FABRICATION OF DOUBLE SLOPE SOLAR DISTILLATION SYSTEM

A PROJECT REPORT

Submitted by

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in partial fulfilment for the award of the degree

of

BACHELAR OF ENGINEERING

in

MECHANICAL ENGINEERING

BHARATHIDASAN ENGINEERING COLLEGE,

NATTRAMPALLI -635 854

ANNA UNIVERSITY: CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report **"FABRICATION DOUBLE SLOPE SOLAR DISTILLATION SYSTEM"**is the bonafide work of **"P.PRADEEP KUMAR(510517114034),C.PRASANTH(510517114036),K.PRASANTH(510517114037),G.RAJESH (510517114036)",** who carried out the project work under my supervision.

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Submitted for the viva voice examination held on _______________during The academic year 2020 – 2021

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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The completion of this project brings a sense of satisfaction, but it is never completed without thinking the person who were responsible for the successful completion.

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ABSTRACT

The project titled that **"Fabrication of double slope solar distillation system".** There is almost no water left on earth that is safe to drink without purification after 20-25 years from today. This is a seemingly bold statement, but it is unfortunately true. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Keeping these things in mind, we have devised a model which will convert the dirty/saline water into pure/potable water using the renewable source of energy (i.e. solar energy). The basic modes of the heat transfer involved are radiation, convection and conduction. The results are obtained by evaporation of the dirty/saline water and fetching it out as pure/drinkable water.Its application was proven to be most economical, as most systems in individual uses requires. This paper reviews the present day solar thermal technologies. Performance analyses of existing designs (study),and fabrication of double slope solar distillation system have been discussed in this paper.

CHAPTER 1

INTRODUCTION

Water is the basic necessity for human along with food and air. There is almost no water left on Earth that is safe to drink without purification. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Moreover, typical purification systems are easily damaged or compromised by disasters, natural or otherwise. This results in a very challenging situation for individuals trying to prepare for such situations, and keep themselves and their families safe from the myriad diseases and toxic chemicals present in untreated water. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water. Fortunately there is a solution to these problems. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step,but is simple, cost-effective, and environmentally friendly. That is use of solar energy.

1.1. About Solar Energy

The sun radiates the energy uniformly in all direction in the form of electromagnetic waves. When absorbed by body, it increases its temperature. It is a clean, inexhaustible, abundantly and universally available renewable energy.

Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted. This solution is solar water distillation. It is not a new process, but it has not received the attention that it deserves. Perhaps this is because it is such a low-tech and flexible solution to water problems. Nearly anyone is capable of building a still and providing themselves with completely pure water from very questionable sources. 3.8x1024 joules of solar radiation is absorbed by earth and atmosphere per year. Solar power where sun hits atmosphere is 1017 watts and the total demand is 1013 watts. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require. The energy radiated by the sun on a bright sunny day is 4 to 7 KWh per m2

1.2 Solar Still Operation

Water to be cleaned is poured into the still to partially fill the basin. The glass cover allows the solar radiation to pass into the still, which is mostly absorbed by the blackened base. This interior surface uses a blackened material to improve absorption of the sunrays. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle. Feed water should be added each day that roughly exceeds the distillate production to provide proper flushing of the basin water and to clean out excess salts left behind during the evaporation process. If the still produced 3 litres of water, 9 litres of make-up water should be added, of which 6 litres leaves the still as excess to flush the basin.

CHAPTER 2
LITERATURE REVIEW

2.1 Abstract

A solar unit to investigate the effect of PCM on the temperature change of the water during the entire day (day time and night time) was designed. The unit is also used to test the effect of PCM on the amount of fresh water produced. Candle wax (tricosane) was used as PCM and its amount was varied to achieve the ratio of mass of PCM to mass of water of 0, 0.17, 0.35 and 0.51 respectively. The amount of water used was fixed throughout all the experiment at 3kg tap water. The wax was placed in copper tubes immersed in water. The results showed that presence of PCM causes the appearance of two zones in which the temperature is strongly affected by the PCM. The firstzone appearsdue to the melting of the PCM(during day time) andthe secondzone appearsdue to solidification (during night time) of the PCM. The effect of the PCM is prominent in the second zone where the temperature remains constant at the PCM melting point. The length of the solidification zone is proportional to the amount of PCM. Fresh water production is strongly affected by the presence of the PCM. During the day time fresh water production is inversely proportion to the value of R. However, during the night time fresh water production is directly proportional to the value of R.

2.2 Introduction

Through the era of the twenty-first century, there has been a lot of interest in renewable energy, because of the depletion of the fossil fuels resources, as well as the sharp rise in oil prices. Since ancient times, humans have harvested lightandheatthatemittedfromthesuntotheir advantage using a combination of constantly evolving technologies. Solar energy technologies include the use of solar thermal energy for direct heating, thermal process, photovoltaic electricity generation, solar-based architectural designs and solar desalination, technologies that can contribute significantly in solving some of the most pressing problems today. Solar desalination is one of these technologies that are receiving global attention due to the scarcity of water in many places in the world. Solar desalination is a simple, durable and affordable alternative way to solve the problems of arid remote areas of the world, which are rich in solar irradiation. One of the applications of solar desalination is solar still which consumes solar energy to purify water of pollutants, including salts, heavy metals, and microbes. This distillation process from some aspects simulates the natural water cycle of the earth. It contains only a few moving parts and its operating and maintenance requirements are low. Solar still distillation may be a good treatment option for developing

countries that have plenty of sunny days, because it ischeap and almost no investment or infrastructure is required. However, such systems adhere to the power of sunlight and are more effective in the warm, sunny climate

2.3 Experimental part

A single slope solar still is designed and used to conduct the experimental part of this work. The solar still is made of a rectangular metal basin covered with a 4mm thick glass panel with a slope of ~30o. At the bottom side of the basin, copper tubes filled with PCM are laid down and submerged under water. Sliding water condensate at the inside surface of the inclined glass panel is collected from the lower end of the glass panel in a graduated cylinder using a collection tray. All metal sides of the solar still were insulated with a 1.5cm thick polystyrene board to minimize heat losses (Fig. 1.). The metal basin had a rectangle shape of 0.62m length and 0.41m width, while its height from the backside is 0.54m reducing to 0.195m at the front side. The basin was painted with a black colour to maximize the absorption of solar irradiation. A small channel was installed in the lower front side on the glass panel to collect the sliding water condensate from the glass cover. At the bottom side of the basin, 38 copper tubes of 1.5cm outer diameter were carefully arranged and submerged under three litter of tap water. Depending on the desired R-value, some of the tubes were filled with PCM and the remaining tubes were left empty. In each experiments, all the 38 tubes were always used and the only thing changes is the number of PCM filled tubes to investigate the effect of the amount of PCM on the water productivity. The PCM capacity of each tube is 40 g and the PCM filled tubes were tightly sealed to prevent water from leaking in or PCM from leaking out of the tubes. All tubes were painted with a black colour to maximize the solar irradiation absorption.

