

DESIGN AND FABRICATION OF WATER SEER

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Abstract - An waterseer is a structure or device that collects water by promoting the condensation of moisture from the air. Designs for air wells are many and varied, but the simplest designs are completely passive, require no external energy source and have few, if any, moving parts. All air well designs incorporate a substrate with a temperature sufficiently low so that dew forms. Dew is a form of precipitation that occurs naturally when atmospheric water vapour condenses onto a substrate. It is distinct from fog, in that fog is made of droplets of water that condense around particles in the air. Condensation releases latent heat which must be dissipated in order for water collection to continue. An air well requires moisture from the air. Everywhere on Earth, even in deserts, the surrounding atmosphere contains at least some water. A related, but quite distinct, technique of obtaining atmospheric moisture is the fog fence. An air well should not be confused with a dew pond. A dew pond is an artificial pond intended for watering livestock. The name dew pond (sometimes cloud pond or mist pond) derives from the widely held belief that the pond was filled by moisture from the air. In fact, dew ponds are primarily filled by rainwater. A stone mulch can significantly increase crop yields in arid areas. Despite this, substantial crops can be grown by using a mulch of volcanic stones, a trick discovered after volcanic eruptions in 1730. Some credit the stone mulch with promoting dew; although the idea has inspired some thinkers, it seems unlikely that the effect is significant. Rather, plants are able to absorb dew directly from their leaves, and the main benefit of a stone mulch is to reduce water loss from the soil and to eliminate competition from weeds

I. INTRODUCTION

WaterSeer is a low-tech, low-cost atmospheric water condenser that could help create water self-sufficiency in communities around the world. A new device developed by VICI-Labs, in collaboration with UC Berkeley and the National Peace Corps

Association, aims to provide a sustainable source of clean safe water for the millions without a reliable water supply. In the developed world, where most homes and businesses have ready access to clean water at the turn of a tap, we don't really have to worry about most waterborne diseases, or dehydration, or the ability to wash ourselves, our clothes, or our eating utensils, but those worries are still very real for the millions around the world without a reliable clean water source. The WaterSeer could help to alleviate some of those water poverty issues.

The WaterSeer is relatively simple device, designed to be operated without an external power input, and without the need for costly chemicals or maintenance, that can 'pull' moisture from thin air and condense it into water using the temperature difference between the above-ground turbine and the collection chamber installed six feet underground. The potable water can then be delivered to the surface for use via a simple pump and hose, and the device is said to be able to produce up to 11 gallons per day, even in arid regions.

The above-ground turbine spins in the breeze, turning internal fan blades and sending air down into a condensation chamber, where the air is naturally cooled by the surrounding earth, which causes the water vapor to condense into liquid water that flows into a reservoir below. The current model of WaterSeer, which is based on a unit first developed and then tested at the UC Berkeley Gill Tract Farm this spring, will be field-tested in collaboration with the National Peace Corps Association over the next 6 months, with the intent of shipping the finalized design within the next year.

The team is currently seeking crowd funding to underwrite the field-testing and to generate pre-orders that will fuel the WaterSeer 'buy one give one' model, which will see a device go to a family in

the developing world for each one purchased. Backers at the \$134 level will be able to reserve a WaterSeer unit of their own, which will be fulfilled once production begins. WaterSeer is working to help people get clean water right where they live. WaterSeer condenses pure water from the air without power or chemicals. It is green, sustainable, simple, low maintenance, easily deployed and scalable for any community.

To make an immediate impact, our 'buy one give one' engagement model will send a WaterSeer to a family in a developing country for each one purchased. Our partnership with the National Peace Corps Association and other nonprofits ensures WaterSeer deploys where it is needed most. Through microfinance and micro-consignment families will be able to start business their days collecting water.

1.1 Wind Turbine:

CLASS	AVG WIND SPEED (m/s)	TURBULENCE
I A	10	18%
I B	10	16%
II A	8.5	18%
II B	8.5	16%
III A	7.5	18%
III B	7.5	16%
IV A	6	18%
IVB	6	16%

Table 1.2 class referring to the turbulence

A wind turbine is a device that converts the wind's kinetic energy into electrical power. Wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels.

