AN APPLICATION OF SOLAR DRYER IN ORDER TO REMOVE MOISTURE AND DIFFERENCIATING WITH SAMPLE DRIED IN OPEN AIR

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ABSTRACT

Due to the current trends towards higher cost of fossil fuels and uncertainty regarding future cost and availability, use of solar energy in food processing will probably increase and become more economically feasible in the near future.The solar dryer is one of them which help to preserve our food and many eatable things like vegetable fruits and many more things . In this experiment we find that how much moisture removed from the sample which is present in solar dryer and the sample which is present in ordinary air and we compare both of them by mathematical calculation. In this paper we took green chili, some of the chili we put inside the dryer and some in the ordinary air and then compare their moisture removed with respect to time and temperature. We find that temperature inside the dryer is two times outside the temperature. As per our experiment the maximum peak temperature inside the drying chamber is 75°C during mid-day(3pm) and in an average approximately 60°C-62°C in a full sunny day(10:00AM to 03:00PM). In 6 hours continuous drying in one full sunny day under the same climatic condition and in same time the solar dryer removed a maximum of 30- 40% moisture content from drying chamber for drying of low moisture content food products.

Keywords: Solar dryer, drying chamber.

I. INTRODUCTION

The concept of drying food in order to preserve them is a very ancient technique which the human beings had been using for a long time .Drying in the ancient times was under direct sunlight and the drying technique which is developed in today's modern world is solar drying .This modern technique is far more efficient than the ancient one as it is covered up and hence it protects the food stuffs from dust particles and insects. Preservation of fruit and vegetables are essential now a day, and it has become a part of our life. From ancient times fruits, vegetables and other eatables were kept to dry in the sun in order to preserve them .This is one method by which we can preserve our food items, the other method of food preservation is solar dryer .In this method we preserve the food items by taking out the moisture content from them .The more we heat the air, its moisture absorbing capacity increases. This

is the main principle behind the working of solar dryer. This is an economic way of preserving food and that too using solar energy .No other source of conventional energy is used in this process. In today's world ,where there is rapid demand for conventional fuels and the fact that it will not be available to us in the near future ,in that case the need and development of non conventional sources of energy is good for the future generations .The solar dryer can be of great use in the developing countries such as military feeding and space food formulations etc. One of the main advantages of solar dryer over open sun drying is that it prevents the fruits and vegetables and other eatables away from insects and flies and also from dust particles. In this paper we will do some important calculations based on the observation regarding solar dryer which are as follows:

1. The comparison between different samples before and after being kept in the solar dryer with photographical illustration.
2. Graphs showing the relation between the observations.

Some of the previous work which were done by different scientists on solar dryer are as follows **Dattatreya M. Kadam and D.V.K. Samuel** (2005) develop forced convective system for cauliflower drying. **Ghatrehsamani S.H. et. al**. (2012) develops indirect type forced circulation solar dryer for apricot drying and compare results of indirect solar drying with the mixed mode solar drying. **B. K. Bala and Nipa Debnath** presented comprehensive review of solar dryer developments and potentials for drying of fruits,vegetables, spices, medicinal plants, and fish(2012). **D. R. Pangavhave and R. L. Sawhney** presented the review article of different solar drying technologies with detailed development and performance for grape drying (2002). **O.V. Ekechukwua and B. Norton** discussed the review of solar drying technologies for application of each design type for rural farmers in developing countries (1997). **S. VijayaVenkataRaman** presented comprehensive review of various solar drying technologies with design, development and performance evaluation also discussed the drying in off sunshine hours by using different desiccant materials (2012). **V. Belessiotis and E. Delyannis** presented comprehensive study of different solar drying technologies with fundamental principles and parameters (2010). **Bolin** (1980) discussed the relative merits of five experimental methods for the solar dehydration of fruits, namely: black wooden tray, solar troughs of various materials designed to reflect radiant energy onto bottom of black metal drying trays, cabinet dryers with slanted plate heat collectors with natural convection, utilizing inflated polyethylene (PE) tubes as solar collectors with and without partial air recirculation; and PE semicylinder with a fan blower to be used in inflated hemispheres or as a solar collector, to blow air over the fruit in a cabinet dryer. They reported that utilizing inflated PE tubes method was cheap, 38% faster than sun drying for apricots and could be used as supplementary heat source for conventional dryer. **A.R Celma and F. Cuadros** presented energy and exergy analyses of the drying process of olive mill wastewater (OMW) using an indiret convection solar dryer. **J.K. Afriyie** (2009) tested chimney dependent direct-mode solar crop dryer for different angles.

II. WORKING PRINCIPLES OF SOLAR DRYER

The main principle of this low cost solar cabinet dryer is based on greenhouse effect where the solar heat is trapped inside the drying chamber and thus increases the temperature level. It is a mixed-mode solar cabinet dryer. Here both direct and the indirect solar energy collected in the chamber heats up the food products. The direct solar energy

collected in the chamber converted in to heat energy heats up the food product and thus removes moisture from the food product.

III. EXPERIMENTAL SETUP

Materials required for making the solar dryer:

The materials which are used to make the solar dryer are used in our everyday life .And they are found easily near our locality.

Plywood, Hammer, Nail and glue, wired mesh, Glass, Thermometer, Black paint.

With the help of these things we constructed the solar dryer. The picture is given below:

(A)

(B)

(C)

Figue:(1): (A),(B) underconstruction and (C) fully constructed solar dryer

IV. OBJECT OF THE OBSEVATION

Details of moisture removed during drying (in the month off fab-march) both in outside and the inside chamber are as shown below. Room temperature during drying period was 31^0c. and the comparing the percentage of moisture removed from the solar dryer and the ordinary air(fruit present in the atmosphere) the following table is experimental based data.

TABLE 1 Temperature, weight and %moisture removed in different condition

SI. No	Time	Upper Tray			Lower Tray			Outside Chamber	
		Temperature ^{o}c	Weight (gm)	Moisture Removed	Temperature ^{o}c	Weight (gm)	Moisture Removed	Weight (gm)	Moisture Removed
1.	10:00(AM)	31	250	0.00%	31	250	0.00%	250	0.00%
2.	11:00(AM)	58	225.00	10.00	56	228	8.8	247	1.20
3.	12:00(AM)	63	202.01	19.20	63	206.45	17.42	236.03	5.58
4.	01:00(PM)	66	177.02	29.20	65	184.66	26.13	226.54	9.38
5.	02:00(PM)	71	125.00	50.00	68	128.20	48.72	199.04	20.38

6.	03:00(PM)	75	90.03	64.00	73.97	93.44	62.66	150.00	40.00

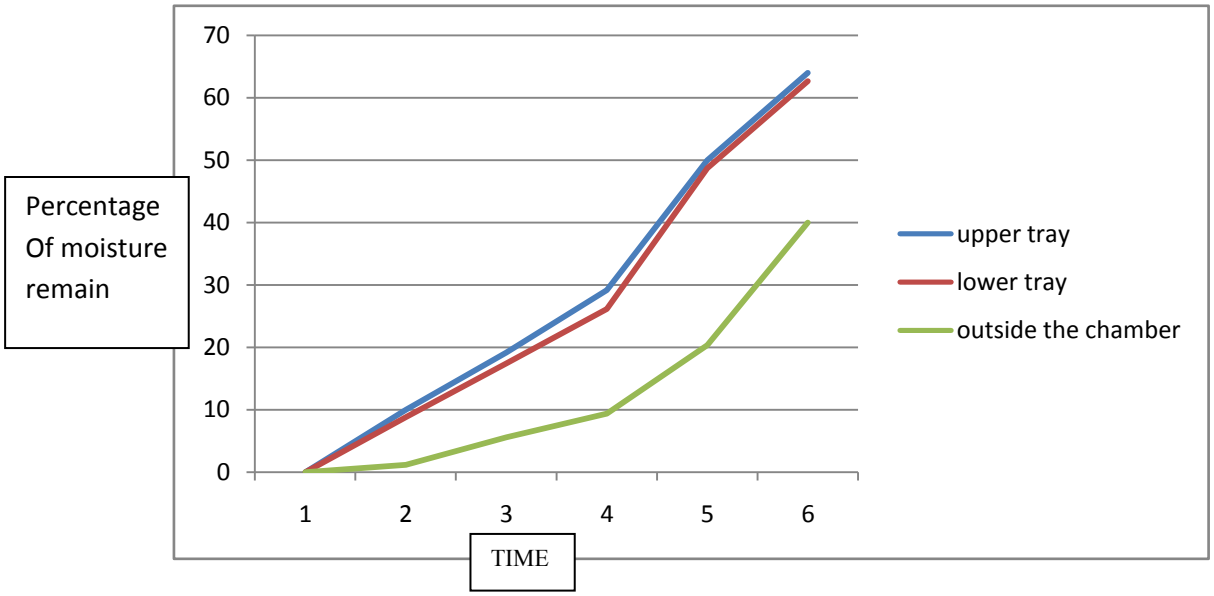
(A)

(B)

(C)

Figure: 2 (A) Chili before drying (B) Inside drying chamber (C) Outside drying chamber

4.1 Graphical Representation of Drying Rate: The following graph represents total moisture % removed per every hour inside and the outside of the chamber. The lower most and the middle graphical line represent moisture content removed in % at inside the chamber. Lower most graphical lines represent the MC removed in % outside the drying chamber. The following represents the MC removed in % with respect to time and the temperature at that point. Since the solar drying does not give constant temperature because of climatic condition; so the moisture % removed varies un-uniformly with time and the varied temperature.



Graphical Representation (Moisture remove vs time)

V. RESULT AND DISCUSSION

After study we have found that the solar cabinet dryer gives more than three-four times heat inside the chamber than that of the outside atmospheric temperature. In 6 hours continuous drying under the same climatic condition and same time it removed 28.73 % (upper tray) and 27.28 % (lower tray) moisture content from inside chamber chili whereas at outside only 12.75% moisture.

VI. CONCLUSION

With the help of this project we find how much solar dryer is more efficient in our Morden generation. The function of solar dryer is more effectively and efficiently with minimal maintenance cost, hence it is easy to access and is affordable by local farmers because of its low cost. There had been a lot of impediments while performing this project. This project can be proved thriving if it is being brought in used for many purposes.

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THERMAL PERFORMANCE OF SOLAR AIR COLLECTOR BY COMPARING SINGLE GLASS COVER WITH DOUBLE GLASS COVER: EXPERIMENTAL INVESTIGATION

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ABSTRACT

Solar energy is that energy which is rapidly gaining acceptance as an energy saving measure in various applications. It is preferred as an alternative source of energy. The thermal performance of the air collector is investigated experimentally at various different operating parameters. Air is used as the working fluid in this experimental set-up. The aim of the experiment is the production of hot air by using the aluminium tubes with single glass sheet and double glass sheet. Air Collector efficiency in between these single and double glass sheet is been found. The temperature difference and the collector efficiency are studied with different flow rates of air. It is observed that the air collector containing single glass sheet has higher efficiency when compared to the double glass sheet air collector. The maximum efficiency in case of single glass sheet air collector is 72.1% which is higher when compared to the efficiency of the double glass sheet air collector which is found to be 58.8%.

Keywords: Solar Air Collector, Single and Double Glass Sheet, Air Collector Efficiency

I. INTRODUCTION

A solar collector is a device which converts the solar energy into the useful heat energy in the most efficient way. As we all know that our conventional energy resources are decreasing day by day. It is mainly due to the prolonged use of the electricity which is produced by coal, gas, diesel, etc. The emissions and the byproducts of these fuels are effecting the environment very badly which is resulting in the global warming, depletion of ozone layer, causing acid rain, etc which is very harmful for all the living beings. So, we need to find an alternative method by which we can reduce consumption of the electricity. Solar energy is the best non-conventional energy resource which can be use as an alternative method. Solar energy can be utilized directly in two ways. (I) by collecting the radiant heat and using it in the thermal systems. (II) By collecting and converting it directly to electrical energy using a photo-voltaic system. The solar air heating is pollution free and the running cost is also very low. It is environment friendly. But, the initial cost for set-up is very high and works in day time. It does not work properly on the cloudy or foggy days. This paper will present the comparison of thermal performance of the solar air heating consisting of aluminum tubes with single and double glass sheet.

A review of literature suggests that the considerable effects have been invested in research and development of solar air heating technology. **R Perez et al (1995)** developed a radiation model for evacuated collector with tubular absorber [1]. **L Qin (1999)** investigated the tube geometry and panel design of evacuated tube solar

collector [2]. **G L Morrison (2004)** measured the typical performance of the water in glass evacuated tube solar water heater [3]. **Young Kim (2007)** investigated the thermal performance of glass evacuated solar collector numerically and experimentally [4]. **Louise Jivan Shah (2007)** investigated heat transfer and flow structures inside the glass evacuated tubes for different flow operating conditions by computational fluid dynamics [5]. **Liangdong Ma (2010)** investigated the thermal performance of the individual glass evacuated tube solar collector by analytical method [6].

II. EXPERIMENTAL SETUP

The main objective of this experiment is to study the thermal performance of solar air collector and to produce hot air. The experimental setup is shown in Figure 1. The setup consists of 10 aluminium tubes, the length and diameter of each aluminium tube is 73cm and 2.54 cm respectively. The surface area of solar air collector is 1.40 m^2. The open ends of aluminium tubes are connected to the manifold channel and closed end is supported by frame. Blower is used to blow the air in the tubes.

Figure 1. Solar Air Collector

The experimental setup consists of the following parts:

(I) Aluminium tubes - Ten number of aluminium tubes are being used. Air is allowed to flow inside the aluminium tubes.

(II) Manifold channel – It supports one end of the aluminium tube.

(III) Screen - It is made up of toughened glass. It is a type of safety glass processed by controlled thermal or chemical treatments to increase its strength compared with normal glass. Thickness of both glass sheets is same i.e 5 mm.

(IV) Fan - It is a mechanical device which is used to direct the air flow inside the air collector.

(V) Frame - It is the outer boundry of the air collector which support the other end of the aluminium tubes.

2.1 Measuring Instruments or Devices

The various parameters which are to be measured in this experiment:

Figure 2. Temperature Sensor

(I) Inlet and Outlet temperatures – The inlet and outlet readings are taken with the help of a temperature sensor. It gives the digital display reading in degree Celsius (^oC).

