CLEAN WATER AS AN AGENT FOR SOCIO – ECONOMIC DEVELOPMENT OF A COMMUNITY. A CASE STUDY OF NORTH – EAST PART OF NIGERIA.

Hayatu Abba Ibrahim

Department of Physics
University of Maiduguri, Borno State, Nigeria.
Email: hayatuabbaibrahim5@gmail.com

Abstract: *In this research, a device is suggested to be use in the north – east part of Nigeria, which is a passive wick tilted single slope solar still which can produce high yield of distillate through the process of distillation .As the region is in the sahel arid zone and it get enough sunshine especially in summer. Right now, the region is destabilize through insurgency of boko haram , as such clean water is a big problem for the community residing in this region .Even in the urban and rural areas people hardly get clean water. Example in Maiduguri a capital city of Borno many internally displaced people are camped at various location within the city called IDP'S camps. While if you move out from the city you reach to the rural communities where the same problem of clean water arises as they hardly get clean water even if the get the water from surface water it is contaminated water. So the need, to get clean water is necessary for every community.*

Keywords*: Clean Water, Wick – Tilted Solar Still, Water, Environment and Economy.*

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INTRODUCTION

Water, Environment and Economy

Water (chemical formula H_2O) is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of organisms. Water is the major component of human's body. Almost in

every organism, nutrients and other enzymes are transported with the help of water. Human body consists of about 66% of water[a]. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on Earth with its solid state, ice and gaseous state, steam (water vapor). It also exists as snow, fog, dew and cloud. Water moves on Earth continually through the water –cycle of evaporation transpiration, condensation and runoff, usually reaching the sea. Evaporation transpiration contributes to the precipitation over land. Water used in the production of a good or service is known as virtual water [c]. The total water supply of the world is 1,400,000,000 km^3 (A m^3 of water equals 1,000 litres). Each year119, 000 km^3 of water precipitates on land and 74,200 km^3 evaporates into the atmosphere, by transpiration from soil and vegetation. On ocean and sea surface 450,000 km^3 of water fall every year and 502,830 km^3 evaporates. Of the freshwater on Earth, about 2,200 Km^3 flows into the ground [Tiwari et al, 2003]. More than two-third of the earth's surface is covered with water. Most of the available water is either present as seawater or icebergs in Polar Regions. More than 97% of the earth's water is salty; rest around 2.6% is fresh water. Less than 1% fresh water is within human reach. Even this fraction is believed to be adequate to support life and vegetation on earth. Nature itself provides most of the required fresh water, through hydrological cycle. A very large- scale process of solar distillation naturally produces fresh water. The essential features of this process are thus summarized as the production of vapors above the surface of the liquids, the transport of vapors by winds, the cooling of air-vapor mixture, condensation and precipitation. This natural process is copied on a small scale in basin type solar stills.

As the available fresh water is fixed on earth and its demand is increasing day by day due to increasing population, rapidly increasing of industry, and desertification in sahel region due to deforestation like in Nigeria in the north-east part, hence there is an essential and earnest need to get fresh water from the saline brackish water present on or inside the earth. This process of getting fresh water from saline brackish water can be done easily and economically by desalination. According to world health organization (WHO) the permissible limit of salinity in water is 500ppm and for special cases up to 1000ppm while most of the water available on earth has the

salinity up to 10,000ppm whereas seawater normally has salinity in the range of 35,000-45,000ppm in the form of total dissolved salts. Excess brackishness causes the problem of taste, stomach problems and laxative effects. One of the control measures includes supply of water with total dissolved solids within permissible limits of 500ppm or less. This is accomplished by several desalination methods like reverse osmosis, elector dialysis, vapor compression, multistage flash distillation, multiple-effect distillation and solar distillation, which are used for purification of water. Among these, the solar stills can be used as desalination for such remote settlements where salty water is the only type of moisture available, power is scarce and demand is less than 200m^3/day. On the other hand, setting of water pipelines for such areas is uneconomical and delivery by truck is unreliable and expensive. Since other desalination plants are uneconomical for low-capacity fresh water demand, under these situations, solar stills are viewed as means to attain self-reliance and ensure regular supply of water. Among the non-conventional methods to disinfect the polluted water, the most prominent method is the 'solar distillation'. Comparatively this requires simple technology as no skilled workers needed and low maintenance due to which it can be used anywhere with lesser number of problems. One of the core elements of life is water, which it existence increases the probability to found a life. About three-fourth of world are submerged by water but main question is 'how much is useable?'. For proper utilization of water some special techniques are required which can purify the water at useable format. With those special techniques energy resource is the basic requirement but limited conventional energy resource through a great challenge during the use of it. Hence a generic solution becomes the demand of time by which dependency on conventional energy resource is reduced. As a renewable energy source solar energy can be the best solution. Solar energy can be converted into various smart form of energy, but in this investigation it is implemented directly as an energy source.

