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Experimental Study of Aliminium Integrated Solar Water Purification

Dr. T. Elango[1], N. Ramakrishna[2], K. Kiran Kumar [3], D.N. Gowtham[4], Y. Bujjibabu [5], P. Chandu[6]
[1]*Professor,* [2,3]*Assistant Professor,* [4,5,6]*UG Students, Department of Mechanical Engineering, Amrita Sai Institute of Science and Technology, Paritala, A.P. India*

Abstract: ***Now-a-days water contamination (fluoride and nitrate) has been increased. So, that main object of our project is to reduce water impurities by experimental study on aluminium integrated solar water purification is access to clean drinking water remains limited in many sun-rich, water-scarce regions. In our project work aluminium was selected for its high thermal conductivity, high evaporation capacity, corrosion resistance and it proves to be a promising material for designing efficient. The study reinforces aluminium's suitability as a core material in sustainable water purification technologies***
Key words: Double slope sola still Water impurities, Evaporation, Aluminium,

I. INTRODUCTION

A solar still is a simple device used for desalinating brackish or saline water using solar energy. The double slope single basin aluminium integrated solar still is an advanced design that improves productivity by increasing the surface area of water exposed to sunlight and enhancing heat transfer efficiency. This system is particularly useful in areas where freshwater scarcity is a major issue.

The still works on the basic principle of the greenhouse effect and evaporation–condensation cycle. Sunlight passes through a transparent cover and gets absorbed by the water in the basin. The absorbed energy increases the water temperature, causing evaporation. The vapor rises, strikes the cooler inner surface of the glass cover, condenses, and is collected as distilled water.

The double slope single basin aluminum integrated solar still is a simple and efficient device for producing freshwater from saline or brackish water using solar energy. It works on the principle of the greenhouse effect and evaporation–condensation cycle, where sunlight heats water in aluminum basins, causing evaporation, and the vapor condenses on the cooler sloped glass cover to yield distilled water. The double slope design enhances condensation and collection, while the double basin setup improves heat transfer and evaporation rates. Aluminum, with its high thermal conductivity, ensures rapid heating, faster evaporation, and higher output compared to conventional materials. Overall, this system is lightweight, durable, and capable of delivering greater productivity in areas facing water scarcity.When sunlight enters the still, the blackened aluminium basin surface absorbs the maximum solar radiation. The absorbed heat raises the temperature of water in both basins. Due to the higher temperature gradient, water molecules start evaporating more rapidly than in a single slope, single basin still.

As the temperature increases, water vapour rises and fills the enclosure. Since the design has two basins, evaporation occurs simultaneously from both levels, creating more vapour in the chamber. This maximizes the rate of evaporation, which is directly proportional to the temperature difference between the water surface and the glass cover. The transparent glass covers on both slopes are exposed to ambient air and remain cooler than the water vapour inside. As the hot vapour comes into contact with the inclined glass surface, condensation occurs. The condensed droplets slide downward along the slope due to gravity and are collected in a freshwater channel at the base.

