DESIGN AND ANALYSIS OF MAGLEV WIND TURBINE

A DESIGN PROJECT – V REPORT

Submitted by: -

P. YESWANTH SAI	**(18127035)**
T. SOURISH	**(18127052)**
J. HARSHA VARDHAN JAKIREDDY	**(18127012)**
P. MOHAN SRINIVASA GUPTA	**(18127005)**

Under the guidance of
DR. A. JOHN PRESIN KUMAR

in partial fulfilment for the award of the degree
of
Bachelor of Technology
in
MECHANICAL ENGINEERING

HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE

SCHOOL OF MECHANICAL SCIENCES
DEPARTMENT OF MECHANICAL ENGINEERING
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BONAFIED CERTIFICATE

Certified that this Project Report titled **DESIGN AND SIMULATION OF SOLAR STILL USING MATLAB** is the bonafied work of **P. YESWANTH SAI (18127035) J. HARSHA VARDHAN REDDY (18127012) T. SOURISH (18127052) P. MOHAN SRINIVASA GUPTA (18127005)** who carried out the project work under my supervision during the academic year 2021.

Head of the Department **Dr. P. VIJAYA BALAN**	**SUPERVISOR** **DR. A. JOHN PRESIN KUMAR**
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Assistant Professor (SG), Dept. of Mechanical Engineering, Hindustan Institute of Technology and Science, Padur, Chennai.	Assistant Professor (SG), Dept. of Hindustan Institute of Technology and Science, Padur, Chennai.

Project Viva-Voce conducted on __________ .

ACKNOWLEDGEMENT

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We express our heartfelt thanks to our Honorable chancellor, Dr. ELIZABETH VERGHESE, Chancellor of HITS for endeavor in educating us in her esteemed institute which helped us towards our goal.

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We express our gratitude and heartfelt thanks to our project guide, DR. A. JOHN PRESIN KUMAR, for encouraging me into this project work with numerous ideas and advices in completing this project work on time.

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ABSTRACT

Magnetic levitation is a method by which an object is suspended with no support other than magnetic fields. Magnetic pressure is used to counteract the effects of the gravitational and any other accelerations. The principal advantage of a maglev windmill from a conventional one is, as the rotor is floating in the air due to levitation, mechanical friction is totally eliminated. That makes the rotation possible in very low wind speeds, which is the new direction to improve the performance of wind turbines. In this project work, magnetically levitated (maglev) wind turbines are designed and developed. It is the self-starting turbine.3D Designing is done using Solid works 2018 software and Finite Element Analysis is used to study effect of air flow on the Turbine blade using ANSYS FLUENT. The choice for this model is to showcase its efficiency in varying wind conditions as compared to the traditional horizontal axis wind turbine and contribute to its steady growing popularity for the purpose of mass utilization in the near future as a reliable source of power generation. Power will then be generated with an axial flux generator, which incorporates the use of permanent magnets and a set of coils. Inverter circuit is used to convert DC voltage to AC voltage by rectifying it. Vertical axis wind turbines offer promising solution for smaller ruler areas or medium sized residential spaces.

Keywords: Wind Turbine, Renewable Energy, Magnetic Levitation, Power Generation, Magnets.

CHAPTER – 1

INTRODUCTION

A wind turbine is device that converts the winds kinetic energy into electrical energy. The blades of wind turbine turn between 13 and 20 revolutions per minute, depending on their technology, at a constant velocity, where the velocity of the rotor varies in relation to the velocity of the wind in order to reach a greater efficiency. Rapid evolution of wind technology has led to an increase in the durability of wind turbines. Wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines used for applications such as battery charging, for auxiliary power for boats or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electric grid.

A) Renewable Energy: -

Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and some others. The need for the renewable energy is high from last few decades due to the exhaustion of conventional power generation methods. The use of renewable energy is the only thing that reduces the dependency of human on fossil fuels. Among all the other renewable energy sources Wind Energy is one of the fastest growing energy sources which is growing at the rate of 30% annual graph. The wind speeds in Asian countries is very low, especially in the cities, and this much amount of wind speed is not enough to start the wind mill. This paper introduces structure and principle of the proposed magnetic levitation wind turbine for better utilization of wind energy. In Maglev Wind turbine there is no friction, and therefore it can work on low speed.