For analyzing purpose a special arrangement have been built which have three parts. The upper part is made up of a single slope solar still in which the inside is blackened and the base is covered with wick, also the whole basin is covered with a transparent glass. The evaporator or the basin is made up of copper plate and the wick that is placed on the base also comes out or passed through chamber and end in another container box consists of wick material

,soil and water i.e. water logged . As an extension to the overall basin which is now half filled with water becoming waterlogged-soil. Next is also water supply through a hose from time to time and also a thermometer is attached to the system to determine the ambient temperature and also the maximum temperature. In this research the design constitute two main parts which are most considerable. The upper part consists of the basin covered by transparent glass so that the system gets the opportunity of greenhouse effect in this purpose. The whole basin is made to be blackened and placed on top a mesh wire and blackened wick facing the covered glass which is the upper part of the system. Within the blackened basin the system experience an air-tight situation. As copper is a very good heat conductive material. It can transfer heat as uniform fashion. The wick material are laid from the base of the basin down and passed out to another container mix of water and soil, the container is below the basin as it constitute the lower part of the system., which is also made of copper. So it is always assumed half water logged soil. The sun ray fall inside the blackened basin and so also on the copper plate. In this manner, the copper plate gets heated. The hot copper plate being heated likewise the wick and the water it had absorbed. Then water inside the wick becomes vaporized and water vapor leaves from the wick. Then the vaporized water condenses at comparatively cool place in the same time water lifted up to fill up the water gap inside the wick. This process has continued during sunny period. The basic principles of solar water distillation are simple yet effective, as distillation replicates the way nature makes rain. The sun's energy heats water to the point of evaporation. As the water evaporates, water vapor rises, condensing on the glass surface for collection. This process removes impurities such as salts and heavy metals as well as eliminates microbiological organisms. The expectation is that the result is water cleaner than the purest rainwater. The solar still is a passive solar distiller that only needs sunshine to operate. There are no moving parts to wear out. In addition, a solar still usually the top part is covered by glass, with an interior surface made of a water proof membrane. This interior surface uses a blackened material to improve absorption of the sun's rays. The glass cover allows the solar radiation (short wave) to pass into the still, which is mostly absorbed by the blackened base. The water been absorbed inside the wick begins to heat up and the moisture content of the air trapped between the blackened wet wick surface and the glass cover increases. The base also radiates energy in the infra-red region (long-wave) which is reflected back into the still by the glass

cover trapping the solar energy inside the still (the "greenhouse" effect). The heated water vapor evaporates from the wick and the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass covers to an interior collection trough and out to a separate storage container being provided. There are no moving parts in solar still and only the sun' energy is required for operation. The container that is half fill with mixed crude water ,wick material and soil is always supply with water in the morning and evening. Finally, the total yield out day is collected at that time. The still will continue to produce distillate after sundown until the water temperature cools down. Feed water into the container with soil and wick should be added each day that roughly exceeds the distillate production to provide proper flushing of the container and to clean out excess salts/contaminants left behind during the evaporation process. Clean water is highly essential for good health which influences the social and economic development of any nation. People who use contaminated water are prome to waterborne diseases (WHO,2006) and they cannot effectively engage themselves in economic activities. Moreover, financial resources that could have been allocated to developmental projects are channeled to disease – curing efforts. Consequently, ill health contributes to the retardation of economic growth. Nevertheless, there is little access to quality water that meets acceptable standard levels of biological, chemical and physical constituents. More than 97% of water available on the earth's surface is salty (Tiwari et al, 2003), and environmental pollution caused predominantly by anthropogenic activities is also contributing to the degradation of fresh water resources. The WHO (2008) reported that 78% and 96% of the rural and urban populations used pure drinking water in 2006 on a global scale respectively. That means, four billion cases of diarrhea are reported annually, with 88% of them being ascribed to the use of unclean water, and insufficient sanitation and hygiene (WHO, 2007). This indicates the need for interventions that aim at providing pure water. In view of this, the millennium development goals incorporate a target to halve the percentage of the population without access to safe water by 2015 (UN, 2007). Indeed, this goal can be achieved through a multi-faceted approach which includes the development of appropriate technologies for water distillation. Hence, a sustainable source of energy informs of renewable is needed to provide fresh water to a larger proportion of the world population. Currently, there have