(II) Solar Intensity – The reading of solar intensity is taken with the help of a solar power meter.

(III) Air flow rate – The readings of the velocity at the outlet of the air is taken with the Anemometer.

III.CALCULATION AND RESULT

3.1 Formulae Used

Thermal performance of the solar air collector can be estimated by the collector efficiency which is defined as the ratio of output to the input. Output in this case is the heat gain by air flowing through the manifold channel and input is the energy of the solar radiation falling on aluminium tubes:

$$\eta = P_{out} / P_{in}$$

Where;

$$P_{out} = \dot{m} C_{pa} (T_{out} - T_{in})$$

$$P_{in} = I_o A$$

$$\dot{m} = \rho A V$$

Area of the solar collector is given by (A) = Number of tubes × 2DLe.

3.2 Nomenculature

T_{out}: Outlet temperature of air, ^oC

T_{in}: Inlet temperature of air, ^oC

C_{pa}: Specific heat of air, J/kg K

$\dot{m}$: Mass flow rate of air, kg/hr

A: Area of solar air collector, m^2

I_O: Solar radiation intensity, W/m^2

η: solar air collector efficiency.

Table 1. Data Obtained in Experiment

WHEN SINGLE GLASS SHEET IS USED AS COVER

Time	Outlet Temperature of air, T_{out} (^oC)	Inlet temperature of air, T_{in} (^oC)	Mass flow rate of Air, $\dot{m}$ (Kg/sec)	Solar Intensity, I_o (W/m^2)	Temperature difference, ΔT (^oC)	Efficiency, η (%)
10:00 AM	30	20	.017498	450	10	27.9
10:45 AM	34	20	.017498	480	14	36.6
11:30 AM	38	20	.017498	510	18	44.4
12:15 PM	46	20	.017498	540	26	60.4
1:00 PM	52	20	.017498	555	32	72.1
1:45 PM	45	20	.017498	530	25	59.2
2:30 PM	40	20	.017498	500	20	50.2
3:15 PM	33	20	.017498	470	13	34.7

4:00 PM	29	20	.017498	440	9	25.6

Table 2. Data obtained in experiment

WHEN DOUBLE GLASS SHEET IS USED AS A COVER

Time	Outlet Temperature of air, T_{out} (^oC)	Inlet temperature of air, T_{in} (^oC)	Mass flow rate of Air, $\dot{m}$ (Kg/sec)	Solar Intensity, I_o (W/m^2)	Temperature difference, ΔT (^oC)	Efficiency, η (%)
10:00 AM	28	20	.017498	450	8	22.3
10:45 AM	32	20	.017498	480	12	31.4
11:30 AM	36	20	.017498	510	16	39.4
12:15 PM	42	20	.017498	540	22	51.1
1:00 PM	46	20	.017498	555	26	58.8
1:45 PM	41	20	.017498	530	21	49.1
2:30 PM	37	20	.017498	500	17	42.3
3:15 PM	30	20	.017498	470	10	26.7
4:00 PM	25	20	.017498	440	5	14.2

Table 3.Comparison between single glass and double glass cover

No of glass sheet used as cover	Maximum effieciency (η)(%)	MaxTemperature difference ΔT (°C)
Single	72.2	32
Double	58.8	26

IV.CONCLUSION

From the experimental analysis the following conclusion is been obtained:

(1) The maximum temperature difference of single glass sheet is found to be 32 ^{0}C at air flow rate of 0.017498 Kg/sec.

(2) The maximum temperature difference of double glass sheet is found to be 26 ^{0}C at air flow rate of 0.017498 Kg/sec.

(3) The efficiency obtained in case of single glass sheet is found to be 72.2 %.

(4) The efficiency obtained in case of double glass sheet is found to be 58.8%.

(5) Thus, the efficiency in case of the single glass sheet air collector is higher when compared to that of double glass sheet air collector.

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BIOGRAPHICAL NOTES

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EXPERIMENTAL INVESTIGATION OF SOLAR AIR COLLECTOR BY COMPARING GLASS WOOL AND FOAM AS AN INSULATION MATERIAL

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ABSTRACT

The Sun is the most powerful heat generator, which neither of the heat sources created by mankind can compete with. Solar energy is that energy which is rapidly gaining acceptance as an energy saving measure in various application. In this experimental set up the thermal efficiency of the air collector containing aluminium tubes is been found out by using two different insulating material. Glass wool and Foam are used as the insulating material. The temperature difference and efficiency are studied at constant air flow rate. The main aim of this paper is to compare the thermal efficiency between the glass wool insulated air collector to the foam insulated air collector. The maximum efficiency in the case of the glass wool insulated air collector is found to be 63.9% and in case of foam insulated air collector is 70.16%. Thus the efficiency of the foam insulated air collector is higher.

Keywords: Air Collector, Thermal Efficiency, Glass Wool and Foam Insulation

I. INTRODUCTION

Solar energy is preferred as another alternative sources of energy because it is abundant, inexhaustible and non-polluting. So if more people used solar energy to heat the air and water in their homes, our environment would be cleaner. Over the past century, fossil fuels provided most of our energy, because they were much cheaper and more convenient than energy from alternative energy sources. The limited reserves of fossil fuels cause situation in which the price of fuels will increase as the reserves are decreased. Solar air heaters are simple devices to heat air by utilizing solar energy. A solar collector has two functions: (1) Absorb solar radiation and (2) transfer the heat from absorber plate to the transport fluid (Air is the fluid in this case). In all air type collectors the flow of the transport fluid should be restricted so as to create a high flow velocity against the solar absorber plate. The performance of solar air heaters is mainly influenced by meteorological parameters (direct and diffuse radiation, ambient temperature and wind speed), design parameters (type of collector, collector materials) and flow parameters (air flow rate, mode of flow). The principal requirements of these designs are a large contact area between the absorbing surface and air.

Chiou, El-wakil, Duke in the year **1965** and **Hachemi** in the year **1999** proposed that the Collectors performances depend on the collector materials [1-2]. **Binodi P, Circala L, Farina G** in the year **1988** and **Gupta D, Solanki SC, Saini JS** in the year **1993** said about the technology used in the manufacturing of the collector [3-4]. **El sawi AM, Wifi AS, Younam MY, Elsayeded EA** in the year **2010** and **Lanjewar A, Bhogoria** in the year **2011** said that the Solar collectors performance depends, on their operating parameters: the

global solar irradiance, air-flow velocity and air-flow rate discharged through the solar collector, and operating time [5-6]. **Krzaczek M, Kowalczuk Z** in the year **2011** and **Chan HY, Riffat SB, Zhu J** in the year **2010** proposed that the improvement in the energy performance of solar heat collectors is important, both for their use in space heating, and also in natural ventilation systems integrated in the technology of building passive houses [7-8]. Thus, there are two technologies to consider regarding solar air collectors: in a closed loop system, when the air is circulated from the house to the collector and back to the house—for heating; and in an open loop system, when the air is taken from outside, flows through the panel, is circulated into the building, and goes back outside—for ventilation, to improve indoor air quality [9].

II. EXPERIMENTAL SETUP

In this experiment we will be comparing the thermal efficiency between the air collector containing different insulating material. Glass wool is used in one case and foam is used in another case as an insulating material. The objective of the experiment is to study the performance of solar air collector and to produce hot air. The set up consists of 10 aluminium tubes , each having diameter of 2.54 cm and length 73 cm. The surface area of solar air collector is 1.40 m^2. The one end of the aluminum tube is connected to the manifold channel and the other end is supported by frame. Fan is used to blow the air into the aluminium tube.

Figure 1. Solar Air Collector For Space Heating

Experimental set up consists of the following

(I) Aluminium Tubes – Aluminium tubes are used in this air collector through which the air is passing. Number of aluminium tubes used in this experiment are ten .

(II) Screen – The screen is made up of toughened glass. It is a type of safety glass processed by controlled thermal or chemical treatments to increase its strength compared with normal glass. Toughened glass sheet of 5mm thickness is used.

(III) Glass wool insulation – Glass wool is an effective insulation material whose main function is to prevent the heat losses. Thickness of glass wool is 2cm.

(IV) Foam insulation – Foam insulation is a very good air barrier but does not provide any type of water vapor barrier. It is much more sponge like in appearance. It is often used for interior walls because it provides sound reduction. Thickness of Foam used is 2cm.

(V) Frame – It is the outer most boundry of the setup. This frame is made up of wood. One side of the aluminium tubes are supported by this frame.

(VI) Fan - A small fan is used to direct the air flow into the collector system.

Figure 2. Fan

2.1 Measuring Instruments

These are the various parameters which are to be measured in this experiment:

(I) Inlet and Outlet temperatures – The inlet and outlet readings are taken with the help of a temperature sensor. It gives the digital display reading in degree Celsius (^oC).

(II) Solar Intensity – The reading of solar intensity is taken with the help of a solar power meter.

(III) Air flow rate – The readings of the velocity at the outlet of the air is taken with the Anemometer.

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Where ;

$$P_{out} = \dot{m} C_{pa} (T_{out} - T_{in})$$

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$$\dot{m} = \rho A V$$

Area of the solar collector is given by (A) = Number of tubes × 2DLe.

3.2 Nomenculature

T_{out}: Outlet temperature of air, ^oC

T_{in}: Inlet temperature of air, ^oC

C_{pa}: Specific heat of air, J/kg K

$\dot{m}$: Mass flow rate of air, kg/hr

A: Area of solar air collector, m^2

I_O: Solar radiation intensity, W/m^2

η: solar air collector efficiency.

Table 1. Data Obtained in Experiment

WHEN GLASSWOOL IS USED AS AN INSULATION

THICKNESS OF GLASS WOOL USED IS 2CM

Time	Outlet Temperature of air, T_{out} (^oC)	Inlet temperature of air, T_{in} (^oC)	Mass flow rate of Air, $\dot{m}$ (Kg/sec)	Solar Intensity, I_o (W/m^2)	Temperature difference, ΔT (^oC)	Efficiency, η (%)

10:15 AM	30	21	.016387	455	9	23.2
11:00 AM	34	21	.016387	485	13	31.5
11:45 AM	38	21	.016387	515	17	38.8
12:30 PM	45	21	.016387	545	24	51.8
1:15 PM	52	21	.016387	570	31	63.9
2:00 PM	43	21	.016387	535	22	48.3
2:45PM	39	21	.016387	505	18	41.9
3:30 PM	34	21	.016387	490	13	31.2
4:15 PM	29	21	.016387	445	8	21.1

Table 2. Data Obtained in Experiment

WHEN FOAM IS USED AS AN INSULATION

THICKNESS OF FOAM USED IS 2CM

Time	Outlet Temperature of air, T_{out} (^oC)	Inlet temperature of air, T_{in} (^oC)	Mass flow rate of Air, $\dot{m}$ (Kg/sec)	Solar Intensity, I_o (W/m^2)	Temperature difference, ΔT (^oC)	Efficiency, η (%)
10:15 AM	32	21	.016387	455	11	28.4
11:00 AM	36	21	.016387	485	15	36.3
11:45 AM	40	21	.016387	515	19	43.3
12:30 PM	48	21	.016387	545	27	58.2
1:15 PM	55	21	.016387	570	34	70.1
2:00 PM	46	21	.016387	535	25	54.9
2:45PM	42	21	.016387	505	21	48.9
3:30 PM	36	21	.016387	490	15	36.0
4:15 PM	31	21	.016387	445	10	26.4

Table 3.Comparison Between Glass Wool and Foam Insulation

Type of insulation material	Maximum effieciency (η)(%)	MaxTemperature difference ΔT (°C)
Glass wool	63.9	31
Foam	70.16	34

IV.CONCLUSION

From the experimental analyisis the following conclusion have been obtained :

(1) The maximum temperature difference in case of glasswool as an insulation material is found to be 31^0C and air flow rate is 0.16387 Kg/sec.

(2) The maximum temperature difference in case of foam as an insulating material is found to be 34^0C and air flow rate is 0.16387 Kg/sec.

(3) The efficiency in case of the glasswool as an insulating material is found to be 63.9 %.

(4) The efficiency in case of the foam as an insulating material is found to be 70.16 %.

(5) Thus, the efficiency in case of the foam insulating material is found to be higher when compared to the glasswool insulating material.

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EXPERIMENTAL INVESTIGATION OF PERFORMANCE COMPARISON OF ELECTRIC POWERED VCRS WITH SOLAR ASSISTED VCRS

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ABSTRACT

Energy conservation and use of the renewable source of the energy in most efficient manner is the main challenge faced by the engineers in today's world. In this experiment our main objective is to develop a solar assisted and electric-powered conventional vapour compression refrigeration system (VCRS) connected in series. A minimum value for the total solar insulation needed to overcome internal irreversibility for start-up of the system is defined and the effect of the solar panel design parameters on this value is investigated. Initially, VCRS is electricity powered. Again, we power the VCRS with solar panels. The results indicate that the coefficient of performance (COP) of the proposed system is relatively equivalent as compared to the conventional VCRS but there is a saving of 5.63% in power consumption during peak load demands in case of solar assisted VCRS. It is noticed that the performance of the novel refrigeration system increases as sunlight becomes intense from 8:00 to 13:00 hrs.

Keywords: Solar Assisted Vapour Compression Refrigeration System, COP

I. INTRODUCTION

Refrigeration system uses solar energy which is eco friendly source of energy. The energy use associated with refrigeration system operation and the environmental impacts associated with its generation and distribution often outweighs the choice of energy source. To minimize environmental impacts associated with refrigeration system operation, it is reasonable to evaluate the prospects of a clean source of energy. Using solar as a primary energy source is attractive because of its universal availability, low environmental impact, and low or no ongoing fuel cost. Researchers have found that solar energy is an ideal source for low temperature heating applications such as space and domestic hot water heating. The use of solar energy to provide refrigeration is less intuitive. It provides refrigeration at temperatures below 0°C (32°F). We conclude that, photovoltaic-based vapour compression is presently a viable solar refrigeration technology. The basic principle of solar vapour compression refrigeration system is to form the foundation for nearly all conventional refrigeration. In the vapour compression cycle, cooling is provided in the evaporator as low temperature refrigerant entering the evaporator as a mixture of liquid and vapour is vaporized by thermal input from the load. The vapour exiting the evaporator in a saturated or slightly superheated condition enters a compressor that raises the pressure and, consequently, the temperature of the refrigerant. The high pressure hot refrigerant enters a condenser heat exchanger that uses ambient air or water to cool the refrigerant to its saturation temperature prior to fully condensing to a liquid. The high-pressure liquid is then throttled to a lower pressure, which causes some of the

refrigerant to vaporize as its temperature is reduced. The low temperature liquid that remains is available to produce useful refrigeration. The major energy input to a vapour compression refrigeration system is the mechanical power needed to drive the compressor. The compressor power requirement is substantial because the specific volume of the refrigerant vapour, *v*, is large. Its coefficient of performance (COP) defined as the ratio of the cooling capacity to the total electrical power required. The COP for a system providing refrigeration at –10°C(14°F) while rejecting heat to a temperature at 30°C (86°F).Photovoltaic (PV) involve the direct conversion of solar radiation to direct current (dc) electricity using semiconducting materials. Solar photovoltaic panels produce dc electrical power that can be used to operate a dc motor, which is coupled to the compressor of a vapour compression refrigeration system. Incident solar radiation of 1,000 W/m^2 (10800 W/ft^2) and a module temperature of 25°C (77°F) is capable of being generated by a PV system.