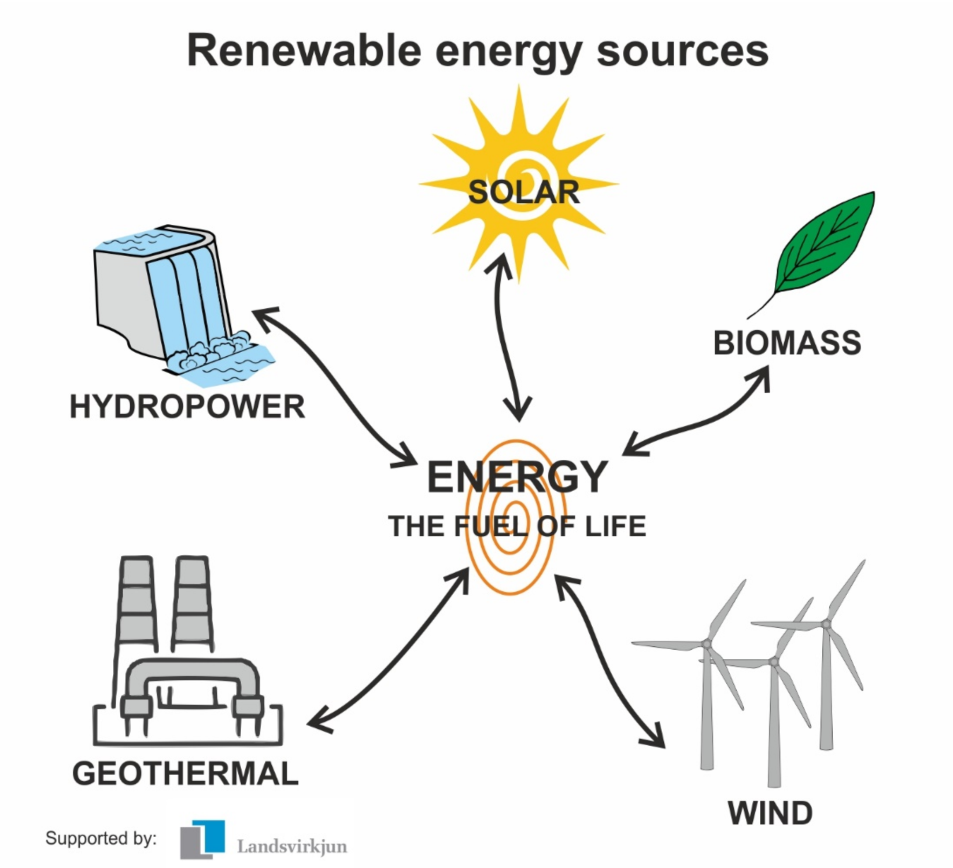
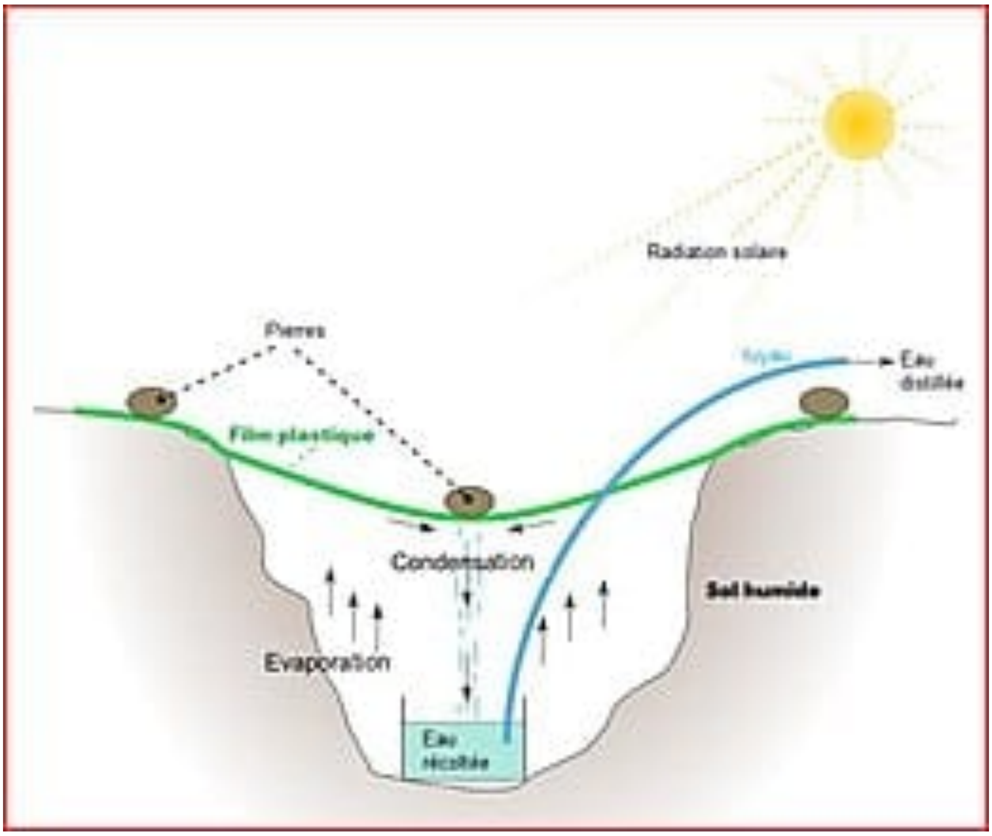


Fig 1: Renewable Energy

B) Maglev Wind Turbine: -



Introduction Diagram

CHAPTER – 2

LITERATURE SURVEY

BOOK/JOURNAL/ PAPERS/ARTICLE	AUTHOR	DATE OF PUBLISH

A Comprehensive review of direct solar desalination techniques and its advancements	Chauhan VK, Shukla SK, Tirkey JV, Singh Rathore PK	15 October 2020
Experimental study on various solar still design	T. Arunkumar, K. Vinoth Kumar, Aminul Ahsan, R. Jaya Prakash, Sanjay Kumar	3 May 2012
Solar thermal desalination system with heat recovery	Klemens Schwarzer, Maria Eugenia Vieira, Christian Faber, Christoph miller	17 August 2000
Monthly performance of passive and active solar still for different Indian climatic conditions	H.N. Singh, G.N. Tiwari	24 February 2004

A Thermal model for predicting the performance of a solar still with fresnel lens	Ana Johnson, Lei MU, Young Ho Park, Krishna Kota, Sarada Kuravi	7 September 2019
An Experimental study on Hemispherical solar still	T. Arun kumar, R. Jayaprakash, D. Denkenberger, H.S. Aybar	21 December 2011
Effect of top cover tilt angle with ground surface on productivity of basin type solar distillation unit	Hosney Ara Begum, M. Abu Yousuf, K.S. Rabbani	14 November 2018

