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College of Post Graduate Studies

Performance test of Flat Plate Collector In Atbara

A thesis Submitted in Partial Fulfillment of the Requirements of the M.Sc. IN Mechanical Engineering

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الآية

بسم الله الرحمن الرحيم

قال تعالي:

وَالشَّمْسُ تَجْرِي لِمُسْتَقَرٍّ لَّهَا ذَلِكَ تَقْدِيرُ الْعَزِيزِ الْعَلِيمِ {38}
وَالْقَمَرَ قَدَّرْنَاهُ مَنَازِلَ حَتَّى عَادَ كَالْعُرْجُونِ الْقَدِيمِ {39} لَا الشَّمْسُ يَنبَغِي لَهَا أَن تُدْرِكَ الْقَمَرَ وَلَا اللَّيْلُ سَابِقُ النَّهَارِ وَكُلٌّ فِي فَلَكٍ يَسْبَحُونَ {40}

صدق الله العظيم .....

(سورة يسن الآيات 38 – 39 – 40)

Dedication

Human teacher and prophet of mercy - Prophet Muhammad (peace be God attic ibex his family and him) - Because of its bounty to mankind after God Almighty
To any of the charity is a god and down the flank for them Mom and Dad
Cherish and pay homage
To safe pure innocent brothers' hearts
Thank you and meet
My teachers to any and all of the characters taught me
In response to some of the beautiful
To each of these dedicate this modest work

Thanks, and gratitude

I extend my sincere thanks and gratitude to any All those who contributed in the output of this research this his image

And especially thank Mr. Respected:

Mr. Khalid Taha

Who has spared no effort in providing all do not know I had the help of God after the access results of this research

Abstract

The use of energy varies over time depending on the level of economic growth, weather conditions, energy prices and many other factors. The world's energy consumption began to increase with a drop-in energy prices.

It is easy to conclude that as demand for oil increases, prices will rise as a result of the increasing rate of energy consumption and the depletion of other sources of energy, such as renewable energies.

And enjoy the Nile River and especially the city of Atbara excellent solar card can be used for thermal generation through flat solar complexes and you experience a solar complex at the Faculty of Engineering Atbara through the flow of water naturally. The aim of the research was to study the performance of the solar complex. The temperature curves of the 96C system were upgraded and the efficiency of the system was increased by 45%. It was observed that the efficiency increased gradually since the morning. It reaches its peak in the afternoon and gradually decreases in the evening.

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Terms:

Ac (m^2)≡ complex area

≡ thermal transfer coefficient F_R F_R

≡ solar Irradiation intensity $w \backslash m^2$ I

≡ medium degree of complex heat (℃) T_C

T_i ≡ degree of fluid inside the compound temperature (℃)

T_o ≡ degree movement of water outside of the compound (℃)

Ta ≡ ambient temperature (℃)

U_L ≡ heat loss coefficient $(w \backslash m^2)$

Q_i ≡ the amount of heat input of the compound (W)

Q_O ≡ the amount of heat lost from the compound (W)

Q_U ≡ amount learned, including heat $(w \backslash m^2)$

m^o ≡ mass flow rate of the water passing through the compound $(kg \backslash s)$

η ≡ complex thermal efficiency

τ ≡ permeability coefficient of the surface of the transparent

α ≡ absorbance coefficient of the surface of the transparent

If (I_t) is solar radiation $(w \backslash m^2)$ incident intensity on the flat solar collector area $(w \backslash m^2)$ the amount of heat received by the complex are:

$$Q_i = AI_t \text{.....} \quad (1)$$

1.1 Introduction:

The sun is something we all take for granted and yet without it there would be no life. It can be split into three maim zones namely, the core the radioactive zone, and the convective zone. {1} It is a sphere made up of intensely hot gases (mainly hydrogen and helium), the center of which is unimaginably hot and under extreme pressure.{1} This pressure caused by the Sun s gravitational pull is high enough to force atoms of hydrogen to come to gathering nuclear fusion reaction.{1}

This reaction energy to be released which travels outwards from the suns core through the radiative zone in the form of photons. As one photon is made it travels about 1 micron before being absorbed by a gas molecule. Upon absorption the gas molecule heats up and re-emits another photon of the same wavelength and so on once this energy has passed through the reactive zone it enters the convective zone where the energy is carried outwards by convective. (Rising movements of hot gas and falling movements of cooler). It is then radiated out into the emptiness of space at the speed of light before reaching the Earth's atmosphere. At this point insulation is said to be constant (known as the solar constant) and is around $1.370 \ {}^{w}/_{m^2}$. As the solar energy enters

{1} the Earth's atmosphere some of it is absorbed defected and or reflected (scattered) by clouds, water vapor and particles in the air. We receive light (or solar energy) in two forms, direct and diffused Direct light or beamed light reaches us without defection and is easy to distinguish because it creates a shadow and is more intense than distinguish it creates a shadow and is more intense than diffused light, Diffused light is light that has been scattered usually by clouds or the Earth's atmosphere, but also objects such as buildings and mountains etc. It simulate-directional and so does not cast a shadow. Solar – thermal collectors are able to convert both forms of solar radiation into usable hot water.

1.2 The use Of Solar Energy:

1. used to generate electrical power through solar cells

2. used in thermal power generation using solar collectors. There are two types of collector

(i). Flat plat collector

(ii). concentrated collector

1.3 Aim and Objective:

This research aims to study the performance of Flat plat collector

1. Testing the performance of the collector in two ways

2. Develop computer program to analysis the result

3. Compare the experimental result with the theoretical

Chapter Two

Energy

Introduction:

2.1 RenewableEnergy:

Energy use throughout the ages is different depending on the different level of economic growth, conditions Weather, energy prices, and many other factors. At the end of the eighties and even in 2000 began our energy consumption on the rise with a decline in energy prices and a strong development of the economy {1}. Currently however the remarkable rise in energy prices has been giving great attention to the extent the possibility of energy conservation and retain it for as long as possible. This is easy to conclude that the greater the demand for oil has increased, the prices will rise as a result of rate Increased consumption of energy and the depletion of fossil fuel sources. This in turn encourages work Programs based on the use of other energy resources such as renewable energies, nuclear energy and energy Coal as a source of energy production. It is expected that the average global energy consumption is growing at a rate of 2% per annum in the period from 2003 to 2030 and the rate of consumption will continue to grow As a result of the strong growth of the economy {1}. It is expected that renewable energy sources play an important role in the future the following are the main Renewable energy sources:

2.1.1 Biomass:

Start of forests and agricultural crop residues down to crops grown specifically for the production of energy and any organic materials. And mass provide vital oxygen producing feature during operations growth it is also released during the combustion or shift operations and generate ratio of carbon and less toxins from fossil fuels.

2.1.2 Solar energy:

It is one of the sources of energy that can be highly reliable as it has many uses which include heating operations and electric power generation.

This differs Solar energy applications for different types applicable technology such as solar water heating and energy Concentrated solar and solar photovoltaic and passive lighting and heating passive cooling. the heat extracted from the ground, a clean reliable power. and sources Thermal energy extracted from the soles of multiple land are starting from shallow water and land Hot, hot rocks and where we find them a few miles from the Earth's surface. And rocks Volcanic magma that exist at great depths from the surface where the temperature is there Thigh.

2.2.1 Wind Power:

Use of wind power in the next generation of electricity and charge batteries and water pumping and grinding purposes grain. The air turbines convert the kinetic energy into other forms of energy and there Modern and large turbines installed in wind farms to produce electricity to be used for different purposes. A small wind turbine used by homeowners is also used in areas and remote villages in order to meet energy needs.

2.2.2 Hydrogen Energy:

It is a clean source of energy available and which plays an important role in reducing greenhouse gas Harmful where water is produced from hydrogen burning in the air or oxygen.