Murthy et al. (1991) tested different ejector dimensions at the cooling capacity about 0.5 kW. R12 was used as the refrigerant. A COP in the range of 0.08-0.33 was obtained.A single stage solar driven ejector system with 3.5kW of refrigeration capacity at an evaporating temperature of 4ºC and a generating temperature of 90-105°C with R114 was designed by **Bejan et al. (1995). Göktun (2000)** proposed a solar assisted ejector-vapour compression cascade system. The inter-cooler was installed serving as a condenser for the vapour compression system and an evaporator for the ejector system. **Ersoy et al. (2007)** presented performance variations of a solar-powered ejector cooling system (SECS) using an evacuated-tube collector in different cities in Turkey.To assess system and refrigeration efficiencies of a solar assisted ejector cycle using water as a working fluid was theoretically studied by **Varga et al. (2009).**

II. EXPERIMENTAL SETUP

The experimental setup is categorized into two parts i.e.; one is solar powered source and another is electric powered vapour compression refrigeration system. In this experimental setup initially we run our compressor part with direct electrical power and further we move toward VCRS with solar assisted electrical power. First we calculate different parameters by using simple electric run VCRS system and then we calculate same parameters by using VCRS with solar assisted electrical power.

The solar powered VCRS set up is equipped with solar panels, voltage controller, battery of 12V, inverter (600W) and power cables and VCRS.

On the other hand, we have vapour compression refrigeration system. This setup consists only of compressor (100W), condenser, capillary tube and evaporator along with the working fluid termed as R134a.

INSTRUMENTS USED

1 Pressure Gauge

2Thermocouple

3Voltmeter and Ammeter

Two pressure gauges are used in this set up, one for the measurement of suction pressure before the compressor and other for the measurement of discharge pressure after the compressor. Thermocouple is used to measure the temperature of the working fluid. Thermocouple sensor of RTD PT100 type is used, which directly gives the value of temperature at various points in the air conditioning system. Voltmeter and ammeter are the devices used to measure the voltage and current of the input power to the air conditioning system. Both voltage and ammeter are of dial gauge manual type.

Figure 1: VCRS system run with simple electric power

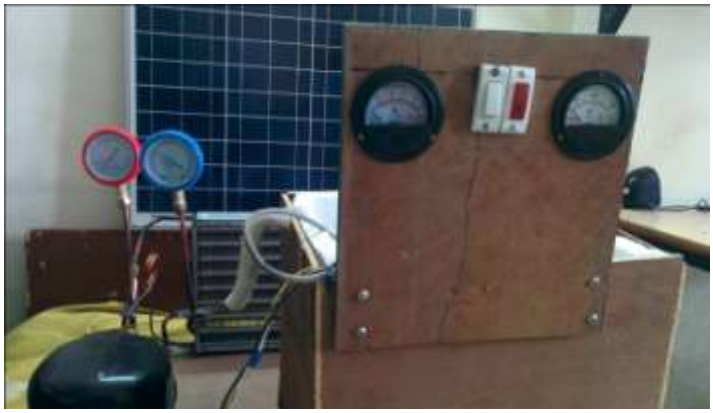

Figure 2: VCRS system assisted with solar power

III. CALCULATION AND RESULT

Based on the experimental results, thermodynamic properties of the refrigerant at different points in the cycle are obtained using the P-H chart of refrigerant R-134a and the parameters such as mass flow rate, cooling capacity and COP of the system are calculated from the equations:

A. Compressor Work $W_c = V * I = m_{ref} * (h_2 - h_1)$

B. Mass flow rate of refrigerant $m_{ref} = \frac{Wc}{(h2 - h1)}$

C. Cooling effect produced $Qr = m_{ref} * (h_1 - h_4)$

D. $COP = \frac{Qr}{Wc}$

Where,

h1 = enthalpy of refrigerant at inlet of compressor in kj/kg (1)

h2 = enthalpy of refrigerant at exit of compressor in kj/kg (2)

h3 = enthalpy of refrigerant at exit of the condenser kj/kg (3)

h4 = enthalpy of refrigerant at entry of evaporator in kj/kg (4)

The voltage and ampere of the input power are obtained from the voltage meter and ampere meter attached in the experimental set-up. Using this voltage and ampere reading, work done of the compressor is obtained.

Table 1: Result obtained at ambient temperature 30 ^{o}C

Ambient air conditions : DBT - 30^{o}C, WBT - 23^{o}C, RH - 55%				
Parameter	**Symbols**	**Unit**	**Electrical**	**Solar**
Evaporator Absolute pressure	P_{eva}	bar	0.48	0.43
Condenser Absolute pressure	P_{con}	bar	11.96	11.07
Compressor inlet temperature	T_1	^{o}C	-12.17	-13.01
Compressor exit temperature	T_2	^{o}C	49	44
Condenser exit temperature	T_3	^{o}C	37	33.34
Total electric current	I	Ampere	0.75	0.71
Total electric voltage	V	Volts	215	215

Table 2: Result of the experiment at ambient air temperature 30°C

Performance Results of Air Conditioner (T_{amb} - 30^{o}C)				
Parameter	**Unit**	**Electrical**	**Solar**	**Variation**
Compressor Work , W_c	Watt	161.25	152.65	5.63%
COP	------	4.34	4.63	6.68%

IV. CONCLUSION

During the hot summer day when electrical energy at a peak demand at that time solar energy is alternate source of energy. We can save solar energy and utilize it for further household work. Similarly in this way we make a setup of VCRS which is assisted with solar panel which stored solar energy and we utilize this solar energy in order to run compressor of VCRS system. Initially we run our VCRS setup at ambient temperature 30 ^{o}C and after that VCRS with solar assisted setup is used at 30 ^{o}C. From the experimental performance we conclude that COP of solar assisted setup is quite more as compare to simple VCRS system. Also power consumption of solar assisted VCRS system is less as compare to simple VCRS system which is about 5.63%. So we can use this solar assisted panel in normal air conditioning system. But initial setup cost is high as compared simple VCRS system; also performance of solar assisted setup is high and we get higher cooling capacity.

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EXPERIMENTAL STUDY OF COMPARISON OF ORGANIC PCM (STEARIC ACID AND PARAFFIN WAX) AND INORGANIC PCM (ZINC NITRATE HEXA-HYDRATE) IN SOLAR COOKER AND SOLAR WATER HEATERS

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ABSTRACT

The use of Solar cooker has been increasing day by day because of the constant depletion of our natural resources, respectively the experimentation of the use of Phase Change Material (PCM) in the solar cookers is also increasing .As the use of PCM is increasing, some experimental study should be done on the kind of Phase change materials that are more advantageous. In this experiment, we compare the use of Organic PCM (Stearic Acid and Paraffin Wax) and inorganic PCM (Zinc Nitrate hexa-hydrate) in the solar cookers. In this particular experiment, we use two Aluminum containers for the design of the cooking vessel, Rice, Mung Beans and Bulgur (Dalia) as the food materials. Organic phase change materials takes less time in cooking food as compared to Inorganic phase change materials. The time taken by Stearic Acid follows the following order:- Rice- 99 minutes (961.45 J) >Mung Beans- 81 minutes (940.5 J) >Bulgur- 53 minutes(668.8 J); similarly by Paraffin Wax :- Rice – 103 minutes (1045 J)> Mung Beans 79 minutes(1099.2 J)>Bulgur 56 minutes (919.65 J); and Zinc Nitrate hexa-hydrate :- Rice- 127 minutes (606.1 J)>Mung Beans 112 minutes (543.4 J)> Bulgur- 54 minutes (522.5 J), concluding Organic kind of PCM materials are better option for PCM integrated solar cookers as compared to Inorganic kind. In addition to this, a copper tube carrying water is being passed through the outer diameter of aluminum vessel which heats the water .The outlet temp of heated water follows the following order Stearic Acid(48.6^{o}c), Paraffin Wax(51^{o}c), Zinc Nitrate hexa-hydrate(39^{o}c).

Keywords: Phase Change Material, Solar Cooker, Solar Water Heater

I. INTRODUCTION

The world is turning more and more towards the use of renewable sources of energy because of the continuous depletion of the energy resources and emission of green house gases into the atmosphere. The best way to solve this crisis is to use renewable energy resources. Solar energy is one of the most important and cleanest type of renewable energy resources available. Despite the benefits of solar energy, it still cannot be used on cloudy days or evening time. Our project focuses on the use of PCM (phase change material) as a thermal energy storage medium to increase the efficiency and overcome the limitation of night cooking in the solar cookers. PCM stores energy, as well as heats up the vessel thus increasing the efficiency of the solar cooker. This project uses a

different kind of design, that includes concentric aluminum vessels fixed together, with a copper tube going through it, which is being used for solar heating of water. This project also uses green house effect with the help of a glass container in which the cooking vessel is put to increase the efficiency. In this process we are comparing the heat storage capacity of different PCM materials by taking the time taken by them to cook the food as a reference.

Hussein et al. developed a novel indirect solar cooker with outdoor elliptical cross-section wickless heat pipes, flat-plate solar collector with an integrated indoor PCM thermal storage and cooking unit. Two plane reflectors are used to enhance the insulation falling on the collector, while magnesium nitrate hexahydrate (melting temperature 89 8C, latent heat of fusion 134 kJ/kg) is used as the PCM inside the indoor cooking unit of the cooker. It is found that the average daily enhancement in the solar radiation incident on the collector surface by the south and north facing reflectors is about 24%.**Khalifa et al.** developed wickless heat pipes for cookers employing flat-plate solar collectors. The cooker consisted of a flat-plate solar collector with integral copper wickless heat pipes network placed outdoors and a cooking chamber placed indoors. The wickless heat pipes were charged with acetone. A shallow pool of oil was maintained in the cooking chamber between the condenser section of the wickless heat pipes and the cooking pot to enhance heat transfer between them. The time required to heat food in the pot, at numerous combinations of the oven arrangement, was investigated for different temperature levels, and recommendations were made for further areas of improvement. **Stumpf et al**. investigated theoretically and experimentally three heat pipe coupled solar cooking systems. The first one was heated by a flat-plate solar collector with integrated heat pipes, while the second and third systems were heated by a vacuum tube solar collector with integrated heat pipes. The experimental results proved the operational stability of the different heat pipe systems even on days with rapidly varying irradiance.

II. CONSTRUCTION DETAILS

This design is made by keeping the efficiency as the prime focus. Unlike other conventional designs, this design is made by using a different approach by using two concentric aluminum cylinders, with one bigger then the other. These two cylinders are attached together with the help of TIG welding with the help of aluminum filler rod. A Copper tube is inserted from the top side of the container and coiled inside around the inner container exiting near the base. A glass box is used to get the effect of Green House from the sunrays in order to trap the heat. The basic design parameters of this vessel are as follows-

2.1 Design Specification of Containers

Outer cylinder diameter	-	29cm
Inner cylinder diameter	-	21cm
Height of outer cylinder	-	31cm
Height of inner cylinder	-	21cm
Volume of the cooker (volume of inner cylinder)	-	$\pi * r^2 * h$

- 7273.57cm^3

2.2 Design Specification of Copper Tube-

Copper pipe diameter (d)	-	5 mm
Coil diameter (D)	-	25 cm
No. of turns (n)	-	3

Pitch (P) - 7.5 cm

Extensions on starting and ending point (E) - 5 cm

Total length of the coil (L) - (n * (2 * π * R)) + (2* E0

- (3* (2 * 3.14 * 12.5)) + (2 * 5)
- 245.5 cm = 2.455 m

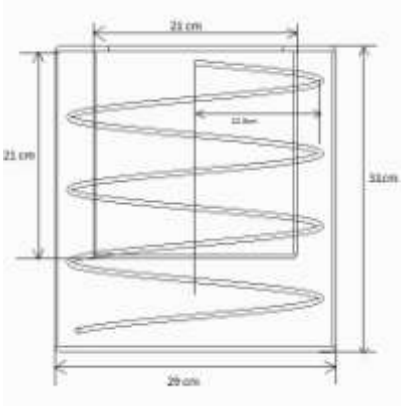
2.3 Design Specifications of Glass Box

Side face Dimension - (46 x 38) cm

top and bottom face Dimension - (38 x 38) cm

Volume of the glass box - (L * B * H) cm^3

- (46 * 38 * 38) cm^3
- 66424 cm^3



III. WORKING

This design works by utilizing the heat from the solar radiations efficiently. The glass container helps in creating **Green House Effect** by trapping the heat inside the container for as long as possible. As the sunrays fall on the vessel, the heat is enclosed within the glass container, and the black paint on the vessel helps in creating the effect of black body which absorbs maximum sun radiations. Copper tubes are mounted between the two cylindrical containers and the phase change material (PCM) is filled between the space left between the two containers. Water is filled inside the copper tube and the food is put in the container while the vessel is placed in the sun. the PCM works as a heat storage material as well as heat radiating material. When the sunrays falls on

the container, phase change material changes it's phase on reaching its melting point and starts absorbing heat, thus providing heat to the food placed inside the container and to the water inside the copper tubes. Some PCMs have a property of absorbing the heat on reaching their melting point and then radiating it on reaching their normal temperature, one such example is Paraffin wax.

