# THE IMPROVE QUALITY OF WATER PURIFICATION BY CONTROL IMPURITY THROUGH HEAT EXCHANGER

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**ABSTRACT**

The cool water purification paper provides a small, economical, water purification system that may be applied on a larger scale. The design has minimal moving parts, thereby reducing the risk of mechanical failure. The final device is driven from a windmill interface. The design easily separates waste and optimizes clean water output. The cool water purification paper work is intended to fulfill the requirements of the ASME design competition and then be adapted to use a renewable energy source. When adapted to a renewable energy source, this small scale water purification device will attempt to satisfy market needs for individual families who desire purified drinking water.

The purpose of this paper is to design and manufacture a small scale water purification system which requires minimal maintenance and is cost efficient. Originally, a human powered bike will be used to power the purification system for the competition and a wind turbine will be used to adapt the system to renewable energy. The power produced will be converted into heat by using a resistive heating element which will be placed in a boiling chamber. Once the water is boiled, it is condensed in the heat exchanger and the system will collect the potable water. The final product of the cool water purification system will provide potable water to people around the world. The system will efficiently transmit heat to the water and all components of the device will be cost efficient and require minimal maintenance.

***Keywords: Construction , Classification and Working of Water Cooler.***

## I INTRODUCTION OF WATER COOLER

A water cooler or water dispenser is a device that cools and dispenses water. They are generally broken up in two categories: bottle less and bottled water coolers. Bottle less water coolers are hooked up to a water supply, while bottled water coolers require delivery (or self-pick-up) of water in large bottles from vendors.

Water cooler may also refer to a primitive device for keeping water cool Early drinking fountains provided room temperature drinking water, but demand led to the development of fountains that could provide cooler water thereby killing the micro-organisms responsible for pollution and disease. But early water coolers did not have a discrete water treatment method for purifying the dispensed H2O. As the years went by, water coolers further evolved into smaller, lighter, and more efficient units. They also varied in shape and size, depending on the needs of the consuming public. With health and safety being the main drivers in recent years, modern water coolers were created with inbuilt purifying systems with some having a reverse osmosis system that removes chlorine and destroys microbial. Today there are two main types of water cooler: bottled and bottle less. The bottle less cooler connects directly to the water supply and has a filtering process for purifying the water. One of the big advantages here is that you don't have to maintain the cumbersome and heavy bottles; plus, bottle less water is cheaper and more environmentally friendly.

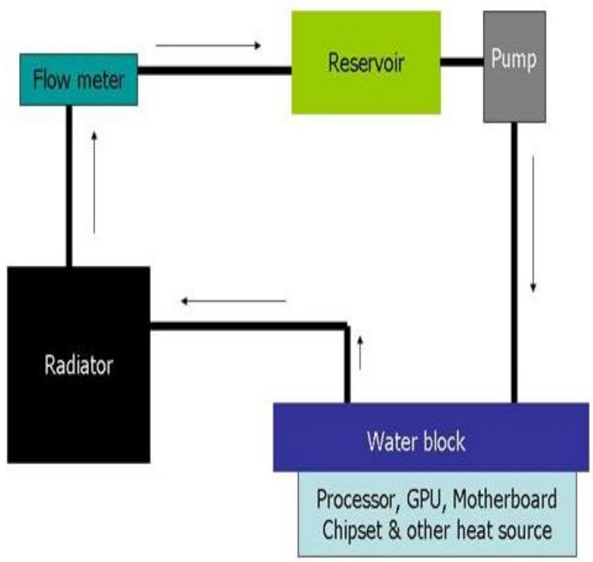


**Fig: - Water Cooling System**

## II INTRODUCTION OF RO WATER PURIFIER

Osmosis is a natural process by which water flows into plant and animal cells, through cellular membranes, also known as semi-permeable membranes or osmotic membranes. These membranes have a unique property that pure water can freely flow in either direction, but passage of salt and other dissolved impurities are inhibited. Living cells contain salty solutions, which allow them to absorb water from their natural surroundings, through the osmotic process. Osmotic pressure is a unique, natural property of all solutions. The osmotic pressure of a solution depends on the concentration of the salt and other dissolved materials. Suspended impurities like silt and bacteria do not contribute to osmotic pressure. As the cell absorbs water, it starts building pressure inside the cell. At the same time, the concentration of salt inside the cell decreases, so does its osmotic pressure value. The flow of water into the cell continues, until the pressure inside the cell equals the osmotic pressure value of the remaining salty solution inside the cell. The above diagram explains the concept of osmotic pressure.