CHAPTER – 3

METHODS OF DESALINATION

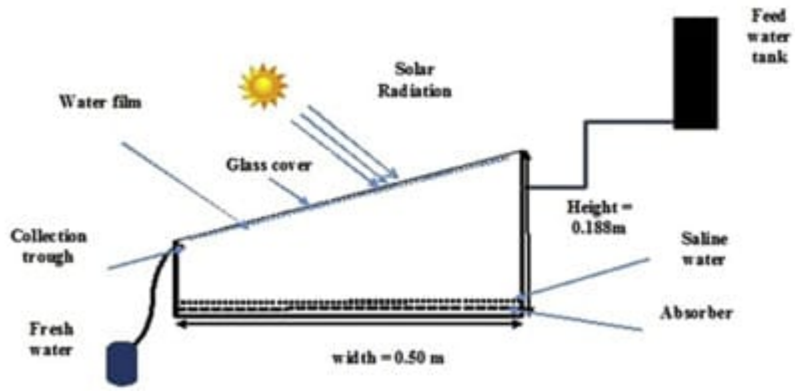
Solar desalination is combined process of basic phenomenon like evaporation and condensation. Based on conditions and requirement it can be classified.

Solar desalination can be done in two methods

- Direct method
- Indirect method

<u>DIRECT METHOD</u>: -

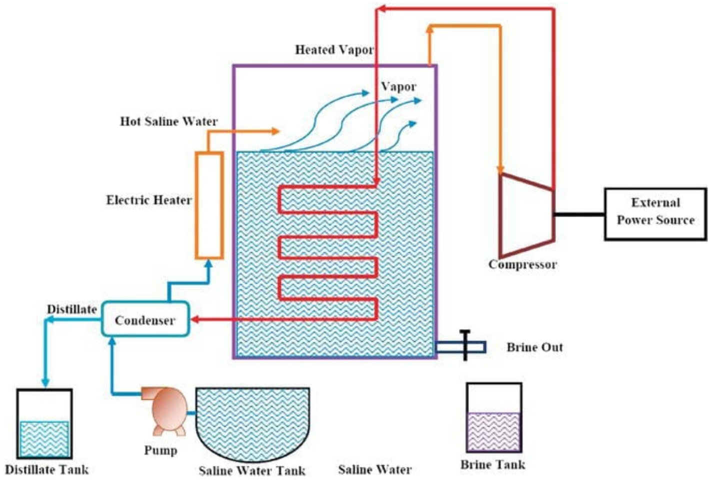
- Direct method is a simple process in which we use direct solar energy for evaporation of water.
- In this apparatus a tub is used which is good heat conductor copper and steel for evaporate the water.
- There will be a glass panel on top of apparatus for direct contact to sunlight and to condensate water as it is bad conductor of heat.
- Condensed water will be collected into collecting tank.
- The process can be enhanced by adding the reflectors to increase evaporation.



Direct Method

INDIRECT METHOD: -

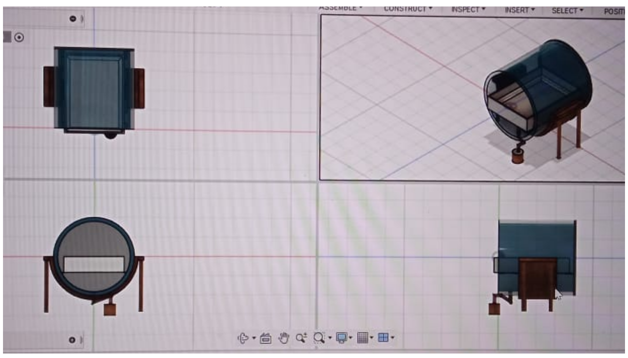
- Indirect method is complex phenomena in which a setup consisting heater, pumps, condenser, heat exchanger.
- In this method solar energy is collected and through heater water will be heated.
- The condensation can be done by pumps to decrease temperature and condensers are used to condense vapour and turn it into liquid state.



