

# Efficient Way of Desalination of Sea Water for Agricultural and Commercial Use

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**Abstract:** India is an agricultural dependent country where majority of people are into farming and they depend on Rain Water, Canal water or Bore well. But due to climatological changes and Drought areas the water is not available at suitable time and in suitable amount, so their crops are getting damaged to solve this problem, this project is based on desalination of sea water and use of sea water in farming and other residential and commercial use. For purifying the water, desalination process is used in which first the sea water is taken from the ocean then the water is pour in to the heating chamber where water is converted to steam due to heat energy is supplied, then condensation of steam is to be done to get pure water, which will be further stored in a large tank and can be distributed all over the region using distribution pipeline, the pure water obtained is distilled, so it cannot be used for drinking but if adding minerals in it that can be used as drinking purpose also, other uses such as cleaning in house, hotels and hospitals can also be done and in this way the sea water can be utilized in proper manner. And by product is raw salt which can be purified and will be used in food industry.

## INTRODUCTION

Now a days the problem of water scarcity is increasing day by day in many countries and conditions like drought are arising, As we know India is an agricultural country, so the farmers are only depend on the rain water, but due to climatological changes the rain water they require won't be available all the time, in addition, due to pollution and global warming, ground water is sinking deeper and deeper into the soil and the little bit of water that is also found to be saline or polluted. so in this project the sea water is given to farmer, using Desalination process in pure form of water is obtained and so water from sea is taken and heated to convert it into steam using mechanical system after then the steam is cooled and pure form of water obtained and as a byproduct Raw salt is also obtained, which again can be sold and pure form of distilled water is obtained, which will have all kind of quality parameters, which can be used in cultivation and poultry farms. In India the farmers are engaged in different types of agricultural farming i.e. conventional and nonconventional farming.

### Nonconventional Farming

In nonconventional farming, we uses modified methods of farming and growing crops. In this farming we use some new method like hydroponic to vertical farming and Aeroponics, a groecology, urban farming etc. In hydroponics farming the cultivation of plant in nutrient enriched water and less utilization of soil in this cultivating we utilize large amount of water for cultivating.[1] In Aeroponics farming is similar to the hydroponics farming in this faming we also used a huge amount of water for planting.[2] Hydroponics, Aeroponics, urban farming, a groecology , and so on in a wide range of cultivating we required a lot of water for the fulfillment of this prerequisite regardless the purpose of distilled water which are collect through our project.

### Conventional Farming

Conventional farming are also called the traditional faming in which we used the water, soil, and pesticides for better production of plants in this farming we also required a huge amount of water and this project is very helpful in all kinds of farming for fulfillment the needs of water.[3]

Instead of using in farming we can use it for several other purposes like cleaning, gardening. Thus many water related problems can be solved with this project.

## LITERATURE REVIEW

In India 20-40% of farmer do not get irrigation water for farming, which they usually get from rain and they are bearing heavy losses, so through this project the irrigation water for farming is to be given to farmers in any season so they can grow their crops and the others farmers or ranchers also use this water in poultry farming and cattle farming. Coming up next is a portrayal of how residents use water in India.[4]

The consistent increase in the rate of growth of population has led to increase the demand of the water. According to survey of urban citizen need water "THE HINDU"[4] estimated the daily use of water per person in 100%(135 liter) of water use 40.740%(55 liter) for bathing purpose, 22.222%(30 liter) for flush, 7.407%(20 liter) for cloth washing, 7.407% (10 liter) for cleaning purpose, 3.703%(5 liter) for cooking, 3.703%(5 liter) for drinking and 7.407%(10 liter) for cleaning purpose. The water used in household purpose, the 96% of water is used. Our project is very helpful for fulfillment the need of water for all purpose (Drinking and cleaning purpose)

This water cannot be used for drinking purpose, but the future scope by add minerals in be distilled water, the problem of drinking water can be resolved. The Water Farmer and Rancher Get from bore well the pH Of Water Isn't Great the pH For Cultivating for Required Is 6.5 to 7.