3.1 PCM Used

1) Name	-	Paraffin Wax
Density of the material	-	900 kg/m^3
Melting Point (MP)	-	58-60 ^oC
Latent Heat	-	220 J/g
Specific Heat Capacity C_p	-	2.9 J/g-K
2) Name	-	Stearic Acid
Chemical Formula	-	$CH_3.(CH_2)_{16}.COOH$
Melting Point	-	54^oC
Molecular Weight	-	284.48
Density	-	847 kg/m^3
Latent Heat	-	198.91 J/g
Specific Heat Capacity C_p	-	2.359 J/g-K
3) Name	-	Zinc Nitrate Hexa Hydrate
Chemical Formula	-	$Zn(NO_3)_2.6H_2O$
Melting Point	-	36^oC
Molecular Weight	-	297.49
Density	-	2.065 g/cm^3
Latent Heat	-	147 J/g

IV. CALCULATIONS

Assume the initial temperature of the water as 22^oC.

Amount 5kg of each type of food is taken

Volume of cooking vessel	-	0.00727 m^3
Water Density	-	1000 kg/m^3
Specific Heat of water	-	4.817 KJ/Kg-K

While using **Paraffin Wax**-

FOOD	Initial Temp.(°C)	Final Temp. (°C)	Time Required (min)	Energy Required(J)
RICE	22	72	108	1045
MUNG BEANS	22	74.5	79	1099.2
BULGUR	22	66	56	919.6

While using **Stearic Acid**-

FOOD	Initial Temp.	Final Temp.	Time Required(min)	Energy Required

	(^oC)	(^oC)		
RICE	22	68	99	961.4
MUNG BEANS	22	67	81	940.5
BULGUR	22	54	53	668.8

While using **Zinc Nitrate Hexahydrate-**

FOOD	**Initial Temp. (^oC)**	**Final Temp. (^oC)**	**Time Required(min)**	**Energy Required**
RICE	22	51	127	606.1
MUNG BEANS	22	48	112	543.4
BULGUR	22	47	54	522.5

V. CONCLUSION

In this particular experiment, the performance of organic (Stearic Acid and Paraffin Wax) and Inorganic (ZincNitrate Hexahydrate) phase change materials (PCM) is compared. A concentric Aluminum container is used with a copper tube coiled around the inner container. It is observed that the performance of Organic phase change material is better as compared to the Inorganic phase change materials on the basis of time taken in cooking.

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EXPRIMENTAL STUDY OF PERFORMANCE COMPARISON OF AIR COOLED AND WATER CONDENSER IN AMMONIA VAPOUR ABSORPTION REFRIGERATION SYSTEM

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ABSTRACT

The continuous growth in the energy demand and in the economy cost has led to the more research and development for efficient utilization of available energy resources by minimizing the waste energy. Absorption refrigeration has gained more attraction in the research interest. Absorption cooling offers the possibility of utilizing the heat to provide cooling. For this purpose the heat from conventional boilers can be utilize or the use of waste heat and solar energy can be done. Absorption system falls in two different categories based upon the working fluid or refrigerant. These are the LiBr-H_2O and NH_3-H_2O Absorption Refrigeration system.

In this article the experiment research is conducted in order to study the performance comparison of the air cooled condenser and water cooled condenser in ammonia VARS System. The experiment tests are conducted at three different ambient temperatures 20°C, 25°C and 30°C.Intially at ambient temperature 20°C the COP of Water cooled condenser is 2.14 which is more than air cooled condenser i.e.1.94.Now, at 25°C the COP of air cooled condenser is 1.85 and COP of water cooled condenser is 2.03.Similarly in last case at ambient temperature 30°C.The COP of air cooled condenser is 1.75 and again COP of water cooled condenser is more as compared to air cooled which is 1.95.

Keywords: Water Cooled Condenser, Air Cooled Condenser, Ammonia Vapor Absorption Refrigeration System, Coefficient of Performance.

I. INTRODUCTION

Refrigeration is the process of removing heat from where it is not wanted. Heat is removed from food to preserve its quality and flavor. It is removed from room air to establish human comfort. There are innumerable applications in industry in which heat is removed from a certain place or material to accomplish a desired effect. The first mechanically produced cooling system was developed in England in 1834. The process later became known as vapour compression. After availability of electricity automatic refrigeration system was developed in 1897. Basically a refrigeration or air conditioning is nothing more than a heat pump whose job is to remove heat from a lower temperature and reject heat to high temperature. A vapour absorption refrigerator is a refrigerator that uses a heat source (e.g., solar energy, a fossil-fueled flame, waste heat from factories, or district heating systems) which provides the energy needed to drive the cooling process. Vapour Absorption refrigerators are often used for food storage in recreational vehicles. The principle can also be used to air-

condition buildings using the waste heat from a gas turbine or water heater. This use is very efficient, since the gas turbine produces electricity, hot water and air-conditioning (called cogeneration/trigeneration).In this study comparison of air and water cooled condenser take place at three ambient temperature 20°C, 25°C and 30°C.The COP of water cooled condenser is 2.14 and air cooled is 1.94 at ambient temperature 20°C.As ambient temperature increases the COP further goes on decreases i.e.at ambient temperature 25°C the COP of water cooled is 2.03 and air cooled is 1.85.In last case at ambient temperature 30°C the COP of water cooled condenser is 1.95 which is higher than air cooled condenser i.e.1.75.The survey of the literature regarding the VARS system.

John Leslie in 1810 kept H_2SO_4 and water in two separate jars connected together. H_2SO_4 has very high affinity for water. It absorbs water vapour and this becomes the principle of removing the evaporated water vapour requiring no compressor or pump. H_2SO_4 is an absorbent in this system that has to be recycled by heating to get rid of the absorbed water vapour, for continuous operation. **Windhausen** in 1878 used this principle for absorption refrigeration system, which worked on H_2SO_4. **Ferdinand Carre** invented aqua-ammonia absorption system in **1860**. Water is a strong absorbent of NH_3. If NH_3 is kept in a vessel that is exposed to another vessel containing water, the strong absorption potential of water will cause evaporation of NH_3 requiring no compressor to drive the vapours. A liquid pump is used to increase the pressure of strong solution. The strong solution is then heated in a generator and passed through a rectification column to separate the water from ammonia. The ammonia vapour is then condensed and recycled. The pump power is negligible hence; the system runs virtually on low- grade energy used for heating the strong solution to separate the water from ammonia. These systems were initially run on steam. Later on oil and natural gas based systems were introduced. In **1922, Balzar von Platen and Carl Munters**, two students at Royal Institute of Technology, Stockholm invented a three fluid system that did not require a pump. A heating based bubble pump was used for circulation of strong and weak solutions and hydrogen was used as a non-condensable gas to reduce the partial pressure of NH_3 in the evaporator. In **1859, Ferdinand Carre** introduced a novel machine using water/ammonia as the working fluid. This machine took out a US patent in 1860. Machines based on this patent were used to make ice and store food. It was used as a basic design in the early age of refrigeration development.

II. EXPERIMENTAL SETUP

The experimental setup consists of a single stage vapour absorption system with the basic components i.e. evaporator, generator, absorber, pump, expansion device and condenser. The set up was built using the components of refrigerator like a condenser and an evaporative unit. The setup was installed on a wooden plank of length 2’5” and width 2’2”. A frame is built and used the water dipped condenser. A water circulation system within the Generator and the Absorber is achieved by using a submersible pump and with the help of connecting pipes made of aluminum. Water supplied to the condenser is done by using a water pump and connecting pipes. Water circulation rate is constant for all tests. Ambient air passes over the condenser and finally exits from back side of the condenser. A Thermostat is used to limit the supply of heat to the Generator. Temperatures of refrigerant and circulation air at different points are recorded with digital thermometer TPM-10. Before temperature measurement, the surfaces of the tubes are polished for removing any dust or rust and then the thermocouples are laid down on the surface. The readings were just taken at the outlets of the components to reduce the convection effect in the system. The condenser and evaporator are made of aluminum so that

ammonia does not react with the material of the pipelines. The evaporative unit is insulated with the help of thermocole material.

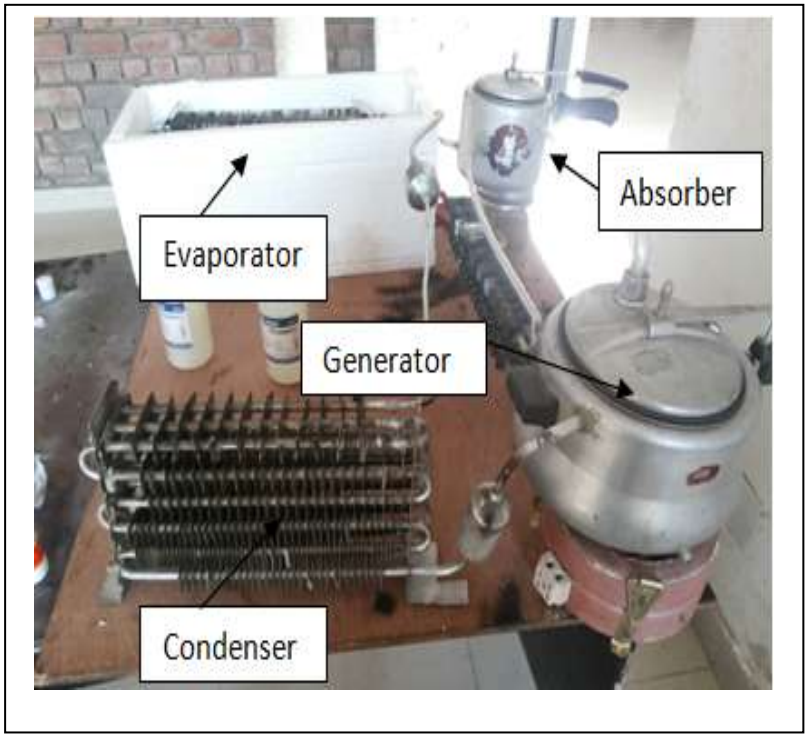

Figure 1: VARS system

The experiment (figure 1) consists of the VARS system having the different parts such as evaporator, generator, absorber, and condenser. The working Refrigerant is ammonia in our setup and experimental performance takes place after steady state is achieved.

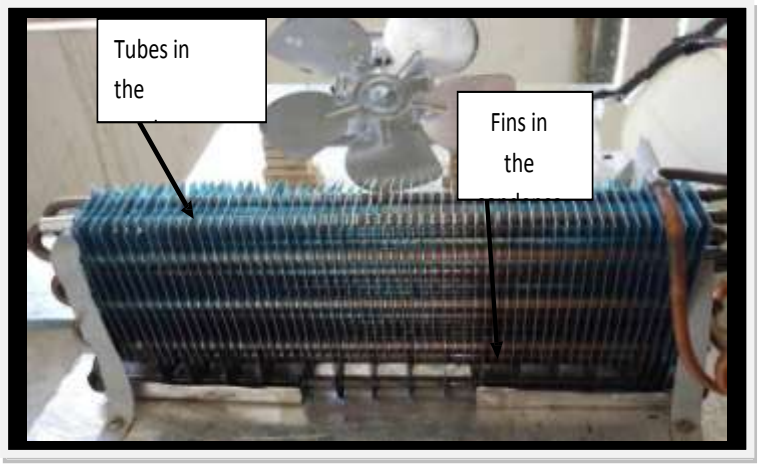

Figure 2: Air cooled condenser

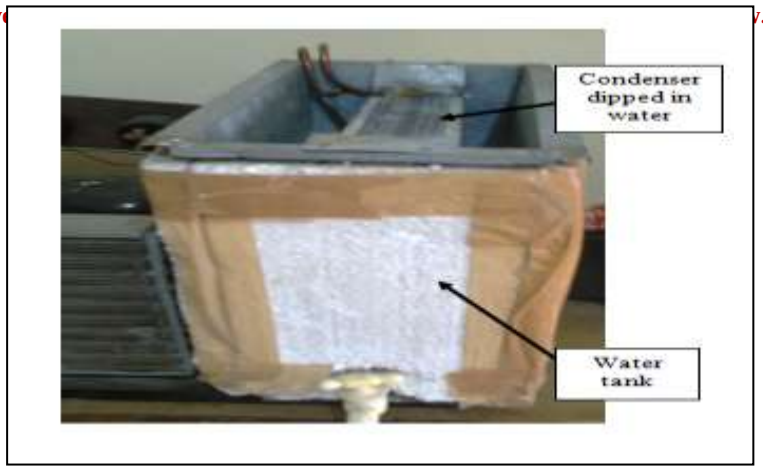

Figure 3: Water cooled condenser

The air cooled condenser (figure 2) represents the condenser that is cooled by external air provided by fan. Similarly (figure 3) represent the condenser that is dipped in water tank. Initially we calculate the value for air cooled condenser and than for water cooled condenser.

Types of condenser	Air cooled condenser	Water cooled condenser
Temperature of generator T_g	120°C	120°C
Temperature of condenser T_c	24.1°C	20.6°C
Temperature of evaporator T_e	-9°C	-10°C

Table 1: Performance at Ambient Temperature T_{amb}=20°C

Types of condenser	Air cooled condenser	Water cooled condenser
Temperature of generator T_g	120°C	120°C
Temperature of condenser T_c	27.5°C	25.3°C
Temperature of evaporator T_e	-6.23°C	-8°C

Table 2: Performance at Ambient Temperature T_{amb}=25°C

Types of condenser	Air cooled condenser	Water cooled condenser
Temperature of generator T_g	120°C	120°C
Temperature of condenser T_c	30°C	29.6°C
Temperature of evaporator T_e	-5°C	-7.23°C

Table 3: Performance at Ambient Temperature T_{amb}=30°C

III. CALCULATION AND RESULT

Many preliminary investigations were performed to prepare the setup for getting reliable data. In order to have a basis for comparison and also to specify the effect of water on condenser, each investigation was carried out in two consequent stages .In the first stage, conventional air cooled condenser was studied and data were recorded after steady state condition was established. Then the investigation on water cooled condenser was carried out. The time difference between two stages was small so the weather condition for two experiments was the same. In all investigation the data were recorded after steady state condition was established and the properties of refrigerant and air remained constant.