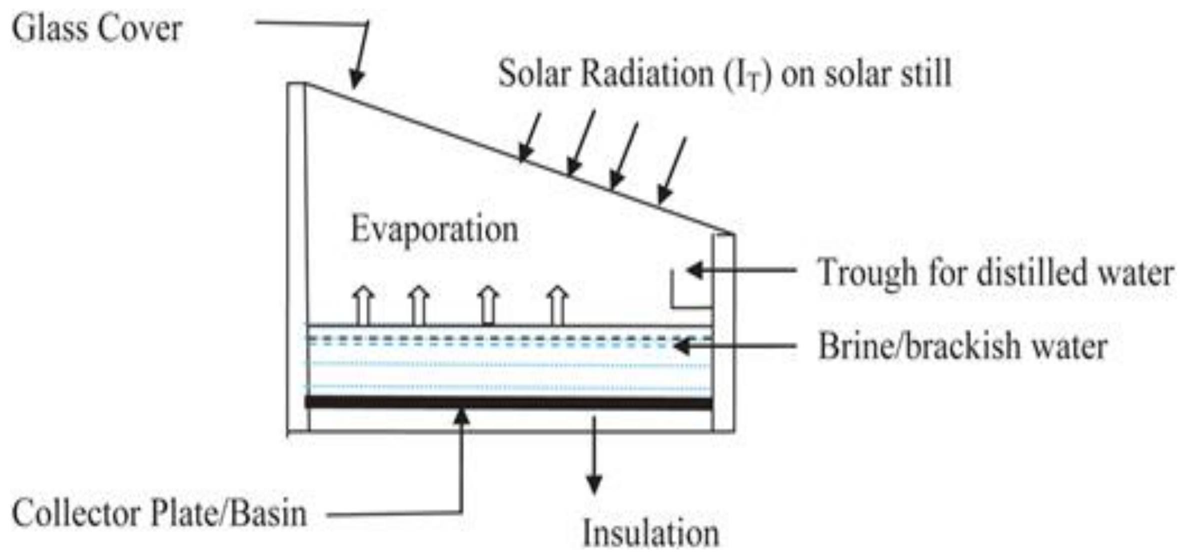

Fig 2.1 single slope solar distillation system

2.3.1Data collection

In this work, a thermocouple device (SD logger, type k) was used to record different temperatures during each experiment. Fig. 2 shows a schematic diagram of the thermocouples locations to collect temperatures readings. Thermocouple sensors were connected inside the basin to measure water temperature (Tw), PCM temperatures (Tpcm), vapor temperature (Tv), and outside to collect ambient temperature (Ta). The device was set to record temperature every 2 min. This kind of thermocouple has good specification and works at a high temperature.

2.3.2 Experimental procedure

The experiments were carried out from April to August 2018 in Muscat-Oman. Each set of experiment was conducted within four consecutive days for the four desired values of the parameter R (0, 0.17, 0.35 and 0.51) which is defined as Mass of PCM Mass of Water. The experiments typically start from 8:30 a.m. until the next day 7:30 a.m. The collected water (condensate) was recorded every one hour until 12:00 a.m. and the accumulated water produced after 12 a.m. is recorded the next day morning. After each experiment, the pH and conductivity of the collected water were measured and recorded and the recorded temperatures data (basin water, ambient, PCM, and vapor) were extracted from the temperature recorder and analysed using excel. Table 1 shows the numberofPCM filledtubes,massofPCMandthevalue ofRforeachset of four experiments. The mass of the water is constant and equals 3kg and its electrical conductivity is 869.6 μS/cm.

2.4 Types of Solar Still

Basin Type: It consist of shallow, bracken basin of saline/impure water covered with a sloping transparent roof solar radiation that passes through the transparent roof heats the water in blackened basin.Thus evaporating water which gets condensed on the cooler under side of the glass and gets collected as distillate attached to the glass. Wick Type Solar Still: It consists of a wick instead of a basin. The saline/impure water is passed through the wick or absorbed by the wick at a slow rate by capillary action. A waterproof liner is placed between the insulation and the wick. Solar energy is absorbed by the water in the wick which gets evaporated and later condensed on the underside of the glass and finally collected in the condensate channel fixed on the lower side of the bottom surface.

2.5 Measuring Instruments

2.5.1 Measurement of temperature

Copper (100% Cu)-constantan (55% Cu + 45% Ni) thermocouple were used to measure water, water vapor and condensing cover temperature. Thermocouples used in the experiment are properly calibrated with the help of zeal thermometer (standard thermometer). The ambient air temperature is recorded with the help of a calibrated mercury thermometer having a least count of 1°C.

2.5.2 Measurement of distillate yield

The condensed water is collected in a galvanized iron channel fixed at the lower end side of both the glass covers. The distillate collected is continuously drained through flexible pipe and stored in a jar placed outside on both side. The collected distillate yield has been measured using graduated cylinder with least count of 1 ml.

2.5.3 Measurement of solar radiation

The sun emits an electromagnetic radiation with different wavelengths and with a peak centred in the visible spectrum. This radiation is arrive to the earth ground must go through the earth atmosphere, where suffer absorptions, refractions, reflections and emissions that work in selective way. Every element in the atmosphere in fact reacts in different way to the various electromagnetic radiation wave lengths that is every component absorbs and emits the radiation to a different wave length (absorbing the radiation it heats in accordance with the reached temperature and emits a different one). This fact provokes that the solar radiation to the ground level has a spectrum much different from the extra atmospheric level.

