International Journal of Future Generation Communication and Networking
Vol. 13, No. 2s, (2020), pp. 1090–1096

Solar water distillation

Prof. S. S. Waybase[1], Shambhavi Kulkarni[2], Prachi Kamble[3], Vaishnavee Nanaware[4], Chaitanya Korde[5]

[1]Asst. Professor, [2345]Students, Department of Mechanical Engineering, Smt. Kashibai Navale College of Engineering, Pune, Maharashtra, India

[1]swapnil.waybase_skncoe@sinhgad.edu
[2]shambhavi206@gmail.com
[3]kambleprachi278gmail.com
[4]vaishnaveenanaware@gmail.com
[5]Chaitanyakorde1998@gmail.com

Abstract—

In this research paper we studied water is the main source of sustaining living beings in earth. Nearly 70% of earth surface is covered with water. Water is available in different forms such as sea water, surface water, underground water, and atmospheric water. There is less amount of water only left on earth that is safe to drink without purification after 20-25 years. 99% of Earth water is in a solid state and other impure form and the remaining is in liquid form water on earth is contaminated with impurities and chemical substances. Therefore, it cannot be used for agriculture, industrial and human consumption. Due to water shortage has become one of the major global challenges, which is linked to population growth. Ground water and reservoirs are the available sources of fresh water to fulfil the needs of living beings. But these sources are not always useful due to dissolved impurities for this reason, purification of water supplies is extremely important. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water Solar distillation is an effective method by which we can purify the water with the help of solar radiation. Distillation replicates the way nature makes rain. The sun's energy heats water to the point of evaporation. As the water evaporates, water vaporizes, condensing on the glass surface for collection. This process removes impurities such as salts and heavy metals as well as eliminates microbiological organisms. The end result is water cleaner than the purest rainwater. The Solar aqua still is a passive solar distiller that only needs sunshine to operate. There are no moving parts to wear out.

Keywords*—Solar water distillation, Solar energy, Renewable energy, Active techniques, Passive techniques, etc.*

I. INTRODUCTION

Water is an essential element on earth for the living beings. Nearly 70% of earth surface is covered with water. Water is available in different forms such as sea water, surface water, underground water, and atmospheric water. Water on earth is contaminated with impurities and chemical substances. Therefore, it cannot be used for agriculture, industrial and human consumption. For this reason, purification of water supplies is extremely important. Moreover, typical purification systems are easily damaged or compromised by disasters, natural or otherwise. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water.

Technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost- effective, and environmentally friendly. That is use of solar energy. Water and energy are necessary for life on Earth and sustain the modern world. In many parts of the

ISSN: 2233-7857 IJFGCN

developed world, the control and exploitation of water and energy has driven economic development and progress. In the developing world, many regions suffer from shortages of fresh water and energy supplies. The United Nations Environment Program (UNEP) stated that one third of the world's population live in countries with insufficient fresh water to support the population. Consequently by 2025, two thirds of the world population will face water scarcity. Drinking water of acceptable quality has become a scarce commodity.

The World Health Organization estimates that over a billion people lack access to purified drinking water and the vast majority of these people are living in rural areas where the low population density and remote locations make it difficult to install traditional clean water solutions. Purification of seawater is known to be one of mankind's earliest forms of water treatment, and it has become one of the most sustainable alternative solutions to provide fresh water for many communities and industrial sectors. This plays a crucial role in socio-economic development in a number of developing countries, especially in water stressed regions such as Africa, Pacific Asia and countries in the Middle East. Hence, the increase in population together with the industrial and agricultural development in emerging countries will accelerate rapidly the deterioration and depletion of the available freshwater resources. Solar distillation is one of the methods of getting potable water using solar energy. Solar distillation is cost saving in comparison to other type of distillation such as: reverse osmosis, due to easily available solar energy. Solar distillation is highly effective in cleaning up impure water to provide safe drinking water. It is an affordable and reliable source of potable water. Now days solar stills are widely used for distillation. It is one of the most important and technical application of solar energy.

In this an author investigated the optimization of different parameters of distillation process. The technology based on solar energy and its usage very important and useful for developing and undeveloped countries to sustain their energy needs. Water shortage has become one of the major global challenges, which is linked to population growth. Ground water and reservoirs are the available sources of fresh water to fulfil the needs of living beings. But these sources are not always useful due to dissolved impurities. In this paper an author concluded that solar distillation is an effective method by which we can purify the water with the help of solar radiation[6].