2.2.3 Introduction TO Solar Energy:

The renewable energy sources are sources that generated on natural manner and permanently, which is renewed every day as long as the sun remains and This kind of energy useful to humans and can take advantage of these resources without impact on the environment, the main source of these energies is the sun and gravity and rotation of the Earth, most of renewable energies such solar as energy, wind and wave energy and ocean energy heat their source and the main source is solar radiation. Sun is the source of life on the planet which is a gaseous ball with a diameter of 696 million meters, and its mass about 2*10^ 29

tons, and the degree of surface about 6000 ° C, the basic components are: hydrogen gas (about 75%) and helium gas (about 25%) in addition to small amounts of some other elements such as iron, silicon, carbon and neon {4} solar power generated by the ongoing transformation of each four atoms of hydrogen to one atom of helium in a nuclear fusion reaction {4}. As the helium atom mass resulting from less than the sum of hydrogen atoms involved in it blocks the interaction of this bloc teams turns into light and heat rays transmitted on a body their emission rate of 3.8*10^ 23 Kw {4}. This quantity radiates in all directions and did not get but a small proportion to the amount of land area and with the distance between the Earth and the sun of them. The sun sends its rays in the form of a stream of particles called (photons). And it kicks off the solar radiation in the form of different lengths parallel wavelengths packages, and this visible and invisible ray. And radiation him wavelengths between (0.53 and 0.75) micrometer, and infrared (invisible) of (0.75, 100) micrometers, X - R (invisible) more than 100 micrometers {4}. The rays that at least for the length of the wavelength of visible light waves with greater power are called ultraviolet, X - rays, and They rays, and cosmic rays. In spite of the incoming solar radiation on the atmosphere consists of a broad range of positive packets,

however, approximately 98% of it is made up of three types of rays are: UV (8%), visual and X-ray (47%), and infrared (43 %). Therefore, the higher the intensity of solar radiation lies in the extent of visible light and an incident solar radiation on the outer periphery of the land of 1366 watts per square meter rate value is the famous solar cosmological, and exposed during its path through the atmosphere to the Earth's surface to cases of proliferation and absorption and reflection by the casing components ocean gaseous globe as these components operate, including the different gases and dust and water overalls airborne absorption and refraction and reflection part of the solar radiation hyphen in percentage Earth's surface as shown in Figure (2-1).

Painting percentages of solar radiation

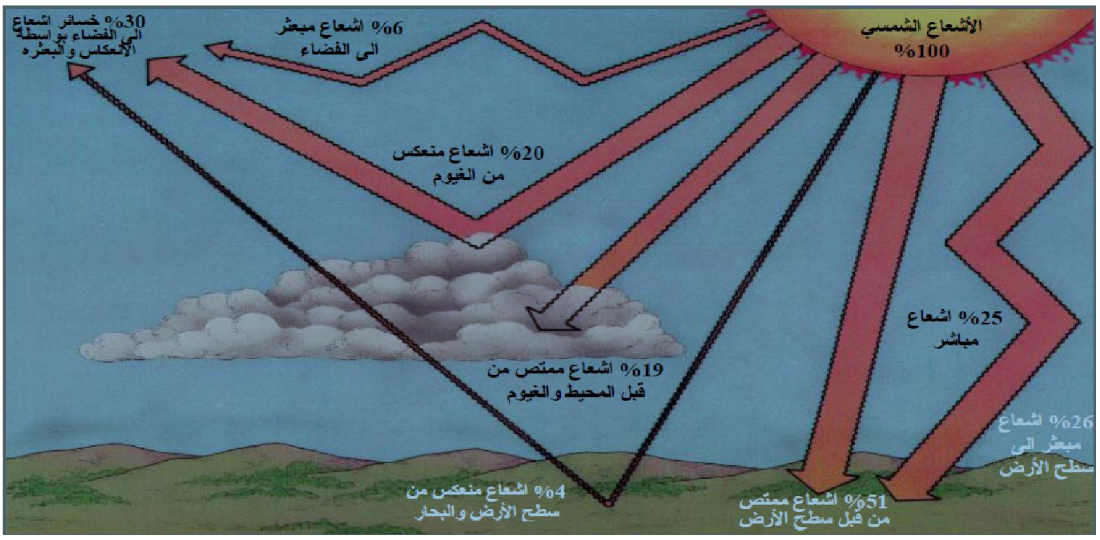


Figure (2-1) percentage distribution of solar radiation {3}

Energy reaching us from the sun of the most important types of energies that can be exploited for man they considered a permanent energy and nor produces used for gases or secondary products harmful to the environment compared to other sources, and never let remnants of the degree of risk, such as radioactive waste left behind when the use of nuclear energy. The idea of using solar energy for heating or to move the machines are not new at all and tell us the date that Archimedes, who lived in the third century BC has used the sun's rays in the burning of some enemy ships in one of the battles of war is believed that he used some of the mirrors to focus sunlight on these masts ships. become solar its proper place among other sources of energy for the time being adopted large budgets in most countries to take advantage of this energy, as there were many proposed ways to benefit from them, such as: the use of mirrors to collect sunlight, or invent ways to collect the sun's heat and absorbed, Conversion sunlight into electrical energy by solar cells and other uses.

2.4 Uses OF Solar Energy:

uses optical:

Associated with solar energy conversion directly into energy, electric solar cells made mostly of material silicon {5}.and the reason is that this method is the most common and widely used is concentrated around a lot of efforts to develop them, and pinned them very much hope that make a significant contribution in energy use solar effectively for energy production Electric, which has high flexibility on the one hand they can be used in all areas that require energy.

2.5 Solar Cell:

Are those crystalline material that are impurities cultivation where the composition of a positive charge materials and other negatively charged and separated or meet at the contact points, and produces Alfotvuolati influence where the radiation absorbed securing atoms in the vicinity of Mosul, any liberalization of electrons If the radiation energy absorbed is greater than Energy bind electrons corn, this leads to free electrons and the formation of pairs of electrons – the gaps, and lead in turn to bring the power of electric movement can make entry into electric current and become the electrons liberated in the negatively charged

region while becoming the gaps in the positively charged region, and thereby generate a difference voltage and electric current runs in the circuit if the link ends of the two wire connector.

Energy photons of sunlight depends on the optical wavelength alfotonat whose capacity is greater than energy link electrons maize occur Alfotvuolati effect, the photons that are overloaded less they absorb and generate heat only without generating effect Alfotvuolati or voltage, and even for the same energy of the photons The large part of the capacity is used to generate Alfotvuolati influence while the other part leads to the generation of heat.

Manufactures photovoltaic cells of different materials silicon and arsenic gallium and cadmium sulfide{5}. in addition to the difference in materials, the there are numerous roads for the manufacture of cell solar of the same material and influence of these factors, whether a difference materials or manufacturing variability ways in solar cell efficiency, which in the conversion efficiency of solar radiation energy to electrical energy, cells made of silicon also be made of chips and have efficiency ranging between $(12-18\%)$ {5}. and either way you know membrane slave ranging efficiency between $(2-5\%)$, while the solar made the cells of arsenic gallium, which is still in the process of testing The total efficiency

(16-20%), and the cadmium sulfide cells efficiency amounts (5-8%).

To raise solar cell experiments carried out on the use of solar complexes concentrated to the concentration of more solar radiation on the cell and increase the production of electric power, is that this method collides with the negative impact on the efficiency of the high degree of cell temperature efficiency therefore being considered in the cooling solar cells and take advantage of the heat effect so cell into a solar collector electric - thermal electric power and thermal energy produced in the same time.

2.6 Thermal Uses

There are many uses of solar thermal energy and the most common ones include:

2.6.1 Electric Power Generation Thermal Transfer

The production of electric energy thermal conversion of solar energy does not differ from its production in the traditional way but in the fact that solar radiation is the heat source, which is to provide the session its requirements of energy instead of the use of fuel and instead use for the production of steam with high pressure and high temperature boiler, the complexes solar this role and This to difference between power plants and fuel stations powered by solar is to replace fuels the sun's rays and

solar collectors are used instead of the boiler.

Electrical power station consists thermal conversion of solar energy from

Described parts in Figure (2-2).