2.6 Experimental Set-up

The photograph of double slope active solar still under study have been shown in fig.2. In active solar still, the flat plate collector is integrated with double slope active solar still in such a way that the hot water from collector plate enters into the basin of solar still under forced circulation mode. The inlet and outlet connections to the collector plate are taken from the bottom of the basin as shown in Figure 1a. A gate valve has been provided in the inlet pipe to control the circulation of water through the collector plate. The collector plate absorbs the solar energy and transfers that energy to water flowing through tubes. The double slope solar still placed in east-west direction and collector plate was inclined at 30o facing south to

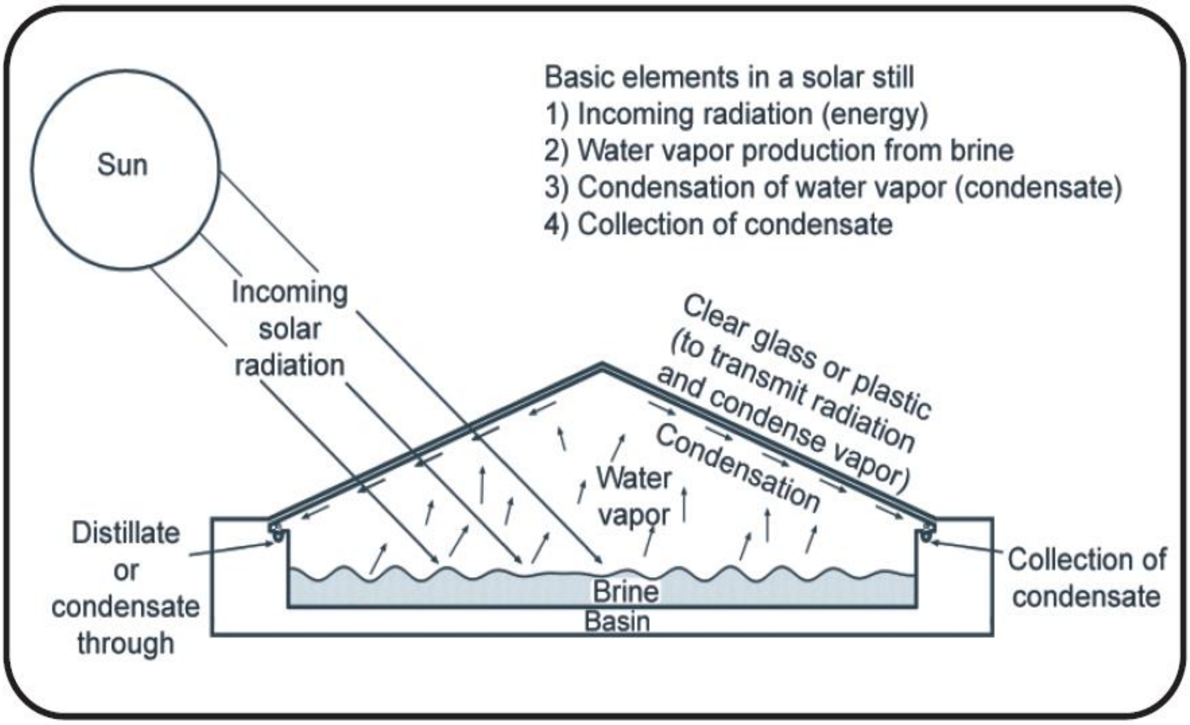

Fig.2.2 double slope active solar still set up

2.7 Experimental Procedure

Outdoor and Indoor tests of the solar distillation system were carried out with various variables. Those steps have been classified according to their time relative to the data collection i.e. before, during and after data collection.

2.7.1 Before data collection

- A proper adhesive was applied on all side, at all joints of distillate carrying channels to ensure leak proof collection of distillation.
- Sponge rubber gasket and silicon wax were used between the contact surface of condensing cover and basin to avoid any chances of vapor leakage.
- The lower edges of the still were set horizontally using the spirit level.
- The inclination angle of the flat plate collector was set with the aid of the inclinometer.
- The required flow rate of the feed water was adjusted by measuring the over-flow rate and the distillation rate, with the aid of a stop watch and measuring cylinder.

2.7.2 During data collection

The following were the parameters measured every hour for a period of 24 hours during each experiments conducted.

- Outer glass cover temperature
- Inner glass cover temperature
- Water vapor temperature
- Water temperature in the basin
- Ambient air temperature
- Solar intensity on glass cover

- Solar intensity on collector plate
- Weight of distillate yield

2.8 After data collection

Analysis has been carried out as discussed in the subsequent section.

2.9 Result and Discussions

The experiments were conducted in the month of August 2011, to investigate the effect of water depth in the basin on distillate output and instantaneous thermal efficiency. Hourly measurements were made for ambient temperature, basin water temperature, glass cover temperature, distillate output and solar intensity from 9 AM for 24 hours and shown in table 2.4 to 2.6. For different water depths viz. 0.03 m, 0.04 m, and 0.05 m during clear sunshine hours (9 am-5 pm), distillate output and instantaneous thermal efficiency were calculated from collected data.

As depth of basin water increase the distillate output decrease. From table 5 and fig.3, it is clear that distillate output is maximum 0.684 kg at 2 pm for water depth 0.03 m and minimum 0.17 kg at 10 am for water depth 0.04 m. Fig.4 shows the variation of instantaneous thermal efficiency with depth of basin water. The maximum instantaneous thermal efficiency is 46.96 at water depth of 0.04 m.

2.10 CONCLUSION

The distillate output is varies with the water depth and it decreased with increase of water depth in the basin. Instantaneous thermal efficiency varies from 0.41 to 46.96. Solar distillation presents a promising alternative to produce fresh water from saline water with free solar energy

CHAPTER 3
COMPOUNENT

3.1 Plywood

Plywood is a material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another. It is an engineered wood from the family of manufactured boards which includes medium density fiberboard (MDF) and partical board (chipboard).