Indirect Method

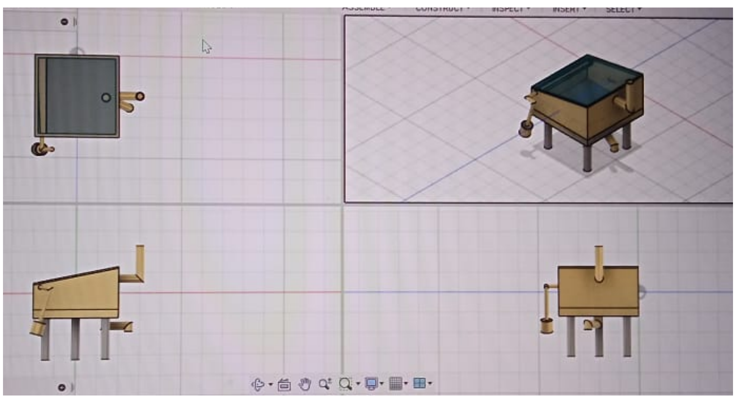
CHAPTER – 4

DESIGN OF VARIOUS SOLAR STILL



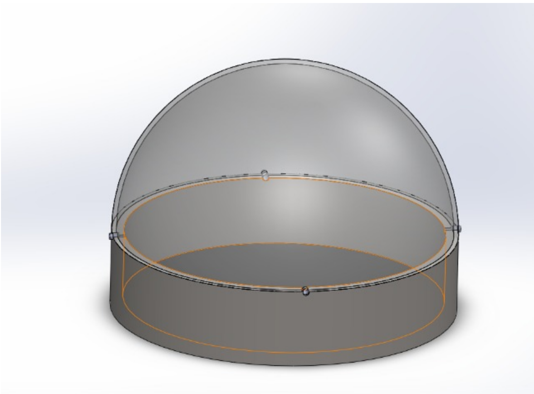
TUBULAR STILL

A CPC concentric tubular solar still design with a rectangular absorber picture. The inner and outer circular tubes are positioned with a 5 mm gap for the flowing water and air to cool the outer surface of the inner tube. A rectangular trough of dimension 2 m×0.03 m×0.025 m is designed and coated with black paint using a spray technique. The water level in the trough decreased due to fast evaporation from the basin, so a dry spot appeared in the basin. This is avoided in successive trials by flowing the water continuously in the still with the help of a graduated tube. This tube maintains a constant level of water in the basin independent of the evaporation rate. This continuous supply of water is maintained by a water storage tank, which is kept near the CPC still. The outlet of the storage tank is connected to the inlet of the CPC still.



Single Slope Solar Still

The single slope solar still is one of basic and traditional model of solar still. The solar still with the dimensions 1 m×1m×0.5m. The outer basin is made with copper and inner side painted with absorber black paint to absorb more heat.



Hemispherical Solar Still

The water storage basin of the hemispherical still is constructed with a diameter of 0.95 m and a height of 0.10 m using mild steel. The water storage basin is painted black to increase the absorptivity. The still was filled with saline water to a height of 0.05 m. The top hemispherical cover of diameter 0.945 m and height 0.20 m is constructed of transparent acrylic sheet of 3 mm thickness with solar transmittance equal to 88%. The outer box of the still is constructed of wood of thickness 4 mm with the dimension 1.10 m × 1.10 m × 0.25 m. The bottom of the basin is filled with sawdust (to support the weight of the basin) up to a height of 0.15 m. The sides of the basin are insulated with the glass wool.

CHAPTER – 5

NOMENCLATURE OF CALCULATION

Convective heat transfer:

$q_{c,\, w\text{-}g} = h_{c,\, w\text{-}g} * (T_w - T_g)$

$h_{c,\, w\text{-}g} = [[(P_w - P_g)/(268.9*10^3 - P_w)]*(T_w+273.15)+(T_w T_g)]^{(1/3)}$

$P_w = \exp(25.317 - (5144/T_w+273.15)$

$P_g = \exp(25.317 - (5144/T_g+273.15)$

Evaporative heat transfer:

$q_{e, w-g} = h_{e, w-g} *(T_w - T_g)$

$h_{e, w-g} = 16.23*10^{-3}*h_{c,w-g}*((P_w - P_g)/(T_w - T_g))$

Hourly yield:

$m_e = [(h_{e,w-g}*A*t_{int}*(T_w - T_g)/L_v]$

$L_v = (2501.67 - 2.389*T_w)*10^3$

Daily production:

$M_e = \Sigma m_e$

Nomenclature:

$q_{c,w-g}$= convective heat transfer rate from water to glass cover (w/m^2)

$q_{e, w-g}$ = Evaporative heat transfer from water to glass cover (w/m^2)

$h_{c,w-g}$ = Convective heat transfer coefficient from water to glass cover ($w/m^2\,{}^oc$)

$h_{e,w-g}$ = Evaporative heat transfer coefficient from water to glass cover ($w/m^2\,{}^oc$)

T_w =Temperature of water (°c) = 58.2°c

T_g= Temperature of glass (°c) = 45.5°c

P_w = partial pressure of water (N/m^2)

P_g = partial pressure of glass (N/m^2)

A = Area of the basin (m^2)

t_{int} = time interval (s) = 3600 sec

m_e =hourly predicted yield (kg)

M_e = daily production (kg)

L_v = Latent heat of vaporization (j/kg)

CHAPTER – 6

CALUCLATIONS OF TABULAR SOLAR STILL

Let,
Rectangle basin,
Length – 1.5 (1500 mm)
Breadth – 0.5 m (500 mm)

Area of Basin

Area of rectangle = l * b

$= 1.5 * 0.5$

$A = 0.75\ m^2$

Assume,

Temperature of glass, T_g = 42.5 ^{C}

Temperature of water, T_w = 58.2C

Time interval, t_{int} = 3600 sec

Partial pressure of water:

$P_w = \exp[(25.317) - 5144/T_W + 273.15]$

$P_w = \exp[(25.317) - 5144/331.35]$

$P_w = \text{epx}[(25.317) - 5144/331.35]$

$P_w = \exp[(25.317 - 15.524]$

$= \exp(9.793)$

$P_w = 17907.9495\ N/m^2$

Partial pressure of glass:

$P_g = \exp[(25.317) - 5144/T_g + 273.15]$

$= \exp[(25.317) - 5144/318.65]$

$= \exp[(25.317 - 16.143]$

$= \exp[9.174]$

$P_g = 9643.1201\ N/m^2$

Convective heat transfer coefficient from water to glass:

$h_{c,w\text{-}g} = 0.884[(p_w - p_g/268.9 * 10^3 - P_w) * (T_w + 273.15) + (T_w - t_g)]^{1/3}$

$=0.884\ [(17907.9495-9643.12301)/268.9*10^3 - 17907.9495)*\ (58.2 + 273.15) +(58.2 – 45.5)]^{1/3}$

$= 0.884[8264/250992.0505 * 331.35 +12.7]^{1/3}$

$= 0.884[23.6109]^{1/3}$

$= 0.884(2.8688)$

$h_{c,w-g} = 2.5360\ W/m^2$

Convective heat transfer from water to glass cover:

