# Study and Construction of a Purified Water Cooling and Heating System Using Peltier Module

A Thesis

By


| | |
|---|---|
| Md. Toufiqur Rahman | ID: BME-1901017180 |
| Md. Habibur Rahman | ID: BME-1901017239 |
| Bellal Hossain | ID: BME 1901017653 |
| Mir Ali Mondal | ID: BME 1701011325 |
| Md. Samim Reza | ID: BME 1901017434 |

Department of Mechanical Engineering

Sonargaon University (SU)

Dhaka-1215, Bangladesh


January, 2024

# Study and Construction of a Purified Water Cooling and Heating System Using Peltier Module

Submitted by


| | |
|---|---|
| Md. Toufiqur Rahman | ID: BME-1901017180 |
| Md. Habibur Rahman | ID: BME-1901017239 |
| Bellal Hossain | ID: BME 1901017653 |
| Mir Ali Mondal | ID: BME 1701011325 |
| Md. Samim Reza | ID: BME 1901017434 |

Supervisor: Niloy Sarkar
Assistant Professor


SUBMITTED TO THE:

Department of Mechanical Engineering

SONARGAON UNIVERSITY (SU)

In partial fulfillment of the requirement for the award of the degree

Of

Bachelor of Science in Mechanical Engineering

January, 2024

# APPROVAL

This is to certify that the project " **Study and Construction of a Purified water Cooling and Heating System Using Peltier Module**'', By Md. Toufiqur Rahman (ID: BME-1901017180), Md. Habibur Rahman (ID: BME-1901017239), Bellal Hossain (ID: BME 1901017653), Mir Ali Mondal (ID: BME 1701011325), Md. Samim Reza (ID: BME 1901017434) has been carried out under our supervision. The project has been carried out in partical fulfillment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2024 and has been approved as to its style and contents.

Signature of the Supervisor

Niloy Sarkar
Assistant Professor
Department of Mechanical Engineering
Sonargaon University (SU)

## LETTER OF TRANSMITTAL

January, 2024

To

Niloy Sarkar

Assistant Professor

Department of Mechanical Engineering.

Sonargaon University

Subject: Submission of Project Report**.**

Dear Sir,

We are pleased to submit the project report on "**Study and Construction of a Purified water Cooling and Heating System Using Peltier Module".** It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

Md. Toufiqur Rahman
ID: BME-1901017180

Mir Ali Mondal
ID: BME 1701011325

Md. Habibur Rahman
ID: BME-1901017239

Md. Samim Reza
ID: BME 1901017434

Bellal Hossain
ID: BME 1901017653

## DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for award of any degree or certificate

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.


Md. Toufiqur Rahman
ID: BME-1901017180

Mir Ali Mondal
ID: BME 1701011325

Md. Habibur Rahman
ID: BME-1901017239

Md. Samim Reza
ID: BME 1901017434

Bellal Hossain
ID: BME 1901017653

## ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. This thesis is accomplished under the supervision of Niloy Sarkar, Assistant Professor, Department of Mechanical, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

The authors are also grateful to Md. Mostofa Hossain, Head of the Department of Mechanical Engineering and all respect teachers of the Mechanical Engineering Department for their co-operation and significant help for completing the thesis work successfully.

# ABSTRACT

This project presents the design and implementation of an innovative Water Purifier System employing a Peltier Module for both cooling and heating functionalities. The system integrates advanced filtration components, including Activated Carbon, Mineral Sand Ball, Zeolite & Silica Gel, and a Ceramic Filter, along with a Pump Motor for water circulation and a Heat Sink for efficient heat dissipation. The filtration process begins with the ceramic filter, removing larger particles, followed by activated carbon to adsorb impurities and enhance water taste. Mineral sand balls contribute beneficial minerals, while zeolite and silica gel provide additional purification. The heart of the system lies in the Peltier Module, capable of cooling or heating the water as needed, offering a versatile solution for diverse applications. A carefully designed water circulation system, powered by the pump motor, ensures that water passes through each filtration stage and interacts with the Peltier Module for optimal treatment. The heat sink plays a crucial role in maintaining the efficiency and longevity of the Peltier Module by dissipating the generated heat. This integrated water purifier system aims to deliver purified water with improved taste, reduced impurities, and the flexibility of temperature control. The combination of cooling, heating, and multi-stage filtration makes it suitable for various environments, offering a sustainable and efficient solution for enhancing water quality. The project aligns with the growing demand for innovative water treatment technologies, addressing the need for clean and customized water solutions in different contexts.

## TABLE OF CONTENTS

## LIST OF FIGURES

# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction

Access to clean and temperature-controlled water is a fundamental requirement for both domestic and industrial applications. The increasing concern over water quality has prompted the development of advanced water purification systems that go beyond basic filtration. This project introduces a cutting-edge Water Purifier System incorporating a Peltier Module for dual cooling and heating capabilities, along with a comprehensive array of filtration components.

Traditional water purification methods often focus solely on eliminating impurities, neglecting the importance of temperature control. This project addresses this limitation by integrating a Peltier Module, a versatile Thermoelectric device capable of both cooling and heating water. The addition of this technology offers a dynamic and adaptable solution for various scenarios where precise water temperatures are crucial.

The filtration system consists of multiple stages, each contributing to the overall purification process. The inclusion of Activated Carbon enhances taste and removes organic contaminants, while Mineral Sand Balls release beneficial minerals. Zeolite & Silica Gel provide additional purification, and a Ceramic Filter removes larger particles and bacteria. These components work synergistically to deliver water of exceptional quality.

The project's innovation lies in the combination of temperature control and advanced filtration, ensuring that not only are impurities removed, but the water temperature can also be customized according to specific needs. The incorporation of a pump motor facilitates efficient water circulation through the filtration stages, and a dedicated heat sink ensures the optimal performance and longevity of the Peltier Module.

As water quality and temperature preferences vary across applications, this system offers a versatile and customizable solution. Whether used in households, offices, or industrial settings, the proposed Water Purifier System strives to meet the increasing demand for sophisticated water treatment technologies, providing a reliable and efficient means of obtaining clean and temperature-controlled water. This introduction sets the stage for exploring the design, components, and operation of this innovative water purification project.

## 1.2 Proposed Method / System

The Water Purifier System with Peltier Module Water Cooling and Heating integrates advanced technologies and multiple filtration stages to ensure optimal water quality and temperature control. The proposed method/system involves a systematic process that includes the following key components and steps: A pump motor is employed to facilitate the continuous circulation of water through the entire purification system. This ensures that water passes through each filtration stage and comes in contact with the Peltier Module for cooling or heating. The water initially passes through a ceramic filter, effectively removing larger particles, sediments, and bacteria.

This serves as the first line of defense in the filtration process. Subsequent to the ceramic filter, water encounters an activated carbon stage. Activated carbon adsorbs impurities, organic compounds, and undesirable odors, significantly improving the taste and quality of the water. The system incorporates mineral sand balls that release beneficial minerals into the water.  This stage contributes to mineralization, enhancing the overall quality and health benefits of the water. The heart of the system is the Peltier Module, a Thermoelectric device capable of both cooling and heating. By applying an electric current, the Peltier Module can cool the water by absorbing heat or heat the water by transferring heat from the surroundings.

A dedicated heat sink is integrated to dissipate the heat generated by the Peltier Module during the cooling process. This ensures the efficiency and longevity of the Peltier Module. The Peltier Module allows for precise temperature control, catering to various preferences and applications. Users can select the desired water temperature, providing a customization and versatile solution. The combination of cooling, heating, and multi-stage filtration ensures a comprehensive water treatment process. The system not only removes impurities but also offers the flexibility of adjusting water temperature to meet specific requirements.

## 1.3 Objective

The objectives of this project are:

- To study about **Study and Construction of a Purified water Cooling and Heating System Using Peltier Module**.
- To Implement enhance the overall quality and taste of the water by combining various filtration components, including activated carbon, mineral sand balls, zeolite & silica gel, and a ceramic filter. And Integrate a Peltier Module to provide dual functionality of water cooling and heating.
- To take necessary notes from the project for future improvements.

## 1.4 Organization of book

The report has been organized into five chapters.

**Chapter 1:** Discusses introduction, motivation and objective.

**Chapter 2:** Description of Structural design, block diagram.

**Chapter 3:** Description of hardware which issue in this project such as SMPS, Evaporator, Temperature Controller, Pressure Gauge.

