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THE EFFECT OF PASSIVE SINGLE SLOPE WICK TILTED TYPE SOLAR STILL IN PROMOTING PUBLIC HEALTH, THROUGH PHYSICS TECHNIQUES, IN ENERGY PHYSICS

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Abstract

Health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Access to safe drinking water is fundamental for health and happiness, a basic human right, and a component of effective policy for health protection. Safe drinking water presents no significant risk to health over a lifetime of consumption, including groups with different sensitivities. Those at greatest risk of waterborne disease are infants and young children, people who are debilitated or living under unsanitary conditions and the elderly. Thus, the passive single slope wick-tilted type solar still is able to separate the clean-water from the highly dissolved solid matter and many other organisms. Hence, distillation process is one of the technology which is affordable, less cost effective and environmentally friendly, all of these will be achieve with the help of solar energy.

***Keywords*:** Safe drinking water, waterborne diseases, wick tilted solar still, distillation.

INTRODUCTION

The routes of disease transmission are broken by sanitation in food processing, waterborne treatment to reduce the pathogen discharge into rivers and lakes, filtration and disinfection of drinking water to kill pathogens, and managing the water cycle to protect sources of drinking water.

Once a properly designed and well- operated drinking water treatment system is in force one hundred per cent of the time for everyone in the service area. It will simultaneously protect all consumers against many different kinds of pathogens, including threats that may be unidentified. So that, a passive single- slope wick tilted type solar still will be use. The system has the capability of separating clean water from the highly dissolved solid matter and many other organisms.

In case of disease transmission which can be broken through sanitation of foods or drinks. Cholera is one of the water borne diseases which is an infectious disease that affects the absorption of water in the small intestine. It is caused by the bacterium vibrio cholera. In severe cases it produces violent diarrhea within only a few days. The dangerous aspect of cholera is the vast and rapid loss of fluid that if untreated can be fatal within 24 hours of developing the disease. Treatment is simple replace the fluid with the right mix. Of sugar and salts – water alone is not adequately absorbed. Bad cases require admission to hospital where fluids can be administered straight into the bloodstream via drip. Cholera is related to standards of hygiene and the quality of drinking water. This is true of many other serious diseases. Improved sanitation and hygiene are still the basic foundation of the fight against waterborne diseases. It is more cost- effective than putting people in hospitals.

In case of disease transmission which can be broken through sanitation of foods or drinks, like cholera and others. Can be able to do away with the disease or reduce it, like cholera in a particular area through the following possibilities:

1. Cholera is likely transmitted through something eaten or drink.
2. The ferocious diarrhea that characterized cholera is likely a factor in the spread.
3. Pollution of wells and other water supplies produced outbreaks.
4. Cholera is likely due to some parasite or other tiny germ.

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WATERBORNE INFECTIOUS MICROORGANISMS

Fortunately, most bacteria and other microbes do not cause disease. Most – in the sense of number of species and mass – are beneficial.

You are mostly not you. That is to say, 90 percent of the cells residing in your body are not human cells. They are microbes. These bacteria that live on us and in us, aid our digestion and help defend us from pathogens. A healthy biota in our guts make the PH in hospitable and even toxic to many pathogens [1].

The human body is a comfortable environment for many pathogens, especially those of the gastrointestinal tract that pass from infected individuals into the food supply or water supply and cause disease when exposure exceeds a person's limit of tolerance. Most pathogens do not survive long once outside the body, but they may be long enough to be transmitted to a new host. To prevent disease we must block transmission, increase the rate of pathogen die – off and dilution, and effectively kill the pathogens. Water borne pathogens can infect thousands of people simultaneously, which creates an unmanageable burden for health care facilities. Engineered preventive medicine is much preferred to letting people get sick and then hoping that the medical profession can take of care them.

WATER IS ESSENTIAL TO SUSTAIN HUMAN LIFE

Water is abundant, but not infinite in quantity. Man is dependent on rivers, lakes, and underground water to get freshwater, but these sources are not always clean. Salts and organisms will be present. The ocean covers some 70.8 per cent of the earth's surface containing about 1350 million cubic kilometers of saline water with 35000 ppm impurities. However, the maximum salt level in fresh water for human consumption is only 550 ppm [2]. With the present rise of world population, intensified agriculture, possible climate change and industrial growth in certain parts of the world, the available annual water supply will probably be insufficient on a world basis. The growth of the world's population may require expansion into relatively isolated and arid zones which are characterized by shortage of fresh water. Unfortunately a major portion of the fresh water supply is not available where it is needed. The problem can be partially solved by transporting potable water to some of these communities , but the costs involved are of such magnitude that this proposition is not feasible. Some other way of obtaining potable water will have to be found.