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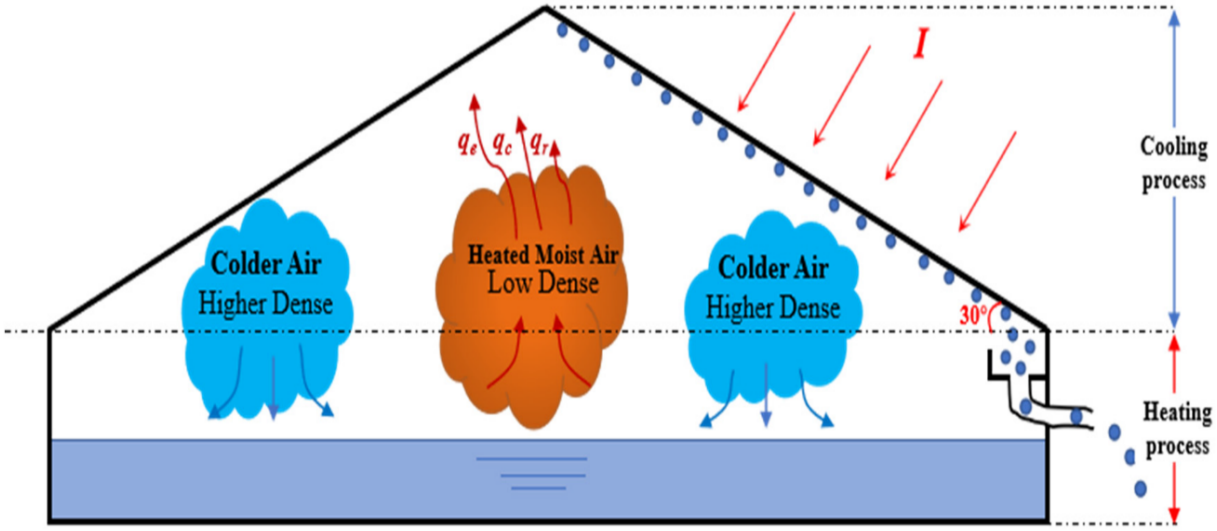

COMPONENTS AND QUANTITY: The various components used in these project work is mentioned below table

S.N0	COMPONENTS	QUANTITY
1	Aluminium sheet	3x4 meters
2	L-Angle strip	6 meters
3	Silicon glue	1
4	Water taps	2
5	Water tube	1 meters
6	Solid head rivets	30no.s

II. LITERATURE SURVEY

1) K. Sampathkumar et al. (2010) presents a comprehensive review of active solar distillation systems, which integrate solar stills with external energy sources or collectors to enhance productivity.

2) Badran et al. (2005) investigated a solar still coupled with a flat plate collector to enhance water productivity. The study showed significant improvement in distillate yield compared to a conventional still.

3) Tanaka and Nakatake (2007) analyzed the effect of reflector inclination on basin-type solar still performance in winter. They found that optimizing the reflector angle increases solar radiation input and improves distillate yield.

4) Rajaseenivasan et al. (2014) experimentally studied a solar still integrated with a flat plate collector. Results showed higher water output and improved efficiency compared to a conventional solar still.

5) Chaichan and Kazem (2015) enhanced solar distiller productivity by integrating a concentrating solar water heater with phase change material (PCM). The system achieved greater thermal storage and significantly higher freshwater yield.

6) Tanaka, Nakatake, and Tanaka (2005) conducted indoor experiments on a vertical multiple-effect diffusion solar still coupled with a heat-pipe collector. The study demonstrated improved evaporation–condensation cycles and higher distillate productivity.

III. FABRICTION PROCESS

The fabrication of a double slope single basin aluminium integrated solar still begins with the construction of the main frame. The frame can be made of mild steel, wood, or other durable material to provide strength and stability. The dimensions of the still are chosen depending on the design requirements, usually around 1 m² in area, which is sufficient for laboratory or small-scale field testing. The frame is designed to support the weight of the double basins, glass cover, and insulation materials.

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The next important step is the preparation of the basins. In this model, two basins are fabricated using aluminium sheets, as aluminium is lightweight, corrosion-resistant, and possesses high thermal conductivity. These properties make aluminium an ideal choice for faster heat absorption and transfer, thereby improving the evaporation rate of water. The basins are positioned inside the frame either in a stepped or parallel arrangement to hold saline or brackish water for distillation.

The transparent cover is fabricated using two glass sheets arranged in a double slope configuration. These sloping glasses, usually 3 mm thick, are mounted on opposite sides of the still to form a roof structure. The double slope design not only helps in efficient condensation but also allows sunlight to pass through at different angles during the day, thereby increasing exposure to solar radiation. The inner surface of the glass becomes cooler compared to the heated water, which facilitates condensation of vapour.