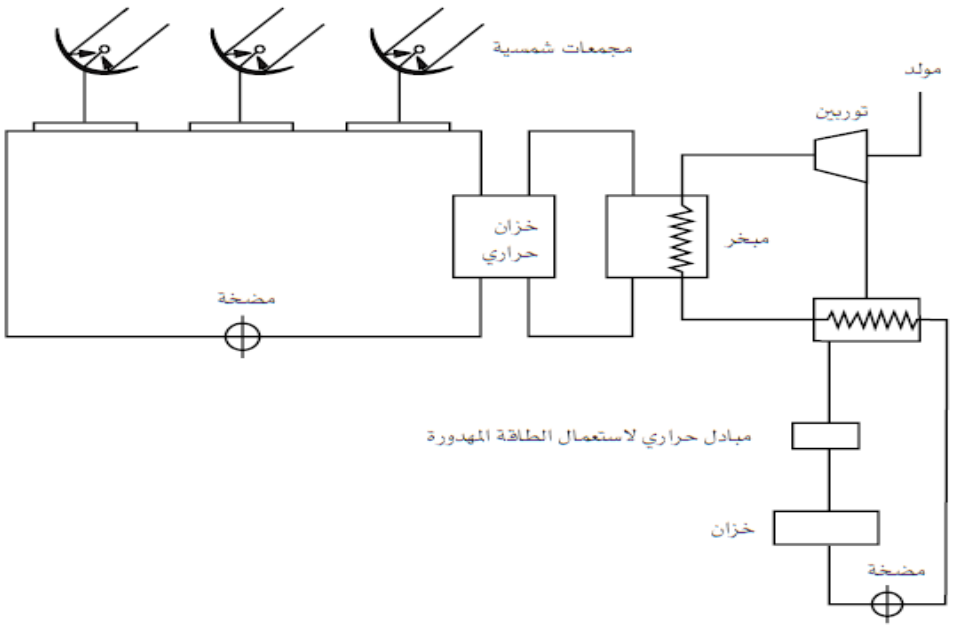


Figure (2-2) master plan for electric generating station solar{4}

2.6.2 The Use OF Solar Energy in The Absorption Cooling:

The absorption cooling systems similar to systems cooling strut normal but it differs that there is no compressor, and are in these systems modify the compressor a generator fed from the heat source, and in the solar absorption cooling systems are solar collectors role heat source which provides system Refrigerating its requirements, as shown in Figure (2-3).

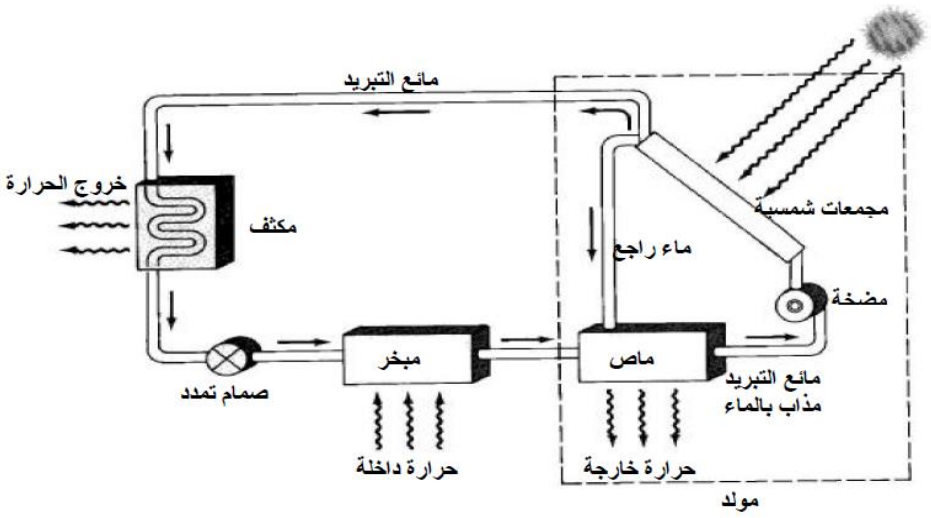


Figure (2-3) cooling system absorbency are fed from solar source {4}

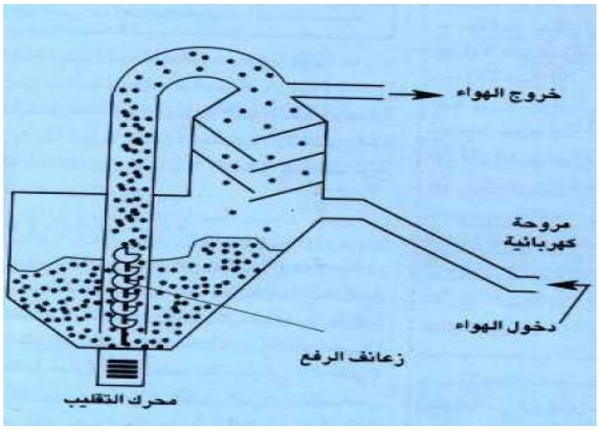
In these systems two solutions is used instead of Freon used in the strut cooling systems, namely: a mixture of ammonia and water, or a mixture of lithium Brohmeyt and water. And usually it uses ammonia and water solution in the lithium-icing systems Brohmeyt solution and water it uses in normal cooling systems and used for the purposes of adapting the air. And enter the solution to the generator, which is processed by heating it by solar energy complexes this is caused in the ammonia solution for gas separation.

2.6.3 Solar Energy Use In Agricultural Crop Drying:

Drying is generally one of the oldest uses of solar energy land is the suit and rainwater dry thanks resulting from solar radiation and the movement of wind-heat, the clothes washed dry quickly when exposed to sunlight, as well as dry trees, fruits and crops papers by the sun, and can preservation the nutritional value of fruits and crops when dried by

This solar energy as well as in percentage cleanliness and the quality of fruits and crops after the drying process and submission maintain natural freshness in the off-season. And solar dryers consist of three main parts.

Heating unit, drying unit, and the unit move the air inside the dryer. These units differ from each other depending on the type of powder. Dryers solar vary depending on the diversity of agricultural crops, there dryers Berger to dry field crops (cereals, pulses, etc.), and there is a potpourri flat to dry bulky crops (fruits, dates, vegetables, etc.) Figure (1-4) planned to Dryer one works natural entry into force and the other works entry into force Disappearance



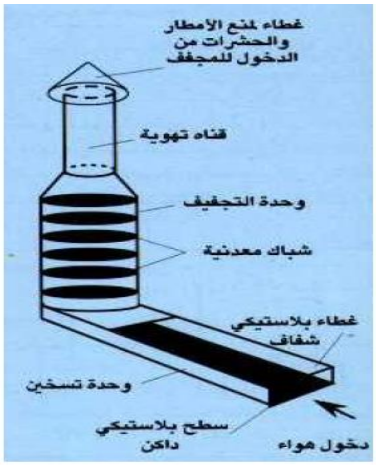


Figure (2-4) dryer works natural entry into force and dryer works forced entry into force {3}

2.6.4 Solar Energy Use in Cooking:

The use of wood as a source of energy in the rural areas to the extinction of large tracts of forest have this place has become a problem for environmental sizeable, and that the use of solar energy for cooking

is one of the possible solutions to this problem, especially cost few and obtained very moving, and supports the scientific basis of the solar cooker to take advantage of the principle of global warming caused by the fall of the solar radiation and reflection inside the insulated box in all its aspects good thermal insulation except the higher side facing the sun as it covers plank of glass are also coating the interior Dark-colored matte so that the maximum amount of heat absorption as shown in Figure (2 -5).