One of the promising options to solve this problem of water shortage appears to be desalination. Desalination methods are already mitigating water shortage in parts of the world adjacent to the sea or saline bodies of water by desalination plants. These plants use fossil fuels which have finite reserve and contribute to environmental pollution. Therefore, it is natural to look at some other methods of desalination using renewable sources of energy like solar, wind and biomass. Solar desalination can be used to purify either seawater, or brackish water in areas which lack potable water and have abundant solar radiation such as some of those located in the middle east [3] .

SOLAR DISTILLATION

Solar distillation has been long known and the earliest documented work is that of the Arab alchemists in 1551 [4]. It has been investigated since the nineteenth century, but used on a limited scale. Normally, two approaches have been taken in using solar energy. One is the direct absorption of energy in saline water and the other is indirect heating of water followed by evaporation in a centralized facility.

The first approach is more suitable for small capacities, (less than $50m^3$/day) while the second approach is economically unfeasible for plants with a capacity of less than $200m^3$/day, because of the capital costs [5] .

Solar distillation has similarities to the natural hydrological cycle, which consist of : (i) absorption of solar energy by the top layers of water in oceans, lakes and rivers (ii) heating up these layers (iii) evaporation of the water (iv) transport of the resulting vapor to cooler regions and (v) condensation of the vapor leading to precipitation as rain or snow.

Accordingly, since very early ages engineers have considered this process for supplying fresh water from saline water in the following conditions:

(1) Places lacking natural fresh water but where brackish water is abundant e.g. coasts, ships and deserts.
(2) Transport of water is expensive
(3) High levels of solar radiation are available
(4) Potable water is needed on a small scale
(5) The land is available

Water distillation is accomplished by exposing layers of saline water to solar radiation, and condensing the water vapors produced under a transparent sloping cover. The condensate runs down the sloping cover and is collected In a trough along the lower end to provide pure water. There are many solar stills which use the distillation process. All are aimed at optimizing the efficiency and lowering the construction cost. They may differ from one another in shape and materials used, but all use the same principles and serve the same functions.

PASSIVE SINGLE SLOPE WICK TILTED TYPE SOLAR STILL

Excepts in the tropics, a horizontal surface intercepts less solar radiation than one which is tilted toward the equator. The more nearly perpendicular a receiving surface to the Sun's rays, the greater is the radiation intercept by a unit area [3]. Using an inclined solar still is a way to achieve this . However, a greater gain of solar radiation can be achieved with a high transmittance still cover and a high absorption absorber/evaporator surface. These enhance a higher absorber temperature which, in turn, is a strong factor affecting the evaporation rate in inclined solar stills. Consequently, the production rate of the distillate is enhanced.

Heat and Mass Transfer in Solar Distillation

Crude/contaminated water absorbed inside the wick placed inside the evaporator of a passive solar still is heated by solar radiation that passes through the transparent cover and is absorbed by the water inside the wet-wick, the wick and entire parts of the evaporator. Vapor rises from the hot water inside the wet- wick and condenses when it gets into contact with the inner surface of the transparent glass at or below dew point. The condensate is collected through a channel fitted along the lower edge of the transparent glass.

The solar distillation involves all the three modes of heat transfer. There is heat conduction through the transparent cover, bottom and side walls, which results in a loss of heat from the still. Heat from the bottom of the evaporator is transferred to the water inside the wick placed on the mesh wire by convection while thermal energy from the hot water in existence inside the wet wick is transferred by vaporization, convection and radiation, onto the condensing cover . Water vapor condenses on the cover, yielding latent heat of condensation and distilled water collected.

If turn, the cover it dissipates heat to the environment by convective and radiation heat transfer modes. It should be noted that internal heat transfers in a solar still also includes mass transfer.