3.1.1 Types of plywood

1. Softwood plywood
2. Hardwood plywood
3. Tropical plywood
4. Aircraft plywood
5. Decorative plywood (overlaid plywood)
6. Flexible plywood
7. Marine plywood

Fig 3.1 Plywood

3.1.2 Plywood Specifications

Plywood facts include information about the different types of face veneers, the glue lines that are available for different applications, available preservative treatment, emissions emitted from the ply and the preservative treatment available for plywood:

A. Face Veneers

i. **A Grade Veneers:** An appearance grade face veneer with no visible defects making it suitable for "clear finishing". Where surface decorative appearance is a primary consideration, this appearance grade quality should be specified. This includes Austral Premium Ply & Marine Ply.

ii. **B Grade Veneers:** An appearance grade face veneer suitable for high quality paint finishing and is not generally suitable for clear finishing. Where a high quality paint finish is a primary consideration, this face veneer quality should be specified. This includes Austral Premium Plywood, Birch Plywood & Hardwood Plywood.

iii. **C Grade Veneers:** A non-appearance grade face veneer with a solid surface in which all open defects such as holes, knots or splits are filled. For applications requiring a solid non-decorative surface, this face veneer quality is designed specifically for this purpose, such as ply flooring which is to be overlaid with a decorative flooring surface. This includes Austral Premium Plywood, Birch Plywood, Flooring, Hardwood Plywood and Structural & Non-Structural Plywood.

iv. **D Grade Veneers:** A non-appearance grade face veneer in which open limperfections are permitted. For structural and non-structural applications where decorative appearance is not a requirement, this face veneer should be specified. A limited number of knots and knot holes up to 75mm wide are permitted within this veneer specification. This includes Flooring, Hardwood Plywood and Structural & Non-Structural Plywood.

B. Core Gaps

i. Marine Plywood

Consists of a solid full grade cores throughout the ply with no core gaps.

ii. Exterior/ Structural Ply

Minimal core gaps in the laying up of the inner plies ensuring the maximum potential in attaining the full strength potential across the entire panel for the structural ply.

iii. Interior Plywood

Minimal core gaps.

C. Gluelines

i. Type A Bond

Produced from a Phenol Formaldehyde (PF) resin, which sets permanently under controlled heat and pressure. This forms to create a permanent bond that will not deteriorate under wet conditions, cold or heat. This bond is recognisable by its distinct black colour. Type A bond is specified in AS/NZS 2272 for marine plywood, AS/NZS 2271 for exterior plywood used under conditions of long term full exposure or under wet or damp conditions.

ii. Type B Bond

Produced from Melamine Fortified Urea Formaldehyde (MUF) resin, which sets permanently under controlled heat and pressure. The exterior plywood standard includes Type B bond and is suitable for application involving concrete formwork plywood that is stamped with the EWPAA Approved B bond stamp.

iii. Type C & D Bonds

Both the C and D bond glue lines are both interior bonds. Type A bonded plywood should be used for areas of doubtful moisture conditions, such as areas around vanity units, sinks, and laundry tubs.

iv. Exterior Bond

Produced for exterior use with a phenolic resin adhesive.

D. Emissions

i. Formaldehyde

Formaldehyde is a colourless, strong smelling gas that occurs naturally within the environment and is emitted by processes such as decay, combustion and naturally by all timber species.

ii. **Formaldehyde Emissions**

Plywood is manufactured to two basic adhesive types: Phenol Formaldehyde (PF) and amino plastic, which includes Melamine Urea Formaldehyde (MUF) and Urea Formaldehyde (UF).

There are vast differences in the chemistry between the two types of adhesives. With PF bonded products, after any low level residual formaldehyde from the manufacturing process has dissipated within a few days, they do not emit formaldehyde.

PF adhesive, being identifiable by its black colour, is called Type A under the Australian and New Zealand ply standards as is used in the manufacture of structural plywood, marine plywood exterior (Type A) products.In both Europe and the United States, products that are bonded with PF adhesives are classified as non-emitting and are exempt from formaldehyde emission regulations.

3.2 Aluminium sheet

Aluminium sheet is used as a absorber plate to absorb the solar radiation. The chemical element aluminium (symbol Al) is a metal, which in its pure, bulk form is relatively soft, light and abundant - 8.07% of the Earth's crust compared, for example, with the familiar metal iron at 5.06% . Only oxygen and silicon are more abundant in the Earth's crust, and yet it was only a century ago that aluminium was discovered as the most common of metals History and production process of aluminium. We are all familiar with the bronze and iron ages that considerably predate the discovery of aluminium - so why was aluminium so late in appearing on the scene? The answer, as for the pre-historic copper and bronze ages (bronze is a metallic mixture of copper and tin) and later iron and steel (a mixture of iron and a small quantity of carbon), relates to man's technological capability not only to extract the material from the Earth's crust but also to process the material into a useful product.

Fig 3.2 Aluminium sheet

3.2.1 Specification of aluminium

i. **Physical Properties of Aluminium Density of Aluminium**

Aluminium has a density around one third that of steel or copper making it one of the lightest commercially available metals. The resultant high strength to weight ratio makes it an important structural material allowing increased payloads or fuel savings for transport industries in particular.

ii. **Strength of Aluminium**

Pure aluminium doesn't have a high tensile strength. However, the addition of alloying elements like manganese, silicon, copper and magnesium can increase the strength properties of aluminium and produce an alloy with properties tailored to particular applications.

Aluminium is well suited to cold environments. It has the advantage over steel in that its' tensile strength increases with decreasing temperature while retaining its toughness. Steel on the other hand becomes brittle at low temperatures.

iii. **Corrosion Resistance of Aluminium**

When exposed to air, a layer of aluminium oxide forms almost instantaneously on the surface of aluminium. This layer has excellent resistance to corrosion. It is fairly resistant to most acids but less resistant to alkalis.

iv. **Thermal Conductivity of Aluminium**

The thermal conductivity of aluminium is about three times greater than that of steel. This makes aluminium an important material for both cooling and heating applications such as heat-exchangers. Combined with it being non-toxic this property means aluminium is used extensively in cooking utensils and kitchenware.

v. Electrical Conductivity of Aluminium

Along with copper, aluminium has an electrical conductivity high enough for use as an electrical conductor. Although the conductivity of the commonly used conducting alloy (1350) is only around 62% of annealed copper, it is only one third the weight and can therefore conduct twice as much electricity when compared with copper of the same weight.

vi. Reflectivity of Aluminium

From UV to infra-red, aluminium is an excellent reflector of radiant energy. Visible light reflectivity of around 80% means it is widely used in light fixtures. The same properties of reflectivity makes aluminium ideal as an insulating material to protect against the sun’s rays in summer, while insulating against heat loss in winter.

vii. Mechanical Properties of Aluminium

Aluminium can be severely deformed without failure. This allows aluminium to be formed by rolling, extruding, drawing, machining and other mechanical processes. It can also be cast to a high tolerance.