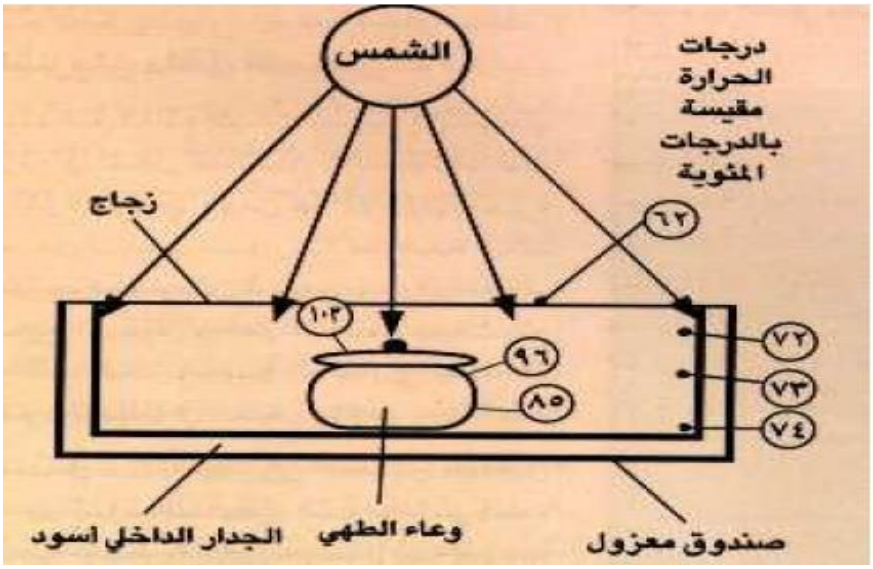


Figure (2-5) Simple Solar Cooker {3}

2.6.5 The Use OF Solar Energy in Water Desalination:

Desalination is one of the soft means to raise the level of communities and regions that complain of excessive salinity of the water. The use of solar energy for water desalination in two ways according to the way hat use solar energy either directly or indirectly, Means direct desalination take solar radiation to vaporize part of the brine and then intensified and is done using a simple distillates, which usually consists of: Base metal Or plastic often What are painted black dye dark its ability to absorb a greater amount of solar radiation falling on them, and the cover glass italic Towards one or two directions in the form of a triangle as Annotated in Figure (1-6) and can briefly explain the modus operandi of thermal distillate as follows: -

Solar radiation passes through the glass into salt water located at the base, which helps to vaporize molecules and intensified on the inner surface of the glass, and collects water droplets condensed in the side channels of the basin to pour in a bowl assembly. The average amount of desalinated water 4 liters per day per square meter of solar distilled. Several transfers were made to the basic design to increase efficiency and productivity, but productivity is still ranging between (6 to 4) liters per day per square meter.

The second method relies on the establishment of electric power generated from solar energy to replace conventional energy use in the familiar techniques of desalination.

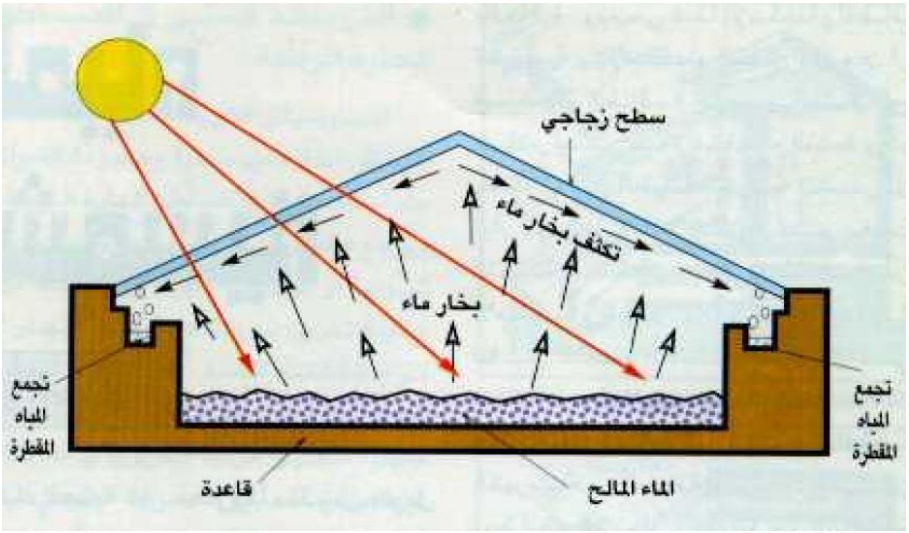


Figure (2-6) a simplified scheme for solar thermal distillates {3}.

2.6.6The Use OF Solar Energy in Water Heating:

Known for a long time has increased interest in the development of heating systems since the beginning of this century as a result of the need to in distant from the sources of conventional energy areas. Over time interest increased solar Heater which is one of the best solar energy applications at the present time, for ease of manufacture and the lack of cost, and because of the resulting higher costs for all electric operation, has spread used extensively in the past decades in countries around the world, including some Arab countries. The purpose of it

really hot water on sunny times the supply in the non-sunny weather to supple be warm water.

Solar water heating from one or more of the solar collectors and water tank and pipes that link between the complexes and the reservoir system consists, moving water from the reservoir, where the temperature rise of the complexes and then to the back of the tank. In order to pump water from the reservoir to the complexes used water pumps in some designs while water is moving in the other designs by the phenomenon of thermal Almtab (larmesfon).

Chapter Three

Analysis of flat plat collector and solar radiation

3.1Solar thermal complexes

Solar thermal complexes are systems that convert solar radiation falling on them into thermal energy through the physical properties of objects related to the ability to absorb solar radiation. There are three types of solar thermal complexes are: - flat complexes, and intensive complexes, and complexes circle. Each type on different forms, and each form distinctive characteristics make it suitable for certain uses.

3.2 flat solar complexes:

Solar collectors flat is the most common types of solar collectors, for ease of manufacture and low price compared with other complexes, and the reason for the multiplicity of its use is the possibility to use this type of complexes in those applications that require access to thermal energy at temperatures relatively low for exceeding $(90-100)$ ° C, and is worth mentioning that uses thermal energy to such low grades and many common use and meets a large part of the requirements of human beings.

Solar collector flat from a wooden box or Metallic isolated composed and has a transparent cover and contain inside plate sucking and some

insulating material that isolates the plate from the other fund parts, wooden or metal box and protects the plate it from weather and minimize the effects and minimize the effects of heat transfer as it constitutes an appropriate framework for practical applications in terms of construction and fittings requirements, and Figure (2−1) shows the flat solar collector.

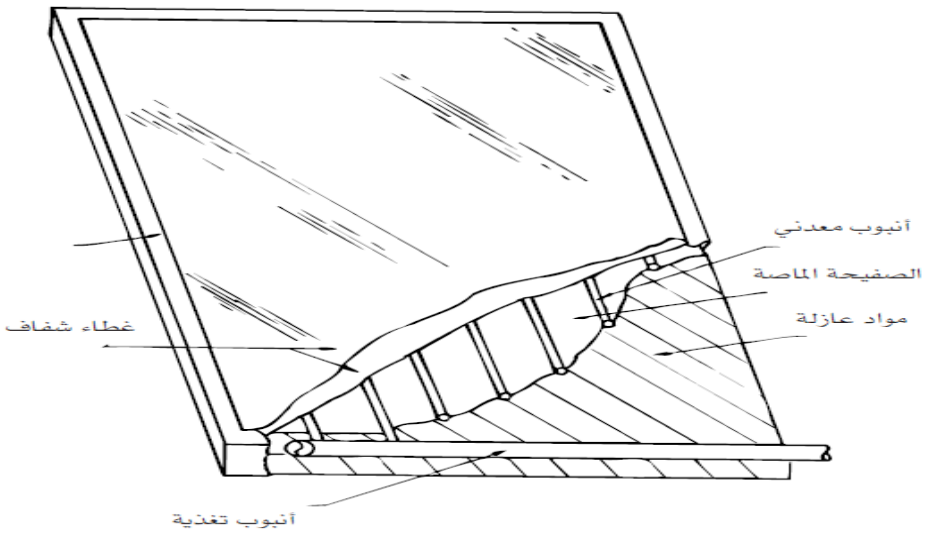


Figure (4−1): flat solar collector {4}

3.3 Flat solar collector parts:

3.3.1 Transparent cover (Glazing):

There are many blankets transparent in flat solar collectors is that glass is the most common, and allows the glass due to its transparency for the most part to sunlight access to inside the box and access to the waving absorber, and when we say it allows for the most part of the

solar radiation access, we take into account the fact that the glass absorbs part of the sun's rays falling and reflects another part while allowing the most part, access and access to the board absorber - as is made clear in form and for the covers used glass in solar collectors flat it allows about (80-90%) of the sun's rays have access to inside the compound While absorb the other part and reversed, may come to mind a question about the need to cut glass if it is an obstacle to the arrival of each solar radiation to the board absorber, and the fact that the glass cover plays an important role in the life of solar collector It saves board absorber of the effects of natural phenomena (include rain and dust) as well as the transparent cover is an impediment to heat transfer from the board absorber to the surrounding atmosphere. Which leads to increase the compound effectiveness in addition to the foregoing, the glass properties it allows the rays of shortwave access through it while the object through the X-ray with long waves and does not allow her access, this feature is known as the greenhouse or green house property (green house) where the glass intercept Using the long waves of the board of the absorber and kept inside the compound for reabsorbed by this same board as well but the glass reduces the effects of heat transfer through pregnancy and delivery.