1.2 Resources:

A quantitative measure of wind energy available at any location is called the Wind Power Density (WPD). It is a calculation of the mean annual power available per square meter of swept area of a

turbine, and is tabulated for different heights above ground. Calculation of wind power density includes the effect of wind velocity and air density. Color-coded maps are prepared for a particular area described, for example, as "Mean Annual Power Density at 50 Metres". In the United States, the results of the above calculation are included in an index developed by the National Renewable Energy Laboratory and referred to as "NREL CLASS". The larger the WPD, the higher it is rated by class. Classes range from Class 1 (200 watts per square meter or less at 50 m altitude) to Class 7 (800 to 2000 watts per square m). Commercial wind farms generally are sited in Class 3 or higher areas, although isolated points in an otherwise Class 1 area may be practical to exploit.

Wind turbines are classified by the wind speed they are designed for, from class I to class IV, with A or B referring to the turbulence.

2.1 LITERATURE REVIEW: VERTICAL AXIS WIND TURBINE

Vertical axis wind turbine offer economically viable energy solution for remote areas away from the integrated grid systems. In order to spread the use of VAWT, the problems associated with various configurations,

i.e. poor self-starting and low initial torque, low coefficient of power, poor building integration should be overcome. Sufficient wind energy potential is available in the world. In order to make best use of it efficient designs of wind turbines need to be developed. Various vertical axis wind turbines can offer solution to the energy requirements with a reasonable payback period. Coefficient of power can be maximized by selecting a suitable operating range for various configurations. Remarkable advances in wind turbine design have been possible due to developments in modern technology. The advanced wind turbine technologies have been reviewed as follows considering overall performance point of view. The factors such as selection of site, height, choice of wind generators, wind velocity, wind power potential have been considered as an objective function of probabilistic models. Selection of windy site for wind power generation requires meteorological data for installation of wind generator. Experimental and theoretical methods are used to analyse vibration problems of wind turbines. Aero acoustic tests are used to find noise in the aerofoil. Wind field modelling is an important part of a structural analysis of wind turbines. In aerodynamic modelling blade element moment theory is used for calculation of aerodynamic forces acting on the rotor blade.

Control system modelling is used to keep the operating parameters of the wind turbine within the specified limit. These developments and growing trends towards wind energy signal is a promising future for the wind energy industry. With this improved technology wind turbine can be designed for its optimum power production at less cost.

2.2 Literature Review: Centrifugal fan in waterseer

The total pressure and dynamic pressure distribution of volute section Impeller optimization weakened the vortex intensity of secondary flow in volute, and reduced the energy loss caused by the secondary flow vortex and volute tongue of fan. Through the optimization of blades number and impeller outlet setting angle, the energy loss in fan's impeller channel caused by wake current-jet and positive incidence angle was reduced.

The total pressure and dynamic pressure distribution of impeller passage. The full pressure grows evenly along the circumferential direction before optimization. It can form a low- pressure area at the front of the suction surface. And this indicates the existence of the positive attack angle, which causes the eddy-current in suction surface and the low energy region. After optimized, the full pressure of the flow grows evenly, and the area at the front of the suction surface decreases following the increase of the pressure. That thanks to the reduction of impeller outlet setting angle. Then the positive incidence angle and he eddy current loss of the suction surface reduced accordingly. That caused by the different velocity between the pressure and suction surface in impeller channel, inducing uneven distribution of the dynamic pressure and current-jet flow structure in the channel outlet. After optimisation the number of leaf blade increased, and enlarging the flow channel, narrowing the width and lengthen the acting time of vane to air current. At the same time, the reducing of the flow channel width cuts down the differential dynamic between the pressure and suction surface, bringing the dynamic pressure distribution more homogeneous and reducing energy loss caused by current-jet flow.

It shows the parts of centrifugal fan. Like inlet pipe, bell mouth, volute casing, outlet pipe, diffuser and the main part impeller.