**Chapter 4:** Description of methodology of this project and its relevant project view.

**Chapter 5:** Here we describe about result, discussion, advantage, limitation, application in this part.

**Chapter 6:** Finally we discuss about Conclusion and future scope of this project.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 Introduction

In this section topics related to **Study and Construction of a Purified water Cooling and Heating System Using Peltier Module** are included. These provide a sampling of problems appropriate for application of Study and Construction of a Purified water Cooling and Heating System Using Peltier Module. The references are summarized below.

## 2.2 Literature Review

Product designers should instead modify existing designs, rather than design new ones. This modification to produce high quality products whether previously successful or unsuccessful design. The water cooling and heating effect produced by water cooling and heating performance analysis (TEC) for high power electronic packages such as processors. Two sets of analytical solutions for TEC is based on the TEC module parameters. The system constraint in intended is the junction temperature Tj at constant cooling power Qc and for Qc at constant Tj, respectively. Besides that, the iterative procedure that are often reported in literature. The fact that the solutions can be obtained without using the pellet water cooling and heating parameters and geometric details [1].

Udo FritschJames J. J. Costello Et al has made the product water cooler and warmer. The water cooling and heat-resistant system with a unique ventilation system to distribute cool or warms air throughout the unit so that there is no hot or cool place, the door are installed so that they can be easily opened with either front or front door, lids or door handles that can be operated easily and reliably, and or the configuration of the unit does not balance the unit so that it can be easily mounted with a door or end with a lids or front door so that it can be used gradually as a conventional chest or as a mini fridge mobile or heating unit. As such, these invention assemblies are designed to provide unique combinations of components that allow selected units to be placed at the end as refrigerators [2].

Water is very important for the human in everyday life. This is because your body loses water through breathing, sweating, and digestion, it is important to rehydrate by drinking fluids and eating foods that contain water. This product is created in smaller sizes, so it is easy to handle by the user. This product is made in smaller sizes for easy operation by the user. This is because size factors also as a role for the user. If it has a portable water container it has made it easy for users to use it anytime and anywhere. In summer, people need cold water to do their work in a comfortable environment. [3]

So, we need a portable soft drink cooler. Not having enough water can affect a person's ability to perform a task. Instead of, if you are working in a very cold environment like in the office, it needs warm water to lower your body temperature. Therefore, this product is suitable for all conditions and your body temperature. In addition, if you have portable hot water, it can also help you get warm water everywhere.[4]

With two different water temperatures, you can choose according to the temperature of your body to drink. There are two conditions to drink when cold water or warm water is for example Dr Neha says, ‘Never drink cold water while eating food. When you drink cold water immediately after meals or along with a meal, your body spends a lot of energy in increasing its temperature [5].

This slows the digestion process, which may cause indigestion. Warm water is also important for the body. Besides, not the warm water only has its advantages and disadvantages, but the cold water also has its own goodness and disadvantage. For example, ‘Avoid drinking warm water after a bout of exercise. As your body temperature is already high post workout, drinking cold water will lower the temperature of your body.’ explains Dr Neha [6].

## 2.3 Summary

The above has been discussed in detail in the past few literature's which has given us a lot of motivation to do this project.

# CHAPTER 3
# HARDWARE ANALYSIS

## 3.1 Components List

### Water Purifier Section:

1. Ceramic Filter
2. Multi layer Cartridge Filter
3. Mineral Stone Box
4. Magnetic Tap

### Cooling and Heating Section:

1. Arduino Nano
2. SMPS
3. Buck Converter
4. Pump Motor
5. Peltier Module
6. Heat Sink
7. Ultrasonic Sensor
8. Digital Temperature Meter

## 3.2 Ceramic Filter

**Ceramic water filters** (**CWF**) are an inexpensive and effective type of water filter that rely on the small pore size of ceramic material to filter dirt, debris, and bacteria out of water. This makes them ideal for use in developing countries,[1] and portable ceramic filters are commonly used in backpacking. Similar to other methods of filtering water, the filter removes particles larger than the size of the pores in the filter material.[3] Typically bacteria, protozoa, and microbial cysts are removed. However, filters are typically not effective against viruses since they are small enough to pass through to the "clean" side of the filter. Ceramic water filters (CWF) may be treated with silver in a form that will not leach away. The silver helps to kill or incapacitate bacteria and prevent the growth of mold and algae in the body of the filter.

Ceramic filtration does not remove chemical contaminants, *per se*. However, some manufacturers (especially of ceramic candle filters) incorporate a high-performance activated carbon core inside the ceramic filter cartridge that reduces organic and metallic contaminants.

Figure 3.l: Ceramic Filter

The active carbon absorbs compounds such as chlorine. Filters with active carbon need to be replaced periodically because the carbon becomes clogged with foreign material. The two most common types of ceramic water filter are pot-type and candle-type filters. Ceramic filter systems consist of a porous ceramic filter that is attached to, or sits on top of a plastic or ceramic receptacle. Contaminated water is poured into a top container. It passes through the filter(s) into the receptacle below. The lower receptacle usually is fitted with a tap. Contaminants larger than the minute holes of the ceramic structure will remain in the top half of the unit. The filter(s) can be cleaned by brushing them with a soft brush and rinsing them with clean water. Hot water and soap can also be used. In stationary use, ceramic candles have mechanical, operational and manufacturing advantages over simple inserts and pots.

Filter candles allow sturdy metal and plastic receptacles to be used, which decreases the likelihood of a sanitary failure. Since their filter area is independent of the size of the attachment joint, there is less leakage than other geometries of replaceable filter, and more-expensive, higher-quality gaskets can be used. Since they are protected by the upper receptacle, rather than forming it, they are less likely to be damaged in ordinary use. They are easier to sanitize, because the sanitary side is inside the candle. The non-sanitary part is outside, where it is easy to clean. They fit more types of receptacles and applications than simple pots, and attach to a simple hole in a receptacle. They also can be replaced without replacing the entire upper receptacle, and larger receptacles can simply use more filter candles, permitting filter manufacture to be standardized. If a filter in a multifilter receptacle is found to be broken, the filter hole can be plugged, and use can continue with fewer filters and a longer refill-time until a replacement can be obtained. Also, standardizing the filter makes it economical to keep one or a few filters on hand. There are also portable ceramic filters, such as the MSR Miniworks, which work via manual pumping, and in-line ceramic filters, which filters drinking water that comes through household plumbing. Cleaning these filters is the same as with the clay pot filter but also allows for reverse-flow cleaning, wherein clean water is forced through the filter backwards, pushing any contaminants out of the ceramic pores.

The major risks to the success of all forms of ceramic filtration are hairline cracks and cross-contamination. If the unit is dropped or otherwise abused, the brittle nature of ceramic materials can allow fine, barely-visible cracks, allowing larger contaminants through the filter. Work is being done to modify clay/sawdust ratios during manufacture to improve the brittle nature and fracture toughness of these clay ceramic water filter materials.[4] If the "clean" water side of the ceramic membrane is brought into contact with dirty water, hands, cleaning cloths, etc., then the filtration will be ineffective. If such contact occurs, the clean side of the filter should be thoroughly sterilized before reuse.

## 3.3 Multi Layer Cartridge Filter

A cartridge filter is a piece of tubular filtration equipment that can be used across various industries for an array of filtration requirements. A cartridge is encased within a housing or a casing and used to remove unwanted particles, pollutants, and chemicals from liquids. The cartridge is exposed to water, liquid or solvent that needs filtration, as it flows inside the housing and passes through the filter element. Cartridge filters can also remove sub micron particulates.

Filter cartridges typically consist of several basic components, including:

**Filter Media:** This is the primary component of the filter cartridge and is responsible for capturing and removing contaminants from the fluid being filtered. **Filter media** can be made from a variety of materials, including paper, **polyester**, **polypropylene**, and activated carbon.

**End Caps:** These are the components that hold the filter media in place and provide a seal between the cartridge and the **filter housing**.

**Core:** This is the central structure of the **filter cartridge** that provides support to the filter media and prevents it from collapsing under pressure.

**Gaskets/O-rings:** These are the components that create a seal between the filter cartridge and the filter housing to prevent fluid from bypassing the filter.

**Support Cage:** This is a metal or **plastic structure** that provides additional support to the filter media and helps maintain its shape during operation.

Figure 3.2: Multi Layer Cartridge Filter

The specific components and materials used in filter cartridges may vary depending on the type and intended application of the filter.

Filter cartridges are used in many industrial applications to trap contaminants and solid waste. These liquid filter cartridges must be replaced when they reach their pre-set differential pressure. It is important to know when to replace your filter cartridge. The cartridges may come with a general guideline that suggests the number of days it will work – for example, every 30 days or every 45 days based on its dirt holding capacity. However, the number of days a cartridge will last also depends on the concentration of contaminants in the liquid.