Sometimes it requires the use of Two cover glass or more to reduce the amount of heat leakage from the board absorber in percentage surroundings are commonly multiple glass lids in those circumstances where there are large differences in temperature between the board and the circumstances surrounding the absorber {4}.

Glass lids properties vary somewhat from the glass windows in the covers solar collectors are disposed of most of the impurities to increase the transparency of the glass and thus increase the amount of radiation to the window inside the compound and reduce the amount of the absorbed or reflected

Conditions to be provided in the glass cover: -

1. Transparent significantly.

2. An appropriate thickness ranging between (3-4) mm.

3. Must be a more efficient transaction in the transmission of energy (Suck - refractive - Ricochet).

3.3.2 Board absorber (Absorber plate):

It is the backbone of the solar flat complex because it absorbs solar radiation, which results in a warming effect of rising degree baseboard heat and then heat is transferred across the board to a fluid (water), which in turn heats up and its temperature rises.

Board absorber usually made of copper or aluminum or iron by On what spend economic, scientific and practical considerations, has been attempts to manufacture these panels of plastic material took place in an attempt to reduce the economic cost is{2} Copper best previous articles from the viewpoint of heat transfer because the heat transfer coefficient greater than the material of copper the other, while the three aluminum it lighter weight materials and transports about 55% of copper, which transmits heat{2}. However, the heat transfer is not the only factor which governs the nature of the materials used in absorbent panels industry despite the great importance of this factor there are other factors such as the economic cost to industry panels of different materials which affects the economic feasibility for the manufacture of solar collectors and if we take this aspect into account, Copper the most expensive of the three materials price as well as the prices are constantly changing up and down, on the other hand, the panels made of copper or iron need to operations common welding while panels made of aluminum need special mechanical operations and add to what is also there offering properties of various materials relating to resistance the effects of natural phenomena such as heat, high humidity, and the

impact of these phenomena on the long-term{3}.

In order to improve the board absorbent properties is required modifying surfaces properties so that increases its ability to absorb solar radiation and reduce the possibility of emission of them, Panels absorbent while absorbing the sun rising temperature and start resurrected infrared radiation emitted by objects free, and therefore improve the surfaces of absorbent panels properties It requires increasing the efficiency of absorbed irradiation with short-wave (solar radiation) and reduce the efficiency of the scholarship long-rays (scholarship objects warm) and for this the panels absorb solar radiation and convert it into heat without losing too much contrast, which leads to raise the temperature and thus provide a stockpile thermally transmitted to the water, In order to achieve this goal are the surfaces of coating absorbent panels unemployment has Feature improve absorption and reduce the emission known surfaces which owns surfaces selectivity of this property (selective surfaces) and common-use items in this area unemployment panels sucking black chrome, black nickel and copper oxide and iron oxide

In the design process has been selected steel slab thickness (1/32) inches.

3. Pipe water flow (water pipes):

These pipes are usually made of good conductivity metal heat and non-steel, such as copper or Steel taking into account the economic side and should fit snugly on the board absorber to ensure good transition temperature of the panel absorber to it, should range from the distance between the pipes $7.5 - 10$ cm. {4} There are several ways to connect with the board absorber tubes as in Figure $(4-2)$

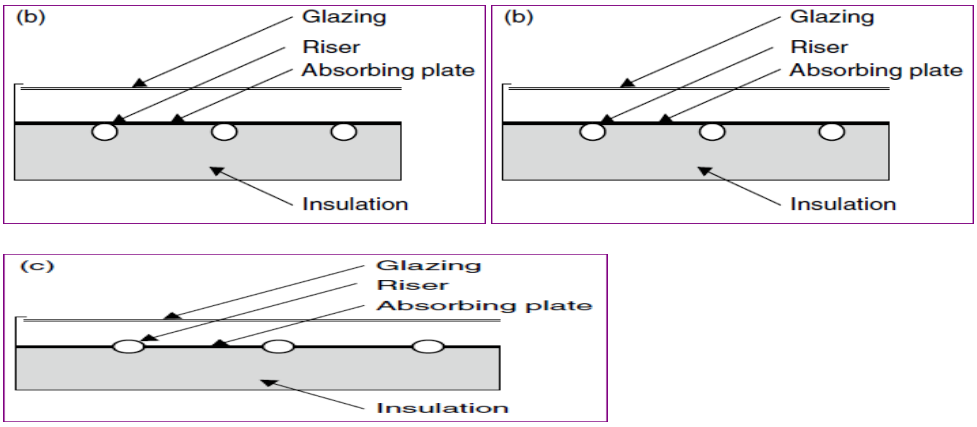


Figure $(4-2)$ by connecting the pipe with the board absorber {4}

Connect the pipes with the board absorber as in the way (a) is the best because it ensures space touches best followed in terms of preference design as in the way (c) and then (b) Given the difficulty of providing pipes as in (a) in the markets has been chosen method (b) in the design process.

3.3.4. Insulation Materials (Isolators):

The goal of the use of insulating materials is insulation between the board absorber Fund containing and reducing the heat transfer from the first to the second, due to the absorption of the board absorber to the sun rises degree Fund container which contains, heat, and thus formed the conditions for a transfer from the board absorber to the fund and then to the outside, and if It is not overcome this phenomenon and to reduce the effects of the large portion of the heat gained by the board absorber moving abroad, which leads to reduce the solar collector efficiency, and in the common design of solar collectors flat is isolated all internal Fund surfaces in order to reduce heat transfer to the board absorber to minima, and is this of course within the economic data accepted so that no more than the thickness of insulating materials to the degree that makes the high cost, and in most solar collectors steam ranges thickness of insulating material between (15−50 mm){4}. and perhaps the most important types of insulation materials used in solar collectors flat is : − fiberglass and mineral fiber, wool and isolators foam, cork, cotton, different thermal properties and composition and economic cost of these different insulators than each of which gives some advantages in certain applications, some of which has a lower

transmission of internal temperature coefficient and others are not affected properties moisture and high temperature properties while the price others low{4}.

3.4 Design equations:

Flat solar collector analysis is complicated, because it contains many of the transactions (factors) has made efforts to integrate a number of the most important transactions in one equation and thus get a mathematical formula described thermal performance of the complex computationally efficient manner.

Figure (2-3) shows a diagram of the amount of heat through the passers complex, that the radiation incident on the compound part of it is reflected by the transparent surface and part of it is absorbed by the transparent and part of it reflects the transparent surface and is absorbed by the board absorbent surface. This part of the radiation is a dominant ratio of about (80%) there is a part reflected by the board absorber addition to the amount of waste heat recovery (lost) the bottom of the complex.