Heat loss from the top of the glass cover to the environment is predominantly by convection (to ambient air) and radiation (to sky) .Wind influences the convective heat transfer from the top part of the cover and the wind coefficient of heat transfer can be calculated from [6]:

$$h_{c,gc-a} = \begin{Bmatrix} 2.8 + 3V_{wd} V_{wd} \leq 5ms^{-1} \\ 6.15V_{wd}^{0.8} > 5ms^{-1} \end{Bmatrix} \quad (1)$$

The radiation heat loss from the top can be referenced to the sky and computed from :

$$h_{r,gc-sk} = \sigma\epsilon_{gc}\left(T_{gc}^2 + T_{sk}^2\right)\left(T_{gc} + T_{sk}\right) \quad (2)$$

The sky temperature can be computed from [7] :

$$T_{SK} = 0.0552T_a^{1.5} \quad (3)$$

Heat is also loss from the bottom part of the still. The coefficient of bottom heat loss can be calculated as follows[8]:

$$U_{bo} = {}^{k}/_{x} \quad (4)$$

The distillate yield (Y) in a specified time interval ($t_2 - t_1$) can be calculated as follows:

$$Y = \int_{l_1}^{l_2} \left[\frac{(T_w - T_{sc})}{L'_w}\right] dt \quad (5)$$

The specific latent heat of water vaporization (L'_w) can be calculated using a correlation reported by[9] while the saturation vapor pressure (p) can be computed according to [10] and the total pressure can be taken to be approximately equal to the standard atmospheric pressure [11] . The timely distilled water output ($M_e in\ {}^{kg}/_{m^2}\ for\ a\ day$) is the amount of energy utilized in the vaporizing of water in the still ($Q_e\ in\ J/m^2\ in\ specified\ time\ interval$) over the latent heat of vaporization of water (L in J/kg). Wick solar still efficiency (η) is the amount of energy utilized in vaporizing water in the still over the amount of incident solar energy on the still (Q_t). These can be expressed as :

Wick solar still production, $M_e = Q_e/L$ (6)

Wick solar still efficiency, $\eta = Q_e/Q_t$ (7)

Wick solar still mass flow rate per given time =(Liter/m^2/per given time) (8)

Wick solar still, power consumption=$\frac{m\times s\times\Delta\theta + m\times l_v}{t}$ (9)

FIG. 1: A picture of wick tilted solar still

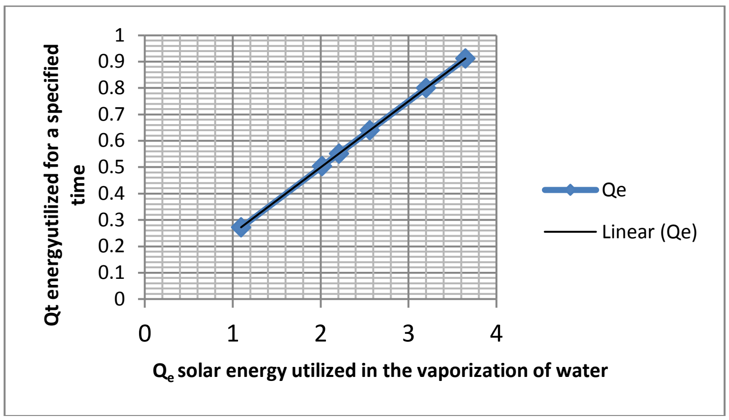


Figure2 : The relation between the energy utilized in the vaporization of water over the latent heat of vaporization and the energy absorbed for a specified time falling on the system

Table 1:The various values of the Q_t and Q_e

Q_t	Q_e
1.096	0.272
2.56	0.64
3.648	0.912
3.2	0.8
2.208	0.552
2.016	0.504

Table 2 : The efficiency of a wick tilted single slope solar still

EFFICIENCY OF A WICK TILTED SINGLE SLOPE SOLAR STILL

T_{amb} C^0	T_{cover} C^0	T_{abs} C^0	Wind speed m/s	Humidity %	Energy utilized in the vaporization of water in the wet wick , Q_e	Amount of incident solar energy on the still , Q_t	Time hrs/day	Efficiency $\eta=Q_e/Q_t$ %
33	58	73	2.5	33	0.774	1.096	8	70
43	49	64	2.5	19	1.940	2.56	8	75
43	54	73	4.7	28	2.912	3.648	8	79.8
42	46	74	3.0	53	2.800	3.2	8	87
34	55	73	2.5	38	1.552	2.208	8	70.28
28	46	67	5.7	59	1.504	2.016	8	74.6
38	57	73	2.8	33	1.548	2.182	8	70.94