## MATERIAL SELECTION

### Material selection of heating chamber

The heating chamber is made up of the 316 stainless steel, the grid of copper wire is used which will be heated and sea water is converted to steam.[5] The properties of 316 stainless steel material are depend on the way of atoms are packed together and 316 stainless steel made up of austenitic chromium-nickel stainless and heat-resisting steel. The atom are held together by a chemical bond and 316 stainless steel have large no. of properties like Density is  $8.00 \text{ g/cm}^3$ , Melting Point is  $1400^\circ\text{C}$ , Modulus of Elasticity is 193 GPa, Electrical Resistivity is  $0.74 \times 10^{-6} \Omega\cdot\text{m}$ , Thermal Conductivity is  $16.3 \text{ W/m.K}$ , and Thermal Expansion is  $15.9 \times 10^{-6}/\text{K}$ . [6] In heating chamber we used grid of copper wire of conductivity is  $386.00 \text{ W/(m.K)}$  at  $2^\circ\text{C}$ . [7]

### Material selection of storage chamber

The entire chamber will be divided into 3 layers, the first layer is of the concrete, the second layer is of polymer and the last layer will be of the regular clay, which will assist with adding normal minerals in the water. [8] The upside of storage chamber which is produced using mud for drinking water and the clay have advantages like they have regular cooling properties the evaporation process ensures the heat of the water inside the pot is lost, which lowers the temperature of the water, and clay is alkaline in nature which interacts with acidic foods and provides the adequate pH balance and the minerals present in water helps to boost metabolism and helps rehydrate quickly, clay pots are not only useful in cooling water but also to purify it naturally. [9]

### Power generation

We know the electricity is one of the most important blessings that science has given to mankind. It has become a most important part of our modern life and we can't think the world without it. Electricity has many uses in our day to day life. It is used for lighting rooms, working fans and domestic appliances like using electric stoves, AC, fans, electric heater, electric boiler and more all of these provide comfort to people. In factories we use large machines are work day and night with the help of electricity. [10]

### There are different sources of electricity we use:

1. Fossil Fuels ( Coal, Natural Gas, Petroleum)
2. Nuclear Energy
3. Renewal energy sources:-
  - Wind Power Plant
  - Solar Power Plant
  - Geothermal Power Plant
  - Biomass Power Plant
  - Hydropower Plant
  - Tidal Power Plant

### Fossil Fuels (Coal, Natural Gas, Petroleum):

Fossil fuels power plant which burn coal, natural gas and Petroleum to produce heat which is used to generate steam to drive turbines which generate electricity. The main purpose of fossil fuels power plant is to convert heat energy of combustion into mechanical energy. [11]

### Nuclear Energy:

Nuclear energy is used for nuclear reactions to produce electricity. It originates from the splitting of uranium atoms as process is called fission. We use uranium and plutonium in nuclear power plant. This generate heat to produce steam, which is used by a turbine generator to generate electricity. [12]

### Renewable Energy Sources:

- **Windmill Power plant:** It is a renewable source of energy it operate at  $14\text{km/hr}$  to  $90\text{km/hr}$  of wind speed. The process used to generate electricity from converts wind speed energy into electrical energy. There are many types of wind turbines we used like Horizontal-Axis Turbines and Vertical-Axis Turbines. [13]
- **Solar Power plant:** It is a renewable source of energy in which we consume energy from sunlight and produce electricity and in this conversion used the solar panels and photovoltaic cells using the photovoltaic effect. [14]
- **Geothermal Power plant:** In this power plant we generate electricity from geothermal energy. It is also a renewable energy. The process of generating electricity to use the earth inside heat. This Power plant also included the dry steam power stations and Binary cycle power station. [15]
- **Biomass Power plant:** In this process converting biofuel into electrical energy. It produces power from biogas which we taken from forest residue and then burns it to produce heat for power generation. [16]