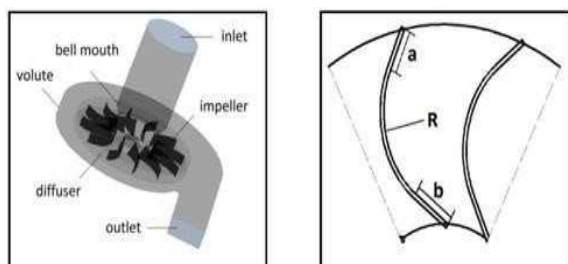


Fig 2.2 centrifugal fan parts

2.3 Literature Review: condensation through copper tubes

Condensation inside vertical tubes occurs usually in nuclear reactors. In the design of passive containment cooling systems (PCCS), existence of non-condensable gases inside condensed steam is an important technical problem. These kinds of condensers have almost 50 mm diameter vertical stainless steel tubes immersed in a tank of water under atmospheric pressure conditions outside the containment. Experimental studies on the heat transfer coefficient of reflux condensation and gravity controlled concurrent flow in vertical tubes were compared with each other in the ESDU data item. Correlations of gravity controlled concurrent flow can be used for the reflux situation due to similarity of the data in the ESDU data item according to the different ranges of the condensate film Reynolds number such as Nusselt ($Re: 67.5$), Kutateladze ($7.5 < Re < 400$), and Labuntsov ($Re > 400$), respectively. Under the assumptions of Nusselt's theory, Hassan and Jakob conducted analytical analysis on the laminar film condensation of saturated vapours on the outside of inclined circular cylinders. They used experimental results of the heat transfer coefficient for the concurrent condensation of steam inside an inclined tube to compare with their analytical results. The analytical results were 28–100% lower than the experimental results due to the rippling of the condensate film, which is not evaluated in their model. Besides this, developed an analytical solution which includes surface tension effects to obtain the local film thickness on the outside of an inclined elliptical tube using Nusselt-type condensation.

2.4 Literature Review: Waterseer

WaterSeer extends the lessons learned from the experiments listed below accelerating the condensate process through an innovative structure that maximizes the temperature difference between atmospheric temperature and the surface of the condenser.

In 2011 Girja Sharan, under funding from Gujarat Energy development Agency, Baroda and World Bank conducted atmospheric humidity yield from passive condensers in a coastal arid Area (Kutch, India). He derived the following conclusions based on three month observations: oPassive condensers extracted significant amounts of water from the air at night in arid regions.

- Passive condensers made of polyethylene mixed with titanium oxide and barium sulphate(PETB) gives much higher yield - nearly 2.5

times- than the galvanized iron and aluminium surfaces under similar ambient conditions.

- PETB condenser can extract moisture from air with lower humidity than the metal condensers alone. High humidity, calm winds, clear sky and relatively warm ambient appear to result in higher condensation yields.

Proof-of-concept field tests in India extracted an average of 1.75 litres of water per day using a 9 Sq. Meter surface. A special coating was applied to the condensing surface. (BaSo₄) Super-hydrophobic coatings were considered but have not been tested.

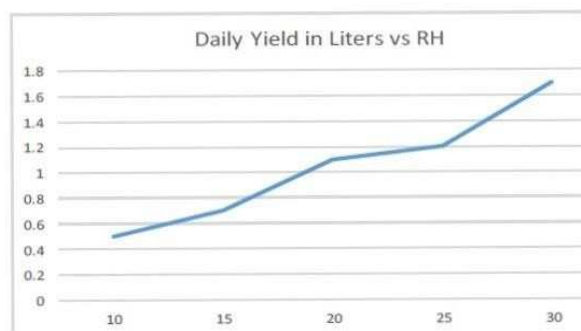


Fig 2.4 Daily yield in litres vs Relative humidity

III. METHODOLOGY

The waterseer is an initiative that every new product starts its life as an idea. In some cases, the idea comes out of a brainstorming session, while other ideas develop as a direct response to a need in the market. This stage is crucial as it lays the foundation for all the other phases, the ideas generated shall guide the overall process of product development.

The very first time the WaterSeer idea came up in conversation was during a meeting between Don and Nancy, after Nancy had read an article about women walking a great distance to collect water, only to end up being infected by the Guinea worm. For those of you who are not aware, the Guinea-worm is an infection caused by drinking water that contains water fleas infested with guinea worm larvae. Let that sink in. Larvae. Fleas. It's just gross.

But, as gross and disgusting as the beginning of that conversation was, Nancy started wondering

what they could do to solve this safe drinking water issue. As Don was listening to her passion about this problem, he noticed the amount of condensation around his water glass. And so, between Nancy's creativity and Don's engineering background, an idea came to life.