When your pressure differential reaches a pre-set value – say 10psi, you know that the cartridges are clogged and need replacement.

**Here is a step-by-step how-to guide to properly and safely replace your liquid filter cartridges!**

- Shut down the system and let it depressurize.
- Open the air vent valve and the drain.
- Clean the drain valve
- Remove the housing lid.
- Remove wing nuts and the alignment plate.
- Carefully remove the springs from the top of each cartridge filter. Make sure that the spring does not fall into the housing.
- Carefully pull out the cartridges.
- Check the housing for any signs of corrosion or dirt residues. Clean the housing if required.
- Remove the protective covering of your new cartridge filters and fit them inside the housing.
- Handle your cartridges carefully and place them in housing using the alignment plate.
- Once all cartridges are in place, reinstall the springs, alignment plate, and wingnuts.
- Make sure all these fitments are in good condition and securely installed in place.
- Clean and lubricate the O ring and then replace the housing lid.
- Screw the housing lid into place.
- Close the drain valve

- Purge any air in the system by running water through the filter.
- Close the air vent valve

## 3.4 Mineral Stone Box

A **water filter** removes impurities by lowering contamination of water using a fine physical barrier, a chemical process, or a biological process. Filters cleanse water to different extents, for purposes such as: providing agricultural irrigation, accessible drinking water, public and private aquariums, and the safe use of ponds and swimming pools. Filters use sieving, adsorption, ion exchanges, biofilms and other processes to remove unwanted substances from water. Unlike a sieve or screen, a filter can potentially remove particles much smaller than the holes through which its water passes, such as nitrates or germs like *Cryptosporidium*.[1]

Figure 3.3: Mineral Stone Box

Among the methods of filtration, notable examples are sedimentation, used to separate hard and suspended solids from water[2] and activated charcoal treatment, where the boiled water is poured through a piece of cloth to trap undesired residuals.[3] Additionally, the use of machinery to work on desalinization and purification of water through the transposal of it into multiple-filtration water tanks. This technique is aimed at the filtration of water on bigger scales, such as serving entire cities.[2] These three methods are particularly relevant, as they trace back to centuries and are the base for many of the modern methods of filtration utilized today.

Point-of-use filters for home use include granular-activated carbon filters used for carbon filtering, depth filter, metallic alloy filters, microporous ceramic filters, carbon block resin, microfiltration and ultrafiltration membranes. Some filters use more than one filtration method. An example of this is a multi-barrier system. Jug filters can be used for small quantities of drinking water. Some kettles have built-in filters, primarily to reduce limescale build-up. Water filters are used by hikers,[5] aid organizations during humanitarian emergencies, and the military.

These filters are usually small, portable and lightweight (1–2 lb (0.45–0.91 kg) or less). These usually filter water by working a mechanical hand pump, although some use a siphon drip system to force water through, while others are built into water bottles. Dirty water is pumped via a screen-filtered flexible silicon tube through a specialized filter, ending up in a container. These filters work to remove bacteria, protozoa and microbial cysts that can cause disease. Filters may have fine meshes that must be replaced or cleaned, and ceramic water filters must have its outside abraded when they have become clogged with impurities.

These water filters should not be confused with devices or tablets that disinfect water, which remove or kill viruses such as hepatitis A and rotavirus. he term water polishing can refer to any process that removes small (usually microscopic) particulate material, or removes very low concentrations of dissolved material from water. The process and its meaning vary from setting to setting: a manufacturer of aquarium filters may claim that its filters perform water polishing by capturing "micro particles" within nylon or polyester pads, just as a chemical engineer can use the term to refer to the removal of magnetic resins from a solution by passing the solution over a bed of magnetic particulate.[8] In this sense, water polishing is simply another term for whole house water filtration systems. Polishing is also done on a large scale in water reclamation plants.

## 3.5 Magnetic Tap

Clean, revitalized water is a cornerstone of a healthy lifestyle, and the Magnetic Water Filter is here to help you achieve just that. Specifically designed for use with Nikken PiMag and Nikken PiMag 10 Water Systems, this innovative filter boasts an array of features that have made it highly sought after among water enthusiasts.

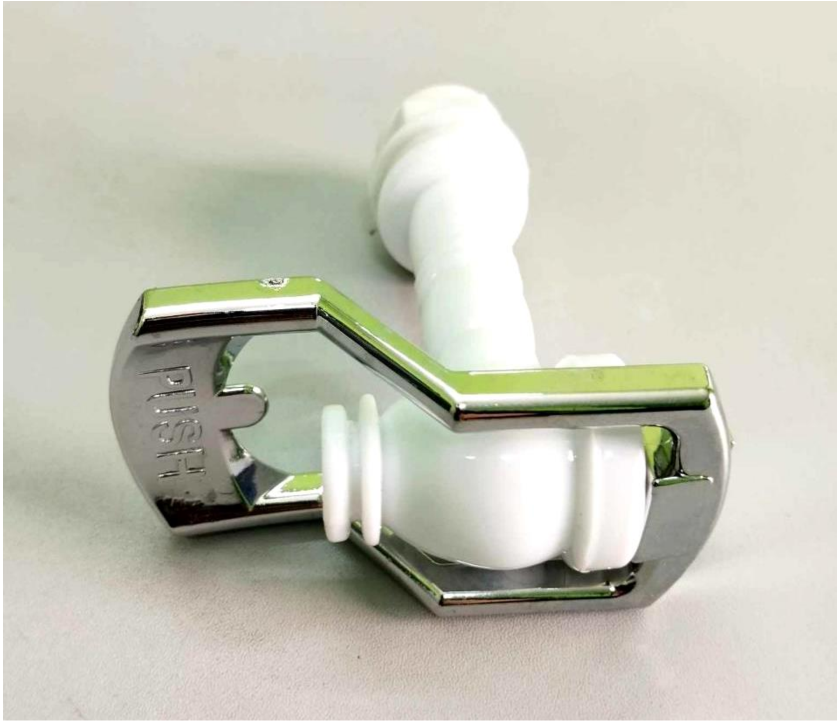



Figure 3.4: Magnetic Tap

## Key Features:

**Restoring Natural Energy:** At the heart of the Magnetic Water Filter is magnetic technology that plays a pivotal role in enhancing water quality. It helps to restore the water's natural energy, aligning it with your body's natural state.

**Optimal Hydration:** Achieving optimal hydration is essential for overall well-being. This filter not only balances the water but also employs a micro-clustering process. This means that it rearranges water molecules into smaller clusters, making it easier for your body to absorb and utilize, thereby promoting efficient hydration.

**Compatibility:** The Magnetic Water Filter is engineered to be seamlessly compatible with Nikken PiMag and Nikken PiMag 10 Water Systems. This compatibility ensures that it can effectively enhance the water purification capabilities of these systems.

## Dimensions:

**Weight:** The Magnetic Water Filter is incredibly lightweight, tipping the scales at just 0.07 kg. This light weight makes it easy to install and handle, adding convenience to your water system setup.

**Dimensions:** With compact dimensions measuring 4 × 10 × 11 cm, this filter is designed to fit seamlessly into your existing water system. Its unobtrusive size ensures it won't take up much space, allowing for a clean and efficient installation.

The choice of the right water filter can have a profound impact on your daily life. The Magnetic Water Filter goes beyond just providing cleaner water. It actively enhances the taste and quality of the water you consume while also supporting your overall well-being. The magnetic technology embedded in this filter aligns the water's energy, making it more harmonious with your body's natural state.

This results in water that not only tastes better but also has a positive effect on your overall health and vitality. The micro-clustering feature further distinguishes the Magnetic Water Filter. By restructuring water molecules into smaller clusters, ensures that the water you drink is readily absorbed by your body. This is particularly beneficial for those who prioritize their health and wellness.