- **Hydropower plant:** In this process we use a dam to store river water in a reservoir. In a hydropower plant, water from a reservoir flows through a turbine and the turbine rotates the water, which in turn activates a generator to produce electricity. This power plant is used as a renewable source of energy.[17]

- **Tidal Power plant:** In this power plant, tidal energy of the ocean is converted into electrical energy by means of a turbine. It is similar to a wind turbine in that it has blades that turn a rotor to power a generator. They can be placed on the sea floor where there is strong tidal flow.[18]

In the above points, we discuss about different types of renewable sources, electricity production methods, and generally, our research is mainly focused around the windmill power plant on the grounds that our necessity is 24-hour energy creation. This prerequisite is satisfied by a windmill power plant and they have many benefits like less pollution, less maintenance required, and effectively accessible. In light of the fact that generally enormous organizations are centered in these areas and many research works are finished in windmill power plants. In our project, we dealt with purging of sea water, that is the reason our arrangement is close to the sea, the air blows close to the sea is too weighty and this is appropriate for our windmill. This is the fundamental motivation to utilize a windmill.

### Types of windmills

- Post mill
- Tower mill
- Smoke mill
- Horizontal axis wind turbine
- Darrieus wind turbine
- Turbina Giromill
- American windmill

For this project, we utilize a horizontal axis wind turbine since we accomplish a better power yield and higher efficiency, so utilized in enormous scope wind power plants and furthermore for power age. In modern plants, huge scope wind farms, or public activities, these wind turbines are most often utilized.[19]

Our arrangement is close to the sea shore, so we utilized offshore wind energy. Offshore wind power is the generation of power through breezes in waterways, ordinarily adrift. There are higher breeze speeds seaward than ashore, so offshore farms create greater power per amount of capacity installed and the offshore wind turbine system will be there for power generation. About 30 MW power is to be generated, which will be used in a thermodynamic system to heat the water, the excess of power generated that will be given to the government.[20]



**Figure 1.** Offshore windmill setup in the ocean [20]

**Table I :** List of Companies manufactured the wind turbines[21]

NO	Name of the company	Country	Off shore wind turbine	Land wind turbine
1	Siemens	Germany	Yes	Yes
2	GE	U.S	Yes	Yes
3	Suzlon	India	NO	Yes
4	Vestas	Danish	NO	Yes
5	Alstom	UK	Yes	Yes
6	Areva	France	Yes	Yes
7	Gamesa technology	Spain	Yes	Yes
8	Clipper wind power	US	NO	Yes
9	Bornay	Spain	NO	Yes
10	Enessere	Italy	Yes	Yes
11	Hi-VAWT	Taiwan	NO	Yes
12	TUGE	Estonia	NO	Yes
13	Urban green energy	USA	NO	NO
14	Goldwind	China	Yes	Yes
15	Envision	China	NO	Yes
16	SANY	China	NO	Yes
17	Pac wind	USA	NO	Yes
18	Inox wind	India	NO	Yes
19	Enecron	Germany	NO	Yes
20	Nordex SE	Germany	NO	Yes

According to the Table III, at 1 bar pressure and 120.4 C temperature, 2706.88 KJ/kg heat is required to convert 1 litre sea water in to dry steam.[22]

**Table II:** Dry Steam table[22]

Pressure		Temperature		Steam(hg)	Specific volume steam
bar	kPa	°C	K	kJ/kg	m <sup>3</sup> /kg
1.0	100	120.4	393.4	2706.88	0.880

## METHODOLOGY

In this project, the sea water is heated and converted to steam using induction heating. The wind power plant will generate high power of electricity which is used in heating the water in thermodynamic system. That is use of wind turbine to produce electric power which is converted to heat energy which will be transferred to the seawater and generate steam, and further the steam is cooled, converted to pure form of water which is distilled water. Then the distilled water will be distributed to farmer and houses for different uses and purposes. We will also get salt as by product which we can purify further to use in food industry.