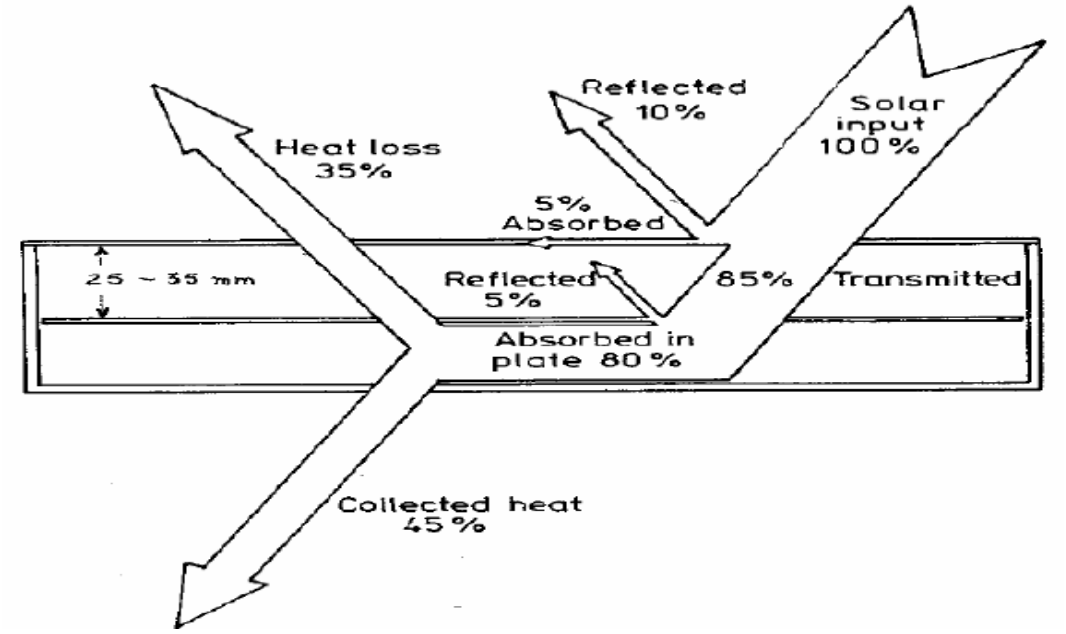


Figure $(3-1)$ Diagram of the amount of heat through the passers compound {4}

Terms: -

Ac $\left(m^2\right)\equiv$ complex area

$F_R \equiv$ thermal transfer coefficient F_R

$I \equiv$ solar Irradiation intensity $w \setminus m^2$

$T_C \equiv$ medium degree of complex heat $(℃)$

$\equiv$ degree of fluid inside the compound temperature $(℃)\, T_i$

$\equiv$ degree movement of water outside of the compound $(°C)\, T_o$

$\equiv$ ambient temperature $(°C)\, Ta$

$\equiv$ heat loss coefficient $(w \setminus m^2)\, U_L$

$\equiv$ the amount of heat input of the compound $(W)\, Q_i$

$\equiv$ the amount of heat lost from the compound $(W)\, Q_O$

$\equiv$ amount learned, including heat $(w \setminus m^2)\, Q_U$

$\equiv$ mass flow rate of the water passing through the compound $(kg \setminus s)\, m^o$

$\equiv$ complex thermal efficiency η

$\equiv$ permeability coefficient of the surface of the transparent τ

α $\equiv$ absorbance coefficient of the surface of the transparent

If (I_t) is solar radiation $(w \setminus m^2)$ incident intensity on the flat solar collector area $(w \setminus m^2)$ the amount of heat received by the complex are:

$$Q_i = AI_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

As described earlier, the part of the incoming solar radiation is reflected by the compound transparent to the upper surface, and another part is absorbed by the transparent surface and the remaining portion up to the board absorber and therefore is rewritten equation (1) as follows: -

$$Q_i = A(\tau\alpha)I_t \quad (2)$$

When the compound is absorbed solar radiation becomes a temperature higher than the ambient temperature occurs loss of heat by convection

and radiation, the amount of waste heat rate (Q_O) depends on the heat loss (U_L) coefficient and the degree of medium-compound temperature (T_C), the amount of heat learned of them depends largely on the amount of waste heat to pregnancy and radiation from the upper surface of the complex, the amount of heat lost from the bottom surface and edges are neglected, which is very small compared Losses

of the upper surface, as the edges and the bottom surface isolated thermally and get:

$$Q_O = U_L A(T_C - T_a) \qquad (3)$$

And thus the amount of heat gained by the compound (Q_U) is the sum raised the amount of heat lost from the compound (Q_O) into the ocean

in the middle of the amount of heat received by the complex and thus: -

$$Q_U = Q_i - Q_O$$

$$Q_O = A(\tau\alpha)I_t - A(T_C - T_a) \qquad (4)$$

The amount of heat gained from the compound can be expressed by the amount of heat phones by passing the water through the complex as

Follows:

$$Q_U = m^o cp(T_O - T_i) \qquad (5)$$

It expresses the ratio between the amount of heat by portable water to

the amount of heat gained by the compound known as thermal transfer coefficient (F_R)

$$F_R = \frac{m^o cp(T_O - T_i)}{A[(\tau\alpha)I - U_L(T_i - T_O)]} \qquad (6)$$

The amount of heat learned of them be the maximum what can be when all the compound is at a temperature equal to the temperature of the water at the entrance of the compound, the amount of actual temperature learned them QU is found by multiplying the thermal transfer FR coefficient in the maximum amount of heat can be obtained, and this enables us to write the equation (5) as follows: -

$$Q_U = F_R A[(\tau\alpha)I - U_L(T_i - T_a)] \qquad (7)$$

Equation (7) is used widely in the energy gained account of the complex (by passing the water through the complex) and know the equation (Hottle - Willer - Bliss)

The thermal efficiency of the compound is given the following relationship: -

$$\eta = \frac{QU}{I_t A_C} \qquad (8)$$

3.4.1 Adjust The Tilt Angle and Direction OF The Complex:

To collect the largest amount of solar radiation it must be directed toward the sun complex and depends the degree to which it tends solar

collector on the horizon on the supply line for the area and the time during the days of the year. If the solar collector directed at an angle equal to the latitude, the solar radiation is perpendicular to the middle of the day during March and September monthly (at the spring equinox and the autumnal equinox, respectively) and to collect the largest radiation possible during the summer must be solar collector directed towards the horizontal plane while it is directed towards the level vertical (Figure 3-2) shows that

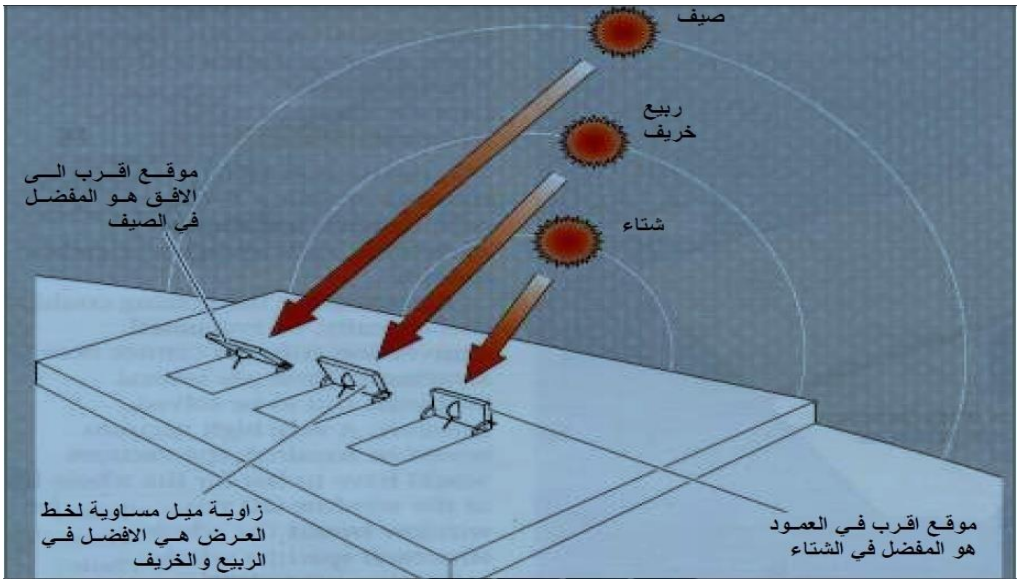


Figure (3-2): Adjust the tilt angle {5}

Are usually styled surfaces at an angle of latitude of the site minus 10 degrees (latitude -10) during the summer but during the winter, the surfaces are focused to be the angle deviation equal latitude plus During the winter, the surfaces are focused to be deviation equal to the line

angle Display plus 10 degrees (latitude + 10) the direction of the solar surfaces should always be towards the south.

3.4.2 Incoming Solar Radiation AT the Expense OF The_Complex:

Solar angles (Solar angles):

The importance of solar angles in it defines position of the sun for a point on the Earth's surface (Figure 3-3) shows the solar angles.