$q_{e,w-g} = h_{c,w-g}[t_w - t_g]$

$= 26.753(12.7)$

$q_{e,w-g} = 340.1733\ w/m^2$

Evaporative heat transfer coefficient from water to glass:

$h_{e,w-g} = 16.23 \times 10^{-3} \times 2.5360 \times [\ 8264.8294 / 12.7\ ]$

$= 0.04115928 \times 666650.7739$

$H_{e,w-g} = 26.7853\ W/m^2$

Evaporative Heat transfer from water to glass:

$q_{e,w-g} = 26.7853\ [58.2 – 45.5\ ]$

$q_{e,w-g} = 340.1733\ W/m^2$

Latent heat of vaporization:

$L_v = (2501.67 – 2.389 * T_w) * 10^3$

$= (2501.67 – 2.389 * 58.2) * 10^3$

$L_V = 2362.6302 * 10^3$

Hourly Yield:

$M_e = [\, h_{e1,w\text{-}g} \; * A * t_{int} * (T_{int} - T_g)]/L_V$

$= [26.7853 * 0.75 * 3600 * 12.7/ 2362.6302 * 10^3]$

$= 918467.937/2362.6302 * 10^3$

$M_e = 0.388748$ kg

Daily productivity:

$M_e = \Sigma_1^{24}\, m_e$

$= \Sigma_1^{24(0.388748)}$

$=24(0.388748)$

$M_e = 9.3229$ Kg

CHAPTER – 7

DIFFERENT INPUTS AND OUTPUTS

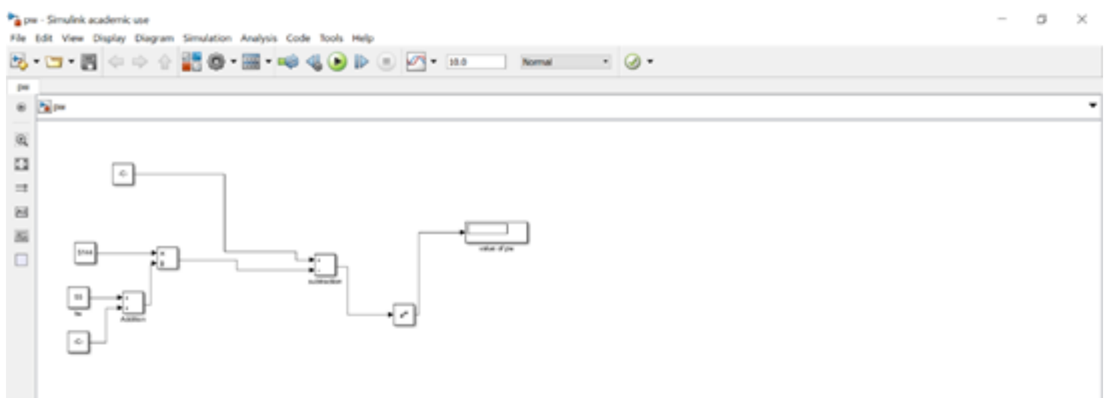
S.NO	MASS PRODUCTIVITY (DAILY) (Litres)	EVAPORATIVE HEAT TRANSFER FROM WATER TO GLASS (qe,w-g) (w/m^2)	EVAPORATIVE HEAT TRANSFER COEFFICIENT FROM WATER TO GLASS ,w-g) (w/m^2)	CONVECTIVE HEAT TRANSFER FROM WATER TO GLASS (qc,w-g) (w/m^2)	CONVECTIVE HEAT TRANSFER COEFFICIENT FROM WATER TO GLASS (hc,w-g) (w/m^2)	TEMPERATURE OF GLASS Tg (°c)	TEMPERATURE OF WATER Tw (°c)

1	2	3	4	5
9.769	10.999	6.460	12.153	7.2312
3.4017×10^2	3.8303×10^2	2.2500×10^2	4.2321×10^2	2.5178×10^2
26.7853	23.79	40.5	21.53	36.19
3.2207×10^1	3.6265×10^1	2.1302×10^1	4.0069×10^1	2.3838×10^1
2.5360	2.5926	2.3694	2.6390	3.4137
45.5	44.4	48.1	39.2	50.2
58.2	58.7	56.5	55	59.6