Alloying, cold working and heat-treating can all be utilised to tailor the properties of aluminium.

The tensile strength of pure aluminium is around 90 MPa but this can be increased to over 690 MPa for some heat-treatable alloys.

3.3 Pressure gauge

Mechanical pressure gauges, which require no external power, provide an affordable and are a reliable source of accurate pressure measurement. When selected using the criteria described below, maximum gauge life can be expected.

To properly select a pressure gauge, consider the gauge process, range, environment, accuracy, dial size, connection and mounting requirements. When selected using these 7 Steps, the gauge performance and reliability will greatly be enhanced.

Fig 3.3 pressure gauge

3.3.1Gauge Process

The wetted parts of the pressure gauge, the bourdon tube and socket must be compatible with the process media. If not compatible with the wetted parts of the gauge, corrosion will occur. Corrosion of gauge wetted parts will eventually cause gauge failure and possibly safety issues.

3.3.2 The Environment

Environmental considerations include ambient temperature, air-borne particulate, condensation, humidity, water and chemicals, all of which can affect gauge performance.

3.3.3 Accuracy

For a mechanical pressure gauge, accuracy is defined as a percentage of the full- scale range.

While requirements differ from one industry to another, the following are general guidelines

3.3.4 Dial Size

Pressure gauge dial sizes range from 11⁄2" to 16" diameters. Generally, readability requirements, space limitations and required gauge accuracy determine dial size. Accuracy's of 0.25% or 0.10% generally have dial sizes of 41⁄2" or larger since more dial graduations are required.

3.3.5Gauge Connection

Gauges are available with a variety of connections including NPT, DIN, JIS, BSP & SAE. Process pressure gauges with 41⁄2" dial sizes or larger are most often supplied with a 1⁄2" NPT connection to best support the gauge.

Factors to consider when selecting a pressure gauge connection include process pressures, gauge size and weight, space limitations, leak integrity, and past experience.

3.3.6 Mounting Requirements

Consider the following mounting options when selecting a pressure gauge:

- Direct stem mount lower connect,
- Remote wall/surface mount lower connect,
- Panel surface mount back connect,
- Panel hole U-clamp flush mount back connect,
- Panel hole front flange flush mount back connect

3.3.7 Glossary Of Terms

Gauge Pressure:

Indicates pressure from a single source and uses ambient pressure as zero.

Absolute Pressure:

The pressure measured above a perfect vacuum. It’s the pressure indicatedby an ordinary gauge added to the atmospheric pressure.

Differential Pressure:

The difference between to independent, but related pressures.

Compound Pressure Gauges:

Indicate pressures above & below ambient pressure or positive & negative pressure.

3.4 Distillation stand

Distillation stand is used to support the double slope solar distillation system. It is made up of iron angle steel rod. This stand is joint with help of arc welding.distillation stand is made of all sides are equal. This stand is facing south direction to absorb maximum solar irradiance. The model collector is shown in fig 3.4.

Fig 3.4 Distillation Stand

3.5 Glass

Glass is a non-crystalline, often transparentamorphous solid, that has widespread practical, technological, and decorative use in, for example, window panes, tableware, and optics.

Glass is most often formed by rapid cooling (quenching) of the molten form; some glasses such as volcanic glass are naturally occurring. The most familiar, and historically the oldest, types of manufactured glass are "silicate glasses" based on the chemical compound silica (silicon dioxide, or quartz), the primary constituent of sand.

Soda-lime glass, containing around 70% silica, accounts for around 90% of manufactured glass.

The term *glass*, in popular usage, is often used to refer only to this type of material, although silica-free glasses often have desirable properties for applications in modern communications technology.

Some objects, such as drinking glasses and eyeglasses, are so commonly made of silicate-based glass that they are simply called by the name of the material.

Fig 3.5 Glass

3.5.1 Specification of Glass

i. **Raw Materials**
   - Silica (70 to 72%)
   - Lime (10%)
   - Soda (14%)
   - Oxide/aluminia/magnesia (5%)

The substances are introduced in the form of quartz sand, soda and lime. 5% oxides such as magnesium and aluminium oxide are added to this mixture. These additives improve the physical and chemical properties of the glass.

ii. **Main Glass Groups**
   - Soda lime glass
   - Lead glass
   - Boro silicate glass

iii. **Main Glass Products**
   - Flat glass (for architectural or automotive applications)
   - Glass containers/glass tubes
   - Special glasses
   - Glass fiber

iv. **Mechanical Properties**

a) **Density:** 2500 kg/m3

A 4mm thick pane of glass weighs 10kg/m2

b) **Hardness:** 470 HK

The hardness of float glass is established according to Knoop. The basis is the test method given in DIN 52333 (ISO 9385).

c) **Compression resistance:** 800 – 1000 MPa

The compression strength defines the ability of a material to resist a load applied vertically to its surface

d) **Modulus of elasticity:** 70 000 MPa

The modulus of elasticity is either determined from the elastic elongation of a thin bar, or from bending a bar with a round or rectangular cross section.

e) **Bending strength:** 45 MPa

The bending strength of a material is a measure of its resistance during deflection. It is determined by bending tests on glass plate using the double ring method according to DIN EN 1288-5. The main characteristics of glass are transparency, heat resistance, pressure and breakage resistance and chemical resistance.

v. **Thermal Properties**

a) **Thermal conductivity:** 0.8W/mK

Thermal conductivity determines the amount of heat required to flow through the cross sectional area of the float glass sample in unit time at a temperature gradient.