been concerns about environmental degradation arising predominantly from the exploitation of non-renewable energy resources. Anthropogenic activities are generating greenhouse gasses (GHG) that account for most of the ambient air temperature rise (Saikku et al, 2008). In particular, the burning of fossil fuels is significantly contributing to climate change through the emission of carbon dioxide (major GHG) and other substances (UNEP,1988,IPCC,1995,UN,2007). Rarry et al, (2008) reported that the impacts of climate change are currently observable. Consequently, application of renewable energy technologies in the provision of fresh water can assist in alleviating environmental degradation. For analyzing purpose a special arrangement have been built which have two parts. The first part consist of a container carrying a mesh wire and on top placed a wet wick and the other part consist of a half filled water logged soil or groundwater inside which existed a wic. The two parts are linked together in a rectangular shape inclined at certain angle facing the rays of sun attached to the rectangular metal copper plate is a hose which convey or carry water to the second part from a separate container carrying crude water and also covered by glass. Next the two upper parts is linked below to another part which contain Ipure water after distillation. An air tight environment is carefully maintained in this arrangement or manner.

Within this arrangement the most important element is the wick which acts as an absorber of crude water. Wick material absorbs water from a hose attached to a container of crude water. Capillarity and surface tension is the most considerable properties during selection of any wick material. A part from its composition of wick material , is also important to consider the absorption properties of wick material. To acquire better performance special composition of wicks is used in this analyzing purpose.

Water Distillation

In principle, Solar energy can be used to separate pure water from most of the natural contaminants, such as dissolved solids (salts) and particles (dirt and algae). Solar distillation is the most economically effective when sunlight is allowed to pass through a transparent cover and into a black evaporating pan with little or no concentration of the sun's rays. Also, the water sources available in Nigeria are threatened by depletion and degradation mainly due to population increase, improper disposal of wastes and poor agricultural

practices. So, there is the need to find sustainable ways of improving the quality of water, especially in remote areas. In Nigeria especially in the northern part, fuel wood is the major source of energy domestically. Unfortunately, the heavy and inefficient consumption of fuel wood is contributing to deforestation and other environmental problems. It appears that solar energy is a potential source of energy for powering thermal and photovoltaic systems because the country has a sustainable solar climate for exploiting solar technologies. In Nigeria, distillation can help solve some of the socio-economic problems as clean water is one of the problems. So, distillation is also among many processes available for water purification scientifically, and sunlight is one of several forms of heat energy that can be used to power that process. Sunlight has the advantage of zero fuel cost but it requires more space (for its collection) and generally more costly equipment. Solar-distillation systems can be small or large. They are designed either to serve the needs of a single family, producing from ½ to 3 gallons of drinking water a day on the average, or to produce much greater amounts for an entire neighborhood or village. In some parts of the world the scarcity of fresh water is partially overcome by covering shallow salt water basins with glass in greenhouse-like structures. This solar energy distill ting plants are relatively inexpensive, low-technology systems, especially useful where the need for small plants exists.

Solar distillation of portable water from saline (salty) water has been practiced for many years in tropical and sub-tropical regions where fresh water is scarce. However, where fresh water is plentiful and energy rates are moderate, the most cost-effective method has been to pump and purify.
Although, Nigeria generally has a reach of fresh water but in the northern part especially in the north-east, growing demand and rising pollution levels demand more and more energy to pump and purify it. Critical seasonal water shortages are occurring with increasing frequency in some parts of the region especially during dry season. Also, natural fresh water often cannot be diverted for direct human consumption without substantial environmental damage. The economic feasibility of solar distillation of lake, and river water will, therefore improve considerably as energy costs continue to escalate and population pressure exerts more stress on available fresh water supplies. With shortage of fresh water in the north-east part of Nigeria, there is much room for innovation and improvement of conventional solar still. Solar

