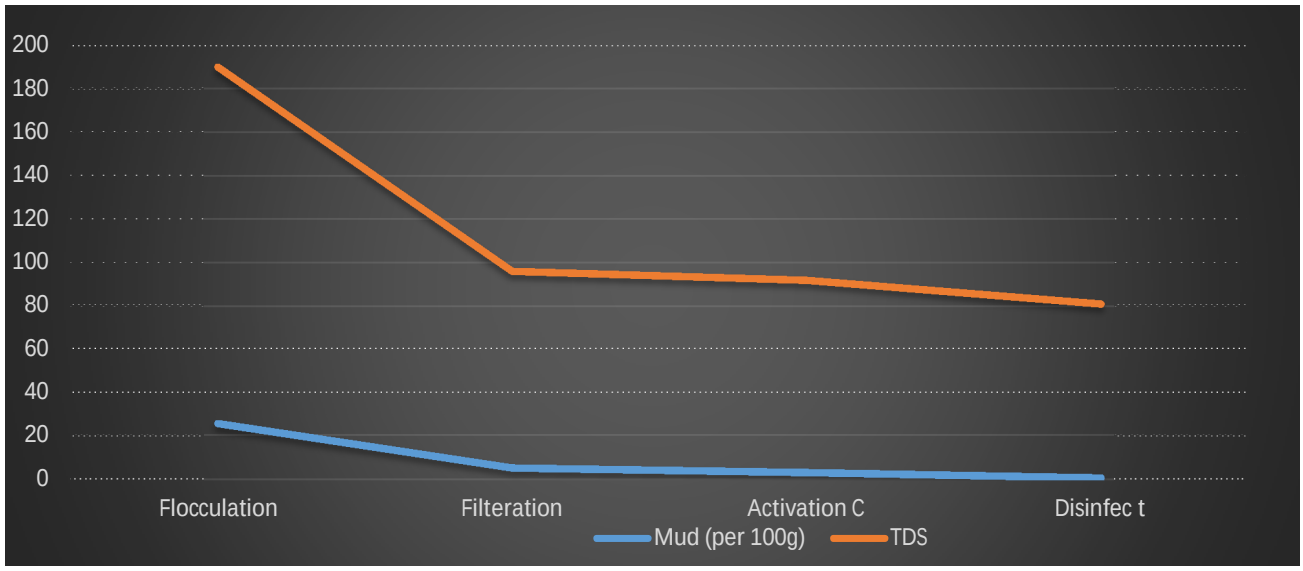
VI. RESULT

A. After passing through all the process we able to remove the mud and made the TDS level down.
B. Our Activation Carbon has given a pleasant taste to water.
C. UV has killed almost all the bacteria and Viruses.
D. Particulates Matter has Trapped in filter media
E. PLC has helped the process to go smoothly without any human interruption.



Graph 1

Following are some sample of water taken during experiment

Sample 1 Before Filteration Sample 2 After Flocculation Sample 3 After Sedimentation
Fig.10 Sample

VII. CONCLUSION

A. After passing through all the process we able to remove the mud and made the TDS level down.
B. Our Activation Carbon has given a pleasant taste to water.
C. UV has killed almost all the bacteria and Viruses.
D. Particulates Matter has Trapped in filter media
E. PLC has helped the process to go smoothly without any human interruption.

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VIII. ACKNOWLEDGEMENTS

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IX. CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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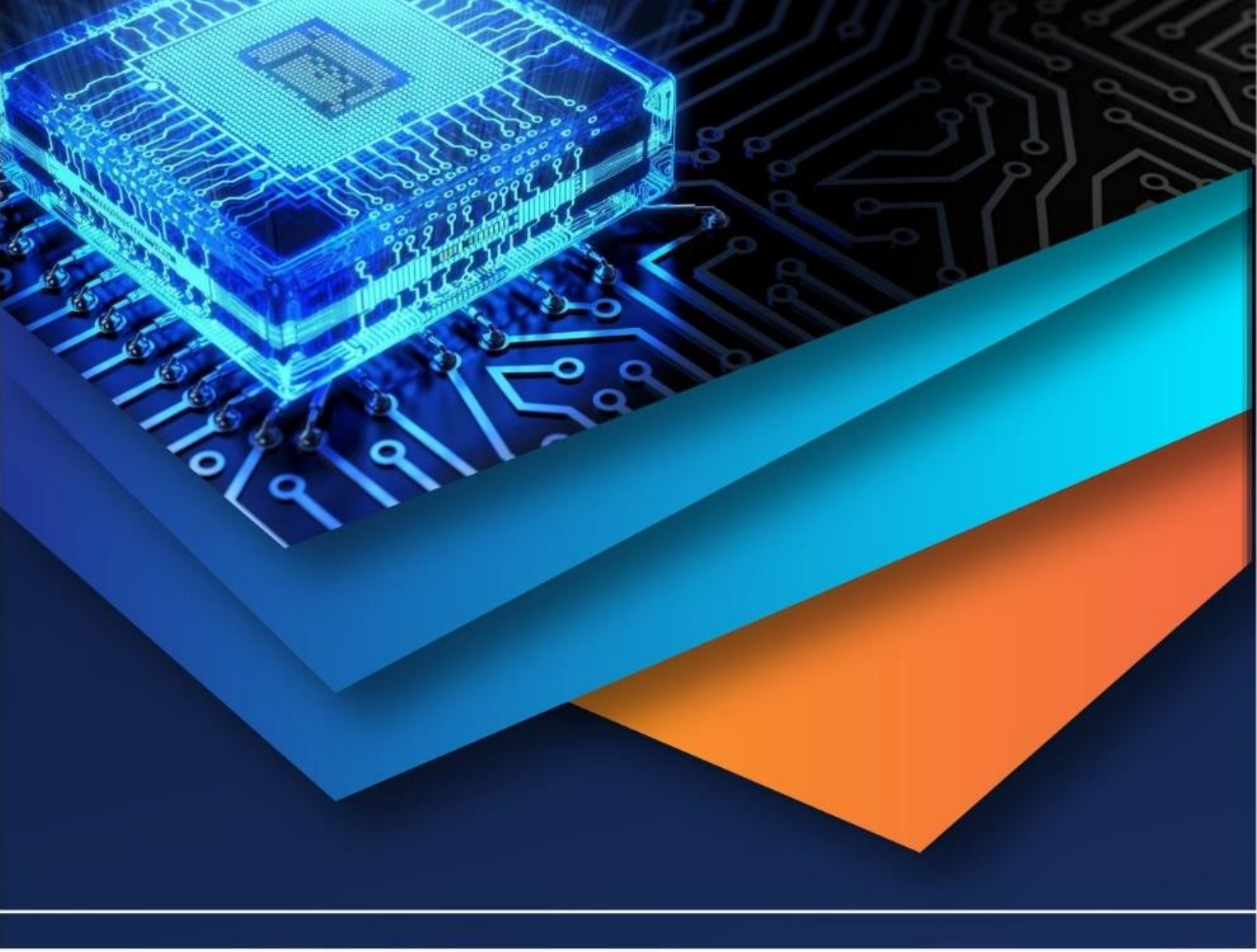

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