### Water suction System

The water from the sea shore is taken using high intensity suction motor, so the flow is obtained and this flow will be direct connected to the heating chamber and water is converted to steam and pure water is obtained. Electric Double Suction 3000 m<sup>3</sup>/h Water Horizontal Centrifugal Split Pump is used to suck the water from ocean, this pump will suck the water from ocean and is able to fill the tank or heating chamber with capacity of 4000m<sup>3</sup> which will be full in 1 hour and 15minute. After the water is sucked the motor switch will turn off for next 16 hours. After that water will be heated and converted to steam and the steam is converted to pure form of water. The motor which we utilized in the water suction system proper design and specifications of BLDC motor pump and solar based PV array plays a significant role play in the water pump. A 6-pole, 3000 rpm, and 3.45 kW BLDC motor is decided to drive the water motor. The PV exhibit, dc link capacitor, and BLDC motor are selected the working of the system deteriorated even by sudden disturbance in the atmospheric conditions.[23]

### Heating system

The water will be converted into dry steam using an induction heater.[24] The heating chamber is made of 3 layer using 1) copper winding, 2) 316 stainless steel. In thermodynamic system one large chamber made up of PVC hollow sheet completely closed which will be used to keep the system isolated from surrounding.

The heating system consist of the PVC hollow sheet cabin[25] inside which the cylindrical tank of 316 stainless steel that is wrapped around by the copper winding. When the electricity is supplied to the copper winding the heat is generated due to induction heating. Induction heating is the process in which heat is generated from the supply of electricity by electromagnetic induction through conductive materials. The heat will be transferred to the cylindrical tank and further to the water which will

absorb the heat and convert into the dry steam. This dry steam will be transferred through the pipe and acted by cooling system to convert in distilled water which further will be stored in the water storage tank and then will go for the distribution.

### **Copper winding**

To transfer the heat, the material should have good conductivity to supply electric current to copper winding. Its electric conductivity and heat conductivity is very high and the melting point of the copper is also high so it is very efficient. The copper is used in the winding which will be placed below the heating chamber and also around the cylindrical tank in circular form, which will result in rapid transfer of the heat. The cylindrical tank is kept inside the heating chamber and on the outer side of the tank copper winding coil is wrapped around it. The electricity is given to the copper winding which will get heated and transfer the heat to cylindrical tank, and water inside the tank will absorb the heat and will be evaporated in the form of dry steam which will be collected in pipe and further to the cooling system.[5]

### **316 Stainless Steel**

This material is used to construct the cylindrical tank for heating chamber, the seawater will be boiled in this cylindrical tank only because the melting point is 1375 – 1400°C which is also good to conduct thermal conductivity is  $16.3 \text{ W.m}^{-1}\text{K}^{-1}$ . This material is also good in corrosion resistance from seawater. There are a lot of materials other than 316 stainless steel such as brass, bronze, 304 stainless steel, gold and many more, but 304 stainless steel has more prone than 316 stainless steel and also gold is too expensive compare to the 316 stainless steel.[6]

The dry steam which will be collected from another pipe which will be attached to the topmost covering of same material that is 316 stainless steel, will further go to cooling system to convert the steam in liquid form.

### **Collection of by product**

After the water is converted in the dry steam and collected in water storage the remaining is the by product which is known as salt will be left in the cylindrical tank. We will be using a suction motor to suck the remaining salt from the tank for this we will put a pipe below the tank firstly which will be closed but after the water is evaporated in the form of the dry air then it will be opened and will suck all the remaining salt from the tank. And this salt will be collected in separate chamber and will be purified and can be used for cooking purpose and other.

### **Cooling system**

The water heated converted to steam is taken to condenser which will cool the steam and pure water is obtained. The condenser system is different here the steam generated is passed from pipe, which pipe will pass over the sea water, and distilled water is obtained. Ocean water cooling system is a complicated system which cool and keep the high temperature parts of engine. The water temperature in pipe is affected by the engine temperature and pump. The ocean water temperature vary from 4°C to 34°C., the power load change within 70% to 100% increasing efficiency of this cooling system used in our project in which we used the heat extract from heating chamber the temperature 4°C to 34°C of water used for dry steam to convert into the distilled water from this cooling system.[26] The distilled water which we obtained after the cooling of the dry steam will be transfers to the water storage.