Now remember, all ideas in the beginning are good ideas (to a certain extent). Once the idea phase ends, the ideas must undergo a screening process to weed out all, but the best ideas. This is where UC Berkeley came into play. An engineering challenge was launched at the Sutardja Centre for Entrepreneurship and Technology to improve the design and yield that Don submitted.

Each of those ideas went through a screening process and from there Don and Nancy integrated the best ones to formulate what is now known as the first generation WaterSeer.

The next challenge in this product development process was how to raise funds to transform WaterSeer, into a functional prototype. In our next blog post, I'll discuss how we went from having a successful crowdfunding campaign to working with engineers on making this vision come to life.

3.1 Water from thin air:

Everything that lives gets its water from the atmosphere, some through precipitation and some directly from the air. According to the U.S. Department of Energy, the air in our atmosphere contains a varying amount of water vapor, depending on the weather.

When it's hot and humid, evaporated water can make up as much as 6 percent of the air we breathe. Therefore, naturally more humidity equals more water. On cold, dry days however, it can be as low as .07 percent of the air's makeup. Yes, we know. It's a concern many of you have for cold weather environments and it's taken into account when designing and manufacturing the WaterSeer.

So, how much water can you get out of the atmosphere. Climatologists estimate that there are nearly 3100 cubic miles of fresh water in the atmosphere in vapor and droplet forms. That's equivalent to all that water that flows over Niagara Falls during a 230-year span. That's pretty impressive. If you poured a cubic mile of water into Manhattan, only buildings taller than 20 stories would break the surface. That's a lot of water and the atmosphere has more than 3000 times that!

Believe or not, in deserts without surface water plants, animals depend on atmospheric water to survive. Atmospheric water is like a bottomless well of fresh water. It can be found naturally anywhere on the planet where water is in vapor or liquid form. So, what happens if the environment is too cold for the WaterSeer to work. This may seem impossible, but it's something we haven't ruled out.

Water condenses out of the air as a liquid at all temperatures below the boiling point and above the freezing point. This covers most climate conditions, however, below freezing point, atmospheric water vapor appears as frost. In order to overcome this limitation, our engineers are developing a cold weather performance kit for the WaterSeer. The purpose of the cold weather performance kit will be to warm the air, thereby increasing the water vapor density before it enters the condensation chamber so that it can be collected as a liquid.

The next question on your mind is, when will we see this cold weather performance kit. Well, it's something we aim to offer next year.

Unfortunately, clean, fresh, unpolluted liquid water is running out, the planet is warming and the population is growing. Everyone wants a solution, and we want to do our part in ending water scarcity. That's where atmospheric water comes into play.

There's water around us all the time, we just can't see it. And that's the beauty of WaterSeer. It taps into that endless supply of fresh clean water and makes the invisible visible.

3.2 Different attempts of waterseer:

While the basic concept of WaterSeer is nothing new, it is far from being close to any other attempt made before. The Incas sustained their culture above the rain line by collecting dew and channelling it into cisterns for later distribution.

Since then, there have been more modern attempts, but they have been damaging to the environment, often require costly distribution systems, and significant maintenance. WaterSeer, on the other hand, is taking a different approach and learning the lessons of those previous efforts. More importantly, WaterSeer is not one size fits all and that's the beauty of it.

WaterSeer is sustainable. Unlike large centralized water treatment systems, or desalination projects which are very expensive to build, maintain, and operate, WaterSeer is a simple, easy to use, family-scale solution. Due to that simplicity and scale, WaterSeer has a carbon footprint that is on average only 1% of the carbon footprint of other water systems. In fact, when used for agricultural and gardening purposes, it is effectively carbon negative thanks to photosynthesis.

WaterSeer can be flexible to your needs. Yes, you heard that right. It can produce water in your backyard, a garden, farm, a park, even a village! This gives the WaterSeer user independence from municipal water system costs and rationing as well as providing an assured source of water in emergency situations, such as earthquakes, floods, or mechanical breakdowns. The simplest design has no moving parts, and no energy requirements. The WaterSeer basic module can be tailored to satisfy the requirements of demanding climates by adding performance enhancing modules, such as solid state coolers, hydrostatic controls, solar power generators, or alternative power sources.