## 3.6 Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

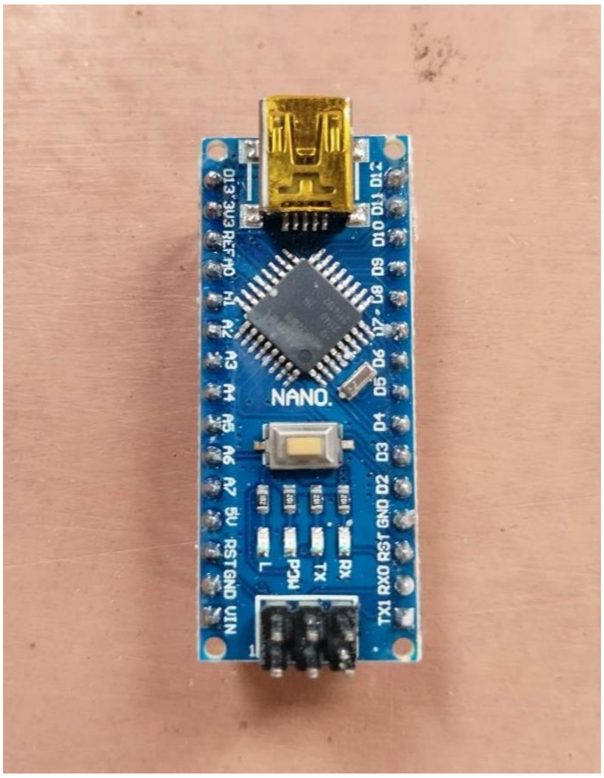



Figure 3.5: Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Maxims'). Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a small, complete, and breadboard friendly component. It has everything that Decimal/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano can automatically sense and switch to the higher potential source of power.

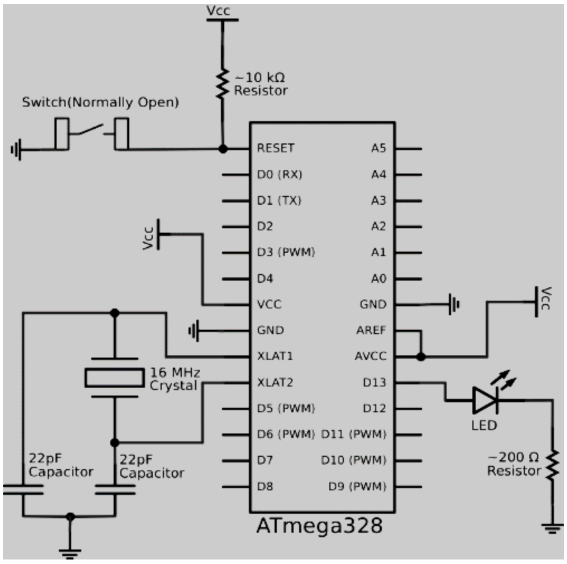



Figure 3.6: Arduino Nano Schematic Diagram

Nano's got the breadboard-ability of the Boarding and the Minibus with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It has two layers. That make it easier to hack and more affordable. One of the best features of Arduino Nano is, it's easy to use, compact and also small.

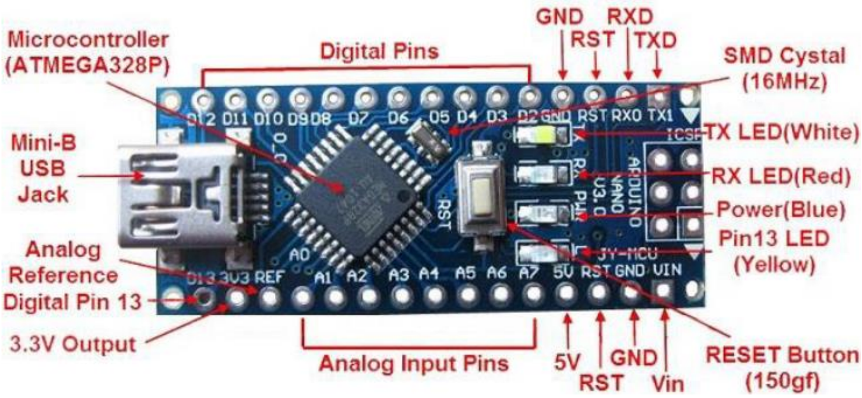



Figure 3.7: How Arduino Nano looks like

## Specifications:

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70” x 1.70”

## Features:

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Manual reset switch

**Micro-controller IC ATmega328p**

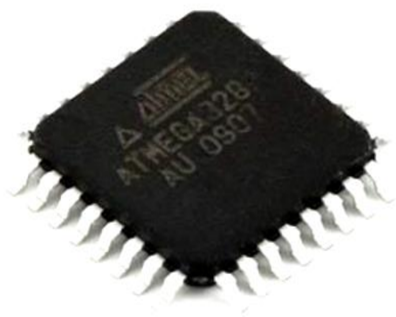



Figure 3.8: Micro-controller IC AT mega 328p

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz, balancing power consumption and processing speed.

## 3.7 Switch Mode Power Supply (SMPS)

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy.

A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.


Figure 3.9: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor. Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

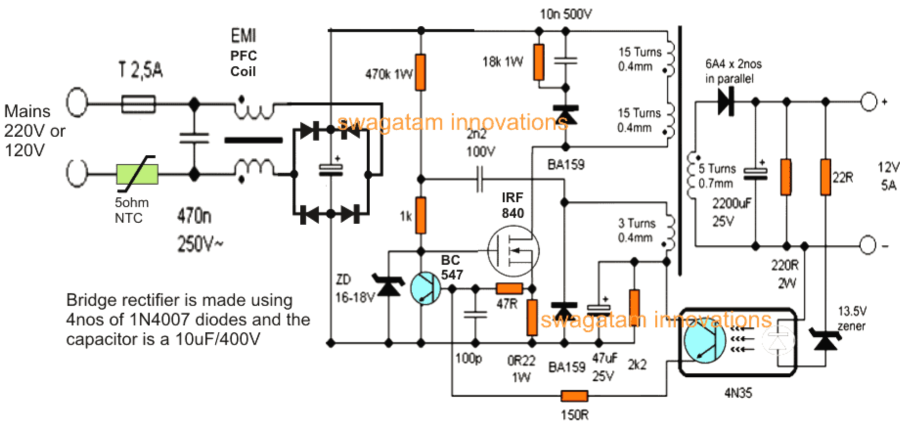



Figure 3.10: SMPS Circuit

Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

**Design basics**

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density
- Disadvantages:
- Generates electromagnetic interference
- Complex circuit design
- Expensive compared to linear supplies

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency. Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series.

These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

**Switch Mode Power Supply**

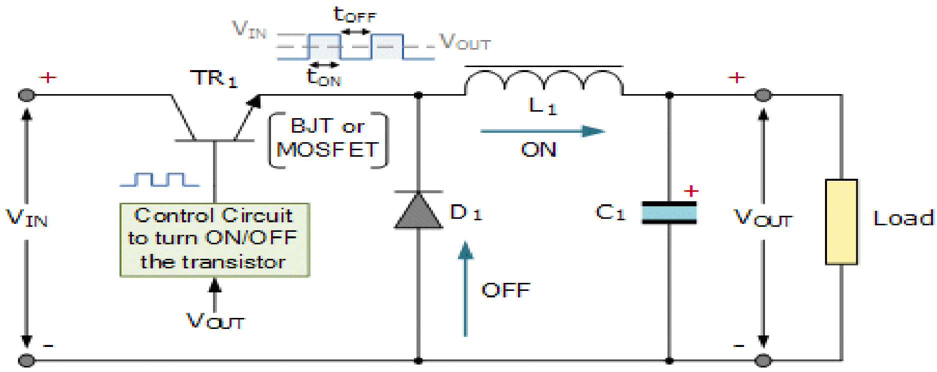



Figure 3.11: SMPS Circuit Connection

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabiliser circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

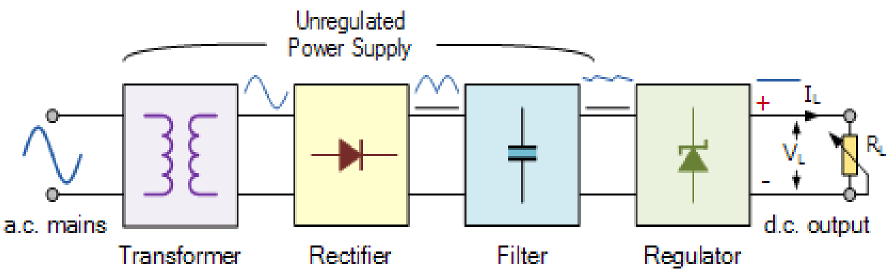



Figure 3.12: DC Power supply way

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

## 3.8 Buck Converter

A **buck converter** (**step-down converter**) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination.

To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor "bucks" or opposes the supply voltage.