### **Water storage**

Distilled water stored in tank with capacity of 8000m<sup>3</sup> and this chamber will be divided in to four section of 2000m<sup>3</sup>, it is built under ground the first layer of tank is made up of concrete and second layer is made up of plastic, the third layer will be made of natural clay which will add minerals to distilled water. The water storage chamber is the made up from different layer the advantage of different material like concrete layer is a composite material consisting a binder which is made up of cement, rough and fine aggregates which are usually made of sand and stone these comprise the constituents materials of concrete.[27]

### **Water distribution pipeline**

The direct pipeline connection will be given to the farmers and house who wants connection and if the user is far away then a substation will be made from where the water is pumped with a force and distributed. Stainless steel will be used for the distribution network; by using SS the pipeline will not be corroded because the distilled is to be passed from this pipeline. We use stainless steel pipeline for supply of water thus the safety of stainless steel pipeline guarantee that people can drink the safe and high quality water. Metals, Plastics, and other distribution component have a certain impact on the drinking water but stainless steel have certain problem and it is economical and easily maintained than other and no need of replacement of pipes during maintenance.[28]

### **Substation**

In this project we really want huge measure of energy for supply the water in different places so we involved powerful solar pump for supply the water with high pressure with the help of high efficiency motor which driven to solar and electric both. The design and specification of high efficiency motor power is 3.45kW, the speed of motor is 3000 rpm, the poles of motors has 6 and the resistance is 0.92ohm the BLDC motor are selected such that functioning of the system is not deteriorated even by sudden disturbances in the atmospheric conditions.[23]

## Calculation

### Calculation of water suction

In water suction process we use a large suction powered motor to suck the water from the ocean and deliver to the heating chamber and the water capacity is 4000000 liter the time take for filling the water in the tank in 1 hours 20min.[29]

One motor sucks 3000m<sup>3</sup> of water per hour

So

Water capacity=4000000 liter

So the time required to fill this will be

For 4000000 liter of suction, motor will fill the tank in 1 hour 20 minutes

### Calculation of heating chamber for water tank

The diameter of the heating chamber is 8m, the height is 10m and the tank water will be filled up to 9m so we calculate the volume of heating chamber[30]

f= 9m, D = 8m, h = 10m

$$v = \pi \times (r)^2 \times h$$

$$v = 3.14 \times (4)^2 \times 10$$

$$v = 502.654824574 \text{ m}^3$$

So the amount of water which can be stored in tank is,

$$v = 502.654824574 \times 1000 \text{ Liter}$$

$$v = 502654.824574 \text{ liters}$$

The Volume of water we got from the calculation that is the amount of water will be stored in one tank. If we consider 8 tanks the amount of water which will be stored is 4,021,238.59659 liters (approx. 4000000 liters).

### Calculation of heat energy required for heating water to convert it into steam

In this calculation we discuss about the heat energy required for heating water to convert into steam

How much time is required to convert 1 litre of water to dry steam when be heated by giving 2706.88 KJ of energy?

$$Q = \frac{m \times Cp \times (T_2 - T_1)}{t}$$

(1)

$$t = \frac{m \times Cp \times (T_2 - T_1)}{Q}$$

(2)

$$t = \frac{1 \times 4.186 \times (393.4 - 293)}{2706880}$$

(3)

t=0.155261556 seconds

(4)

As per the calculation 1 litre water can be converts to dry steam in 0.155261556 second by giving 2706.88 KJ energy. If the mass of water is increased to 4000000 (forty lac) litre, then how much time is required for converting 4000000(forty lac) litre of water to dry steam when be heated by giving 30000KJ of energy?