At the lower ends of each sloping glass sheet, collection channels are installed to gather the condensed fresh water. These channels are connected to taps or outlets that allow easy discharge of distilled water into storage containers. The arrangement ensures that all condensed droplets flow smoothly without dripping back into the basin. Proper slope and smooth surfaces are important here to maximize water collection efficiency.

For structural strength and durability, rivets are used to fix the aluminium basins firmly to the frame and to hold the glass supports securely. Rubber gaskets or sealants are applied along the joints to prevent leakage of vapour or entry of dust and moisture.

This airtight assembly is crucial for maintaining efficiency and avoiding losses during operation. The double slope double basin aluminium integrated solar still effectively utilizes solar energy for freshwater production. Its aluminium basins and double slope glass cover enhance evaporation and condensation, while insulation minimizes heat loss. This simple, low-cost design provides a sustainable solution for clean water in rural and remote areas.

OBSERVATIONS AND CALCULATION: The following observations are noted for the experiment set of aluminium double slope double still solar water distillation

Parameter	Value
Absorber basin area	1.0 m^2

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Parameter	Value
Water depth	5 cm
Daily solar radiation (∑I(t))	20 MJ/m^2
Daily water yield (Vdistillate)	6.0 L
Average basin water temperature (Tw)	80°C
Average inner glass temperature (Tg)	60°C
Ambient temperature (Tambient)	30°C
Latent heat of vaporization (hfg)	2.35×10^6 J/kg
Density of water (ρw)	1000 kg/m^3
Specific heat of aluminium	900 J/kg·K
Mass of aluminium basin (m)	5 kg

Daily Water Productivity

$$P_{daily}=\frac{Vdistillate}{Astill}=\frac{6.0L}{1.0}=6.0L/M\text{^}2.$$

Daily Thermal Efficiency (ηd)

$$\eta_d=\frac{(Vdistillate*\rho w)*hfg}{Astill*\sum I(t)}$$

$$\eta_d=\frac{(6.0L*1Kg/L)*(2.35*10^6\frac{J}{Kg})}{(1.0m^2)*(20*10^6\frac{J}{M^2})}$$

η_d=70%

Vapor Pressures

Pw(Tw=80°C) =47.37 kPa

Pg(Tg=60°C) =19.92 kPa

Convective Heat Transfer Coefficient (h_c,w−g)

$$h_c,w\text{-}g=0.884[(Tw-Tg)+\frac{(Pw-Pg)*(Tw+273.15)}{(268.9*10^3-Pw)}]\text{^}1/3$$

$$h_c,w\text{-}g=0.884[(80-60)+\frac{(47.07-19.92)*10^3*(80+273.15)}{(268.9*10^3-47.37*10^3)}]\text{^}1/3$$

h_c,w-g=3.373W/M^2.K

Evaporative Heat Transfer Coefficient (he,w−g)

$$he,w-g=16.276*10\text{^}-3*hc,w-g*\frac{Pw-Pg}{Tw-Tg}$$

$$he,w-g=16.276*10\text{^}-3*3.73*\frac{(47.37-19.92)*10^3)}{(80-60)}$$

he,w−g=84.1W/m^2.K

Thermal Energy Storage

Heat of aluminium(Q) = Mass of aluminium * Capacity of aluminium * ΔT

Q = 5Kg*900J/Kg. K*(80-30) K

Q = 225000J

IV. CONCLUSION

.The aluminum double slope solar still is an effective and sustainable solution for producing clean drinking water using solar energy. Its double-sloped design enhances condensation and overall efficiency, while aluminium's excellent thermal conductivity supports faster heat absorption and water evaporation. The system is particularly well-suited for remote, rural, or disaster-affected areas where access to safe water is limited.

Despite some limitations such as potential corrosion, high reflectivity, and heat loss these can be mitigated through surface treatments and insulation. With proper maintenance and design optimization, this type of solar still offers a low-cost, eco-friendly, and reliable method for small-scale water purification.

Overall, the aluminum double slope solar still demonstrates strong potential for practical application in water-scarce regions and stands as a valuable tool in the pursuit of sustainable water resource.

