Parameters Affecting the Performance of Single Basin Solar Distillation with Parabolic Reflector: A Detailed Review

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Abstract. The freshwater crisis is already clear in many parts of India. The crisis of fresh water is not the result of natural causes but of human activities. The reason for the need for fresh water is quickly due to the increase in population and the change in lifestyles. The Indian government is playing an important role in fresh water. Nearly 100,000 children die in India directly after drinking unsafe water each year and approximately 45 million people are affected by diseases due to water pollution, such as excess fluoride, iron or salt water. Single basin solar distillation with parabolic reflector is an excellent device to overcome these problems, which produces drinking water from saline water. In this article, we have studied the problem of several parameters to influence the performance of solar energy. In this work, several techniques were studied to increase the productivity of the still.

Keywords: Solar still, Solarimeter, Anemometer, Digital TDS meter, pH meter

1. Introduction
Still, in rural areas, women and girls have to travel longer to drink fresh water at home. So many hours of the day are spent [1]. There are fresh water problems in many areas of Gujarat and Rajasthan state and fortunately, these areas have more sunlight so we can make the salt water drinkable by using this sunlight. In Haryana and Maharashtra, even in the case of high rainfall, saline water is found [2]. Although there are many types of solar still plants which are conventional in construction as single basin still. Their yields are very less of the order of 1.5 to 4.5 litres per day per m² [3]. El-Sebaii investigated computer aided modelling of wind flow effect on still productivity daily basis, which termed as passive solar stills, he experience that active as well as passive productivity can be enhanced by flowing wind up to a reasonable velocity [4]. The various design of still with respect to geographical locations where drinking water can be obtained by solar energy, have been proposed by many investigators [5-6]. Alnaser had studied about the outcome and its efficiency in the context of single and double basin [8]. He did two tests one for still insulation and other has no insulation. They found that insulation gives comparatively good result to produce potable water, mainly with two basins still, which around 41% higher than single basin system. The technologies are existing for water distillation used, are basically run on thermal engineering concept for distillation as phase conversion or by membrane filtration, which can include categories in two groups. In the first group which is based on thermal technology such as multi-state flashing (MSF), other as multi effective distillation (MED), vapour compression (VC) and the cheapest simple in construction still distillation (SD). The Reverse osmosis (RO) is the...
most popular technique, along with electrodialysis (ED) [9]. Due to the running cost of energy consumption these technique and environmental hazards as the use of fossil fuels, they need for reconsideration [10].

Nijmeh investigate the key parameter of solar still generation ,absorptive nature of material at the bottom of basin , how much radiation it capture which transform in to heating water , he is mainly focussed on the different material absorption capacities with single basin system like dissolved salts, violet dye, and charcoal etc. He notified that around 25% of still water generation can be improve with salts and violet dye gives better result up to 29%. Since the last few years of decades, thermal distillation mainly dependent on solar power has been appreciated by inventors [11]. But the performances of this type of setup required for more improvement by advancing the cooling and evaporative technology. Thermo-electric refrigeration technique can be utilized as a solid state heat pump which are based on the Peltier effect [12,13].

The main feature of this device have no moving parts, and therefore its more reliable, noiseless, compact in size, easy operation, and environmentally good [14–15]. Due to the appreciation performance of thermo-electric devices, it has become more popular one. The water level in the basin is another parameter to consider by others authors concern their research on convective heat transfer coefficient in between glass and above water surface in the basin [16]. The sponge medium inside water may contribute to enhance still water generation suggested by Abu-Hijleh and Rababa’h [17]. Many researchers have focused on enhancing the performance of solar stills. Rahin et al.[18] used to support this type of techniques to improve still yield. This was done by putting away the evaporating and condensing envelopes, with the help of copper tube for condensation, while using the black aluminum plate at the basin bottom for water evaporation. The efficiency was increased by 31.1%. Abu-Arabi et al. [19] of a solar desalination design model by using double glass collector. If water and glass temperature differences are increased the productivity of distilling water will increase. This is by many people are taking an interest in the field of solar still.

The performance of concave wick evaporation of solar had been studied by still Kabeel [20]. The still produces 4.1 L/m² as the average daily production of his still which has 30% average efficiency. The productivity of a weir-type inclined solar still studied by Sadineni et al. [21]. This still's daily production was 5.5 L/m² if thin water films uses and temperature difference of evaporation and condensation increased. Phadatare et al. [22] used the same data to observe the effect of water depth. From last few years more people are coming forward to take part in improving solar still performance and to get more productivity they have made a simple still. Mirza et al. [23] proposed a design of simple basin solar still, properties were measured and its still efficiency was 30% and its daily productivity was was 3.1 L/m². His research said that the outcome of the solar still varies with the factor of insulation and surrounding temperature. Srithar [24] quoted the still productivity increases if wick, fin and sponge con enhance the outcome of the sill, he reported that the productivity of the still increased by 45.5 %, 15.3% and 29% with fin, sponge and wick, respectively.

Mathematical modelling was incorporated to estimate the generation of distil water with various aspect of surrounding such as weather, design of setup and operational condition like shallow water basin and insulation had great productivity [25]. Although numerical simulation study based on unsteady Navier–Stokes equation in the conjunction of different fluid properties like Nusselt no. for different pair of medium and temperature differences were studied [26]. Transient model for analytical solution of the energy –balance was investigated by Aboul-Enein [27]. During the numerical investigation, the influence of water film covering the top of glass play an important role to increase the still water generation, and around 21% still efficiency increases with it. Computer aided modelling was performed to get futuristic parameters of single slope solar still by taking temperature difference between top and bottom surface temperatures by concluding effect of this on heat convection coefficient[28].