Input and Outputs

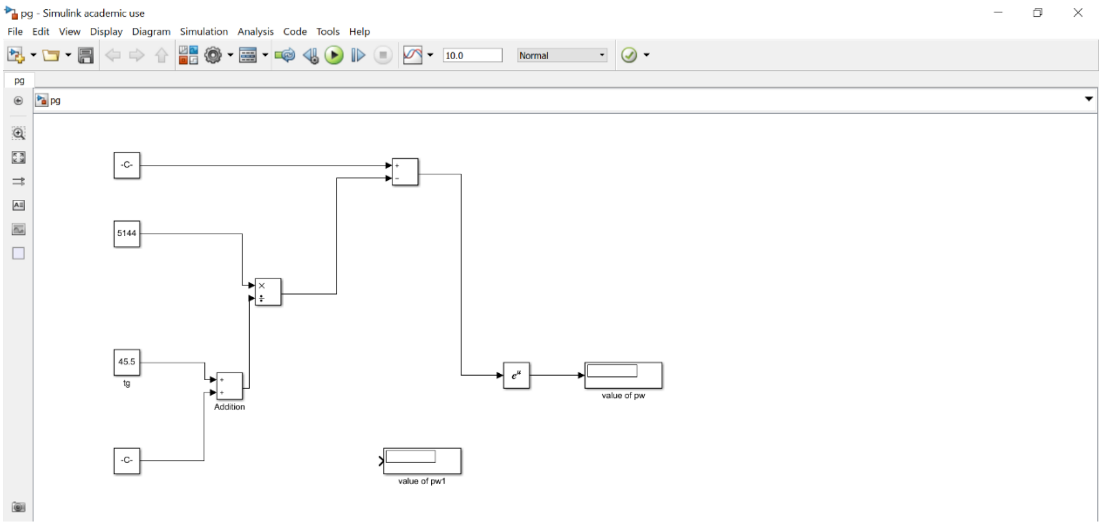
CHAPTER – 8

CALCULATIONS USING MATHLAB



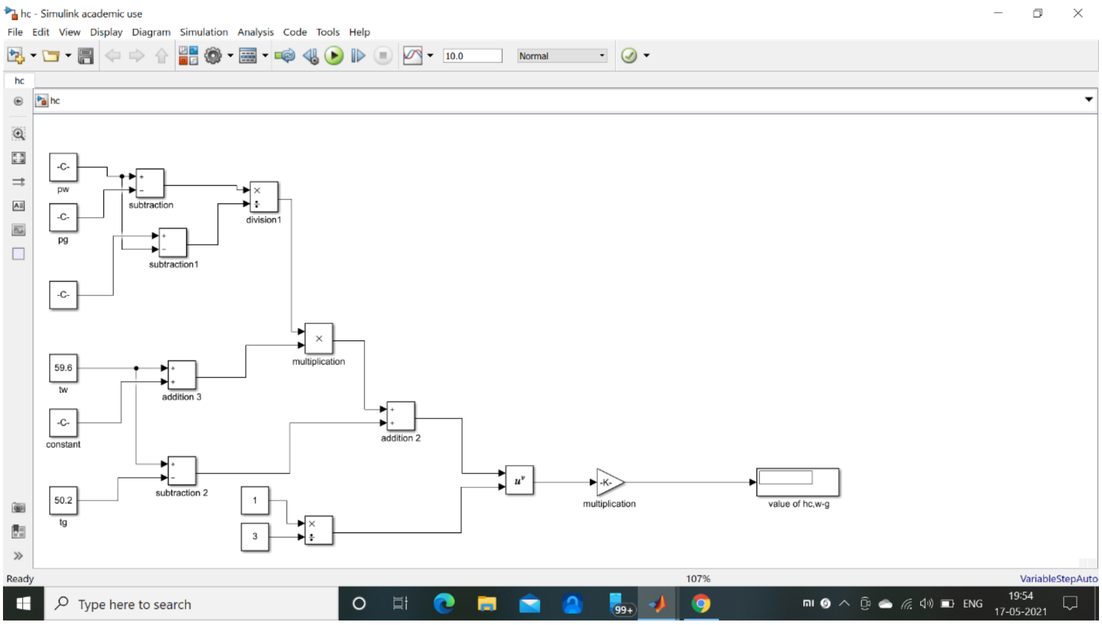
Partial Pressure of Water

We simulated the formula of Partial pressure of water (Pw) in Mathlab Simulink. By substituting the Temperature of water (Tw) value in the formula we get the Pw value. The above picture is the screenshot of the formula we generated in Mathlab Simulink.



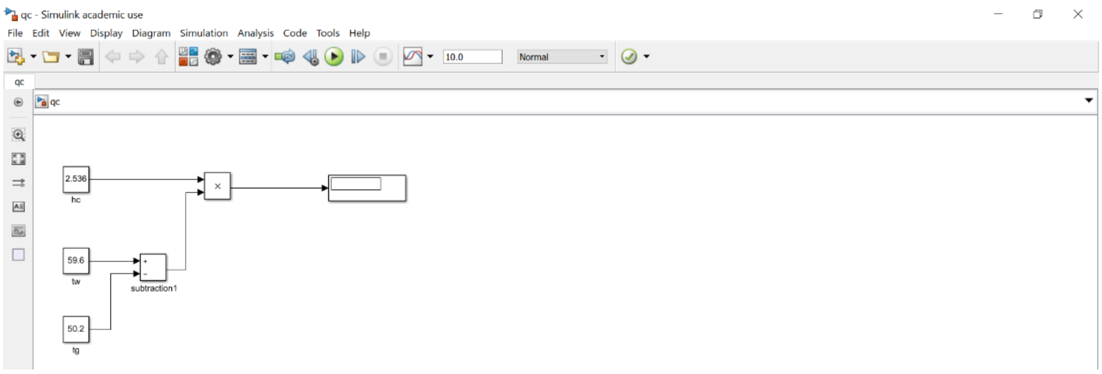
Partial Pressure of Vapour

We simulated the formula of Partial pressure of glass (Pg) in Mathlab Simulink . By substituting the Temperature of glass (Tg) value in the formula we get the Pg value. The above picture is the screenshot of the formula we generated in Mathlab Simulink.