WaterSeer uses technology from many different scientific and industrial areas and combines them in a way to get the best possible result. Because of its modular approach, it can be continuously improved as technology and designs improve. It is an air water generation system, not just a tool or appliance, and will always be on the cutting edge of the best technology.

WaterSeer can be mobile! The basic WaterSeer design is light (about 50lbs) and easy to carry, clean, and move to new locations when required to improve yield, convenience or usefulness.

And it can be scalable, too. By connecting the collection reservoirs of individual WaterSeers and draining them into a cistern, water can be collected for large scale demands or for emergencies. This simple and flexible approach, known as a WaterSeer 'orchard', is adaptable to a wide variety of terrain and environments, while maintaining reliability, sustainability and durability.

Besides all this interesting scientific talk, WaterSeer is beautiful in form and function. It will not disfigure the landscape or the environment. It's designed to be included as an architectural feature of urban parks, walkways, public spaces, and incorporated into fountains, irrigation systems, and recreational spaces.

The WaterSeer design has come a long way since our crowdfunding raise ended in November 2016. Since then, it has advanced from original concept to a beautifully designed 3D model. Most importantly, our business model is uniquely philanthropic from any other water generation solution.

We intend to make fresh, clean water abundantly available to all by funding our worldwide distribution through a buy one, donate one program. For every WaterSeer purchased, one will be donated to a non-governmental organization (basically, a non-profit) and water advocacy organization around the world. WaterSeer is here to assure no one needs to suffer from lack of clean, fresh drinking water.

3.3 Temperature effect in waterseer:

Water condenses out of the air as a liquid at all temperatures below the boiling point and above the freezing point. This covers most climatic conditions, however, below freezing point, atmospheric water vapor appears as frost. In order to overcome this limitation, our engineers are developing a cold weather performance kit for the WaterSeer. The purpose of the cold weather performance kit will be to warm the air, thereby increasing the water vapor density before it enters the condensation chamber so that it can be collected as a liquid.

The pure distilled water can be modified or enhanced to meet health requirements and preferences. There are a variety of water purification tools and techniques that can be added after production, depending on preferences, regional expectations, and local laws and regulations. One in nine people worldwide lives without access to clean drinking water, and that problem is especially bad in areas unsuitable for wells or irrigation. One solution: the WaterSeer, a wind powered device that aims to extract up to 11 gal. of potable water every day—from thin air. The key is Condensation. After a fan pushes air below ground, a pipe-like metal chamber cools it, and then water particles collect in a reservoir. “Anybody who’s had a frothy glass of beer knows there’s moisture in the air,” says Don Zacherl, CEO of VICI Labs, which developed the WaterSeer. “We’re just applying it in a different way.” The company aims to send out the first versions next year, once the National Peace Corps Association has finished field testing. As WaterSeer transforms from an innovative concept to a revolutionary reality, we want to keep you informed during the

lengthy process. The Advanced WaterSeer Development Timeline is a visual representation of where we are and what's ahead of us. As we progress through our schedule and reach each milestone.

3.4 Field test:

The focus of this initiative is to refine the WaterSeer potable water condenser. We are confident the Berkeley Collider project will improve the design and performance of this transformational technology. Similar to natural atmospheric condensation, WaterSeer collects water from the air even in extremely arid regions of the world. Atmospheric condensate is distilled water and is potable, without impurities, and safe for infants, children, and adults. A proof-of-concept of the WaterSeer device was tested in 2014 with good results, 2.3 litres of pure water per day in a relatively humid climate. Your challenge is to design and prototype a device that improves water extraction through condensation by using the temperature gradient between the air temperature and the underground. The current WaterSeer technology framework for the proof-of-concept device is included in Background Information.

4.1 Project formulation:

- The waterseer device is planted about six feet into the ground the metal sides of the underground chamber are cooled by the surrounding soil.
- Wind spins a turbine which in turn spins internal fan-blades that direct air into a condensation chamber As the warmer air cools in the chamber the way vapour condensation onto the sides flowing down into reservoir.
- Clean safe water can be extracted from the reservoir through a simple hose and pump.
- Because the sides of the underground chamber are always cooler than the air waterseer is always collecting water day and night even when there is no wind.