Many tests were performed to get the data. The following parameters were recorded during the experimental investigation:

1. Generator outlet temperature (T_g)
2. Condenser outlet temperature (T_c)
3. Evaporator outlet temperature (T_e)

In order to estimate the effect of water cooled condenser on the system and comparing the results of air cooled condenser and water cooled condenser, experimental tests were performed. In the first stage, air-cooled condenser is used and after getting the data, in the second stage water cooled condenser is used. Data is recorded after steady state condition is achieved in the system and the properties of refrigerant (R134a) and air remained constant (after 20 min). Experimental tests are performed at three ambient air temperatures i.e. 20°C, 25°C and 30°C.

COP of the system are calculate from the required following equation.

$$COP= [T_e/T_c-T_e]*[T_g-T_c/T_g]$$

Performance result of Air Conditioner (T_{amb}-20°C)		
Parameter	**Air cooled condenser**	**Water cooled condenser**
COP	1.94	2.14

Table 4: Result at Ambient Temperature (T_{amb})=20°C

Performance result of Air Conditioner (T_{amb}-25°C)		
Parameter	**Air cooled condenser**	**Water cooled condenser**
COP	1.85	2.03

Table 5: Result at Ambient Temperature (T_{amb}) =25°C

Performance result of Air Conditioner (T_{amb}-30°C)		
Parameter	**Air cooled condenser**	**Water cooled condenser**
COP	1.75	1.95

Table 6: Result at Ambient Temperature (T_{amb}) =30°C

From the above table it is clear mentioned that COP of water cooled condenser is more than that of air cooled condenser .In same ambient temperature COP of water cooled condenser is high as compare to air cooled

condenser. Due to cooling action of water in condenser which take latent heat from the condenser and hence condense the refrigerant as high as compare to air in air condenser.

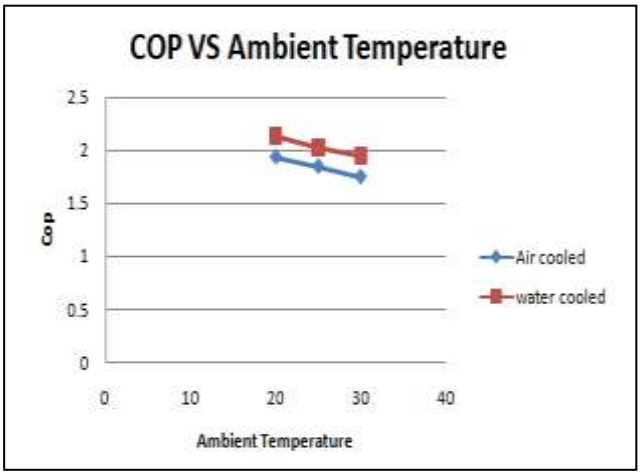

Figure 4: COP VS Ambient temperature

From the (Figure 4) it represent comparison of air cooled and water cooled condenser at three different ambient temperature i.e. 20°C, 25°C and 30°C .As the ambient temperature increase COP of the system goes on decrease in both air cooled and water cooled condenser .Increase in ambient temperature which decrease cooling capacity further decrease in the COP of the system.

IV.CONCLUSION

The effect of water cooling on the condenser generally used in air conditioner in subtropical region where outside ambient temperature is very hot and humid. Experimental results show that there is an increase in the cooling load and COP of the water cooled system as compared to air cooled system. The experimental investigation also verifies that condensing temperature and pressure decreases in case of water cooled condenser. The water cooled condenser thus results in increasing cooling. As we compare the air cooled and water cooled condenser at a particular ambient temperature, so there is increase in COP in case of water cooled condenser as compared to the air cooled condenser. At last we reached at the conclusion that at ambient temperature of 20^{o}C the COP of water cooled condenser is 2.14 which is more than the air cooled condenser i.e. 1.94 at same ambient temperature. Further at the ambient temperature of 25^{o}C the COP of water cooled condenser is 2.07 again is more than the air cooled condenser i.e. 1.84 at same 25^{o}C ambient temperature, so finally at the 30^{o}C the COP of the air cooled condenser is 1.76 which is again lower than the water cooled condenser which is 1.93. So as we increase the ambient temperature the COP of water cooled condenser is increasing as compared to the air cooled condenser.

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DETECTING QUALITY OF WEB SERVICES (DQS)

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ABSTRACT

Non-functional characteristics of web services are described by Quality of Services. In current computing world, although Quality for web services can be determined, still there is lack of real world web services QoS data sets. In our project, we are going to integrate all available free web services in the internet, analyze quality of each web services and then provide the results of which web service is better for the consumers to make use of it .Quality of web service is evaluated based on Service evaluation technique containing an user-item matrix which includes various QoS properties like failure probability, response time, throughput, availability, cost, time aware performance, etc. We can compare different web services and provide the best possible web service to use it by providing ratings for those services and display these particulars visually as graphs

Keywords: Quality Of Service- Qos, Qos Data Set, Web Service

I. INTRODUCTION

In recent years, web services are emerging successfully and it is a renowned technique to build distributed systems. By dynamically composing different web services, we can build effective service-oriented systems. The Quality of service oriented systems is dependent on the employed web services quality. With availability of web services on the internet, determining quality of web services has become a major issue. Nonfunctional characteristics of web services are described by the Qos. As more web services arrives in internet, the Qos value has become a major point of differentiating various functionally equivalent web services. Properties in web service Qos includes failure probability, availability, price, response time, service ratings, throughput, popularity, type of browser supporting the service, and so on[1]. Server side Qos property values (price, popularity, etc) are provided by service providers and is same for various users. User observed Qos properties (response time, throughput, failure probability, etc) varies widely for different users, which is influenced by consumer's internet connections and environment [1].

In service computing [2] field, many Qos based approaches have been engaged for web service recommendation [3], [4], [5], service composition [6], [7], Fault tolerant web services [8], [9], [10], web service Search [11], and so on. But still for Qos validation, there is a lack of comprehensive real time web services Qos data sets.

User observed Qos values can be obtained by evaluating from different locations using variety of different working environments. These values are provided by different companies and active users of those web services. However, it's a tuff task for making large scale evaluation of Web services in different locations because

- Both service users and provider's resources are consumed during web service invocation.

- Evaluating all the available web services is a time consuming and expensive task.
- It is a tedious process to collect web service Qos data from distributed service users.

But enough web service Qos values cannot be acquired without real world evaluations. In service computing, it is difficult to validate feasibility and effectiveness of various approaches in Qos.

To solve this challenge, we make effort to conduct distributed evaluations on real world web services, and released the data sets which are reusable for future enhancement. First, 72 web service addresses are obtained from the internet. Then three web service evaluations are conducted. In the initial evaluation, failure probability of available web services is assessed by limited distributed service users. In next evaluation, properties of available web services i.e., response time and throughput are evaluated with the available service users. In third evaluation, changing ratio of the web services with time is calculated by invoking those web services with available service users in various time slots with a time interval. Initial experiences in real world web service Qos are served in this project and reusable Qos are provided for future research. Extending from its previous journal version [*], which reports the above evaluations, this project includes

- Detailed analysis on relation between Qos values and time, and
- Data set applicability like Qos prediction, selection, search and fault- tolerant web services.

In this project, the remaining portion is as below: Section 2 introduces the information of web services of use. Section 3 gives our distributed QoS evaluations of
web services. Section 4 discusses the applications of the Web service QoS data sets. Section 5 introduces related work, and Section 6 concludes the project.

II. WEB SERVICES INFORMATION

We can discover web services from Universal Description, Discovery, and Integration (UDDI), web service portals and web service search engines. UDDI is an XML based registry and it facilitates companies to publish and discover web services on the internet. We obtained 72 addresses of WSDL (Web Service Description Language) files by crawling information about web services from UDDI, web service search engines and web service portals. In our experiments we cover most of the free available web services on the internet and it counts about 72 in total which comes in five different general categories.

For the 72 WSDL addresses that are obtained by crawling, we established HTTP connections to them and we downloaded those WSDL files. There were few types of WSDL download failures and it is viewed in table 1, and first column lists the HTTP codes which indicate various types of failures. As from the table 1, these are the types of failure availability in the internet and most common type of failure is time-out. Apart from time-out

failures, other failures include File Not Found failure, Internal Server Error failure, etc. The removal of WSDL files in the respective web address lead to the File Not Found failure, whereas Internal Server Error is caused due to servers which encountered unexpected errors preventing them from solving the request. These kinds of download failures depicts that in the internet WSDL files are easily prone to non-availability due to following reasons

- Highly dynamic nature of the internet
- Information about some web services are out dated
- Few web services are permanently removed from the internet as they are deployed only for experimental purposes.

TABLE 1
WSDL File Download Failures

Codes	Descriptions	# WS	Percents
400	Bad Request	173	3.57%
401	Unauthorized	106	2.19%
403	Forbidden	153	3.16%
404	File Not Found	1,468	30.31%
405	Method Not Allowed	1	0.02%
500	Internal Server Error	505	10.43%
502	Bad Gateway	51	1.05%
503	Service Unavailable	22	0.45%
504	Gateway Timeout	788	16.27%
505	HTTP Version Not Support	1	0.02%
N/A	Connection Timed Out	774	15.98%
N/A	Read Timed Out	787	16.25%
N/A	Unknown Host	12	0.25%
N/A	Redirected Too Many Times	3	0.06%
Total		4,844	100.00%

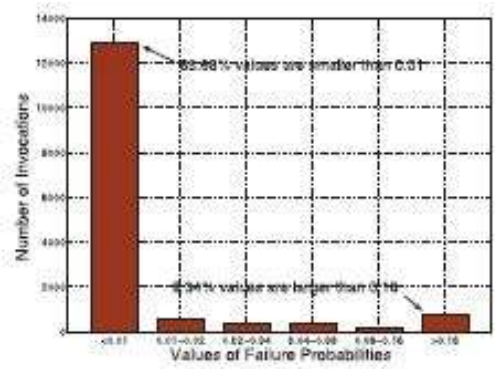
III. WEB SERVICE QOS EVALUATION

To get data sets of Qos for web services, several large-scale evaluations of Qos for real-world web services should be conducted. Client-side web service invocation codes are employed by Axis2 to generate, test the test cases automatically.

From distributed locations to evaluate real-world web services, we should employ a lot of computers in distributed form from the PlanetLab4 so that it can serve as service to the users. A global research network like planet Lab should be made up of more than 1,000 computers in distributed form globally. The web service evaluation codes should be deployed so that the Planet Lab computer can be used to monitor the QoS from the web services of real-world from many distributed locations. From 2009, researchers conducted 3 evaluations of QOS and got three research sets of data. The following provides description of these three data sets.

3.1 Data Set 1: Failure Probability

Random selection of 100 web Services in the first evaluation from the 13,108 web services got from the Section 2 could employ at least 150 computers among 24 countries in the PlanetLab so that it would serve the service users. Their evaluation could focus on the studying of failure probability in QoS data sets, which can be defined with a probability which is an invocation of certain web service that a user may fail. By dividing the failed number of invocations by the invocations total number by a user, we can calculate value of failure probability.



Each web service user invoked all 100 web services which is selected for 100 times and detailed QoS values are recorded. Here 100 times of invocations are selected due to invocations of larger range consume lot of resources from the web services of real-world which is designed typically for business people purpose, while smaller number of invocations will not get a correct probability in failure values. A total range of 1,542,884 invocations in web service are conducted for the service users. Experimenting the results, we get a 150x100 item for user matrix, in which an entry $f_{a,i}$ in the user matrix is probability in failure of web service which can be observed by the service of user a. In the Table 3 format, standard and mean deviation for

All of the 15,000 probabilities in failure is got by 150 users on the web services(100) that are 17.32 and 4.03 percent, to indicate the failure in the probabilities of various web services got by various service users which may exhibit a variation in a great manner. Fig. 2 shows the failure of value distribution in probability. As in Fig. 2, almost85.68 percent of the probability in failure values are less than a percent, i.e., a larger part (8.34 percent) failure in probabilities can still encounter performance with poor values greater than 16 percent. There are many kinds of failures in web service invocation.

Web service responses in HTTP codes can be employed for the detection in the kinds of failure (i.e., HTTP code 200 will indicate the success in invocation, whereas the other HTTP c codes of failures and the exceptions stands for different kinds of failures).

3.2 Set of Data 2: Throughput and Response Time

The evaluation 2 focuses on investigating the throughput and response time of the web services performance. Duration of time between a service user which sends a request and then receiving a corresponding response is defined as a Response Time.

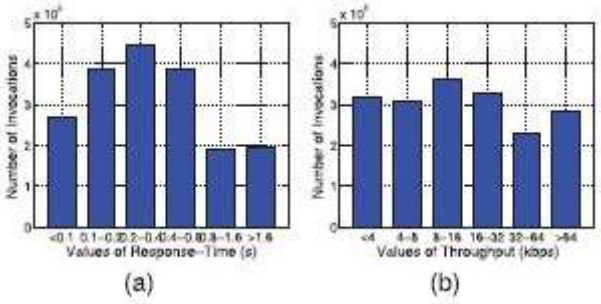


Fig. 3 Value Distributions of Data Set 2.

Throughput can be defined as the average successful message in its size of delivery over channel of communication per second. The evaluation 2 that was conducted in August 2009 shows Table 5,which is a total of 1,974,675 web service in the real-world invocations that are executed by nearly 339 service users from more than 30 countries with 5,825 real-world web services of 73 countries for the evaluation. By the web service invocation processing results, we get two 339 x 5,825 matrices for throughput and response time. Each matrix entry represents throughput value or the response-time value got by a web service by the user. In Table 5, the standard and mean deviation of the response time are 1.43 and 31.9 seconds, while the standard and mean deviation of throughput are531.85 kbps and102.86

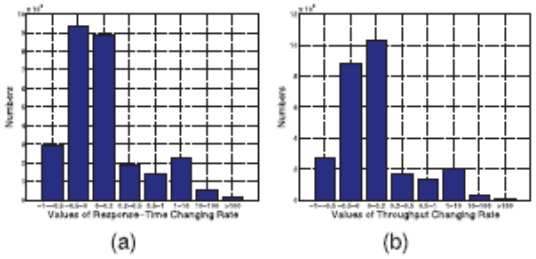
3.3 Data Set 3: Time-Aware Performance

Since Internet is highly dynamic, the user-observed performance (e.g., response time, throughput) of web services is changing from time to time, influenced by the user environment, network condition, server workload, and so on. The third evaluation of web services focuses on investigating time-aware performance of web services. In

March 2011, we employed the distributed PlanetLab computers to monitor real-world web services continuously. A total of 4,532 publicly available real-world web services from 57 countries are monitored by 142 computers located in 22 countries in 64 different time slots. The time interval between neighboring time slots is 15 minutes. The detailed response-time and throughput values of the 64 time slots are collected. Totally 30,287,611 real-world web service invocations are conducted in this evaluation. In the highly dynamic Internet environment, QoS of web services may change from time to time. To investigate the QoS value changing with time, we employ the following equation to evaluate the changing rate of QoS values between two neighboring time slots:

$$r_i = (q_i - q_{i-1})/q_{i-1},$$

Where q_i and q_{i-1} represent the QoS values of the time slots i and i-1, respectively, and r_i represents the changing rate between these two time slots.



ig. 6. Value distributions of QoS changing rate.