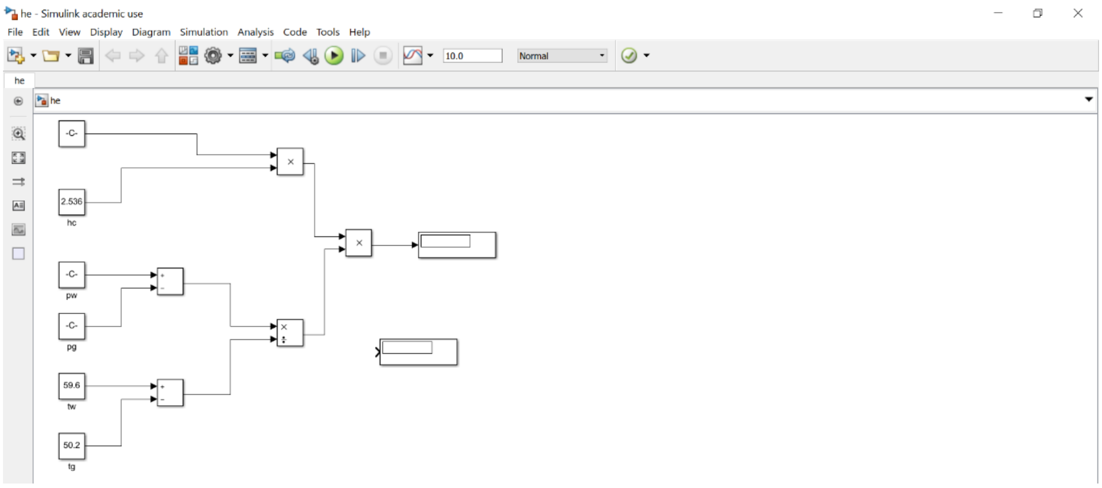
Convective Heat Transfer Coefficient from Water to Glass

The above picture is the screenshot of the formula 'Convective Heat Transfer coefficient from water to glass(hc)' that we generated in the mathlab. By substituting the Tw, Tg, Pw, Pg values in the formula we get the hc value.



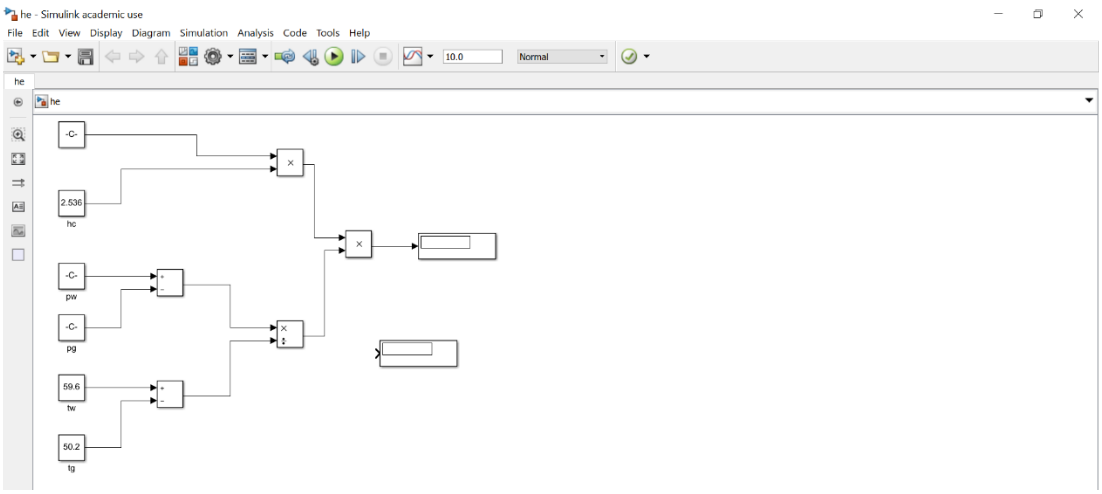
Convective Heat Transfer from Water to Glass

The above picture shows the mathlab simulation of the 'Convective Heat Transfer from water to glass' (qc). By substituting the Convective Heat Transfer coefficient from water to glass (hc), Temperature of water (Tw) and Temperate of glass (Tg) values we get the final value of qc.



Evaporative Heat Transfer Coefficient from Water to Glass

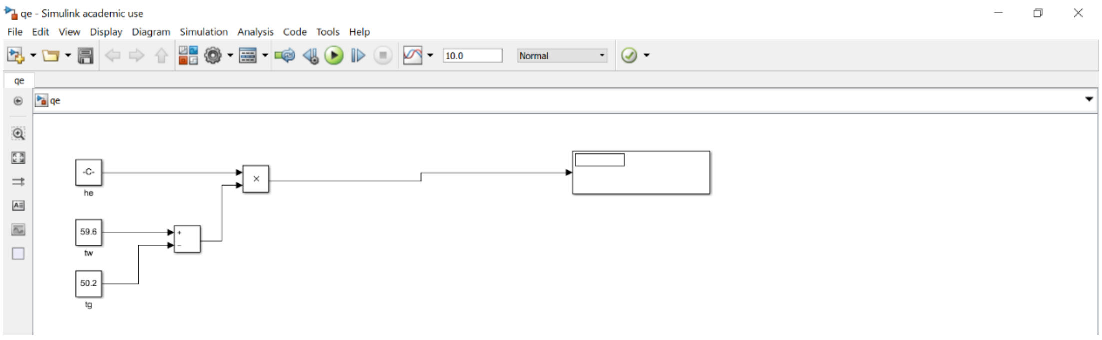
The above picture is the screenshot of the formula 'Evaporative Heat Transfer coefficient from water to glass(he)' that we generated in the mathlab. By substituting the Convective Heat Transfer coefficient from water to glass (hc), Temperature of glass (Tg), Temperature of water (Tw), Partial pressure of water (Pw), Partial pressure of glass (Pg) values in the formula we get the he values.