b) **Tempering & Softening:** Approx. 600°C

Contrary to solid bodies of crystalline structure, glass has no defined melting point. It continuously transforms from the solid state to the viscous plastic state. The transition range is called the transformation range and according to DIN 52324 (ISO 7884), it lies between 520°C and 550°C. Tempering and bending require a temperature of a further 100°C.

c) **Specific heat :**0.8 J/g/K

The specific heat (in joules) defines the amount of heat required to raise the temperature of 1g of float glass by 1K. The specific heat of glass increases slightly the temperature is increased up to the transformation range.

d) **Thermal expansion:** 9.10-6 K-1

There is a difference in the expansion behaviour of a body under the effect of heat between linear expansion and volumetric expansion. With solid bodies, the volumetric expansion is three times that of linear expansion. The temperature coefficient of expansion for float glass is given according to DIN 52328 and ISO 7991.The main characteristics of glass are transparency, heat resistance, pressure and breakage resistance and chemical resistance.

vi. Optical Properties

Glass has several strong points concerning optical properties:

- It can be produced in large and homogeneous panes
- Its optical properties are not affected by ageing
- It is produced with perfectly flat and parallel surfaces

a) **Refractive index:** N = 1.52

If light from an optically less dense medium (air) meets an optically denser medium (glass), then the light ray is split at the surface interfaces. The measure of deflection determines the refractive index. For float glass, this refractive index is n=1.52. The main characteristics of glass are transparency, heat resistance, pressure and breakage resistance and chemical resistance.

vii. Technical properties

Chemical resistance against

- Water = class 3 (DIN 52296)
- Acid = class 1 (DIN 12116)
- Alkaline = class 2 (DIN 52322 and ISO 695)

The surface of glass is affected if it is exposed for a long time to alkalis (and ammonia gases in damp air) in conjunction with high temperatures. Float glass will also react to compounds that contain hydrofluoric acid under normal conditions. These are used for treating glass surfaces.

3.6 Pipe

A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross-section, used mainly to convey substances which can flow — liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members.

In common usage the words pipe and tube are usually interchangeable, but in industry and engineering, the terms are uniquely defined. Depending on the applicable standard to which it is manufactured, pipe is generally specified by a nominal diameter with a constant outside diameter (OD) and a schedule that defines the thickness. Tube is most often specified by the OD and wall thickness, but may be specified by any two of OD, inside diameter (ID), and wall thickness. Pipe is generally manufactured to one of several international and national industrial standards

3.6.1 PVC Hot Water Pipes

Polyvinyl chloride (PVC) pipe is made from a plastic and vinyl combination material. The pipes are durable, hard to damage, and long lasting. They do not rust, rot, or wear over time. For that reason, PVC piping is most commonly used in water systems, underground wiring, and sewer lines.

Fig 3.6.1 PVC Hot Water Pipe

3.6.2 90 Degree PVC Hot Water Elbow pipe

The 90 degree Long Radius Elbow manufactured using superior grade raw materials. The 90degree Long Radius Elbows are used for connecting pipes of different diameters and find wide applications in various chemicals, construction industries, paper, cement & ship builders.

Fig 3.6.2 90 Degree PVC Hot Water Elbow pipe

3.6.3 Materials

Hot water pipes must be able to withstand the maximum temperature of the water being piped. Pipe material may be copper or an appropriate thermoplastic material.

Materials suitable for hot water supply pipes include:

- copper
- polybutylene (PB)
- Polyethylene (PE or HDPE)
- Polypropylene (PP)
- Cross-linked polyethylene (PEX)
- Unplasticised polyvinylchloride (uPVC or PVC-U)

i. Copper

Copper has long been used for all types of domestic water services and distribution because it:

- Is durable
- Has good corrosion resistance
- Is malleable and easy to bend
- Is self-supporting
- Has good flow characteristics
- Requires few fittings
- Can be recycled.

Copper may be annealed (i.e. heated, then cooled slowly) which improves its properties, for example making it less brittle and stronger.

Although copper in general has good corrosion resistance, this depends on the environment. Acidic conditions, either from the soil (if buried) or from the water, can cause corrosion, so local pH levels should be checked before using copper pipes.

ii. Polybutylene (PB)

Polybutylene is a plastic material that was introduced in the late 1970s and used extensively for water supply pipes until the mid 1990s. Unfortunately, one brand of polybutylene gained a reputation for failure, resulting in a significant drop in use.

Polybutylene has excellent properties for use as water supply pipework, including:

- Low cost
- Flexibility
- Ease of installation
- Ability to be used for both hot and cold water services
- Frost resistance.

In outdoor situations, it must be protected from UV exposure.

iii. Polyethylene (PE or HDPE)

High density polyethylene (often called alkathene or polythene) has been used since the early 1960s. It is suitable for both potable water and wastewater services but it can only be used for cold water supply.

It is the most commonly used plastic pipe for supplying the mains water to a dwelling. Polyethylene:

- Is durable
- Is corrosion resistant
- Has good flow characteristics
- Is lightweight and flexible
- Is easy to install

- Has a good bending radius
- Is inexpensive
- Requires few fittings.

iv. Polypropylene (PP)

There are three types of polypropylene:

1.P-H has good mechanical properties and excellent chemical resistance for use as industrial and sewerage waste pipes systems

2.PP-R has good resistance to high internal pressure so it is suitable for domestic pressure water supply systems and both hot and cold water services

3.PP-B is suitable for buried sewerage and wastewater drainage as it has good impact strength, particularly at low temperatures, and excellent chemical resistance.

The use of polypropylene has been increasing since the late 90s as it is:

- Chemical and corrosion resistant
- Heat resistant
- Lightweight
- Easy to install
- Frost resistant.

In outdoor situations, it must be protected from UV exposure.

v. Cross-linked polyethylene (PEX)

PEX tubing is made from a cross-linked, high density polyethylene polymer, which results in a stronger material that polyethylene. Properties include:

- more durability under extremes of temperature and chemical attack
- Greater resistance to cold temperatures, cracking and brittleness on impact

- It can be used for hot water supply and hydronic heating systems, as well as potable water supplies
- Flexibility
- Ease of installation
- It can be used for indoor and buried outdoor situations.