In this an author studied distillation of water using solar still basin is the most economical method to get portable drinking water. Salt, bacteria and other impurities are contaminated which are to be removed completely in the distillation process. The solar stills are best technology for living beings and environment because they do not need electricity for processing, no running water is required, life time is easier to maintain. In this experiment an author found that the black coated solar still is more effective than white coated solar still[2].

In this paper an author experimentally compares physical and chemical characteristics of drinking water samples produced from the conventional and modification of solar water distilleries, water samples of networks from different regions were carried out. From this research paper an author concluded that the physical and chemical factors of water are particularly important in determining the suitability for human use[7].

In this paper an author focused on performance of solar water distillation using phase change materials and studied experimentally Magnesium Sulphate Heptahydrate (MgSO4 7H2O), Sodium Sulphate (Na2S 7H2O) used as phase change material and Titanium oxide is a nano-material used for energy storage material. Among these energy storage materials Magnesium Sulphate Heptahydrate (MgSO4 7H20) improved efficiency of solar water distillation. By this method we can produce distilled water after removal of impurities. An author concluded that there is a strong need to improve the single slope solar still performance and increase the production of water distillation[1].

ISSN: 2233-7857 IJFGCN

Ⅱ. BASIC CONCEPT OF SOLAR WATER DISTILLATION

The basic concept of solar water distillation is simple yet effective, as distillation replicates the way nature makes rain. The sun energy heats the water to the point of evaporation. As the water evaporates, water vapour 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 end result water is cleaner than the purest rainwater.

A. Various technologies of water distillation

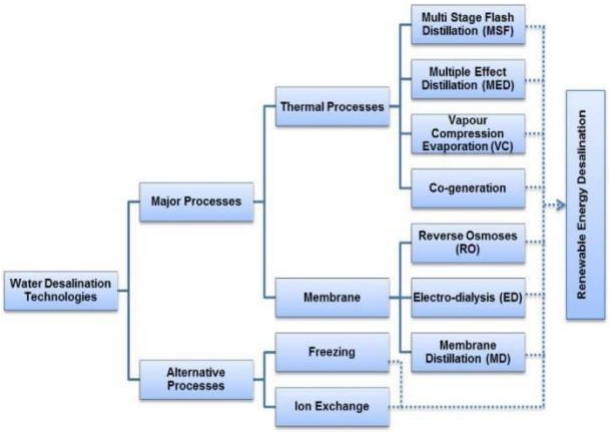

Fig. 1 Configurations of solar energy resources with water desalination technologies

Ⅲ. DESIGN OF PROPOSED WORK

Basic Principle of Solar Still:

A solar still is a device used to produce clean, drinkable water from dirty water using solar energy from the sun. This process removes impurities and eliminates microbiological organisms. It is coupled with thermal collectors, concentrators, and photovoltaic panels which makes the system active and increases distillation three to six times. The sun energy heat water to the point of evaporation. When water evaporates, water vapour rises, which condenses on the glass surface

Ⅳ. VARIOUS TYPES OF SOLAR STILL

A. Based on categories

1. Passive solar still: It uses direct sun energy for its operation. In present days, most of the solar stills are working on passive distillation system because they need sunshine to operate it. The solar radiation is received directly by the solar still and is the only source of energy for rising the water temperature and thus the evaporation of water which condenses on the glass surface leads to lower productivity of pure water. The solar still used for passive distillation system is of a convectional design is basically a sealed enclosure, containing impure water[7].

ISSN: 2233-7857 IJFGCN

Some common types of passive solar still:

- Single-effect
- Multi-effect
- Basin
- Double slope
- Wick
- Multi-wick
- Diffusion
- Greenhouse

2. Active solar still: It is an efficient technique to fulfil the need of potable water for a family using renewable energy. It uses external sources of energy to power blowers, pumps and other types of equipment to collect, store and convert solar energy. These external sources supply thermal energy to the basin water along with the direct sun rays. It uses pumps or fans to circulate fluid through solar collectors. It combines with external sources such as flat plate collector, photo voltaic panels, evacuated tube collector, heat pipe and hybrid system which improves the daily distillation productivity and makes the solar still active[7].