Fig. 6 shows the changing rate distributions of response time and throughput. As shown in the figure, we can see that most changing rates of response time and throughput are between -0.5 and 0.2. Moreover, there is a small part of QoS changing rates with very large values (e.g., larger than 10 or even larger than 100), indicating that response time and throughput values of web services can seriously change at different time.

To further investigate the changing response time of different users, we randomly select three users and plot their observed response-time values on the same web services in the 64 time slots. Fig. 8 shows the response-time values of these three users. From the figure, we have a similar observation with Fig. 7, i.e., the user-

observed response-time performance of web services can change dynamically with time (e.g., user 3 in the figure).

IV. APPLICATIONS OF QoS DATASETS

4.1 Web Service Qos Prediction

Generating QoS values for different web service is more critical .web service evaluation [13][14][15] is the methods for retiring QoS values there are many web services available on internet it is actually a complex task to find out which is best

In order of surveying web services it aim to provide personalized QoS value for web service user dependently each entry of representing matrix of certain QoS property .the research of web service problem is to predict the values of missing QoS by calculating the available QoS

In providing service, web service has turned a lot of attractions in years large number of QoS predication took place.

4.2 Web Service Selection

Service computing many more good quality applications can be constructed by using web service ,used to selection of service candidate .the service candidates has similar functionality but alternate for non functional characters this problem is generally modeled as an optimization problem . Local approaches [1], [7] while global approaches [19], [7], [20] select a set of services that satisfy the process constraints and user preferences for the whole application together. To evaluate the performance of different selection approaches, real-world QoS.

4.3 Qos Aware Web Service Search

In service computing Web service discovery was found to be the fundamental research problem. With increase in number of web services, the functionalities to fulfil users' request will be same in many web service. The two Major approaches in order to discover suitable web service are UDDI and web service engine. In recent survey the availability of web service is decreased. Al-Masri and Mahmoud [21] has given enough proof that UDDI business registered services are invalid which is approximately equal to 53 percent. The common ways to discover web service is using search engine.

Traditional Web service search approaches [22] uses keyword-based techniques without the help of QoS web service. In reality, the web services sharing is different in functionalities and as well non functionalities. The functional and non functional characteristics are required to provide effective personalized web service search result.

Zhang et al [11] discovered a web service named WSExpress by giving importance to functional attributes as well as QoS values. The released data of QoS were taken as experiment in order to study the performance of different QoS-aware web service search approach.

4.4 Fault Tolerant Web Services

The traditional stand-alone software systems is much more challenging than building reliable service-oriented systems is due to several reasons such as 1) without any internal design and implementation details, remote

web services are developed and hosted by other providers. 2) Performance of web service may change frequently. 3) the remote web service may not be available

Software fault tolerance [23] is said to be important approach to build reliable systems. The one approach of software fault tolerance is also said to be design diversity, to employ functionally equivalent yet independently designed components. It is due to the cost of developing redundant software components and software fault is mainly used for critical systems. There are already many different organizations in the area of service computing which is available on the internet. This can be used as alternative component for building fault tolerance service-oriented systems. The QoS is used as alternative service instead of designing optimal fault tolerance strategies.
In previous work [10] QoS-aware fault tolerant is used for service-oriented systems. The recently released QoS data is used as case study for next experiments of different tolerance strategies.

V. RELATED WORK AND DISCUSSION

In Service computing[2] there are many QoS based approaches have been occupied by web service recommendation[3],[4],[5], service composition[6],[7], fault-tolerance web services[8],[9],[10], web service search[11],and so on. Even though, there is a lack in real world web service QoS data are used to verify these approaches. The characteristics of web service cannot be fully mined without large scale web service data sets many QoS based approaches are difficult to be realistic and practical.
In previous work [9], the five service users have been conducted by real world web service. The experimental results are not useful for future research as the scale of this experiment is too small. Al-Masri and Mahmoud [21] released a web service QoS data which will be useful for 2,507 web service. The different user will use different QoS as per the availability of the data set. The data sets of this paper will also include QoS information observed from distributed service users in different time slots. Vieira et al [24] conducted an experimental web service for 300 publicly available web services. The security vulnerabilities will exist at server side and it is user independent. Apart from Vieira's work [24], this paper mainly focuses on investigating user observed QoS properties which will vary widely from different users.

VI. CONCLUSION AND FUTURE ENHANCEMENT

This project conducts evaluations in various web service Qos data sets observed by users from distributed locations. In real world web services, a large number of web services are invoked and these results are gathered. Some data sets which can be reused are released. In our future work, apart from response time, failure probability, throughput, Qos ratio, type of browser support, and its home source, additional Qos properties can be observed by the user and implemented in user friendly manner.

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STEGANOGRAPHY IS THE ART OF HIDING DATA

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ABSTRACT

Steganography has been derived from the Greek word Steganous (covered, concealed or protected) and Graphie (writing) which means "covered writing". It is the process of hiding a secret message with an ordinary message. Which when viewed by someone else will be able to see only the ordinary message they will fail to identify that it contains a hidden or encrypted message. The hidden message can be extracted once it reaches its destination. Steganography is now gaining popularity among the masses because of ease in use and abundant tools available.

In this paper, the emphasis is given on the basic technique used to implement Steganography and also how to extract the data and check whether the file received by the reader carries some hidden message. Paper also depicts various tools available for the same.

Purpose: *This paper introduces steganography by explaining what it is, providing a brief history with illustrations of some methods for implementing steganography. The objective of the paper is to highlight the field of Steganography from different viewpoints (from the terrorist view point, and from a naïve user's outlook).*

Structure of Paper: *Paper begins with the brief introduction, history, and type of steganography. It also focused on several applications that uses steganographic services, highlights methods of steganography, its advantages and disadvantages. Later the implications of stegaonographic are covered, along with the various tools available.*

Design/methodology/approach: *A conceptual approach is followed to comprehend the concept of Steganography and what should be done to identify that the files downloading from internet does not have any hidden files, it has been explained with real case studies.*

Findings: *Steganography can be easily implemented and the hidden message can be retrieved easily once the user is aware of how to retrieve the message.*

Research limitations/implications: *Research design is exploratory in nature hence; the results of the study are not very conclusive.*

Keywords: Cryptography, DOS, Information Hiding, Information Security, MITM, Steganography, Steganography Techniques

I. INTRODUCTION

Steganography is a technique used to transmit hidden information without raising any suspicion about the existence of such information. Steganography aims at hiding information in an original – cover – data in such a way that a third party is unable to detect the presence of such information by analyzing the information bearing stego data.

Earlier it was considered that cryptography is the only way to secure the data or message. But we can say, steganography add-on encryption can make the data or message more secure. In a stego file, we can hide the encrypted message which can later be retrieved and decrypted by the other party who knows about the steganography and the key for decryption. The hidden information can be plain text, sound, video, cipher text, or even images. Steganography works by replacing bits of useless or unused data in regular computer files with bits of different, invisible information. Steganography primary goal is to hide data within some other data such that the hidden data cannot be detected. The secondary focus is to prevent extraction from the cover file without destroying the cover and prevent destruction of the stego-message without destroying the cover. Most frequently, steganography is applied to images, but many other data or file types (audio, video, text, executable program, HTML files etc) are possible.

II. HISTORY OF STEGANOGRAPHY

Steganography was proposed way back in 440BC, it was initially used by ancient Greeks. They used to write messages on the wood, later they used to cover it with wax and write an ordinary message on it. There are some stories of hiding message on the messenger's body like a message tattooed on the shaven head later the person with grown hair was sent and the message was retrieved by again shaving off his hair. This method has a major drawback of time delay and space.

During World War II, concept of invisible ink was introduced by French and Microdots were used by espionage agents. Microdots were typically minute (less than the size of the period produced by a typewriter) needed to be embedded in the paper and covered with an adhesive, such as collodion. This was thoughtful and thus noticeable by viewing against glancing light. Alternative techniques included inserting microdots into slits cut into the edge of post cards. Some secret messages were written beneath the postal stamp. Some messages were made hidden with the help of vegetable oil, milk and juices when heated become dark. Some seemingly innocent letter could contain a very different message written between the lines. Decoding this message by extracting a specific letter in each word could reveal the message. Modern Steganography uses the concept of encryption also. They encrypt/ encode the data hide it and when received the message needs to be deciphered/decoded/ decrypted.

III. WHO USE STEGANOGRAPHY

The concept of Steganography is very interesting it hides the very existence of the message in the communicating data. It could be used by anyone who wants to hide the message from the rest of the world and want to be read by only the intended or original receiver. It is used by anti-forensics mechanism to mitigate the effectiveness of a forensics investigation. It is commonly used by lovers, boy friend- girl friend to exchange notes without anyone else knowing the real conversation. It is used by terrorist to secretly communicate information, by posting the images on a website for download, which is later used by other terrorist to download the image with a hidden message with special attack instructions.

3.1 Applications (Why Should One Use Steganography)

- Confidential communication and secret data storing
- Protection of data alteration
- Access control system for digital content distribution.

- Media Database systems.
- Used in modern Printers

3.2 Advantages Of Using Steganography

- Difficult to detect and only receiver can detect.
- It can be done faster with various software's available.
- Provide better security for sharing data in LAN, MAN, WAN.

3.3 Disadvantages Of Using Steganography

- The confidentiality of information is maintained by the algorithms, and if the algorithms are known then this technique is of no use.
- If this technique goes in the wrong hands like terrorist, hackers then it could lead to dangerous results.
- The files downloaded from internet have some infected files attached to the original/ordinary data which are hidden. When the file runs the hidden infected file also runs simultaneously and will affect the system. For instance, Click on an adware will run the advertisement along with an infected file (may be Trojan, Virus, Key logger etc) which might affect your system in long run.

3.4 Types of Steganography

Almost all digital file formats can be used for steganography, but the formats that are more suitable are those with a high degree of redundancy. Redundancy can be defined as the bits of an object that provide accuracy far greater than necessary for the object's use and display [3]. The redundant bits of an object are those bits that can be altered without the alteration being detected easily [1]. Three categories of file formats that can be used for Steganography techniques are shown in figure 1

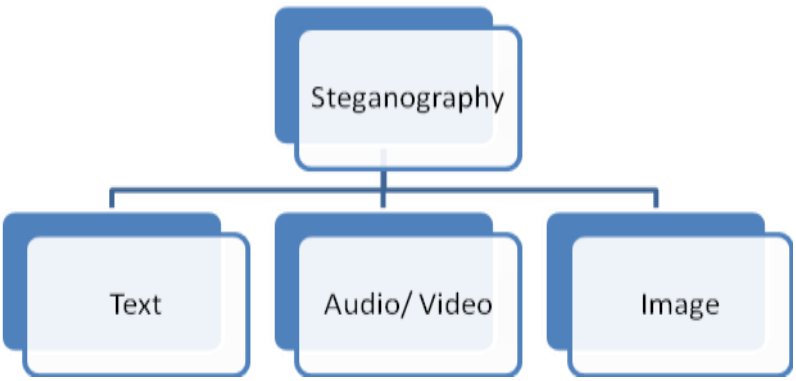

Fig. 1 Techniques of Steganography

3.4.1 Steganography in Text- It involves three types of coding:

- *Line-Shift Coding:* Here, text lines are vertically shifted to encode the document uniquely.
- *Word-Shift Coding*: The codeword's are coded into a document by shifting the horizontal locations of words within text lines, while maintaining a natural spacing appearance.

- *Feature Coding*: In feature coding, certain text features are altered, or not altered, depending on the codeword.

3.4.2 Steganography in Images-Digital images are made up of pixels, the arrangement of pixels make up the image's "raster data". 8-bit and 24-bit images are common. The larger the image size, the more information can be hidden. However, larger images need compression to avoid detection. Two kinds of image compression are lossless and lossy compression. Both methods save storage space but have different effects on any uncompressed hidden data in the image.

- "Lossy" JPEG (Joint Photographic Experts Group) file format, offers high compression, but may not maintain the original images integrity. It loses the data. Hence it is called "lossy".
- "Lossless" compression maintains the original image data exactly; It is thus more favored by steganographic techniques as the message can be reconstructed exactly. Eg: (BMP),(GIF) Formats.

Image Encoding Techniques- The following are the common approaches of hiding information in images:

- *Least Significant bit insertion*- Most popular technique when dealing with images. LSB method is based on altering the redundant bits that are least important with the bits of the secret information. The aim of the LSB is to transmit the secret information to the receiver without knowing to the intruder that the message is being passed. It is very simple, but susceptible to lossy compression and image manipulation
- *Masking and Filtering*- can be used on 24bit per pixel images, applied on both colored and grayscale images. Masking and filtering is similar to placing watermarks on a printed image. These techniques embed the information in the more significant areas than just hiding it into the noise level. Watermarking techniques can be applied without the fear of image destruction due to lossy compression as they are more integrated into the image.
- *Algorithms and transformations*- use mathematical functions to hide the least bit coefficients in the compression algorithms that reduce the file size of images. Many algorithms like [Discrete Fourier transformation technique (DFT). 2. Discrete cosine transformation technique (DCT). 3. Discrete Wavelet transformation technique (DWT)] are used to compress the image.