IV. WORKING

- A three-bladed vertical turbine on top of the device spins in the wind driving a second fan in the body of the machine.
- The second fan directs relatively warm air from the source into the condensation chamber buried 6 feet underground.
- A filter prevents insects and debris from entering the pipe so they don't contaminate the harvested water.

- As the air cools liquid beads up on the sides of the condensation chamber which locals can make from any available materials.
- A hand-operator pump-no electricity required-raise the liquid which is even cleaner than tap water to the surface.

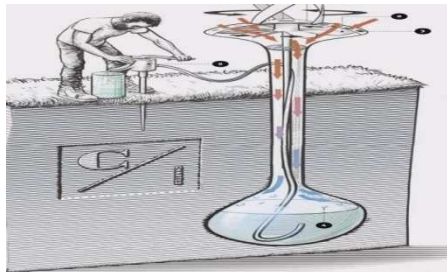
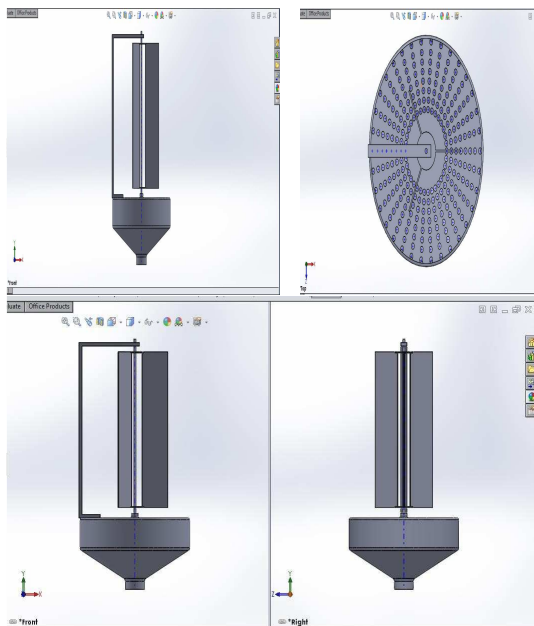


Fig 4.2 Working model

V. DESIGN CALCULATION



Clamped circular plate subject to centre concentrated/point load

The deflection movement and transverse shear are to finite at the centre of the plate($r=0$)

$$\text{Deflection}(w)_{\max} = qa^2 / 16\pi D$$

σ_r -Bending stress N/mm²

τ_θ -Shear stress N/mm²

q-load acted on the plate(1.2kg)

$$q = 12 \text{ N}, h = 0.002 \text{ m}$$

$$d = 30 \text{ cm}, a = 15 \text{ cm}$$

$$= 12 \times (15 \times 10^{-2}) / 16 \times \pi \times (30 \times 10^{-2})$$

$$= 0.1193 \text{ m}$$

$$\sigma_{r \max} = 3q / 2\pi h^2$$

$$\sigma_{r \max} = 3 \times 12 / 2 \times \pi \times 0.002 \times 0.002$$

$$= 9167.32 \text{ N/m}^2$$

Or

$$9.16732 \times 10^{-3} \text{ N/mm}^2 \text{ (induced)}$$

$$\text{Bending stress} = 155 \text{ N/mm}^2 \text{ (material)}$$

Bending stress include < bending stress of material $9.1673 \times 10^{-3} \text{ N/mm}^2 < 155 \text{ N/mm}^2$.

$$\tau_\theta = 3\mu q / 2\pi h^2$$

$$\tau_\theta = 3 \times 12 \times 0.3 / 2 \times \pi \times 0.025 \times 0.025$$

$$= 4297183 \text{ N/m}^2$$

or

$$0.4297 \text{ N/mm}^2 \text{ (induced)}$$

Therefore our design is safe and satisfactory.

shear stress = 125 N/mm^2 (material) Shear stress included < shear stress of material $0.4297 \text{ N/mm}^2 < 125 \text{ N/mm}^2$ Therefore our design is safe and satisfactory.

VI. CONCLUSION

The water seer is a centralized system that extracts the water from the atmospheric air through the natural condensation occurring due to the natural cooling of soil under the ground. with the water seer system we can provide the water around the arid regions of the world. This can provide drinking water for a society which lacks available of water. The water seer is a best solution to meet out the need of water in the world.

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