Reverse Osmosis works on the same principle as osmosis, but in the reverse direction. If external pressure is applied to the above cell containing salty solution, then pure water is forced out of the cell and the salt is retained. As the water is extracted from the salty solution, its concentration rises, so does its osmotic pressure. The process continues until the osmotic pressure value of the remaining salt solution inside the cell equals the applied external pressure. Reverse osmosis membranes also hold back suspended impurities; such as, silt, colloidal particles and microorganisms by virtue of their ultra-fine pore size. Because reverse osmosis membranes hold back all kinds of impurities, reverse osmosis offers an ideal method of water purification.

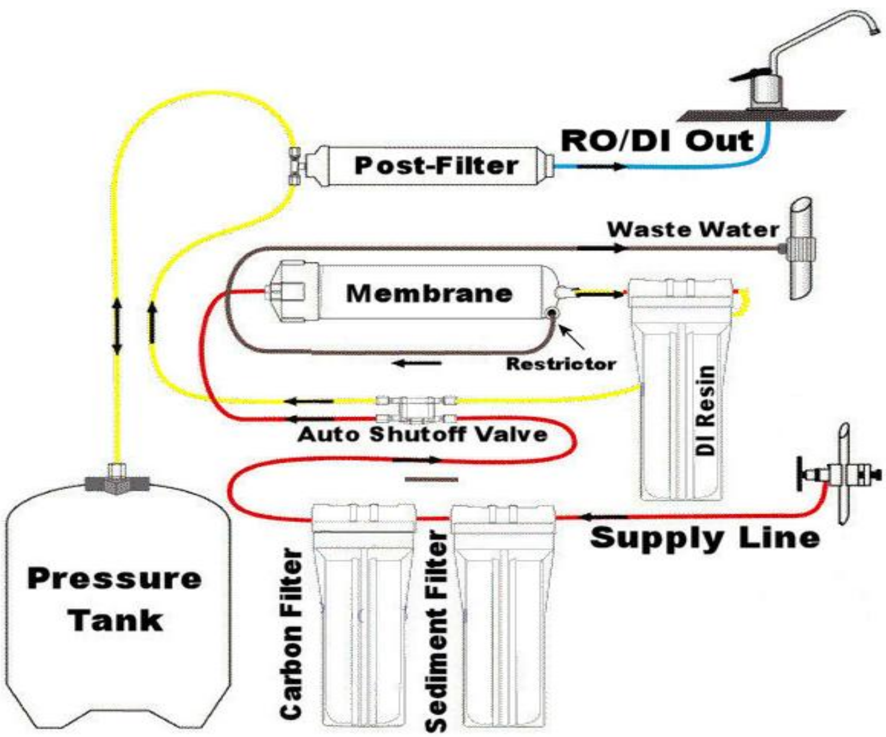


**Fig: Block Diagram of RO Water Purifier**

## III BACKGROUNG

The motivation of the ASME design competition is from natural disasters like the recent hurricane in New Orleans and the lack of clean water in developing countries. More information about the motivation for the design competition can be found in Appendix B.

According to an article published by the Red Cross in March 2005, over 1.1 billion people lack access to safe drinking water. As a result, over 2.2 million people die from unsafe drinking water every year. Almost 90 percent of these deaths are children under the age of five. In fact, British Broadcasting News reports that 4,500-6,000 children die every day from water related diseases.

Existing water treatment processes include desalination plants, reverse osmosis water treatment plants, and household water purifiers. The large facilities are quite costly and require detailed know-how about the latest developments in the sanitation industry. All three methods require a membrane or filter, which translates to constant maintenance and a substantial amount of upkeep cost. The smaller household filters can usually only filter out certain strong smells and tastes, trivial problems for any family.

Many nations have realized the urgency of having potable water and are putting forth funds for supporting purification programs. For example, in response to a proposal by the United Nations, the Red Cross is going to spend 129 million dollars over the next ten years to provide clean water for more people. In a similar effort, the United States' Government has pledged to provide 970 million dollars over the next three years to improving access to clean water and increasing water productivity.

A group of four students have sought to design a device that can clean water efficiently and effectively. The initial design will be completed according to the specifications of the American Society of Mechanical Engineers Student Development Conference in 2007. The final design will use the competition as a guide for sensible improvements and adaptations to a renewable energy source, such as wind. The design will be completed by a mechanical engineering team representing the University of San Diego.