desalination is particularly well suited for backyard experimentation by individuals with little or no technical training. The basic concept of using solar energy to obtain drinkable fresh water from salty, brackish or contaminated water is really quite simple. Water left in an open container in the backyard will evaporate into the air. The purpose of a solar still is to capture this evaporated (distilled) water by condensing it onto a cool surface, using solar energy to accelerate the evaporation. The rate of evaporation can be accelerated by increasing the water temperature and the area of water in contact with the air. A wide, shallow pan painted black makes an ideal vessel for the water. It should probably be baked in the sun for a while before it is used in order to free the paint of any volatile toxicants which might otherwise evaporate and condense along with the drinking water. The pan is painted black (or some other dark color) to maximize the amount of solar energy absorbed. It should also be wide and shallow to increase the water area exposed to air. The addition of a spongy material to the water would further increase the surface area, assuming the availability of a substance with good solar absorbing properties and durability in heated salt water. (This is a very harsh environment for materials to survive in over prolonged periods). To capture and condense the evaporated fresh water, one needs some kind of surface close to the heated salt water (or contaminated water) which is several degrees cooler than water. A means is then needed to carry this fresh water to a storage tank or vessel. The evaporating pan is usually covered by a sheet of clear glass or translucent plastic (to allow sunlight to reach the water) which is tilted at a slight angle to let the fresh water that condenses on its underside trickle down to a collecting trough. The glass also holds the heat inside.

THEORETICAL BASIS OF THE STUDY

Solar Energy

Solar Energy is electromagnetic radiation (including infrared, visible and ultraviolet light) released by thermonuclear reactions in the core of the sun. With a few exceptions (e.g. nuclear energy, geothermal energy), solar energy is the source of all ENERGY used by mankind (Stuart Kallen et al 1995) .Indirect forms include hydroelectricity, ocean thermal energy, tidal energy and wind energy; the sun also powers the process of photosynthesis that is the original source of the energy contained in Biomass, Peat, Coal and Petroleum. Usually, however, the term solar energy refers to the portion of

the sun's radiant energy harnessed for a specific purpose by man-made devices. Solar radiation reaches the earth's upper atmosphere at a rate of1366w/m^2. While traveling through the atmosphere 6% of the incoming solar radiation reflected and 16% is absorbed resulting in peak irradiance at the equator of 1,020 w/m^2. Average atmospheric conditions (clouds, dust, pollutants) further reduce insulation by 20% through reflection and 3% through absorption. Atmospheric conditions not only reduce the quality of insulation reaching the earth's surface but also affect the quality of insulation by diffusing incoming light and altering its spectrum.

Water Circulation

Solar Water device is a water cleaning system that cleans water without the use of chemicals, electricity, preventing waterborne diseases, environmental consequences, deforestation and co_2 emissions. Water absorbed by wick material through capillary action of water as in very small tube (capillary tube). Due to solar heating inside the closed basin of wet wick material are heated and hence water evaporate from the wick material. After that the vaporized water condensed at comparatively cool place. The Capillary action of wick helps the crude water from a tank/container and capillary action, capillarity or wicking refers to two phenomena. The first phenomena refers to the movement of liquids in thin tubes and second phenomena refers to the flow of liquids through porous media. Such as the flow of water through soil. Capillary action is the result of adhesion and surface tension. The surface tension acts to hold the surface intact, So, the whole liquid surface is dragged horizontally. The cohesive forces between liquid molecules are responsible for the phenomenon known as surface tension.

Selection of wick material

It is very crucial and important to select a wick material. The existing usable wick may not be sufficient to fulfill requirements. Hence it is important to focus on composition of material which having well absorption properties comparative to other regular available wick. Locally available wick having well absorption properties are: Natural fibers such as cotton or burlap , man-made hydrophilic fibers (having a low contact angle with water) such as bare fiber glass, braided polyester rope, Soft cotton rope, Nylon Hose, Braided Nylon Rope, Old polyester clothing pantyhose. To acquire better perform the composition of cotton and polyester is used in this work.

The Basic Principle

The basic principles of solar water distillation are simple yet effective, as distillation replicates the way nature makes rain. The solar energy received by solar collector which heats water to the point of evaporation. The evaporated water condensed on the glass. In Nigeria especially in the northern part, distillation can be able to solve some of the socio-economic problems as clean water is one of the problems. So scarcity of water is a problem and also even if you get the water there is always the need to purify it.