Evaporative Heat Transfer Coefficient from Water to Glass

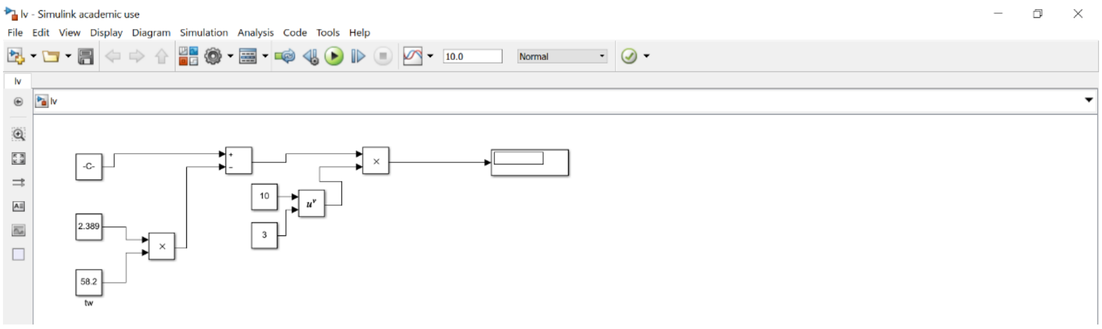
The above picture is the screenshot of the formula 'Evaporative Heat Transfer coefficient from water to glass(he)' that we generated in the mathlab. By substituting the Convective

Heat Transfer coefficient from water to glass (hc), Temperature of glass (Tg), Temperature of water (Tw), Partial pressure of water (Pw), Partial pressure of glass (Pg) values in the formula we get the he values.



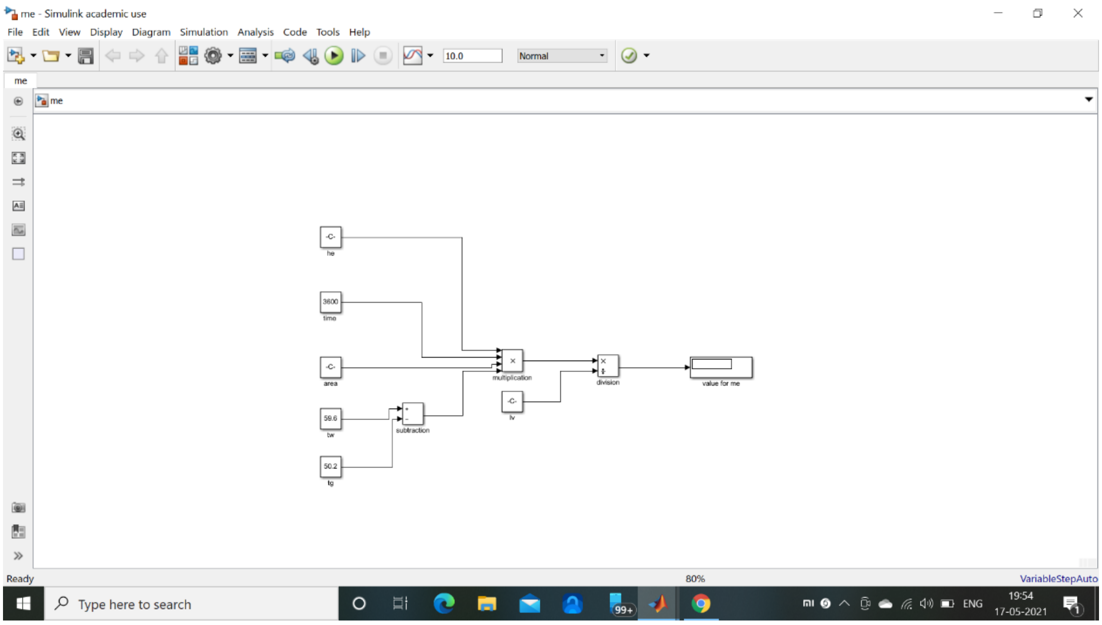
Evaporative Heat Transfer from Water to Glass

The above picture shows the mathlab simulation of the ‘Evaporative Heat Transfer from water to glass(qe)’. By substituting the Evaporative Heat Transfer coefficient from water to glass (he), Temperature of water (Tw) and Temperate of glass (Tg) values we get the final value of qe.



Latent Heat of Vaporization

We simulated the formula of Latent Heat of Vaporization (Lv) in Mathlab Simulink. By substituting the value of Temperature of water (Tw) we get the Lv. The above picture is the screenshot of the Lv formula that we generated in Mathlab.



Hourly yield

Hourly yield (me) we can get this value by substituting the Evaporative heat transfer from water to glass (he), Area of the basin (A), Time interval (tint), Temperatures of water and glass (Tw, Tg) and Latent Heat of Vaporization (Lv). The above picture is the screenshot of the formula we generated in Mathlab.

CHAPTER – 9

CONCLUSION

In this project, comparison of three models has been done (Tubular Solar Still, Single Slope Solar Still, Hemispherical Solar Still) performance and analysis work is done between these models has been presented. The analysis has been done theoretical and simulated model in mathlab software of different parameter in different condition. From the results analysis the tubular solar still model shows the maximum productivity at a volume of around 9.4 liters per day. Even these parameters vary on conditions most of the conditions tubular solar still is more productive and efficient when compared to the other two models. This led to a conclusion that tubular solar still is best choice and also when it comes to affordable or cost efficiency single slope solar still is best. This leads to raise the evaporative and convective heat transfer coefficients in the solar still. The concentrator effect plays a vital role to increase the water temperature up to 95◦C compared to the other types of designs. So evaporative heat transfer is more for tubular solar still, and it is showing the maximum amount of yield.

CHAPTER – 10

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