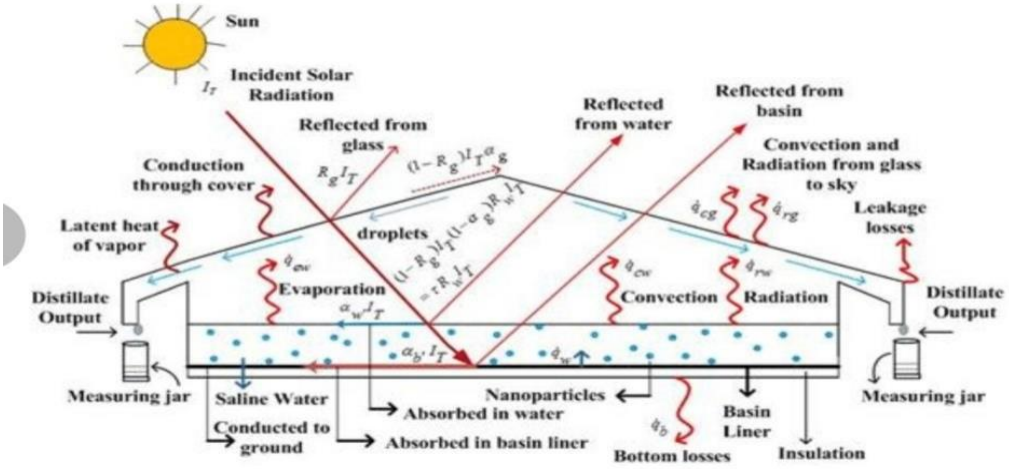

Fig. 2 Active Solar Still[7]

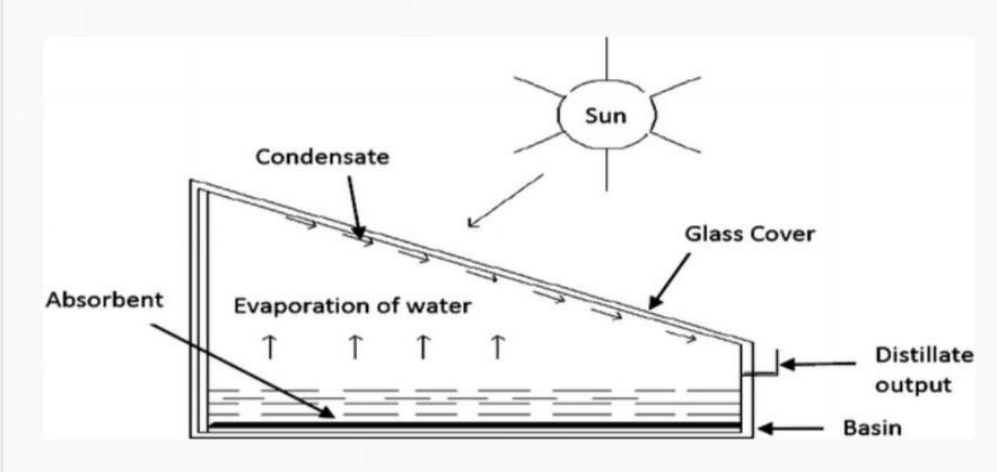

Fig.3 Basic design of single effect single-basin type solar still[2]

ISSN: 2233-7857 IJFGCN

Comparison of Passive Solar Still and Active Solar Still:

For passive solar still system no external equipment is required, so automatically the entire setup is cheaper than active solar still system. For passive solar still system maintenance of equipment less than active solar still system. Passive solar still system better than an active solar still system for health. In active solar still system, the fluid that most efficiently store heat have the potential to release toxic chemicals into the air whereas passive solar still system is pollution free, eco-friendly and does not cause allergies. Since passive solar still system better than active solar still system.

B. Based on configuration
- Double basin solar still,
- Triple basin solar still,
- Multiple basin solar still.
- Pyramid solar still,
- Hemispherical solar still,
- Inverted absorber solar still,
- Wick type solar still,
- Tabular solar still, etc.

There are various types of solar stills in this the simplest and most proven is the basin type which could produce fresh water without having a complex structure or necessity of special maintenance.