By equation (2)

$$t = \frac{m \times Cp \times (T_2 - T_1)}{Q}$$

$$t = \frac{4000000 \times 4.186 \times (393.4 - 293)}{2706880}$$

t=56036.58667 seconds

t=15.56571852 hours

As per requirement of converting 4000000(forty lac) litre of water to dry steam the heat energy required is 30000KJ and time calculated from the above formula is obtained 15.56571852 hours(Approximately 16 hours).

### Calculation of Copper Winding for Induction heater

The diameter of the copper winding is 8.05 m, the height is 10m will be used for 8 different tanks. The amount of electricity supplied to the one coil is 3.75 MW per day, so for 8 tanks the amount of electricity will be 30MW per day. The requirement of electricity will be fulfilled by the wind mill power plant.

We have a coil wrapped around a water tank in a cylindrical shape. Hence the diameter of the coil is 8.05m and its height is 10m.

The copper coil is kept like a hollow pipe and its wall thickness is 0.0254 m. The geometry of the coil is to have multi turn OD.

When water is heated its temperature will be 20 °C and we have to raise the temperature of that water to 120.4 °C. Our project plant will be around the coast so the average temperature around it is 15.88 °C.

If we want to achieve this temperature within an hour we have to give it 3.191MW of power per one tank. From this we will be able to convert seawater into dry steam with the help of induction heating.[31]

**Calculation of storage tank**

$l = 20\text{m}, w = 10\text{m}, h = 5\text{m}$

$v = l \times w \times h$

$v = 20 \times 10 \times 10$

$v = 2000 \text{ m}^3$

$v = 2000 \times 1000 \text{ Liter}$

$v = 2000000 \text{ liter}$

Tank capacity= 2000000 each

Total four tank= 8000000 of water will be stored.[30]

**EXPERIMENTATION**

To obtain distilled water, water is sucked from the ocean using high intensity suction motor is used to suck the water and this motor will suck 4000000 capacity of water in 1 hour and 30 minute so this water will be transferred to heating chamber and the water has to be heated and to heat the water energy is required, now to generate the energy, electric power is to be generated, so the offshore wind turbine is used to generate about 30MW power, which will be used to generate heat energy through thermodynamic system of 3000000J of energy the electric power will be given to Heating chamber in which copper winding is there, The heating chamber is used of radius 4m and height 10m in dimension and the volume of the chamber is 502.654824574 m<sup>3</sup>. The copper winding is given electric power which will generate heat energy and water is converted to steam in heating chamber. After then in the heating chamber the steam is to be passed from cooling chamber where cool water is passed from the pipe section, where the steam is converted to pure water (distilled) water, after heating process when the water is evaporated the remaining salt is removed from the cylindrical tank by suction to continue the process. Now the distilled water get into to 2 layer storage tank which is also made up of the concrete and natural clay, in which the four chambers of 2000000 are made to manage the water and of 8000000 liter and, the dimension of the tank is 20\*10\*10 m (l\*b\*h). Now the distilled water is released from the tank using Stainless steel pipes throughout the substation from this substation the water is flow with a force using the motors so the constant flow of water is obtained all over the farms and villages.

**RESULT AND DISCUSSION**

After the all process given above in the literature review and methodology, The pure form of distilled water is obtained which is given direct to use in farming, household works and commercial use through the distribution network, The water will be given with force so it can go to a far distance using of substation where solar powered pump is used to distribute the water using pump.

**CONCLUSION**

In this way the sea water can be converted to pure water using desalination process and then stored in the large chamber and this water can be used for multiple purpose of like farming, cleaning and for commercial use in factory, the water obtained by this process will be of pH 7 which is the best quality of water for any purpose so this water does not do any adverse reaction, therefore it can be concluded that sea water can be used.

**FUTURE SCOPE**

The future extent of the can be the, according to explore refined water can't be utilized for drinking, so when the water is appropriated to houses and business and private utilize the minerals adding framework can be arrangement which will add fundamental minerals in the refined water which can now use for drinking and second the future extension can be the, each homestead requires different quality and amount of water, so from substation as per the prerequisites minerals are to be include the dissemination line which will assist ranches with expanding the development in ranches.

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