## IV CLASSIFICATION OF WATER COOLER

### Types of Water Cooler

When it comes to choosing a water cooler for your home of office, there are lots of options. Where do you start? Well, the first thing you need to do is decide what kind of water cooler you want. Remember, your objective is cold (and/or hot), filtered drinking water. In this post we present you with seven types of water coolers. A water cooler being anything that provides cold and/or hot drinking water. There are following type of water cooler: -

1. Tap Water
2. Wall Mounted Water Bubbler
3. Instant Hot Water Dispenser
4. Buying Bottled Water
5. Upright Water Dispenser
6. Ezy Fill Water Cooler
7. Direct Connection Water Cooler

**Tap Water**

The benefits of tap water are obvious (convenient, inexpensive and always available) however it's not always the coldest water and you're risking sediment in your water. Plus, tap water is not hot enough for your tea or coffee. The benefits of tap water are obvious (convenient, inexpensive and always available) however it's not always the coldest water and you're risking sediment in your water. Plus, tap water is not hot enough for your tea or coffee.

**Fig: - Tap Water**

**Wall Mounted Water Bubbler**

A wall mounted water bubbler solves the cold water problem however it can be uber inconvenient for drinking and filling up your water bottle. It's also expensive to install and remove. And like tap water, there's no hot water option for tea and coffee.

**Fig: -Wall Mounted Water Bubbler**

**Instant Hot Water Dispenser**

Ok so this solves the hot water problem. Great for instant tea and coffee but where's the cold water option! Too bad when you want a cold refreshing drink.

**Fig : Instant Hot Water Dispenser**

**Buying Bottled Water**

The benefits of this water cooler is you'll get cold and hot filtered water. The downside is that you're buying water bottles which can be expensive, tough on the environment (due to trucks delivering your water) and you can easily run out of water bottles. In addition, a lot of water cooler companies use polycarbonate bottles. According to a study by the Harvard School of Public Health, BPA levels can rise by two thirds when drinking from polycarbonate bottles. Read why you need BPA free water bottles. You also need to lift and replace the bottle when it's empty so watch your back!

**Fig: Buying Bottled Water**

### Upright Water Dispenser

This type of water cooler allows for easier replacement of your water bottles. However, this option shares similar downsides to option 4 above. There are also environmental factors with water bottles.

**Fig: Upright Water Dispenser**

**Ezy Fill Water Cooler**

With this type of water cooler, you refill it yourself. That means you save on buying water, never need to replace the bottle (it's regularly cleaned by your service provider), and the bottle is BPA free. You also can choose from hot and cold options so it's great for instant tea and coffee or that cold drink in summer.

**Fig: -Ezy Fill Water Cooler**

**Direct Connection Water Cooler:**

A direct connection water cooler connects with your plumbing to deliver instant fresh cold water or hot water. While this option can costlier (one off installation) the benefits are obvious. No running out of water, no refilling water bottles and your water cooler company will regularly service, sanitize and change the filter.