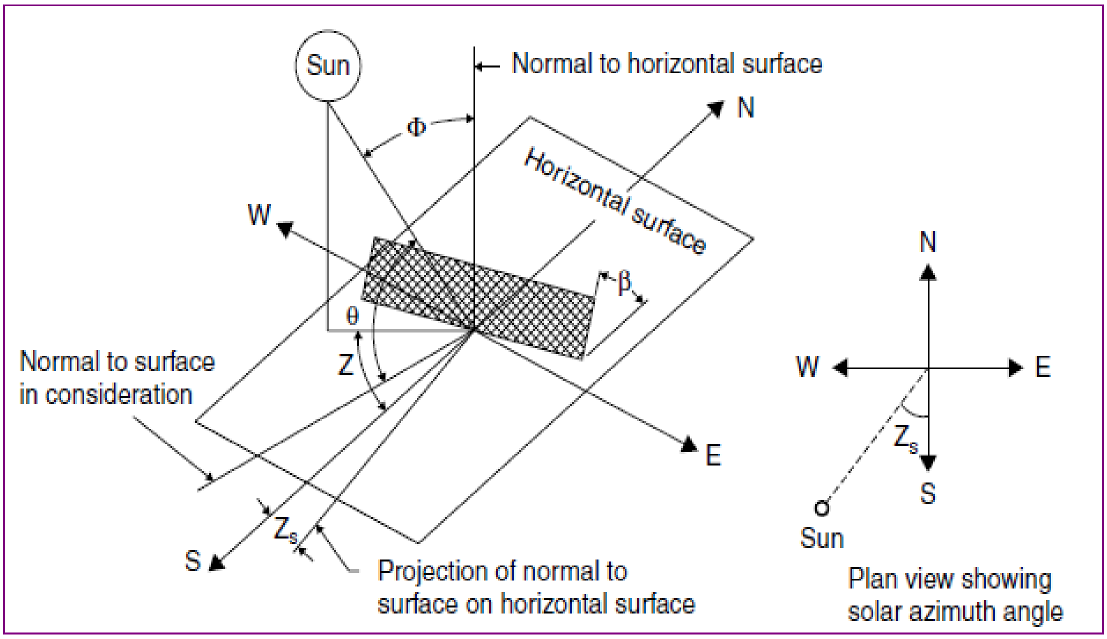


Figure (3-3): solar angles {4}

declination angle) δ) (

$$\delta = 23.45 Sin\left[\frac{(284+N)\times 360}{365}\right] \qquad (9)$$

Hour angle (h)

$$h = \pm 0.25(\text{number of minutes from local solar noon}) \qquad (10)$$

Latitude angle (L)

It depends on the site are either north of the equator or south of the equator solar altitude angle) ∝ (

$$\alpha + \phi = \pi/2 = 90^O \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(11)$$

$$Sin\alpha = Cos\phi = Sin(L)Sin(\delta) + Cos(L)Cos(\delta)Cos(h)^O \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(12)$$

Surface azimuth angle (Z_S)

Since the compound opposite the direction of the south

$$(Z_S = O^O \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(12))$$

Angle of Incidence (θ)

It is given by:

$$Cos\theta = Sin(\delta)Sin(L)Cos(\beta) - Sin(\delta)Cos(L)Sin(\beta)Cos(Z_S) + Cos(\delta).Cos(L).Cos(\beta).Cos(h)$$
$$+ .Cos(\delta).Sin(L).Sin(\beta)Cos(z_S)Cos(h) + Cos(\delta)Sin(\beta)Sin(Z_S)$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13)$$

areas

Tilt angle of the surface (β)

Considering the existence of a period of time between the corners of time

(h_1, h_2) Where $(h_2 > h_1)$

$$I_O = \left(12 \times 3600/\pi\right) G_{SC} \left[1 + 0.033 Cos\left(360N/365\right)\right]$$
$$\times \left[Cos(L)Cos(\delta)(Sinh_2 - Sinh_1)\right] + \left(\pi(h_2 - h_1)SinLSin\delta/180\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

Io is where the solar radiation incident on a horizontal surface out of the

atmosphere

$$I = I_b + I_d \quad \ldots\ldots(15)$$

Whereas: –

(Beam radiation) Direct solar radiation (I_b)

(Diffuse radiation) (I_d)

$$I_b = \tau_b I_O \quad \ldots\ldots(16)$$

Whereas:

The permeability of the atmosphere for direct radiation and is $\equiv \tau_b$ given by

$$\tau_b = a_o + a_1 e^{\left(-K/Cos\phi\right)} \quad \ldots\ldots(17)$$

whereas:

a_0, a_1, k ≡ Constants

$$a_o = 0.95\left[0.4237 - 0.00821(6 - A)^2\right] \quad \ldots\ldots(18)$$

$$a_1 = 0.98\left[0.5055 - 0.00595(6.5 - A)^2\right] \quad \ldots\ldots(19)$$

$$K_1 = 1.02\left[0.2711 + 0.01858(2.5 - A)^2\right] \quad \ldots\ldots(20)$$

Where A is the altitude in kilometers of given site

whereas:

$$I_d = \tau_b . I_O \quad \ldots\ldots(21) \quad \{4\}$$

$\tau_{d\equiv}$ The proportion of diffuse solar radiation on a horizontal surface reality to solar radiation in outer space and gives the following relationship:

$$\tau_b = 0.271 - .0294\tau_b \quad \ldots\ldots(22)$$

Solar radiation falling on the sloping surface can be considered from three components:

1. Beam radiation:

$$I_b = I_b R_b \quad \ldots\ldots(23)$$

whereas:

$\mathbf{R_b} \equiv$ The ratio between the direct radiation falling on the sloping surface to the incident radiation on a horizontal surface. And it is given by the following: -

$$R_B = \frac{Cos(\theta)}{Cos(\phi)} = \frac{Sin(L-\beta)Sin(\delta)+Cos(L-\beta)Cos(\delta)Cos(h)}{Sin(L)Sin(\delta)+Cos(L)Cos(\delta)Cos(h)} \quad \ldots\ldots(24)\{4\}$$

2 .Diffuse radiation:

$$I_d\left(\frac{1+Cos\beta}{2}\right) \quad \ldots\ldots(25)$$

3. Radiation reflected by the Earth: -

$$I_{\rho g}\left(\frac{1-Cos\beta}{2}\right) \quad \ldots\ldots(26)\{4\}$$

whereas:

(ground reflectance (ρ)

And thus be a total solar radiation falling on the sloping surface in the time given to the relationship: -

$$I_t = I_b R_b + I_d\left[\left(\frac{1+Cos\beta}{2}\right)\right]. + I\rho g.\left[\left(\frac{1-Cos\beta}{2}\right)\right] \quad \ldots\ldots(27)$$

$$\eta = \frac{m^o c\Delta T}{I_t A} \quad \ldots\ldots(28)$$

Chapter Four

Experiments and readings and results

4.1 Experiments and readings and results

4.1.1 Experiment Name:

Measure the coefficient of performance of a solar collector

The purpose of the experiment:

Study coefficient of performance of flat solar collector is and study the efficiency curves

Theory:

Flat solar collector performance testing is expressed in the thermal efficiency of the compound which is the ratio between the energy of the synagogue, learned to–energy solar radiation falling on the compound.

Compensation equation (5) in equation (8). {4}

$$\eta = \frac{m^{o} c \Delta T}{I_t A} \qquad (28)\{4\}$$

4.1.2 Experience Steps:

Clean the surface of the device from dust soft cloth.

Make sure that all the discharge valves closed.

Make sure that the hot water tank is empty of water

Fill the cold–water tank with clean water

Open the valves (inside and outside) of the compound is suitable and make the stopwatch slot.

Measure the temperature at the entrance of the compound, and record reading.

After an hour of time take the temperature of the hot water tank, and record high water in the same tank.

Repeat steps two years to the time of the experiment

Enter the results and readings in the computer program.

Measuring devices used

Thermometry

Calibrator meters

Balance water

Stop Watch

This test was conducted to perform compilers by connecting in parallel and without the use of pump (normally into force)

Were measured temperature of the water inside the heat of the complexes using Thermometry while measuring the water temperature outside of the complexes using the letter is sensitive, and using a volumetric flask and the clock was stopped for water mass flow rate measurement. Testing was conducted on the system where the readings taken over three days from nine o'clock am until Third o'clock evening.