C. Based on geometry
- Single slope solar still,
- Double slope solar still,
- Vertical slope solar still,
- Conical solar still,
- Multi-effected solar still, etc.

V. PARTS OF THE SOLAR STILL

A. Transparent cover: It should have high transmittance for solar radiation, opaque to thermal radiation, low cost, light weight, easy to handle and apply, long life, resistance to abrasion and universal availability. This cover transfers solar radiation into the still and also helps to condensate the vapour. The material uses for transparent cover are glass.

B. Black liner: It should be durable, easily cleanable, water tight, low cost and should be able to tolerate temperature around 100 degrees Celsius. It is used to absorb solar radiation in the basin of the solar still.

C. Basin tray: The water is initially stored in the basin tray of the solar still. The materials used for basins should have long life, high resistance to corrosion and low cost. The commonly used materials are steel, galvanized iron, wood, aluminium, asbestos cement, concrete etc.

D. Sealant: It is used to prevent the vapour leakages through the sides of the transparent cover in the solar still. Materials should remain resilient at low temperatures. Materials used as sealant are putty, tars, tapes silicon etc.

E. Insulation: The solar still are thermally insulated to prevent the heat loss through the side walls and the basin. Vapour leakage is prevented by sealant. The energy received from the sun should be kept inside the still to vaporize water. The materials used are saw dust, glass wool etc.

F. Channel: The vapours which are generated inside the solar still is condensed on the inner surface of the transparent cover and water droplets move down words through the transparent cover. The fresh water is collected through the condensate channel fitted inside the solar still. The materials used for the condensate channel are galvanized iron, aluminium, plastic materials etc.

G. Water supply system: Brackish water should be supplied into the still continuously. In systems, the feed rate of water should be kept equal to the evaporation rate of water from the still. The water supply system includes overhead tank, pipes to carry water into the still and regulatory valve.

H. Materials: Wood, Glass or plastic etc.

ISSN: 2233-7857 IJFGCN

Fig.4 Single effect, single slope/basin type passive solar still system

VI. ADVANTAGES

A. Free of sun energy (during sunlight it eliminates 500watt electric consumption per one hour of sunlight).
B. There are no moving parts, therefore it is almost reliable and maintenance free.
C. Water taste is claimed to be better since the device acts as a solar water vaporizer and it does not boil the water.
D. Neutral Ph is claimed (rainwater).

VII. CONCLUSION

After detailed study of the solar energy. It is observed that solar energy has potential energy to occupy the space between demand and supply in future. Still there is scope to reduce the cost of solar energy system through research and technological development.

REFERENCES

[1] N. S. Somanchi, Sri L. S. Sagi, et.al, Modelling and Analysis of Single Slope Solar Still at Different Water Depth, International Conference on Water Resources Coastal and Ocean Engineering, vol. 4, (2015), pp:1477-1482.

[2] S. N. kumar, P.P. Shantharaman, Fabrication of solar water distillation system, International Journal of Core Engineering and Management, vol. 2, (2015), pp:2348 9510.

[3] J. Lodoe, R. Gautam, S. Kumar, S. Sudheer, An Experimental Investigation of an Inclined Solar Distillation and Domestic Water Heating System in Cogeneration, International Journal of Research, vol. 2, (2015), pp:2348-795X.

[4] M. Shashikanth, B. Khadka, Y. Lekhana, P. M. Kiran, N. Alaparthi, S. Veerammneni, Solar Water Distillation using Energy Storage Material, Science Direct, vol. 11, (2015), pp: 368-375.

[5] A. E. Kabeel, Z. M. Omara, F. A. Essa, A. S. Abdullh, Solar still with condenser, Renewable and sustainable energy reviews, Science Direct, Vol. 59, (2016), pp: 839-857.

[6] M. Singhal, D. Singh, Dr. A. K. Sharma, Solar Power Water Distillation, International Research Journal of Engineering and Technology, vol. 05, (2018), pp: 2395-0072.

ISSN: 2233-7857 IJFGCN

[7] H. H. M. Ali, S. T. Ahmed, Physical and Chemical Characteristics Comparison of the Drinking Water and Water produced from the Conventional and Modification Solar Water Distillery, Engineering and Technological Journal, vol. 37, (2019), pp:214-221.

ISSN: 2233-7857 IJFGCN