Passive Solar Distillation under Solar Physics

The simplistic, yet very well established, method of solar distillation was copied from nature's own process of fresh water synthesis by ultra large scale production in the hydrologic cycle. In this, solar radiation striking the surface of rivers, lakes and oceans is absorbed as heat and causes evaporation of water from these surfaces. The resulting vapor, after rising and humidifying the upper atmosphere, is moved along by wind currents. When the air vapor mixture is cooled to the dew-point temperature, condensation of the pure water may occur with precipitation onto the earth in the form of rain, hail or snow. The significant principles of this system which have been applied to solar still design are:

1. The production of vapor above the water surface;
2. The transport of this vapor by air;
3. The cooling of the air-vapor mixture;
4. Condensation; and
5. Precipitation.

Though the actual distillation process is relatively simple, there are many electromagnetic and subatomic transactions that must occur for every drop of pure water that is produced. Knowledge of solar physics and radiation heat transfer is requisite to an understanding of these transactions, thereby enabling their incorporation into an efficient still design. To begin with the basics, a photon can be thought of as being a "package of light energy." It has no charge and no mass, yet possesses momentum. It is a quantum of electromagnetic energy having both particle and wave behavior, with these being the two theories of light which have never been reconciled. The wave theory of light states that an increase in amplitude will lead to an increase in intensity, and the particle theory holds that an increase in the number of

particles will cause an increase in intensity. Photons, which make up light, carry all forms of radiation from cosmic to thermal to radio waves. Within every atom, protons are held together by a tremendous force because they are equally charged and want to repel. If this force be released, as in nuclear reactors or explosions, there results a shower of infrared phptons as heat energy. Theoretically, electrons in atomic orbits are held away from the nucleus by the energy of motion. They have inherently a linear motion but are held in orbit due to the energy pull from the nucleus (Moore, 1978). Thermal radiation is emitted by bodies by virtue of their temperature. When photons hit atoms and molecules, the electrons present are raised to excited states; that is, they jump out to prescribed higher orbital levels. The electrons spontaneously return to lower energy states and in doing so they emit energy in the form of electromagnetic radiation. Every atom has a different emission pattern of light wavelengths. These "finger prints" of atoms are recorded as bright and dark line spectra, revealing the emission and absorption, respectively. The electrons have a complex manner and order in which they jump out and they all return to their initial orbital levels at once. Since the emission results from changes in electronic, rotational and vibration states of atoms and molecules, the emitted radiation is normally distributed over a range of wavelengths,. The spectrum of electromagnetic radiation is divided into wavelength bands. These bands and the wavelengths representing their approximate limits are always considered in accordance. The wavelengths of importance in solar energy and its applications are found in the ultraviolet to near infrared range that is from approximately 0.3 to 2.5 microns. This includes the visible wavelengths, light being the exclusive portion of the electromagnetic spectrum to which the human eye responds (Duffie et al, 1980).

The average amount of solar radiation in near earth space is termed the solar constant. Its measured value, 1.353 Kw/m^2 , represents the total energy in the solar spectrum. A standard spectral irradiance curve based on high-altitude and space measurement is always available which is the spectral distribution of the extraterrestrial radiation, that is, the radiation that would be received in the absence of the atmosphere. The atmospheric window is defined to be any portion of the frequency spectrum of the earth's atmosphere through which light, heat or radio waves can penetrate to the surface of the earth due to the low absorption or dissipation of electromagnetic energy in this

particular portion. This window is subject to fluctuation in size and locality according to changes in the extraterrestrial radiation from sunspot activity and the earth-sun distance. Solar radiation at normal incidence received at the earth's surface is also subject to variations due to atmospheric scattering and atmospheric absorption. Atmospheric scattering results in attenuation of the beam radiation by air molecules, water vapor and dust. The scattering theory indicates that there is more scattering at shorter wavelengths. The total effect of scattering is the product of three exponential terms, each a function of wavelength, and of the quantity of molecules, dust and precipitable moisture which the radiation is transmitted (Duffie et al,1980). Absorption of radiation in the atmosphere is mostly due to water vapor in the infrared and ozone in the ultraviolet bands. The ozone used to have a complete absorption of short-wave radiation in the upper atmosphere at wavelengths below 0.29μm.Ozone absorption decreases as λ increases above 0.29μm, until at 0.35μm when there is no absorption. Likewise, beyond 2.3μm, the energy in the extraterrestrial solar energy spectrum is less than 5% of the total solar spectrum. The transmission of the atmosphere being very low due to absorption by water and carbon dioxide, the energy received at the ground at $\lambda > 2.3\ \mu$m is very small.