4.2 readings:

First day: (15\5\2015)

Clock time	$T_i^{\circ}C$	$T_a^{\circ}C$	ΔT	$T_a^{\circ}C$	$m^o\left(Kg/S\right)$
9:00	31	39	8	30	0.014
10:00	32	53	31	33	0.014
11:00	35	65	30	32	0.014
12:00	39	77	38	33	0.014
13:00	43	80	37	34	0.014
14:00	47	81	34	34	0.014
15:00	49	77	28	32	0.014

Table 4.1

The second day: (16\5\2015)

Clock time	$T_i^{\circ}C$	$T_a^{\circ}C$	ΔT	$T_a^{\circ}C$	$m^{o}\left(Kg/S\right)$
9:00	23	34	11	27	0.016
10:00	26	49	23	28	0.016
11:00	32	61	29	31	0.016
12:00	38	71	33	33	0.016
13:00	42	76	34	34	0.016
14:00	46	75	29	36	0.016
15:00	47	71	24	35	0.016

Table 4.2

The Third day: (17\5\2015)

Clock time	$T_i^{\circ}C$	$T_a^{\circ}C$	ΔT	$T_a^{\circ}C$	$m^{o}\left(Kg/S\right)$
9:00	23	40	17	26	0.015
10:00	30	53	23	29	0.015
11:00	34	73	39	29	0.015
12:00	37	83	46	31	0.015
13:00	39	91	52	34	0.015
14:00	41	89	48	35	0.015
15:00	42	86	44	36	0.015

Table 4.3

4.3 Mass flow rate:

$$m^{0} = 14 * 10^{-3}\ {}^{Kg}/_{S}$$

4.3.1 Following the same method of calculation of solar radiation in the previous chapter was obtained on the results of solar radiation to this day, as in the table below:

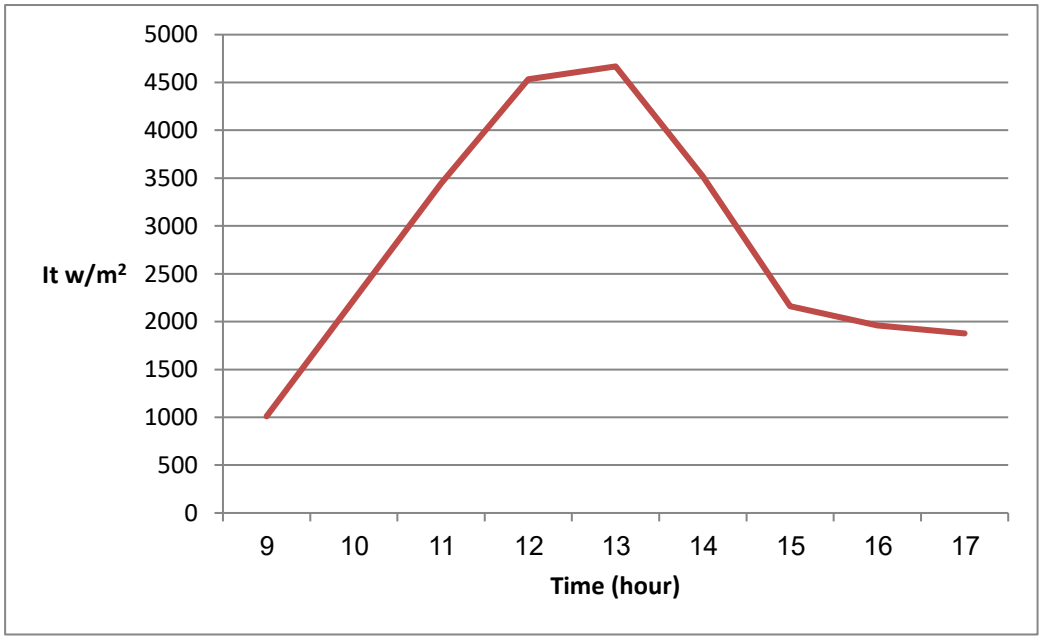
S. O	Clock time	$I_t\left(\frac{W}{m^2}\right)$	$Q_U\ \left(\frac{W}{m^2}\right)$	$\eta\,\%$
1	9:00	1010	87.76	8.9
2	10:00	2227	193.32	22.27
3	11:00	3446	299.13	34.4
4	12:00	4533	393.13	45.3
5	13:00	4668	405.24	46.68
6	14:00	3519	293.95	33.8
7	15:00	2162	305.49	35.19
8	16:00	1959	187.74	21.6
9	17:00	1876	170.07	19.5

4.4 Model calculations and results:

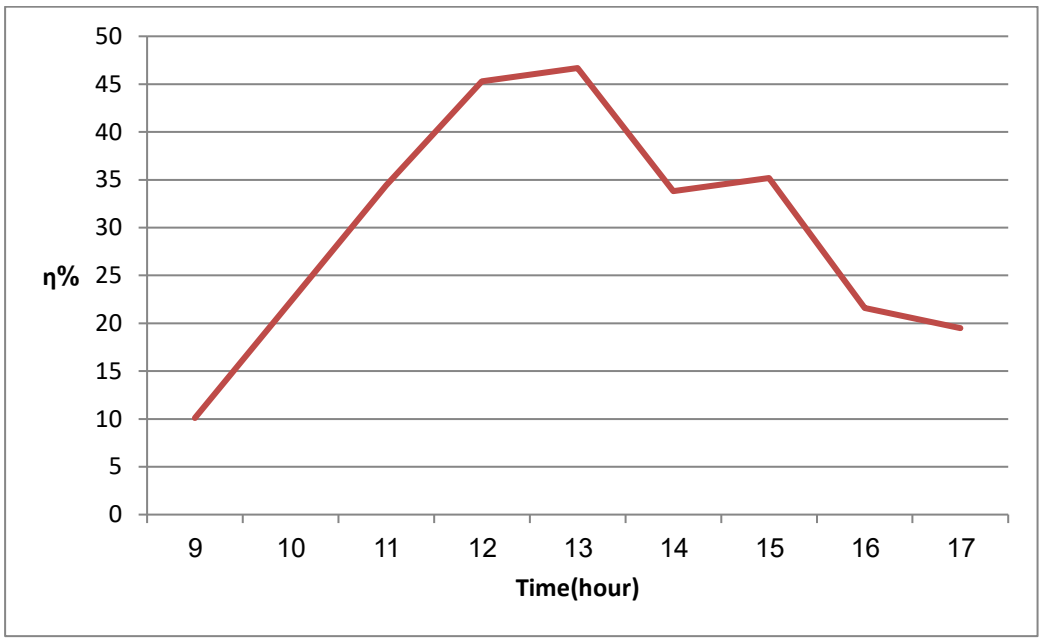
Compensation in the equation (29):

$$\eta_{9:00} = \frac{0.014 * 4.18 * 15}{1010 * 10^{-3} * 1.2} = 8\ \%$$

In the same way was to get the results shown in the following table:



The curve in Figure (4−1) shows the relationship between time and total solar radiation



The curve in Figure (4−2) shows the relationship between time and efficiency

Chapter Five

Results and discussion

5.1 Results and discussion:

Solar collector has been run through the water flow naturally from nine o'clock in the morning till five o'clock in the evening was to measure and record temperatures for the entry and exit of water from the solar collector and the temperature of the air and the flow of solar collector water. And Accordingly these measurements are useful energy, energy efficiency and stored for the complex calculation, 'work in a computer program and method was quick and accurate calculations.

1. Microsoft Excel sheet (1) Program to the Efficiency of the Collector.
2. Microsoft Excel sheet (2) this Program to calculate the degree of Fluid inside the compound temperature at collector.
3. Microsoft Excel sheet (3) this Program to calculate t at collector the degree movement of water outside the compound temperature.
4. Microsoft Excel sheet (4) this Program to calculate the declination and hour angle and solar Altitude and total solar radiation at collector.

Increasing the temperature of the solar complex gradually from nine o'clock in the morning and reaches its peak at midday, and then decreasing gradually after midday The highest temperature reaches a solar collector was $96C^0$, the spectrum in the middle of the day, and explains the change of the degree of solar on the compound heat to radiation intensity solar gradually increase from nine o'clock and reaches its peak around mid-morning, after midday, the intensity of solar radiation in the case of start decrease Booze and decreasing

temperatures and less useful energy and energy efficiency in storage and complex.

5.2 Conclusions:

1. The maximum efficiency of flat plat collector was 46% .
2. during the afternoon period of up to a maximum efficiency values and stabilize in the middle of the day then START decreasing regularly to low solar radiation.
3. The maximum temperatures of flat plat collector were $96C^{O}$.
4. system is considered a low effective in the period post-fifth.

Chapter six

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