**Fig: -Direct Connection Water Cooler**

## CONSTRUCTION OF RO WATER PURIFIER

The basic components of reverse osmosis system are follows: -

1. Cold water line valve
2. Pre-filter
3. Reverse Osmosis Membrane
4. Post filter

5. Automatic Shut Off Valve
6. Check Valve
7. Flow Restrictor
8. Storage Tank
9. Faucet
10. Drain line

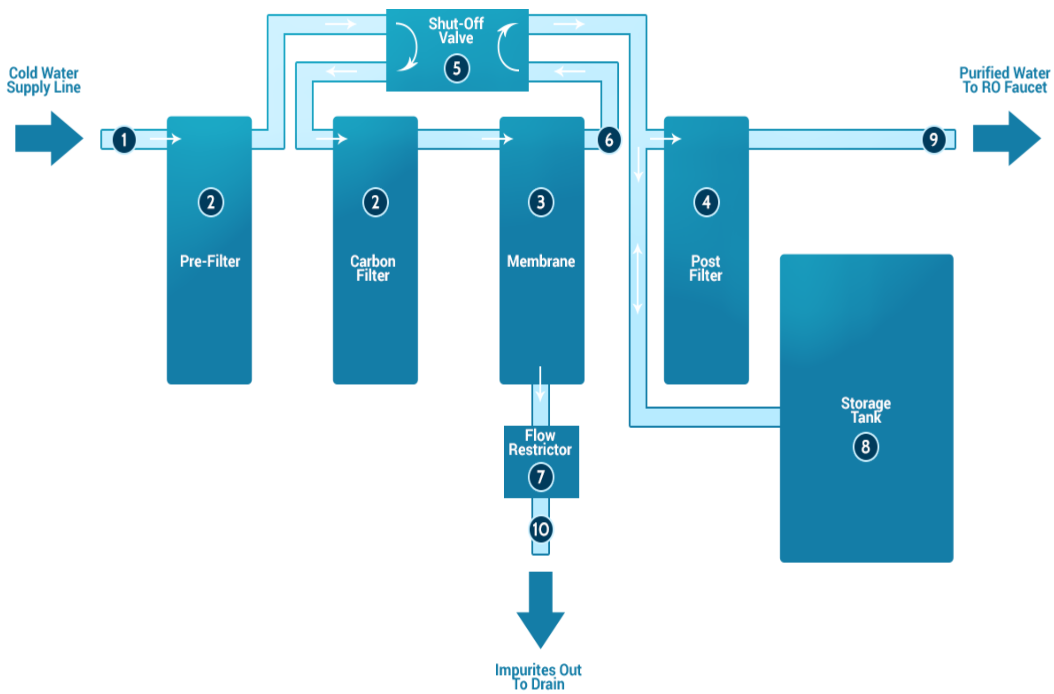


**Fig: - Diagram of a Reverse Osmosis System with Basic Components**

### Cold water line valve: -

Valve that fits onto the cold water supply line. The valve has a tube that attaches to the inlet side of the RO pre filter. This is the water source for the RO system.

### Pre-filter: -

Water from the cold water supply line enters the Reverse Osmosis Pre Filter first. There may be more than one pre-filter used in a Reverse Osmosis system. The most commonly used pre-filters are sediment filters. These are used to remove sand silt, dirt and other sediment. Additionally, carbon filters may be used to remove chlorine, which can have a negative effect on TFC (thin film composite) & TFM (thin film material) membranes. Carbon pre filters are not used if the RO system contains a CTA (cellulose tri-acetate) membrane.

**Reverse Osmosis Membrane: -**

The Reverse Osmosis Membrane is the heart of the system. The most commonly used is a spiral wound of which there are two options: the CTA (cellulose tri-acetate), which is chlorine tolerant, and the TFC/TFM (thin film composite/material), which is not chlorine tolerant.

**Post filter: -**

After the water leaves the RO storage tank, but before going to the RO faucet, the product water goes through the post filter (s). The post filter (s) is generally carbon (either in granular or carbon blocks form). Any remaining tastes and odors are removed from the product water by post filtration.

**Automatic Shut Off Valve: -**

To conserve water, the RO system has an automatic shutoff valve. When the storage tank is full (this may vary based upon the incoming water pressure) this valve stops any further water from entering the membrane, thereby stopping water production. By shutting off the flow this valve also stops water from flowing to the drain. Once water is drawn from the RO drinking water faucet, the pressure in the tank drops and the shut off valves opens, allowing water to flow to the membrane and waste-water (water containing contaminants) to flow down the drain.

**Check Valve: -**

A check valve is located in the outlet end of the RO membrane housing. The check valve prevents the backward flow or product water from the RO storage tank. A backward flow could rupture the RO membrane.

**Flow Restrictor: -**

Water flow through the RO membrane is regulated by a flow control. There are many different styles of flow controls. This device maintains the flow rate required to obtain the highest quality drinking water (based on the gallon capacity of the membrane). It also helps maintain pressure on the inlet side of the membrane. Without the flow control very little drinking water would be produced because all the incoming tap water would take the path of least resistance and simply flow down the drain line. The flow control is located in the RO drain line tubing.

**Storage Tank: -**

The standard RO storage tank holds up to 2.5 gallons of water. A bladder inside the tank keeps water pressurized in the tank when it is full.

**Faucet: -**

The RO unit uses its own faucet, which is usually installed on the kitchen sink. In areas where required by plumbing codes an air-gap faucet is generally used.

**Drain line: -**

This line runs from the outlet end of the Reverse Osmosis membrane housing to the drain. This line is used to dispose of the impurities and contaminants found in the incoming water source (tap water). The flow control is also installed in this line.