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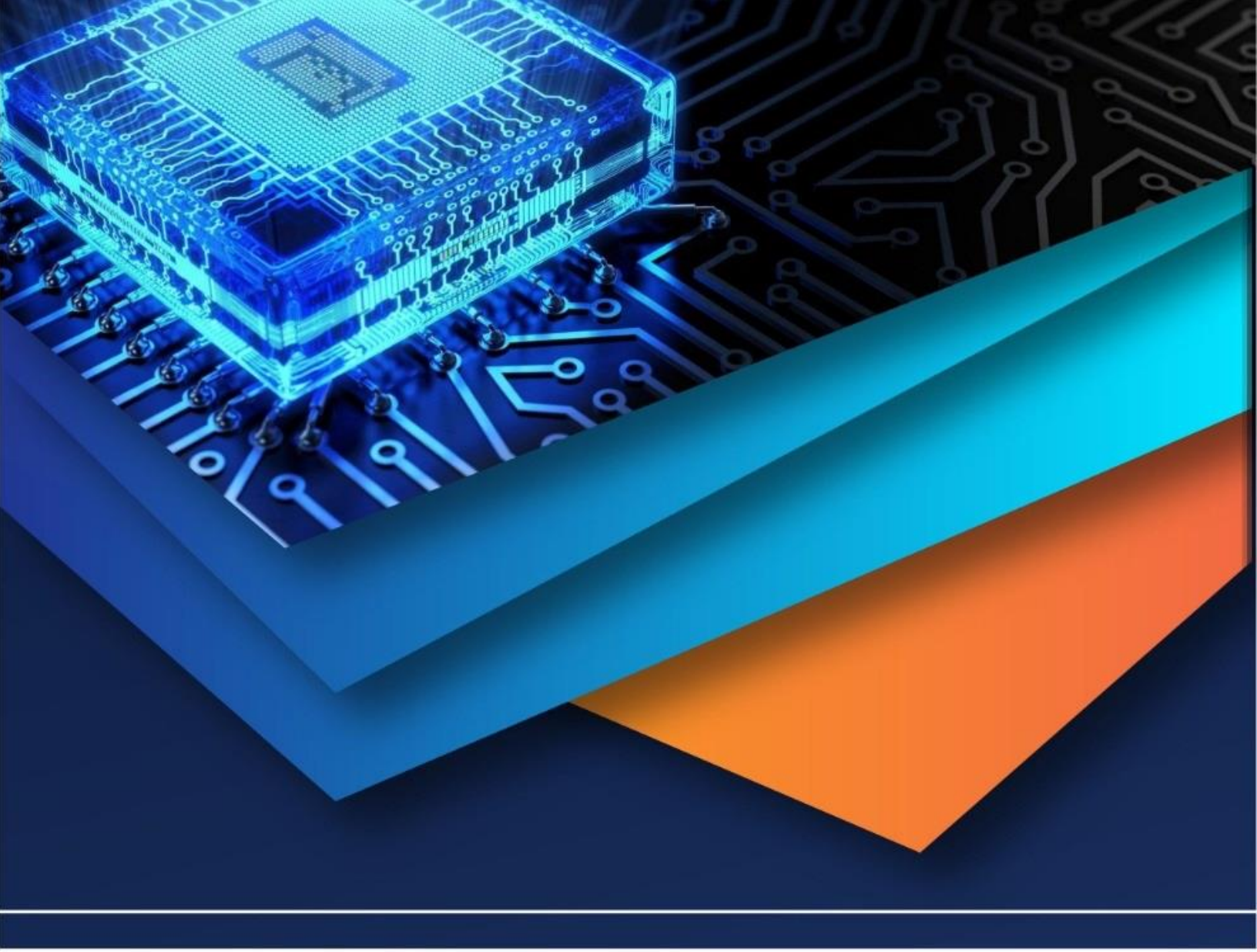

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