PEX is not recommended for outdoor above ground use – although it can withstand some UV exposure, this should not exceed the manufacturer's instructions.

vi. Unplasticised polyvinylchloride (uPVC or PVC-U)

The plastic uPVC has been used extensively in New Zealand since the 1960s. Today in domestic construction it is used chiefly for drains, wastes and vents, and is rare for water supply in new individual houses. The primary jointing method for uPVC is solvent welding, where solvents soften the surfaces of the material, which then chemically fuse together. A rubber ring (elastomeric seal) joint system is also available. This piping:

- Is inexpensive
- Is easy to handle
- Has low resistance to flow

3.7 Black paint

Paint is any pigmented liquid, liquefiable, or solid mastic composition that, after application to a substrate in a thin layer, converts to a solid film. It is most commonly used to protect, color, or provide texture to objects. Paint can be made or purchased in many colors—and in many different types, such as watercolor or synthetic. Paint is typically stored, sold, and applied as a liquid, but most types dry into a solid. Most paints are either oil-based or water-based and each have distinct characteristics. For one, it is illegal in most municipalities to discard oil based paint down household drains or sewers.

Solvents for clean up are also different for water based paint than they are for oil based paint.[1] Water-based paints and oil-based paints will cure differently based on the outside ambient temperature of the object being painted (such as a house.)

Fig 3.7 Black Paint

3.7.1 Specification of black paint

i. **Colour:**

Black, shiny coating when dry - dulls with exposure to sunlight.

ii. **Container Sizes:**

1, 2.5, 5 & 25 litters

iii. **Coverage Rates:**

The coverage per litre is dependent upon the porosity of the surface. For metal and smooth surfaces 10m² per litre per coat should be obtained. On porous surfaces coverage will be considerably less.

iv. **Method of Application:**

By brush or airless spray, apply evenly and ensure no pooling of product. A minimum of two coats of Black Bituminous Paint is recommended.

v. **Application Instructions:**

All surfaces must be free from oil, dirt, dust and loose debris. On metal surfaces all loose rust should be removed using a wire brush and where advanced signs of corrosion are evident the area must be treated with a rust inhibitor. A minimum of two coats of Black Bituminous Paint should be applied, the first coat being allowed to dry before the second is applied.

On porous surfaces where the surface being treated is porous, an initial coat of Primer should be should be applied.

vi. **VOC Details:**

EU Limit for this product CAT. 2(i) : 500g/l (2010). This product contains max. 400g/l VOC's

vii. **Storage Conditions:**

Store away from children. Containers must be kept sealed and stored under cover away from sources of heat and ignition. Do not allow water to contaminate the product.

3.8 Silicone Sealant

Silicone caulk can be used as a basic sealant against water and air penetration A silicone or polysiloxane are polymers made up of siloxane ($-R_2Si-O-SiR_2-$, where R = organic group). They are typically colorless, oils or rubber-like substances. Silicones are used in sealants, adhesives, lubricants, medicine, cooking utensils, and thermal and electrical insulation. Some common forms include silicone oil, silicone grease, silicone rubber, silicone resin, and silicone caulk.

Fig 3.8 Silicone Sealant

3.8.1 Specification of silicone sealant

i. APPLICATIONS

Bostik Home is ideal for sealing, bonding, and mending tasks in and around the house such as sealing around Bathroom and kitchen fittings, bonding up signboards, insulating appliances, fixing leaking plumbing, etc.

ii. ADHESION

Bostik Home exhibits excellent primerless adhesion to many non-porous materials e.g. ceramics, glass, enamel, Porcelain, coated wood, painted surfaces, canvas, stainless steel, aluminium, some rubbers and some plastics (epoxide, polyester, polyacrylate, polystyrene, formica, fiberglass, acrylics, polycarbonates and rigid PVC).

iii. LIMITATIONS

- Not suitable for alkaline surfaces such as concrete, fibrous cement, asbestos, plaster and marble.
- Not suitable for some metals i.e. mild steel, lead, copper, tin, galvanized iron, brass or zinc as it may cause Corrosion.
- CANNOT be over-painted.

- May become discoloured in contact with some organic elastomers, which tend to bleed oil or solvents into the Silicone, e.g. EPDM, APTK, Neoprene and Bituminous surfaces.
- Not suitable for mirrors as it will de-silver the mirror backing, affecting the front appearance of the mirror.
- Not suitable for contact with natural stone i.e. marble, granite, quartzite as it may discolour the surfaces.
- Will not adhere to some plastics such as polyethylene, polypropylene and Teflon.
- NOT SUITABLE FOR FISH TANKS (contains a fungicide).
- Do not apply sealant when relative humidity is below 10% - cure rate will be affected.

iv. SAFETY INSTRUCTIONS

Bostik Home is non-toxic, however it is advisable to wear gloves in order to avoid direct skin contact. In the event Of skin or eye contact, rinse thoroughly and immediately with water. Seek medical assistance if irritation or Discomfort persists. The product releases a pungent vinegar-like odour when uncured. Avoid breathing in Vapours. Always work in a well ventilated area. Keep out of reach of children! Cured silicone rubber can be Handled without any health risk. Refer to our Safety Data Sheets for further toxicological information and Comprehensive handling instructions.

v. **SURFACE PREPARATION**

Ensure surfaces are clean, dry and free of loose materials, dust, grease, rust and other contaminants. Surfaces such as metals and glass should be degreased with a solvent e.g. acetone. Plastics should be lightly abraded with emery paper. Alcohol based cleaners should not be used for cleaning surfaces as alcohol inhibits the cure of silicones. Soaps or detergents used to clean the surface must be rinsed away thoroughly with clean water to ensure that all traces of the soaps are removed before sealing. Use backing material when sealing deep cavities. If the area being sealed needs to be painted, ensure that the paint has dried before applying sealant. You cannot paint over silicone sealant! Poor surface preparation may result in the delamination of the silicone.

vi. **HOW TO USE**

1. Ensure that surfaces are prepared as above.

2. Use masking tape to get a clean, even sealant line and to eliminate cleaning difficulties on porous surfaces. Remove tape after silicone application before the sealant skins.

3. 90ml Tube – remove the cap and pierce seal with reverse side of cap. Cut the nozzle to desired bead size and screw onto tube. Apply silicone at a slight angle in a continuous bead to the prepared joint. After use, remove the nozzle, wipe clear and replace the cap firmly.