In summary, the normal solar radiation incident on the earth's atmosphere usually has a spectral distribution. The x-rays and other very-short – wave radiation of the spectrum are mostly absorbed by oxygen, nitrogen, and other atmospheric components high in the ionosphere. Ozone absorbs most of the ultraviolet at wavelengths greater than 2.5 μm. Very little energy reaches the ground because of a combination of strong absorption of CO_2 and H_2O and low extraterrestrial radiation. Thus, only radiation of wavelengths between 0.29 and 2.5 μm are considered for terrestrial applications of solar energy.

TILTED WICK – TYPE DISTILLATION

Most of the above listed difficulties can be avoided by the use of tilted solar stills. Dr Maria Telkes designed the tilted wick – type solar still to compensate for just these problems listed above. This particular still consists of a rigid, flat frame, only 2 to 3 inches deep, covered with glass to form a continuous surface. A porous black material is placed over a waterproof insulating material. The saline feedwater is discharged by a channel at the upper edge of

the black lining. Condensation occurs only on the front transparent surface. It is crucial that the feeding mechanism should distribute sea water uniformly over the entire surface area of the black porous layer, without the formation of dry spots which would decrease the yield. The brine is collected at the lower end of the still in a gutter and discharged to storage. As the name implies, these frames are tilted at an angle in order to receive the maximum amount of solar radiation during the entire year or dry season. In smaller units the frames can be supported by legs attached permanently to the ground. In larger installations the stills can form the roof of a house, provided that the roof slopes to the south, or the stills may be situated on the south – facing slopes of hills, which otherwise could not be used for horizontal type stills. Because of the tilted surface, the problems of scale deposits or light colored precipitates have been eliminated. These deposits are slowly washed down with the discharging brine, thereby reducing maintenance costs (Telkes M., 1964). The porous evaporator wick of tilted solar stills is best made of recently developed synthetic fabrics which are sun – resistant. This fabric uses carbon black, a finely divided carbon, which is incorporated into the synthetic material before it is extruded into filaments. These filaments are then permanently black, because the black is in the material of the filaments rather than on their surface. The material most often used is a polyester type, Dacron or Orlon; Woven fabrics have been experimented with but are still quite expensive. DuPont is working on developing new highly resistant, yet cost effective, materials called non – Woven fabric, which will permanently resist sunshine and seawater (Teskes M., 1964).

The sea water distributing device has been designed to supply sea water evenly to the porous black fabrick, using a channel at the top of the still from which water is fed by the wicking action of the porous fabric. An automatic feeding device has been developed which can regulate the flow of feedwater by the sun itself . A small black expanding bellows is used; when the sun does not shine the bellows contract and close the flow of sea water, and when the sun shines fully the bellows expand and the water flows into the still (Telkes M., 1964). Plastic pipes supply sea water, and other similar pipes remove brine and product water, this provides a way for a number of still units to be connected to form a larger installation operated by a single regulating device. Consequently, knowledge about its characteristics is vital

in modeling, designing, testing and application of solar technologies which fall into photovoltaic and thermal categories. The former group of solar energy systems directly converts solar radiation into electrical energy through the photoelectric effect (Rappaport,1959;Garcia-Rodrigue,2003) while the latter generates heat from solar radiation. This heat is transferred from the solar absorber to different components of the system through various modes of heat transfer that also affect the performance of solar thermal systems, including solar stills which operate on the principles of heat and mass transfer. So, the present work is within the theme of solar thermal applications. In this chapter, fundamentals of solar radiation, and heat and mass transfer are discussed and applied to the process of solar distillation. Drinking water: Drinking water, also known as potable water is safe enough for drinking and food processing. Water is essential for life. The amount of drinking water required is variable. It depends on physical activity, age, health issues, and environmental conditions. Water makes up about 60% of weight in men and 55% of weight in women, infants are about 70% to 80% water while the elderly are around 45%. Reduction of water borne diseases and development of safe water resources is a major public health goal in developing countries. Sea water: Saline water or salt water is water from a sea or ocean. Sea water in the world's oceans has a salinity of about 3.5% ()35g/L. Sea water is denser than both fresh water and pure water. Sea water pH is typically limited to a range between 7.5 and 8.4. Although the vast majority of sea- water has a salinity of between 3.1% and 3.8%, sea water is not uniformly saline throughout the world. Saline water contains a significant concentration of dissolved salts (Nacl). The salt concentration is usually expressed parts per million (ppm). The saturation level is dependent on the temperature of the water. Brackish water: Brackish water is water that has more salinity than fresh water, but not as much as sea water. It may result from mixing of sea water with fresh water. Brine: Brine is a solution of salt in water. In different contexts, brine may refer to salt solutions ranging from about 3.5% up to about 26%. Other levels of concentration are called in different names