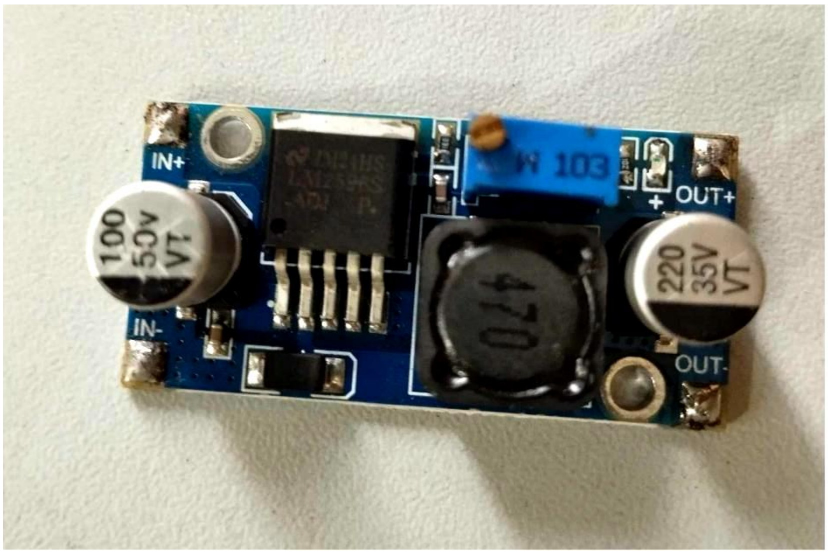



Figure 3.13: DC -DC Buck Converter

**DC-DC Buck Converter Step Down Module LM2596 Power Supply** is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

**Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply :**

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Output current: Rated current is 2A, maximum 3A (Additional heat sink is required)
- Conversion Efficiency: Up to 92% (output voltage higher, the higher the efficiency)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

## 3.9 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

Figure 3.14: Pump Motor

## Feature:

- Operating Current : 130 ~ 220mA
- Flow Rate : 80 ~ 120 L/H
- Maximum Lift : 40 ~ 110 mm
- Continuous Working Life : 500 hours
- Driving Mode : DC, Magnetic Driving
- Material : Engineering Plastic
- Outlet Outside Diameter : 7.5 mm
- Outlet Inside Diameter : 5 mm

## 3.10 Peltier Module

A **Peltier** cooler, heater, or Thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current.

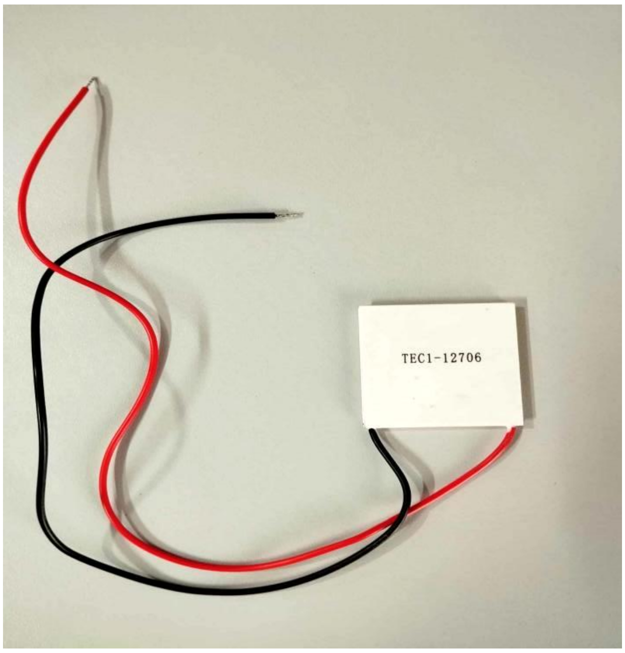
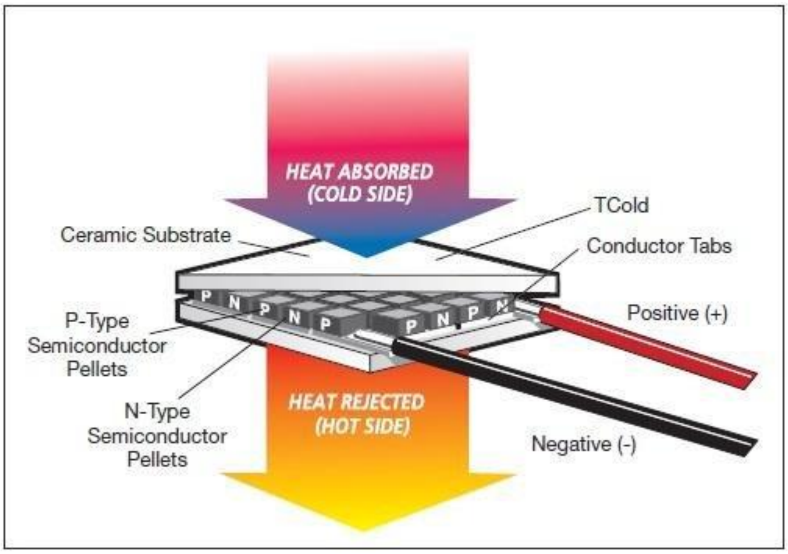



Figure 3.15: Peltier Cooler

The TEC1-12706 40x40mm Thermoelectric Cooler 0~6A Peltier Module is the simple application of Peltier Thermoelectric Effect. Thermoelectric coolers also are known as TEC or **Peltier Module** create a temperature differential on each side. One side gets hot and the other side gets cool. Therefore, they can be used to either warm something up or cool something down, depending on which side you use. You can also take advantage of a temperature differential to generate electricity.



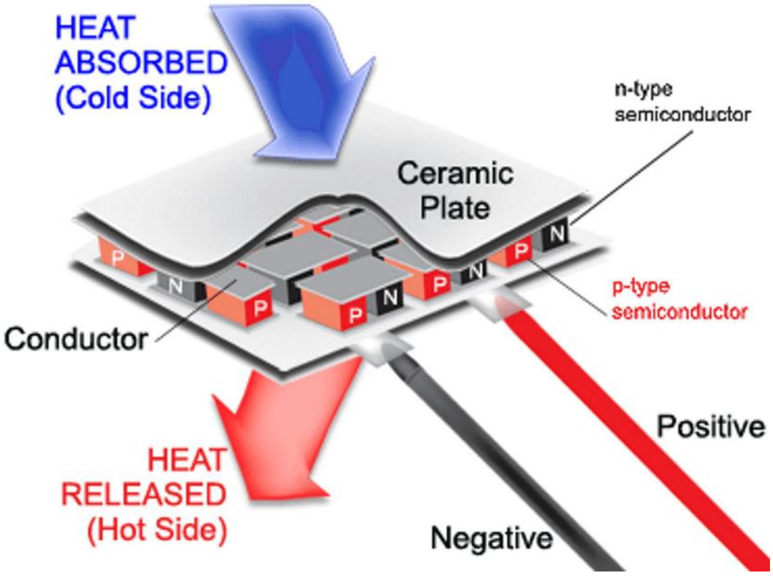



Figure 3.16: Construction of Peltier

Two unique semiconductors, one n-type and one p-type, are used because they need to have different electron densities. The semiconductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors there is a flow of DC current across the junction of the semiconductors causing a temperature difference. The side with the cooling plate absorbs heat which is then moved to the other side of the device where the heat sink is. Thermoelectric Coolers, also abbreviated to TECs are typically connected side by side and sandwiched between two ceramic plates. The cooling ability of the total unit is then proportional to the number of TECs in it. This Peltier works very well as long as you remove the heat from the hot side. After turning on the device, the hot side will heat quickly, the cold side will cool quickly. If you do not remove the heat from the hot side (with a heat sink or other device), the Peltier will quickly reach stasis and do nothing. We recommend using an old computer CPU heatsink or another block of metal to pull heat from the hot side. We were able to use a computer power supply and CPU heat sink to make the cold side so uncomfortable we could not hold our finger to it.

A Thermoelectric cooling (TEC) module is a semiconductor-based electronic component that functions as a small heat pump. By applying the DC power source to a TEC, heat will be transferred from one side of the module to the other. It creates a cold and hot side. They are widely used in industrial areas, for example, computer CPU, CCDs, portable refrigerators, medical instruments, and so on. Also Known as Thermoelectric cooling modules, Thermoelectric modules, Peltier modules, Thermoelectric cooling module.

**Features:**

1. Small module.
2. Easy transition between the hot side to the cool side and vice-versa just by reversing the polarity of supply.
3. Quality tested cooling cells.
4. Solid state, vibration free, noise-free.
5. Simple to install and operate.
6. Should use with a heat sink.

## 3.11 Heat Sink

A **heat sink** (also commonly spelled **heat sink**) is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature. In computers, heat sinks are used to cool CPUs, GPUs, and some chipsets and RAM modules. Heat sinks are used with high-power semiconductor devices such as power transistors and optoelectronics such as lasers and light emitting diodes (LEDs), where the heat dissipation ability of the component itself is insufficient to moderate its temperature.