Water cooler cabinets have sheet metal housing attached to a steel framework. The condenser and hermetic compressor are located in the housing base, and the evaporator is located in the cabinet depending on its type of evaporator, but normally under the drain basin. Most water coolers use heat exchanger or pre cooler, which pre cools the freshwater line to the evaporator, reducing cooling requirements for the evaporator. A thermostat, which is manually set and adjusted, is located in the cooler housing close to the evaporator. Automatic ice machines, similar to the units are often used in galleys, barracks, gymnasiums, and other public areas. Ice machines are self-contained, automatic machines, ranging from a small unit producing 50 pounds of ice per day to a commercial unit producing 2,400 pounds of ice per day.

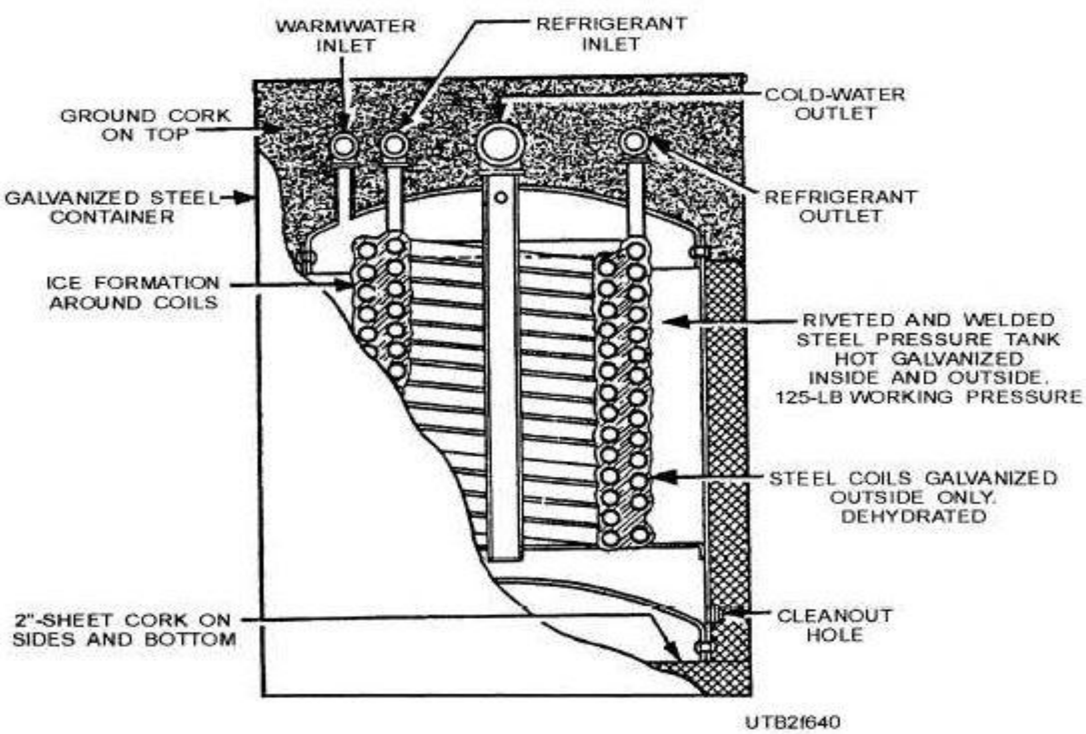


**Fig: - Storage type of water cooler.**

The primary difference in the design of these machines is the evaporator. They automatically control water feed to the evaporator, freeze the water in an ice cube mold, heat the mold and empty the ice into a storage bin, and shut down when the storage bin is full. Floats and solenoids control water flow, and switches operate the storing action when ice is made. Electrical heating elements, hot water, hot gas defrosting, or mechanical devices remove the ice from the freezing surfaces depending on the unit the freezing and defrost cycle of a typical ice cube machine.

## V CONCLUSION

Water may be the world's most abundant resource, but the need for sanitary and clean water is exponentially increasing. Currently available water purification systems require large scale expensive facilities or disposable filters which require costly maintenance and replacement. Deaths in developing countries and rural areas have increased in the past ten years due to lack of clean water, and countries such as the United States have pledged to give over a billion dollars towards water related fields. Around the world there is a growing need and interest in clean water.

Attached is a proposal for a simple inexpensive water purification system. This device will be reusable, require little maintenance and contain minimal degradable parts. This is accomplished by using a windmill to translate mechanical input to electrical power. Heat created by a heating element boils water and removes 99.9% of all bacterial impurities. The cool Water Purification paper uses two sources of energy to create potable water. For normal uses, wind will be used as a renewable energy source and for emergency situations a human powered mechanism provides an alternative energy source. This system will boil contaminated water, purifying it, and then condense the water as a potable source. The system will be simple, cost efficient, and require minimal maintenance.

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