3.4.3 Steganography in Audio/Video- Embedding secret messages into digital sound is known as audio Steganography. This method can embed messages in Wav, au, Mp3 etc

- Sample quantization method
- Temporal sampling rate
- Another digital representation

3.5 Methods of Audio Data Hiding

- *Low Bit encoding*- A very popular methodology is the LSB (Least Significant Bit) algorithm, which replaces the least significant bit in some bytes of the cover file to hide a sequence of bytes containing the hidden data. That's usually an effective technique in cases where the LSB substitution doesn't cause significant quality degradation, such as in 24-bit bitmaps.[4]
- *Parity coding*- is one of the robust audio steganographic technique. Instead of breaking a signal into individual samples, this method breaks a signal into separate samples and embeds each bit of the secret message from a parity

bit. If the parity bit of a selected region does not match the secret bit to be encoded, the process inverts the LSB of one of the samples in the region. Thus, the sender has more of a choice in encoding the secret bit.[4]

- *Phase Coding*- The technique works by replacing the phase of an initial audio segment with a reference phase that represents the secret information. The remaining segments phase is adjusted in order to preserve the relative phase between segments. In terms of signal to noise ratio, Phase coding is one of the most effective coding methods. When there is a drastic change in the phase relation between each frequency component, noticeable phase dispersion will occur. However, as long as the modification of the phase is sufficiently small, an inaudible coding can be achieved [6, 12].
- Echo Data Hiding- Echo hiding technique embeds secret information in a sound file by introducing an echo into the discrete signal. Echo hiding has advantages of providing a high data transmission rate and superior robustness when compared to other methods. Only one bit of secret information could be encoded if only one echo was produced from the original signal. Hence, before the encoding process begins the original signal is broken down into blocks. Once the encoding process is done, the blocks are concatenated back together to create the final signal [7, 8].

3.6 Types of Stegosystems- It can be implemented in 3 ways:-

- Pure stegosystems - no key is used.
- Secret-key stegosystems - secret key is used.
- Public-key stegosystems - public key is used.

Basic block diagram of Stegosystems- The basic diagram depicts the use of carrier file along with the hidden file which will be converted into a stego file. This file will be further send either to the victim for some attack or will be used by terrorist group who is already aware of the steganographic file.

Fig. 2 Block diagram of Stegosystem

Way to implement Steganography- Steganography hides the covert message. The steganography process generally involves placing a hidden message in some transport medium, called the carrier. The secret message is embedded in the carrier to form the steganography medium. The use of a steganography key may be employed for encryption of the hidden message and/or for randomization in the steganography scheme. In summary: steganography_medium = hidden_message + carrier + steganography_key (if you are using cryptography)

Make a folder with any name (test) and place an image (a.jpg) or audio (b.mp3) or video file (c.avi) which you wish to forward it to your friend along with the secret text message. Place the text file also in the same folder with the secret message in it. Let us name the text file as abc.txt which has text written as Hello, How are you? Can we meet at 12:00 in the library.

Now Let us see how to actually implement steganography

1. Goto Command prompt by writing cmd at run or by clicking on command prompt from program.

2. cd test (cd <foldername>- change directory dos command to move to that folder)
3. copy /b a.jpg+abc.txt try.jpg

   Here copy /b is for copying binary files (bits will be copied) a.jpg (is the carrier file)+(is used for concatenation/Joining)abc.txt (hidden message) try.jpg (is a stago file)

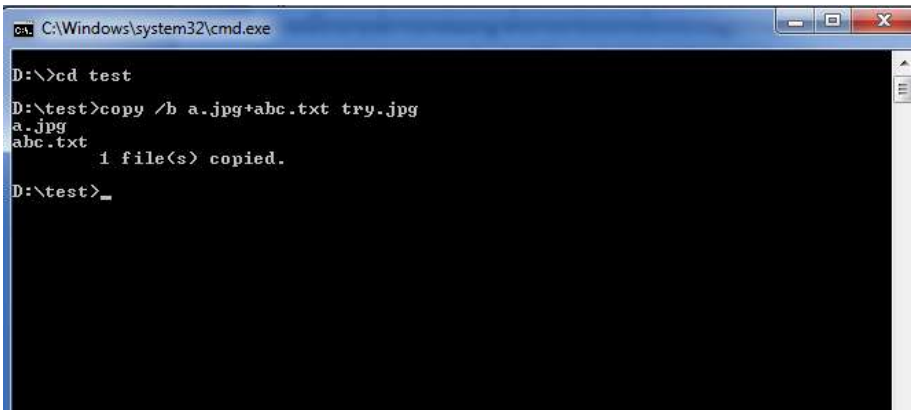

Fig. 3 Command Prompt for performing Steganography

4. Just send try.jpg file to any user. (User will not be able to trace That there is some secret message hidden beneath the image)
5. If the user is well acquainted by the concept of steganography. He will right click on try.jpg and open it with notepad->goto the last line and will be able to see the secret message

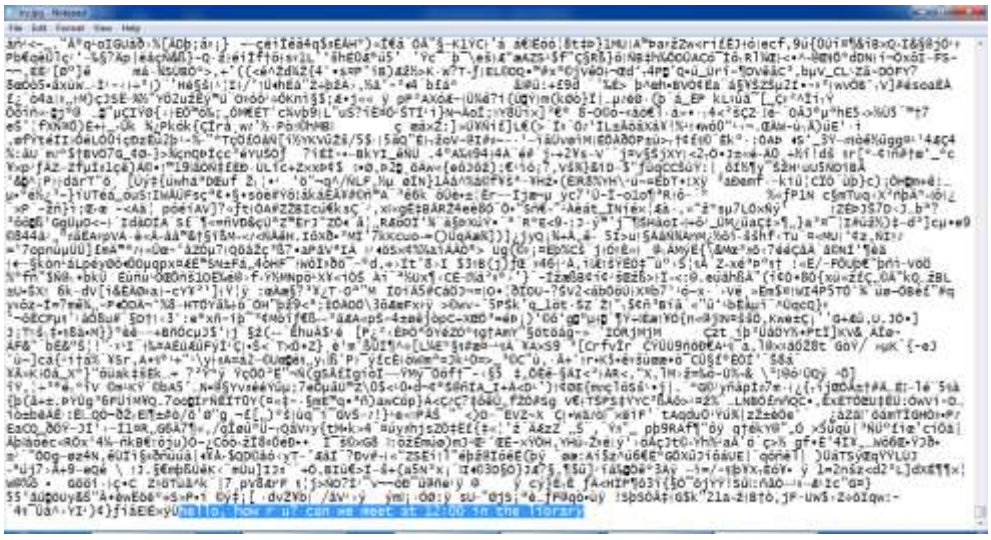

Fig. 4 Notepad file showing the hidden message

Let us see how /b works

Copy /b a.mp3+b.mp3+c.mp3+d.mp3 e.mp3

This will concatenate all songs starting from a.mp3 to d.mp3. When you will send e.mp3 file it will be too heavy can check the properties by right clicking and now it will play songs in a sequence like a playlist. We can say e.mp3 is now working as a playlist comprising of music files like (a-d.mp3)

Imagine a situation if the user need to send an image/audio/video file as a text/ image file. The user needs to compress it so that after seeing the size of the file the recipient should not feel suspicious. Now since the carrier file is a zip or rar file the user need to make stego file also as rar or zip, otherwise the receiver won't be able to retrieve the file. But now there is again a problem when the recipient is clicking on the rar file and extracting the file the hidden message will not be displayed in the notepad (end of the line) as did in the previous example.

Therefore, at the receiver end the user need to goto the command prompt and convert rar or zip file which is delivered to him into jpg or avi or mp3 file. copy /b .rar .jpg

Steganography is concerned with concealing the fact that a secret message has being sent, along with hiding the contents of the message. Let's see few live cases:-

Malwares, spywares, adware's and freeware are using steganography extensively. The moment you download anything online from Torrent (illegal to use in India) your system will have hidden infected files(virus), which will later infect your system by taking data from your system, install key loggers, denial of service attack etc. French security researcher Xylitol noted something strange as he was getting few images (jpg) and when he analysed and compared the original file from google and the file he had received he found discrepancy in size. With the help of hexadecimal viewer software he could find those extra bits, which he highlighted and converted back (unreadable format). Later he used software OllyDbg and was able to retrieve the data which showed few financial institutions targeted like Deutsche bank (Germany). The hidden file was infecting the user's system. The moment he opens the bank website from his system the data will be given to the hacker, MITM attack (Man-In-the-Middle Attack).

Al-Qaeda relied on steganography- When investigators from the United States of America examined the Al-Qaeda's network it was found that they had extensively used steganography to pass on messages. Steganography is being used by various groups to pass on messages between each other. Once the messages were encrypted, the Al-Qaeda members downloaded the files using various software to execute several terrorist plots. Traces of the technique being used during the 9/11 attack were also seen during investigation. [10]

Jack Kelly, USA said [10] "the messages were hidden in the X-rated pictures on several pornographic websites and the posted comments on sports chat rooms may lie the encrypted blueprints of the next terrorist attack against the United States. It sounds farfetched, but US officials and experts say latest method of communication being used by Osama bin Laden and his associates to outflow law enforcement. Bin laden, indicated in the bombing in 1998 of two US embassies in East Africa, and others are hiding maps and photographs of terrorist targets and posting instructions for terrorist activities on chat rooms, bulletin boards and other websites".

Using their imagination- Steganography has most of the time been used by terrorist groups on X-rated files. The messages are embedded into such file. To anyone watching the file it is a normal picture. However the person on the other end would know exactly what to look for.

Steganography messages are difficult to detect by investigators- For an investigating officer detecting steganography is a nightmare. There is absolutely no record to show that the sender and the receiver had ever communicated. They do not exchange calls or emails. What investigating agencies have been doing is keeping a track of all downloaded pictures on the web. Pictures that are downloaded in places where the terrorist networks are strong are part of the data base. They would then keep a watch on these pictures closely to see if there are messages coded into the picture.

Steganalysis- deals with the detection of hidden content rather than focusing on the retrieval/extraction of the message. As steganography deals with the concealment of a message. There are numerous tools used to hide the message and even extract the original message. In short, we can say to make digital steganography easier we use tools [9, 11]:

Invisible Secret tool is used as secret stegosystem tool [5]:

- Select Action

- Select Carrier File
- Select Source File
- Encryption Settings
- Target File Settings
- Encryption or Hiding

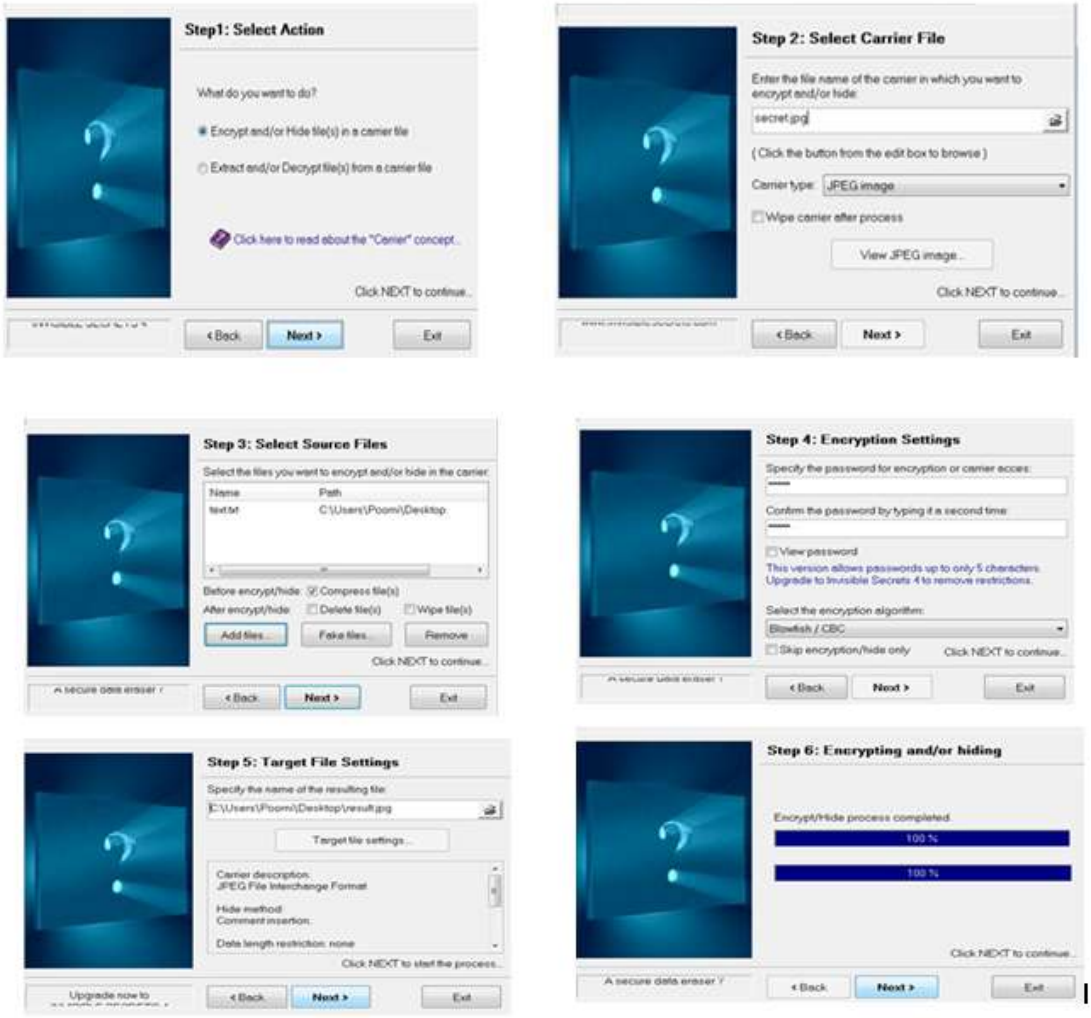

Fig. 5 Invisible Tool used for Steganography

Histogram Analysis- Is used to identify a file with a hidden message. If somebody has the original file can compare it with the suspected file. Can check the properties of the original file and suspected file. To compare the contents we have Notepad, HEX editor to identify inconsistencies and patterns.

WinHex- Is an analysis tool. It allows conversions between ASCII and Hex. It also allows comparison of file and a detailed report is saved (comparative as well as tells differences or equal bytes)

HiderMan- is a sophisticated program in which after hiding a message, we can review the file with HEX. Can see the beginning and end of the file comparing both the files (original and suspected).

Stegspy- It's a signature identification program, searches for stego signatures and determines the program used to hide the message.

Camouflage- Is used to determine the password. The location of the password can be determined by using MultiHex which searches for Hex strings.