4. Cartridge - cut the tip off the cartridge and screw on the nozzle. Cut the tip of the nozzle at an angle to achieve the desired bead size. Apply with a caulking gun in a continuous bead to the prepared joint.

5. Remove unwanted silicone immediately.

6. Smooth down after application within 3-5 min before skin formation occurs, by using a flat or rounded tool.

7. Sealant dries to touch in approximately 45 minutes and reaches full cure after approximately 24 hours.

vii. **CLEANING**

- Uncured silicone can be removed from the hands or tools using a clean solvent soaked cloth, e.g. turpentine or paraffin. If removing uncured silicone from clothing, check fabric colour fastness before applying solvents.

- Cured sealant must be removed mechanically with a sharp knife or chemically with Bostik Silicone Stripper.

viii. **STORAGE STABILITY**

Bostik Home has a shelf life of at least 12 months if stored in a cool (below 25°C), dry place in its original moisture-tight container. If the material is kept beyond the recommended shelf life, it is not necessarily unusable, but a check should be performed to observe whether the product is still workable, apply-able and uncured. To maximize the shelf life of the opened cartridge, we recommend that the nozzle be removed and a piece of plastic placed over the cartridge tip after which the nozzle must be screwed back on. A large screw inserted into the nozzle tip also helps to extend the life. Store in a cool environment.

ix. **PRODUCT PACKAGING**

- 90ml Tube
- 280ml Cartridge

3.9 Box nail

In woodworking and construction, a nail is a small object made of metal (or wood, called a tree nail or "trunnel") which is used as a fastener, as a peg to hang something, or sometimes as a decoration.[1] Generally, nails have a sharp point on one end and a flattened head on the other, but headless nails are available.

Fig 3.9 Box nail

CHAPTER 4

WORKING PRINCIPLE

The development of solar powered water distillation has demanded the need of efficient operation to maximize the efficiency. This paper investigates the optimization of different parameters of distillation process. Basin type water distillation system was discussed in this paper. An experimental prototype is presented to evaluate individual factor that affect the performance of water distillation. To begin with, an elementary principle of water distillation is labeled. Some patent model of distillation is presented by focusing the cost and effectiveness towards water purification. After that, a theoretical analysis of an asymmetrical solar distiller is presented. The theoretical analysis is divided into two different categories. At first, the thermal circuit has illustrated to demonstrate the mathematical equation of conduction, convection and radiation process. Also, the basin size is calculated through this. Next, by calculating the slope of collector the optimal direction was predicted. Finally, the proposed prototyped design of water distillation system is presented. A schematic structure diagram is depicted with different component that further discussed in detail. Finally, predicted output from prototype device is presented in a table. According to this maximum output is possible in the month of March and April

CHAPTER 5

ADVANTAGE :

1. Free of charge sun energy (during sunlight it eliminates Watt electric consumption per one hour of sunlight)
2. There are no moving parts; it is therefore reliable and almost maintenance free (cleaning is required though)
3. Water taste is claimed to be better since the device act as a *Solar Water Vaporizer* and it doesn’t boil the water (resembling rain water)
4. Neutral pH is claimed (like rainwater), not like the not neutral pH of steamed distilled water.
5. They can be constructed with locally available, not expensive materials easily, as simple equipment for the production of fresh water.
6. They do not need special skilled personnel for the assembly, operation, and/or maintenance.
7. They can incorporate rain catchment canals to increase productivity, at low additional cost.

CHAPTER 6

DISADVANTAGE :

1. Solar distillers don’t kill bacteria and they don’t break down harmful chemicals because they don’t boil the water
2. The large area tilted glass cover might be an attraction to bugs and insects
3. Low production capacity, not enough for the drinking water needs of the average family.
4. They operate at low efficiency, about 30% or in best conditions at about 4050%
5. They need high initial capital cost which is counterbalanced by lower operational cost
6. Solar distillation plants need large installation surface areas. If it cannot provided free the land price adds a considerable amount to the initial capital cost

CHAPTER 7

APPLICATION

1. Production of boiler feed water
2. Production of Ultrapure water for use in Medical, Pharmaceutical or Electronic Industry
3. Generation of pure water for rinsing in surface treatment technology
4. Recycling of process solution by concentration
5. Treatment of contaminated fluids (poisonous, Radioactive)
6. The industries applicability for the treatment of process solution has been proven in a plant for nickel electroplating in Dresden/Germany.

CHAPTER 8

RESULT

The production of the distil water depends on the level of water in the basin and to the solar radiation. There is an inverse relationship between water level of the basin and solar radiation. As the radiation increases the production rate also increases. The daily production of solar still depends upon the ratio of water vaporization energy and the latent heat of vaporization. An economic comparison of various types of solar stills has many risks. The material, the geometry, and local prices differ considerably not only from place to place but also, in some occasions, from one site to another of the same region. In small, poor communities especially in remote regions, the main target is for a cheap as possible construction independently of life time. Cost of operation is also minimal in comparison with that for conventional desalination processes.

CHAPTER 9

CONCLUSION

Conventional solar stills are very useful piece of equipment for the production of desalinated water from brackish or seawater for individual or for small communities use, especially for remote regions.

As mainly are addressed to poor communities it is more economical to construct solar stills and/or small plants with local available materials and take care for proper operation and maintenance, if necessary.

Despite the numerous designs and means to increase productivity, the final results do not differ considerably between them in such a way that justifies a complicated design that increases the economy of the system.

Unfortunately there exist not enough data from large solar distillation plants. It is obvious that the operation and the data collected from their operation may differ considerably from the data collected from a single solar still.

CHAPTER 10

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CHAPTER 11

PHOTO COPY

Fig.11 AFTER ASSEMBLE THE PROJECT

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CHAPTER 12

COST & ESTIMATION

S.NO	COMPONENT	COST
1.	Aluminium sheet	4,000
2.	Aluminium sheet cutting	500
3.	Plywood	2,000
4.	Carpentry equipments	1,500
5.	Glass	1,000
6	Supporting stand	2,500
7.	Pressure gauge	300
8.	Silicone sealant	600
9.	Black paint	300
10.	Hot water pipes	1,300
TOTAL COST		**12,000**