Figure 3.17: Heat Sink

## Description

- Aluminum Water Cooling Block for CPU Heat sink Cooler Peltier Plate 80x40x12mm
- Internal flow channel extrusion forming
- Brazing parts into a whole
- Leak rate of less than 5X10-6 mbar.l/s parts
- Internal fin thickness 0.5MM
- Connection: 9 mm id tubes
- Processing: vacuum aluminum brazing
- Surface treatment: silver oxidation
- Applicable to computer CPU water, industrial inverter driver, laser head cooling, industrial control cabinet cooling, Thermoelectric Cooler
- Size:80 (D) x 40 (W) x 12 (H) MM

## 3.12 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound.

### HC-SR04 Ultrasonic Sensor - Working

As shown above the **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively.

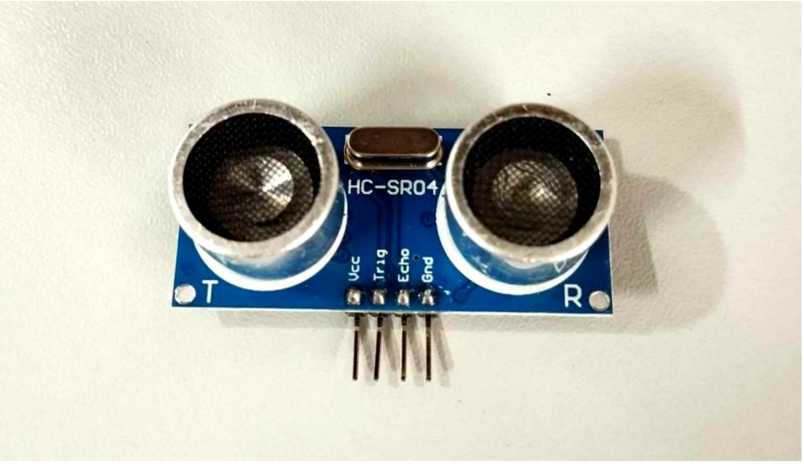



Figure 3.18: Ultrasonic Sensor Pin Out

This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that –

**Distance = Speed × Time**

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the picture below


Figure 3.19: Ultrasonic Sensor Working Procedure

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a micro-controller or microprocessor.

**HC-SR04 Sensor Features**

- Operating voltage: +5V
- Theoretical  Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz

## Ultrasonic Sensor Pin Configuration

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | Vcc | The Vcc pin powers the sensor, typically with +5V |
| 2 | Trigger | Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave. |
| 3 | Echo | Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor. |
| 4 | Ground | This pin is connected to the Ground of the system. |

### 3.13 Digital Temperature Meter

A thermometer is a device that measures temperature or a temperature gradient (the degree of hotness or coldness of an object). A thermometer has two important elements: a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer or the pyrometric sensor in an infrared thermometer) in which some change occurs with a change in temperature.

Figure 3.20: Digital Temperature Meter

some means of converting this change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer or the digital readout on an infrared model). Thermometers are widely used in technology and industry to monitor processes, in meteorology, in medicine, and in scientific research. Some of the principles of the thermometer were known to Greek philosophers of two thousand years ago.

As Henry Carrington Bolton (1900) noted, the thermometer's "development from a crude toy to an instrument of precision occupied more than a century, and its early history is encumbered with erroneous statements that have been reiterated with such dogmatism that they have received the false stamp of authority." The Italian physician Santorio Santorio (Sanctorius, 1561-1636) is commonly credited with the invention of the first thermometer, but its standardization was completed through the 17th and 18th centuries.

In the first decades of the 18th century in the Dutch Republic, Daniel Gabriel Fahrenheit made two revolutionary breakthroughs in the history of thermometry. He invented the mercury-in-glass thermometer (first widely used, accurate, practical thermometer) and Fahrenheit scale (first standardized temperature scale to be widely used).

## Specification

- Temperature range: -50~ +110°C
- Using environment: Temperature: -5~ +50°C Humidity: 5%~80%
- Accuracy: ±1°C
- Size: 47*28*14mm
- Weight: 22g
- Color: Black and white.

# CHAPTER 4

# METHODOLOGY

## 4.1 Methodology

Our methodology for the project:

- Creating an idea for Design and construction of a **Study and Construction of a Purified water Cooling and Heating System Using Peltier Module.**
- And drawing and listed of components/materials to know which components / materials need to construct it.
- Collecting the all components / materials for construct the system.
- Finally, we constructed this system & checked it finally that working very well.

## 4.2 Block Diagram

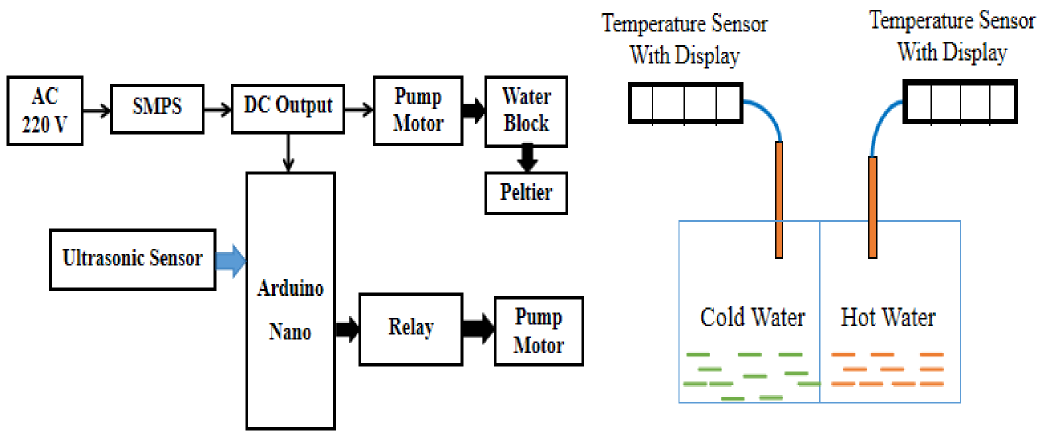



Figure 4.1: Block Diagram

## 4.3 Circuit Diagram

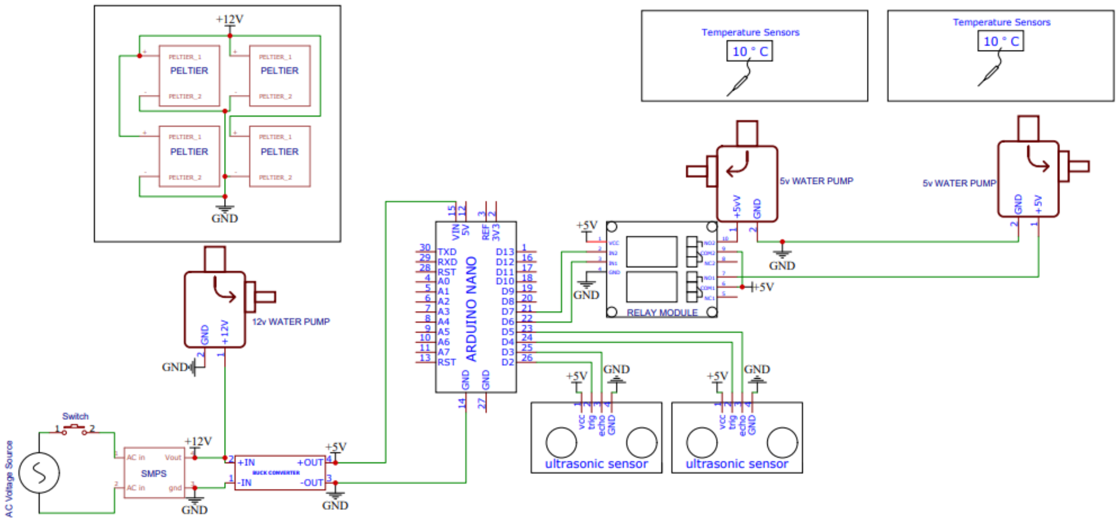



Figure 4.2: Circuit Diagram

## 4.4 Complete Project Prototype Image :

Figure 4.3: Complete Project Picture (Front View)

Figure 4.4: Complete Project Picture (Side View)

## 4.5 Working Principle

The process begins with a pump motor that facilitates the continuous circulation of water throughout the system. This pump motor ensures that water flows through each stage of the purification process. The first stage involves the water passing through a ceramic filter. This filter is designed to remove larger particles, sediments, and bacteria from the water. It acts as a preliminary barrier to contaminants. After the ceramic filter, the water undergoes activated carbon filtration. Activated carbon is known for its adsorption properties, capable of removing impurities, organic compounds, and undesirable odors, thereby improving the taste and quality of the water.