39	49	67	4.2	25	5.92	7.68	8	77.08
31	59	75	2.6	30	12.648	14.592	8	86.6
32	52	70	3	31	12.00	16.00	8	75
41	45	73	2.7	52	11.312	13.248	8	85.38
33	56	71	2.5	33	11.528	14.112	8	81.68
34	55	72	2.5	38	12.032	16.128	8	74.60
42	45	73	2.9	52	13.536	19.636	8	68.93
42	47	73	3.0	53	2.822	3.288	8	85.83
41	44	72	2.6	51	6.192	8.726	8	70.96
43	45	73	2.5	53	21.68	30.72	8	70.57
39	48	67	4.2	25	4.512	6.048	8	74.60
43	46	73	2.6	53	44.112	56.448	8	78.15
31	58	74	2.5	30	5.824	7.296	8	79.8
33	53	71	3.0	32	6.00	8.00	8	75.00
41	44	72	2.6	51	5.656	6.624	8	85.38
32	55	70	2.4	37	5.764	7.056	8	81.68
33	54	71	2.5	38	7.016	8.064	8	87.00
41	44	72	2.8	51	8.268	9.818	8	84.20
41	46	73	3.0	52	1.411	1.644	8	85.82
40	43	71	2.5	50	3.096	4.363	8	70.96
40	44	72	2.5	52	12.84	15.36	8	83.59
38	47	66	4.1	24	2.756	3.124	8	88.22
42	45	72	2.5	52	25.056	28.224	8	88.77
32	57	72	2.5	33	1.546	2.192	8	70.529
43	48	64	2.5	19	3.88	5.12	8	75.78
42	55	73	5	29	5.824	7.298	8	79.80
43	47	74	3	53	5.6	6.4	8	87.50
35	56	75	2.5	39	4.656	6.624	8	70.28
28	47	68	2.5	39	3.008	4.032	8	74.60

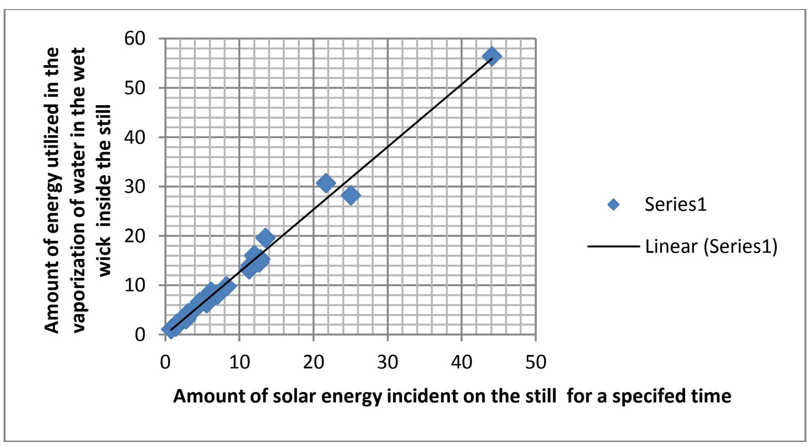
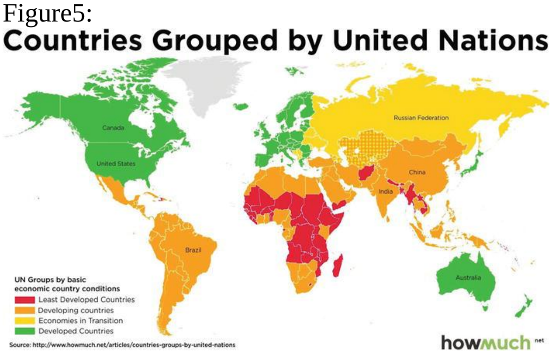


Figure 3 above: shows the relation amount of energy utilized in the vaporization of water and amount of solar energy incident on the still

Figure4:

Figure5:



Conclusion: There is a need to have a sustainable source of water purification through distillation. In this case passive single slope wick tilted type solar still can solve this problem of water borne diseases. So that people will be healthy and productive. Likewise the socio – economic upliftment will take place as the productivity level will rise up.

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