2. Working principle of single basin solar distillation with parabolic reflector

Sunlight is collected in a variety of ways in which the saltwater located on it is converted into vapour. In this study, we have also used a reflector with single basin solar still. When sunlight strikes on the glass of solar still, the water in the basin becomes warm. The use of parabolic reflectors increases the
rate of warm. The hot water turns into the vapour, and this vapour goes the inner surface of glass upwards. This vapour is collected under the glass as small droplets. By which almost all the impurities remain in the basin; steam gets condensed and convert into water droplet/like a sheet of water. Due to the gravity or slope the glass, these droplets begin to fall and collect it in one place.

![Figure: 1. Experimental unit.](image)

3. Factors affecting the productivity single basin solar distillation with parabolic reflector

Particular effects are influencing the sun filled still preferred standpoint, for instance, the social event of sun controlled radiation, wind speed, ordinary temperature, glass – water temperature refinement, without water covering a zone, centrality of water, sound water temperature, a territory of shield base and glass spread point. The intensity of sun based radiation, wind speed and trademark temperature can't be controlled in light of how they are metrological determinants. Exchange parameters can be climbed to improve the sun based still ampleness. By isolating the unmistakable pieces affecting the sun organized still benefit, distinctive adjustments have been made to develop the sun based still capacity [29].

3.1 Area of the solar basin still

The zone of sun oriented still assumes a fundamental job in the generation of refined water. In the event that the region builds, the efficiency of sun powered still keeps on expanding.

3.2 Depth of water in solar basin

Khalifa and Hamood led investigate sun powered still that utilization distinctive dimensions of water profundity in the sun oriented still bowl [30]. They inspected that the rate of vanishing diminishes with expanding water profundity in the bowl.

![Figure: 2. Solar Still](image)
3.3 Inlet saline water temperature
Studies have shown that from higher temperature of saline water in the basin, the vaporization will be more. So by applying the parabolic concentrators, flat plate collectors, the productivity of solar still will be increased.

3.4 Glass inclination and thickness of glass
Jordan, Khalifa and Hamood directed analyses on sunlight based still (scope 31.570N) and found the outcome that efficiency can increment up to 63% [30]. Singh and Tiwari [31] inspected that the edge of glass is equivalent to the scope of the spot; the efficiency of refined water will be high. Akash et al [32] analyzed, if the point of the glass is 35 degrees, the most noteworthy refining happens in the long stretch of May.

![Solar Still](image1)

**Figure: 3.** Solar Still with Glass inclination and thickness of glass

3.5 Temperature gradient between glass cover and water
In the event that the temperature contrast among glass and water is expanded, the rate of vaporization of saline water is increment. This temperature contrast assumes a fundamental job among glass and water, which go about as a main thrust for the buildup. Temperature distinction accomplished by utilizing twofold glasses, splash of water on the upper side on glass [33-34].

![Solar Still](image2)

**Figure: 4.** Solar Still with Temperature gradient between glass cover and water

4. Procedures used to improve the execution of the solar still
4.1. Improving the execution of solar still by utilizing energy absorption and putting away materials
The execution of solar still can be improve by putting material inside the solar still like sponge cubes and wick material, phase change materials etc.

4.1.1. Utilization of sponge cubes and wick material
Murugav el et al. [35] thought about the execution of sun based still with different surface materials like jute texture, cotton material, wipe, quartzite shake and trademark shake and surmised that the cotton texture gave the most outrageous effectiveness. Nafey et al. [36] inspected the execution of sunlight based still with dim shake and contemplated that the productivity of sun powered still has been improved by 19%. El-Bialy [37] thought about the execution of sunlight based still with drifting protections, for instance, copper, solidified steel, mica, and aluminum and assumed that the gainfulness redesigned by 42.2% for mica. Sakthivel and Shanmugasundaram [38] studied the execution of sun powered still with dim stone shake and found that the yield of sun oriented still extended by around 17-20% [39].

![Figure: 5. Solar Still with sponge cubes and wick material](image)

4.1.2 External and inward reflectors
Outside and internal glasses are among the developments which are utilized in the sun based still. They have been incorporated astute materials, for example, reflect cleaned metal plate. Utilization of the outside or interior reflectors has built up the snappy and diffuse sunlight based radiation exchanged through the glass spread and scene on the bowl liner. The reflectors besides updated the distillate yield of sunshine based still.

![Figure: 6. Solar Still with External and inward reflectors](image)

4.1.3 Flat plate collector
In view of standard course, water voyages as a result of the assortment in the water thickness. The measurement plate pro gives additional warm centrality to the bowl water. Water keeps running from the bowl through the measurement plate gatherer to the bowl by using a siphon. By a mix of a sun based still, with a sun based gatherer and expansion of a gleam aggregating tank. The proposed
framework contains a hilter kilter, single-influence sun energized still, a joined a measurement plate light based gatherer and field storing up tank as appeared in Figure 7. The preheated water from the sun based authority was coursed by a barrel through the bowl water or sun orchestrated still joined with a measurement plate pro. The barrel is filling in as a sparkle exchanger, and trades heat from the preheated water to the bowl water.

![Solar collectors](Image)

**Figure: 7. Solar Still with Flat plate collector**

**Conclusion**
There are following conclusions after studied of single basin solar still with parabolic reflector.

**A. Factors affecting the productivity**
1. Insulation thickness plays an important role in production of portable water of solar still. It can be increase with Insulation thickness.
2. In production of distilled water by solar still, productivity will be high, if the inclination of glass is same of latitude angle.
3. Solar still productivity $\alpha \cdot \text{Depth of water in basin}^{-1}$
4. Solar still yield $\alpha \cdot \text{Intensity of solar radiations}$

**B. Techniques used to improve the efficiency**
1. By utilizing Sponge cubes profitability increment upto 273%.
2. Productivity of sun oriented still increment by 57% from Phase change materials.

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