The system incorporates mineral sand balls, which release beneficial minerals into the water. This mineralization stage enhances the overall quality of the water by adding essential minerals. Further purification is achieved through the use of zeolite and silica gel. These components contribute to the adsorption of specific impurities, completing another layer of comprehensive water treatment. The heart of the system is the Peltier Module, a Thermoelectric device capable of both cooling and heating. Depending on the desired water temperature, the Peltier Module adjusts its operation.

When cooling is needed, it absorbs heat from the water, and when heating is required, it transfers heat to the water. During the cooling process, the Peltier Module generates heat that needs to be dissipated. A dedicated heat sink is integrated into the system to efficiently dissipate this heat, preventing overheating and ensuring the optimal performance and longevity of the Peltier Module. Users can set their preferred water temperature through the system's user interface. The Peltier Module adjusts its operation based on these settings, providing precise and customizable temperature control.

## 4.6 Cost Analysis:

| No | Product Name | Specification | Qty. | Unit Price | Total Price | Market Price |
|---|---|---|---|---|---|---|
| 01. | Water Purifier | Multi L.cartridge | 1 | 1500 | 1500 | |
| 02. | Water tap | | 2 | 100 | 200 | |
| 03. | Arduino Nano | ATmega 328P | 1 | 650 | 650 | |
| 04. | SMPS | 12V | 1 | 990 | 990 | |
| 05. | Buck Converter | LM2596 | 1 | 120 | 240 | |
| 06. | Pump Motor | 12V DC | 3 | 150 | 450 | |
| 07. | Peltier Module | TEC-1 12706 | 4 | 300 | 1200 | |
| 08. | Heat Sink | 80*40*12 | 2 | 520 | 1040 | |
| 09. | Temperature Meter | | 3 | 150 | 450 | |
| 10. | Ultrasonic Sensor | HC SR04 | 2 | 140 | 280 | |
| 11. | Others | | | | 1500 | |
| | | | | Total = | 8500/= | 12,000/= |

Table 1: Cost Analysis.

# CHAPTER 5

# RESULT AND DISCUSSION

## 5.0 Data Analysis

Observation-I :

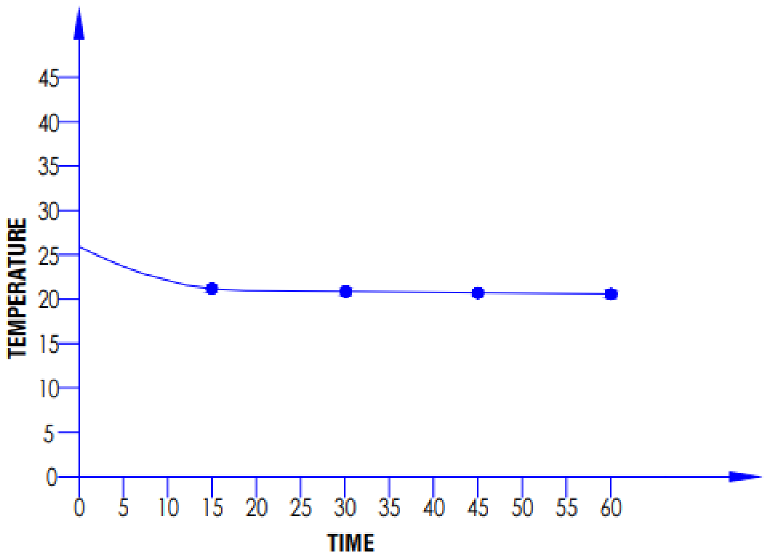
| SL | Time (Min) | Normal Temp. | Cold Temp. |
|---|---|---|---|
| 1 | 0 | 25.2° C | 25.2° C |
| 2 | 15 | 25.3° C | 21.2° C |
| 3 | 30 | 25.2° C | 21.1° C |
| 4 | 45 | 25.5° C | 21.0° C |
| 5 | 60 | 25.2° C | 20.9° C |

Table No. 2: Time duration VS. Cold water temperature:

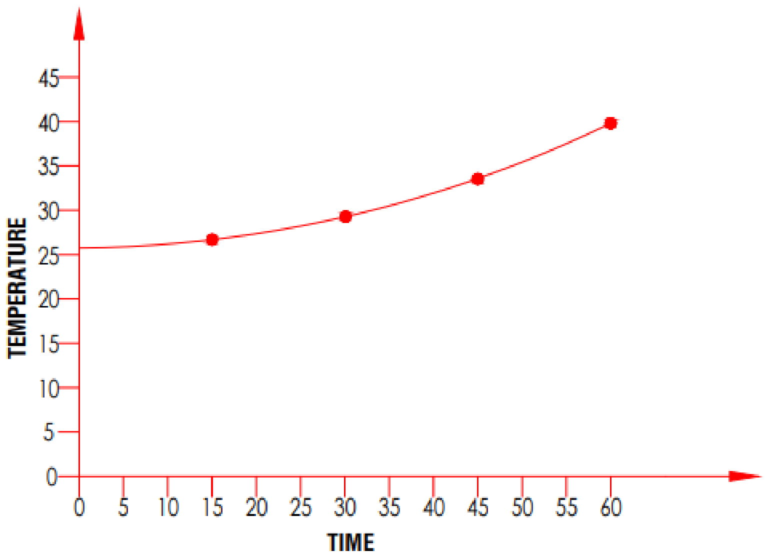
| SL | Time (Min) | Normal Temp. | Hot Temp. |
|---|---|---|---|
| 1 | 0 | 25.2° C | 25.2° C |
| 2 | 15 | 25.3° C | 28.9° C |
| 3 | 30 | 25.2° C | 32.5° C |
| 4 | 45 | 25.5° C | 35.6° C |
| 5 | 60 | 25.2° C | 39.9° C |

Table No. 3 : Time duration VS. Hot water temperature:

| SL | Time (Min) | Normal Temp. | Cold Temp. | Hot Temp. |
|---|---|---|---|---|
| 1 | 0 | 25.2° C | 25.2° C | 25.2° C |
| 2 | 15 | 25.3° C | 21.2° C | 28.9° C |
| 3 | 30 | 25.2° C | 21.1° C | 32.5° C |
| 4 | 45 | 25.5° C | 21.0° C | 35.6° C |
| 5 | 60 | 25.2° C | 20.9° C | 39.9° C |




**TIME DURATION VS COLD WATER TEMPERATURE**




**TIME DURATION VS HOT WATER TEMPERATURE**

Observation-II

| SL | Time (Min) | Normal Temp. | Cold Temp. |
|---|---|---|---|
| 1 | 0 | 25.5° C | 25.5° C |
| 2 | 15 | 25.6° C | 21.1° C |
| 3 | 30 | 25.8° C | 21.0° C |
| 4 | 45 | 25.8° C | 20.8° C |
| 5 | 60 | 25.8° C | 20.7° C |

Table No. 4 : Time duration VS. Cold water temperature:

| SL | Time (Min) | Normal Temp. | Hot Temp. |
|---|---|---|---|
| 1 | 0 | 25.5° C | 25.5° C |
| 2 | 15 | 25.6° C | 29.3° C |
| 3 | 30 | 25.8° C | 32.8° C |
| 4 | 45 | 25.8° C | 36.4° C |
| 5 | 60 | 25.8° C | 40.2° C |

Table No. 5 : Time duration VS. Hot water temperature:

| SL | Time (Min) | Normal Temp. | Cold Temp. | Hot Temp. |
|---|---|---|---|---|
| 1 | 0 | 25.5° C | 25.5° C | 25.5° C |
| 2 | 15 | 25.6° C | 23.2° C | 29.3° C |
| 3 | 30 | 25.8° C | 22.6° C | 32.8° C |
| 4 | 45 | 25.8° C | 20.3° C | 36.4° C |
| 5 | 60 | 25.8° C | 19.7° C | 40.2° C |

Note: Each Data has been taken after 15 minutes

Observation-III

| SL | Time (Min) | Normal Temp. | Cold Temp. |
|---|---|---|---|
| 1 | 0 | 25.6° C | 25.6° C |
| 2 | 15 | 25.6° C | 21.3° C |
| 3 | 30 | 25.7° C | 21.1° C |
| 4 | 45 | 25.7° C | 21.0° C |
| 5 | 60 | 25.7° C | 20.3° C |

Table No. 6 : Time duration VS. Cold water temperature:

| SL | Time (Min) | Normal Temp. | Hot Temp. |
|---|---|---|---|
| 1 | 0 | 25.6° C | 25.6° C |
| 2 | 15 | 25.6° C | 29.8° C |
| 3 | 30 | 25.6° C | 32.6° C |
| 4 | 45 | 25.6° C | 36.8° C |
| 5 | 60 | 25.6° C | 40.6° C |

Table No. 7 : Time duration VS. Hot water temperature.

| SL | Time (Min) | Normal Temp. | Cold Temp. | Hot Temp. |
|---|---|---|---|---|
| 1 | 0 | 25.6° C | 25.6° C | 25.6° C |
| 2 | 15 | 25.6° C | 21.3° C | 29.8° C |
| 3 | 30 | 25.6° C | 21.1° C | 32.6° C |
| 4 | 45 | 25.6° C | 21.0° C | 36.8° C |
| 5 | 60 | 25.6° C | 20.3° C | 40.6° C |

Note: Each Data has been taken after 15 minutes

- **Calculation of Co-Efficient of Performance:**

Hot and Cold Water Chamber dimensions are given bellow.