WATER IMPURITIES

Water contaminants are divided into two main types:

- Biological-Include waterborne pathogens and algae
- Chemical-metals (arsenic, mercury), salts.

Suspended particles- suspended solids refer to small solid particles which remain in suspension in water as a colloid or due to the motion of the water. Suspended solids are important as pollutants and pathogens are carried on the surface of particles. Removal of suspended solids is generally achieved through the use of sedimentation and/or water filters (usually at a municipal level). Dissolved organic compounds: compound that contains carbon. E.g.- Hydro-carbons.
Micro-organisms. E.g.-Fungi, Algae, Bacteria etc
Pyrogens-Fever inducing substances.
Dissolved gases. E.g.- Argon, Methane, Ethylene, carbon monoxide, carbon dioxide, Hydrogen, Helium, etc.

CAUSES OF WATER CRISIS:

There are several principal manifestations of the water crisis:

- In adequate access to safe quality drinking water for about 884 million people in the world is lacking quality drinking water.
- In adequate proper access to sanitation can cause water crisis and for now 2.5 billion people are lacking proper sanitation, which often leads to water pollution.
- In the world ground water over-drafting (excessive) can permits chances to diminishing of agricultural yields.
- Also over use and pollution of water resources can permits damage of biodiversity.
- Also in the world, enormous regional conflicts over scarce water resources resulted in warfare.

Waterborne diseases caused by lack of sanitation and adequate hygiene are some of the leading causes of death worldwide. Right now, for children under the age of five, waterborne diseases are a leading cause of their death. According to the World Bank, 88 per cent of all water borne diseases are caused by unsafe quality drinking water, inadequate sanitation and poor hygiene.

BENEFITS OF DISTILLATION

* Worldwide it produces water of high quality.
* Maintenance is almost negligible.
* Any type of water can be purified into potable.
* Wastage of water will be minimum.

Purified water: It has been processed to remove impurities and make it suitable for use. The distilled water has been the most common form of purified water, but in recent years, water is more frequently purified by capacitive-deionization (CDI), reverse-osmosis, carbon-filtering, ultra-violet-oxidation or electro-deionization. The choice of method will depend on the quality of the water being treated, the cost of the treatment process and the quality standards expected of the processed water. Water purification may be done using solar radiation to destroy harmful elements in water. So, solar purification process has been the best.

THE WICK SOLAR STILL AND PERFORMANCE

The Wick Type Solar Still

Jute wick material in single basin solar still has been proposed by (Yeh and Chen and Sengar et al, 2011). This type of basin wick – type solar stills, with jute and charcoal as wick materials are very simple in construction. The system consists of a simple basin enclosed in a thermally insulated wooden box and covered by a glass. Charcoal wick material is introduced in the tilted basin and been analyzed by (Mahdi et al, 2011). The analysis has been carried out with the following assumptions:

- The wick type solar still is made to be vapor tight.
- The absorptivity of glass cover and water are negligible.
- The stills are perfectly insulated.
- The wick material used is blackened for more absorption.
- The heat capacity of the glass cover and insulating material of the solar still are negligible.

The jute wick material in the basin sucks water and due to capillary action, the upper surface of the wick material is always wet during peak sunny hours. The water gets evaporated and the water vapor condensed in the condensing surface which is pure distilled water. The thermal capacity of the still is less as the jute wick is made to float in the basin water. The charcoal wick material introduced in the tilted basin acts as the evaporating surface during the working hours of the still and water flows throughout the wick material due to good capillary action which serves as thin film of water surface for evaporation. It's design was made with an option of changing the angle of inclination of the still for maximum interception of solar radiation. The results of the study have proven that the wick - type solar still is more

effective than the conventional basin type solar still due to limited thermal capacity. So system can be use in the north – east part of Nigeria for obtaining clean / potable water through distillation process as part proposing for acceptance for people residing within the region for their socio – economic development and healthy living.

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