L= 250 mm = 0.25 m

W=250 mm = 0.25 m

H=160 mm = 0.16 m

Chamber Volume, V=0.25x0.25x0.16

= 0.1 m3

Mass of Water in the Chamber, m= $\rho$V

= 1000x.01

=10 kg

$Q_{cold}$= MS x ($T_n$ - $T_{min}$)

= 10 x 4200 x (25.2 - 20.2)

= 210,000 j

=210 kj

$Q_{Hot}$= MS x ($T_{max}$ - $T_n$)

=10 x 4200 (40 - 25.2)

=621600 j

=621.6 kj

Here, Input Power

P=VI= 12x10 = 120 w

Input Power for Cooling = P x time

=120 x 15 x 60

=108000 j

=108 kj x 0.8 ( peltier module efficiency : 80%)

=86.4 kj

Input Power for Heating = P x time

=120 x 60 x 60

=432000 j

=432 kj x 0.8 ( peltier module efficiency : 80%)

=345.6 kj

# Now Co-efficient of performance,

COP(cooling)= Qcold / Input Work

=210/86.4

=2.43

# Now Co-efficient of performance,

COP(heating) = QHot / Input Work

=621.6/345.6

=1.8

## 5.1 Result

After followed all objectives and plan to build our project. We finally establish our project. In this project first we create our project circuit with sufficient equipment. All the setup is working well with our accurate implementation and plan.

- The successful implementation of the project would demonstrate the feasibility of integrating a Peltier Module for water cooling and heating with advanced filtration technologies. This achievement serves as proof of concept for the proposed system.
- The system is expected to deliver improved water quality by effectively removing impurities, contaminants, and enhancing mineral content.
- Users would have access to temperature-controlled water, offering the flexibility of both cooling and heating based on individual preferences.
- If the mineralization stage effectively imparts beneficial minerals to the water, the system may offer potential health benefits associated with mineral-rich water consumption. These benefits could contribute to the overall appeal of the system.
- Ultrasonic Sensor measure the water and Temperature show the Digital temperature meter.

## 5.2 Advantage

There are certainly many advantages of our project and some of the major ones have been given below:

- Comprehensive Water Treatment.
- Temperature Control.
- Improved Water Taste and Odor.
- Health Benefits
- User-Friendly Interface
- Efficient Water Circulation
- Innovation in Water Treatment

## 5.3 Application

Our project has many application areas and actually we need to use it in many places to verify the exact person which have the proper access. Some of the application areas of the project has been pointed out below:

- Residential Use.
- Office Environments.
- Healthcare Facilities.
- Educational Institutions
- Emergency and Disaster Relief
- Research Laboratories.

## 5.4 Limitation

It is a demo project so we found some limitation. In future we will work for reduce this kind of limitation. These limitations are –

- Energy Consumption.
- Initial Cost.
- Maintenance Requirements.
- Limited Temperature Range.
- Dependence on Ambient Temperature.
- Water Flow Rate.
- Water Source Quality.

## 5.5 Discussion

Certainly, let's delve into a more comprehensive discussion of the theoretical aspects of the Water Purifier System with Peltier Module Water Cooling and Heating. The core of the system lies in the Peltier Module, a thermoelectric device. The theoretical basis of thermoelectricity involves the Seebeck effect, where a temperature difference across the module leads to the generation of an electric current. Understanding the principles of thermoelectric cooling and heating is crucial for optimizing the efficiency of the Peltier Module. Efficient heat transfer and dissipation are essential for the proper functioning and longevity of the Peltier Module. The theoretical aspects of heat transfer mechanisms, such as conduction and convection, guide the design and selection of materials for the heat sink to ensure optimal performance. The theoretical foundations of each filtration stage contribute to the overall water treatment process. Activated carbon's adsorption properties, mineralization with mineral sand balls, and the ion-exchange capabilities of zeolite & silica gel are key theoretical concepts. The ceramic filter's physical barrier properties are also crucial for removing larger particles.

# CHAPTER 6
# CONCLUSION

## 6.1 Conclusion

In conclusion, the Water Purifier System with Peltier Module Water Cooling and Heating represents a cutting-edge and innovative approach to water treatment. By integrating advanced technologies such as the Peltier Module with multi-stage filtration, the system addresses the dual challenges of providing purified water and offering precise temperature control. The theoretical underpinnings, spanning thermoelectricity, fluid dynamics, filtration processes, and environmental science, form the foundation for its design and functionality. The Peltier Module's thermoelectric properties enable both cooling and heating, contributing to the system's adaptability across various applications. The comprehensive multi-stage filtration process, including ceramic filtration, activated carbon adsorption, mineralization, and zeolite & silica gel purification, ensures a thorough treatment of water, removing impurities and enhancing overall quality. Continued research, refinement, and innovation in the theoretical aspects of the Water Purifier System with Peltier Module Water Cooling and Heating will contribute to overcoming existing limitations and enhancing its overall efficiency and applicability.

## 6.2 Future Scope

The model can be improved by making some changes in the program and components. Some suggestions are given below-

- **Integration of Smart Technologies:** Incorporating smart technologies, such as Internet of Things (IoT) connectivity, could enable real-time monitoring and control of the water purifier system
- **Nanotechnology in Filtration:** Exploring the integration of nanotechnology in filtration components could enhance the system's ability to remove even smaller particles and contaminants, further improving water quality.
- **Advanced Filtration Materials:** Research into advanced filtration materials, including bio-inspired materials, could lead to more effective and sustainable water purification.

# Reference


[1] De França Doria M. 2010 Water policy 12 p 1-19.

[2] Asyiqin N A, Fadzly M K and Amarul T 2019 AIP Conf. Proc. 2129 p. 020145

[3] Costin D, Ion-Ene M and Neofit A 2010 Health, Sports and Rehabilitation Medicine 32.

[4] Zhang H Y, Mui Y C and Tarin M 2010 Appl. Therm. Eng. 30 p 561–568.

[5] Najmie M S and Fadzly M K 2019 AIP Conf. Proc. 2129 p. 020147

[6] Radhwan H, Shayfull Z, Farizuan M R, Effendi M S M and Irfan A R 2019 AIP Conf. Proc. 2129 p 020153

[7] Tan J X, Effendi M S M and Radhwan H 2019 AIP Conf. Proc. 2129 p 020162

[8] Xin T J, Farizuan R M, Radhwan H, Shayfull Z and Fathullah M 2019 AIP Conf. Proc. 2129 p 020159.

[9] Farahin K, Effendi M S M and Radhwan H 2019 AIP Conf. Proc. 2129 p 020163.

[10] Farahin K, Farizuan M R and Radhwan H 2019 AIP Conf. Proc. 2129 p 020160

[11] Hazelrigg, G. A. 2010 Research in Engineering Design 21 p 143-144

[12] Ismalina H N, Amarul T, Yusra A Z N, Zahidah M N N, Rakeish K P, Nasuha M N T and Vikneswaran P 2018 AIP Conf. Proc. 2030 p 020021

[13] Haris N I, Wahab M And Talip A 2014 Applied Mechanics and Material 465 p 725-729

[14] Fadzly M K, Foo W T, Amarul T, Mardhiati M M and Fakhira W N 2019 AIP Conf. Proc. 2129 p. 020146.

[15] Masniza Y, Zulfabli H M, Amarul T, Khairunnisa S N, Zilawati N A R N N, Nazera D and Ismalina H N 2019 AIP Conf. Proc. 2129 p 020056

[16] Zulfabli H M, Ismalina H N, Amarul T, and Ahmad S 2019 AIP Conf. Proc. 2129 p 020055

[17] Ismalina H N, Zulfabli H M, Amarul T, Idham M T M A, Fahmi A Z M I,Syuhadah M H N and Fatihah R F N 2019 AIP Conf. Proc. 2129 p 020054.