IV CONCLUSION

Steganography the concept was given to the world by Greeks. Steganography is still in its adolescent age when comes to cyber security, it still have a long way to go. Steganography can be considered an extension of cryptography. The main difference between the two is that steganography is not visible to everyone unlike cryptography which does not attempt to hide the information. [2] Cryptography may not be as secure as steganography because the mere presence of an encrypted message may entice individuals to attempt to 'break the code'. On the contrary, steganography is a process used to hide information so that only the sender and recipients are aware of the hidden information. Data or message can be hidden using any multimedia files like audio, video, text, and image files. This will later become virtually undetectable to individuals that do not know of the hidden information's existence.

Steganography can be used for legitimate and illegitimate purposes. Therefore, the focus of the paper was primarily on the basic implementation of steganography. The paper is a good platform for naïve users to know about the stego files and how to retrieve the message. They can verify the file, if they have some suspicious by checking the properties and file size. The paper conclude that various tools are used to conduct steganography and to retrieve hidden message. But till date steganography is a challenge for the forensics department to trace.

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STUDY ON A FLAT PLATE SOLAR COLLECTOR

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ABSTRACT

Solar energy is become an alternative for the limited fossil fuel resources. One of the simplest and most direct applications of this energy is the conversion of solar radiation into heat, which can be used in water heating systems. A commonly used solar collector is the flat-plate. Flat Plate Collector (FPC) is widely used for domestic hot-water, space heating/drying and for applications requiring fluid temperature less than 100oC. Three main components associated with FPC namely, absorber plate, top covers and heating pipes. The absorber plate is selective coated to have high absorptive. It receive heat by solar radiation and by conduction; heat is transferred to the flowing liquid through the heating pipes. The fluid flow through the collector pipes is by natural or by forced circulation (pump flow). For small water heating systems natural circulation is used for fluid flow. Conventionally, absorbers of all flat plate collectors are straight copper/aluminum sheets however, which limits on the heat collection surface transfer area.The performance of any solar collector is largely affected by various parameters such as Glazing (single glazing and double glazing), Absorber plate, Top covers and Heating pipes. The absorber plate of the FPC transfers solar energy to liquid flowing in the tubes. The collector efficiency is dependent on the temperature of the plate which in turn is dependent on the nature of flow of fluid inside the tube, solar insulation, ambient temperature, top loss coefficient, the emissivity of the plate and glass cover, slope, etc.

Keywords - Flat plate collector, efficiency of collector, solar water heating, solar energy.

I. INTRODUCTION

1.1 Solar Collectors

Solar collectors are the major component of active solar-heating system. They collect and store the sun's energy, transform its radiation into heat, and then transfer that heat to a fluid (usually water or air). The solar thermal energy can be used in solar water-heating systems, solar pool heaters.[1] Solar energy is the most essential and economical of all energy forms. Renewable sources of energy from sun are fairly non-polluting and considered clean. Solar energy as the green and environmental friendly energy has produced energy for billions of years. Solar energy that reaches the earth is around 4x1015 MW and it is 200 times as large as the global utilization. [2] There are a large number of solar collector designs that have are functional.

These designs are classified in two general types of solar collectors:-

1) Flat-plate collectors – The absorbing surface is approximately as large as the overall collector area that intercepts the sun's rays.

2) Concentrating collectors – Large areas of mirrors or lenses focus the sunlight onto a smaller absorber.[3]

1.2 Heat collectors

Solar collectors are either non-concentrating or concentrating. In the non-concentrating type, the collector area (i.e., the area that intercepts the solar radiation) is the same as the absorber area (i.e., the area absorbing the radiation). In these types the whole solar panel absorbs light. Concentrating collectors have a bigger interceptor than absorber. Flat-plate and evacuated-tube solar collectors are used to collect heat for space heating, domestic hot water or cooling with an absorption .[4]

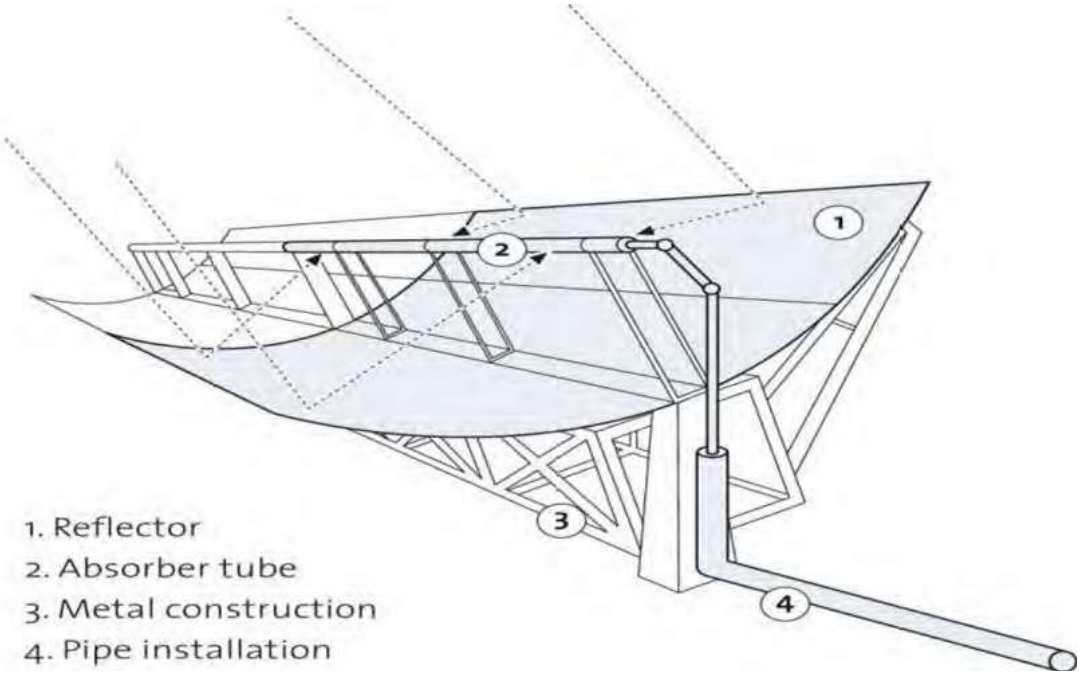

Figure 1. Schematic of a Concentrating Solar Collector[5]

II. FLAT PLATE COLLECTOR

A typical flat-plate collector made up of an absorber which is in an insulated box together with transparent cover sheets (Glazing). The absorber is usually made up of a metal sheet of high thermal conductivity such as copper or aluminium, with integrated or attached tubes. Its surface is coated with a special selective material to maximize radiant energy absorption while minimizing radiant energy emission. The insulated box reduces heat losses from the back and sides of the collector. These collectors are used to heat a liquid or air to temperatures less than 680°C.[7] Flat plate collectors: in which absorbing surface is approximately as large as the overall

collector are that intercepts the sun's rays. Concentrating collectors in which large areas of mirrors or lenses focus the Sun light onto a smaller absorber.[8]

Fig2. Flat plate thermal system for water heating deployed on a flat roof.[6]

Flat-plate collectors consist of

(1) a dark flat-plate absorber,

(2) a transparent cover that reduces heat losses,

(3) a heat-transport fluid (air, antifreeze or water) to remove heat from the absorber, and

(4) a heat insulating backing.[9]

Flat-plate collectors are in wide use for domestic household hot-water heating and for space heating, where the demand temperature is low. Many excellent models of flat-plate collectors are available commercially to the solar designer.[10] Solar flat plate collectors are used for water heating applications and the efficiency of these systems are around 70% which is very high as compared to solar direct energy conversion systems having efficiency around 17% [11].

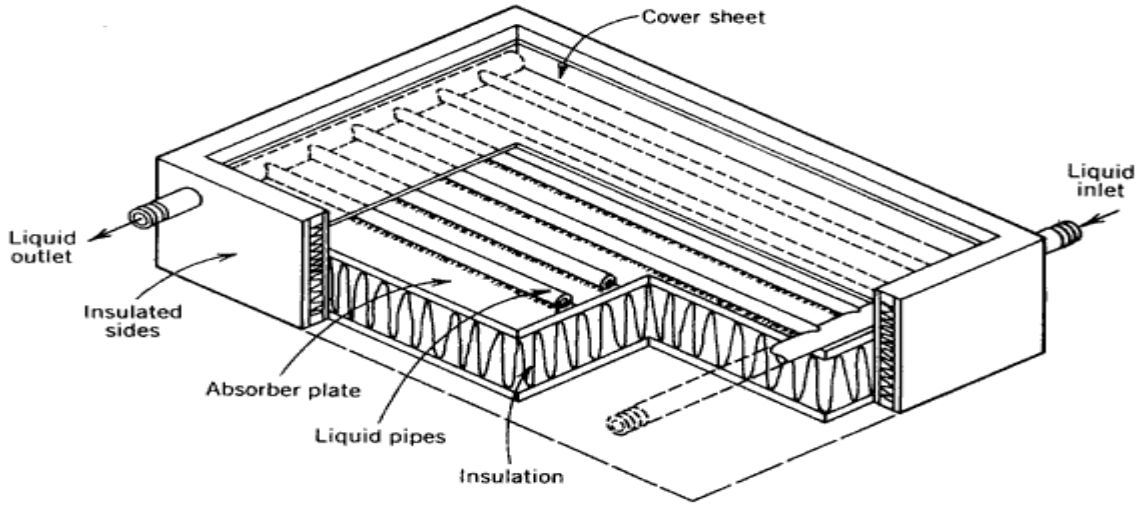

Figure 3: Cross-section of a typical liquid flat plate collector[12]

III THE MATHEMATICAL MODEL DEVELOPMENT OF A FLAT–PLATE SOLAR COLLECTOR SYSTEM

This section presents a mathematical model describing the flat-plate solar collector system the flat-plate solar collector contains one tube that is divided into five nodes (glass cover, air gap, absorber, fluid and the insulation) perpendicular to the liquid flow direction, figure4.[13]

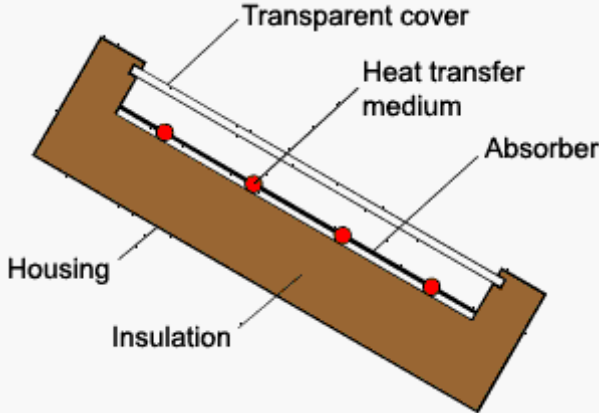

Figure4: Sketch of the five nodes analyzed in the flat-plate solar collector model[14]

IV. PERFORMANCE

The performance of the solar thermal flat plate collector depends on the amount of solar insulations absorbed by the plate. The emissivity of the selective coated plate is Usually around 0.1 and that of glass cover lies between 0.85 - 0.88.[15] The major heat loss in the collector is from the top through the glass cover compared to bottom and side losses. The top loss coefficient from the collector is evaluated by considering both convection and radiation from the absorber plate to ambient. the collector efficiency under different conditions such as the absence of cover, with single and double glazing under different ambient conditions, tilt angles, wind speeds, emissivity of both glass cover and absorber plate.[16]

V. CONCLUSION

Theoretical and experimental analysis is performed on a flat plate collector with a single glass cover. It can be concluded that the emissivity of the absorber plate has a significant impact on the top loss coefficient and consequently on the efficiency of the Flat plate collector. The efficiency of FPC is found to increase with increasing ambient temperature. Using the solar fuel with in solar collector application have enormous potential in the future and is under global focus to attain clean and green energy. A detailed mathematical derivation for the flat-plate solar collector cross sections (cover, air gap, absorber, working fluid, and insulation) was presented. A way to describe the thermal performance of a Flat Plate Solar collector has been shown. The most important measure is the collector efficiency. A more precise and detailed analysis should include the fact, that the overall heat loss coefficient

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ADVANCE COMPOSITE MATERIALS USED IN WIND TURBINE BLADES AND USE OF CARBON NANOTUBES TO ENHANCE ITS PROPERTIES

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ABSTRACT

As the world is growing the need for resources is also increasing with it. Conventional resources are on the verge of extinction and the situation is critical for them. As a result the demand is growing heavily for non conventional resources and how energy can be extracted from them; making them the hottest discussion among the researchers. One of the non conventional resources is WIND ENERGY. Research is widely going on for production of energy using wind energy. The present review article enlightens the advancement in composite materials used in manufacture of wind turbine blade. It specifically throws light on use of carbon Nanotubes composites in wind turbine blades.

Keywords: Wind Turbine, Turbine blades, Carbon nanotubes, Advance Materials, Fibers

I. INTRODUCTION

Global demand for energy has increased concern about greenhouse effects caused by fossil incineration and fuel consumption. This has resulted in global heating and melting of the ice caps and has necessitated the increasing use of the sustainable energy resources provided by biomass, sun, wave and wind. Over the last 35 years, wind energy has become a prominent part of the solution to these problems, and the development, manufacture and operation of wind energy harvesters is no longer carried out on a small-scale, experimental basis but has grown into a fully modern and mature industrial sector.

Wind energy power generation is expected to continue the enormous growth it has enjoyed during recent decades, see Fig. 1.1 [1] .It is expected that wind power will deliver 2.5% of the world's electricity in 2013. Predictions indicate that wind power will be able to meet 8% of the world's consumption of electricity by 2021, only eight years from now. The average annual growth rate for new installations seems to have slowed down due to the economic recession, and it is expected that for 2013 it will be only 10%, although economic and political predictions indicate that the growth rate will increase and once again reach the rates seen 5–8 years ago.[3]

As per T.K Jacobsen [2] the cost of energy can be approximately calculated as:

$$\frac{cost\ of\ turbine + cost\ of\ installation + cost\ of\ maintainance}{power\ produced}$$

This implies that cost of energy increases as the cost of turbine increases. Thus it can be inferred that if cost of turbine can be somehow reduced then cost of energy can be reduced and hence its efficiency. The cost of turbine can be reduced by using highly advanced composite materials which are light, strong and cheap. The materials are discussed in the next section.

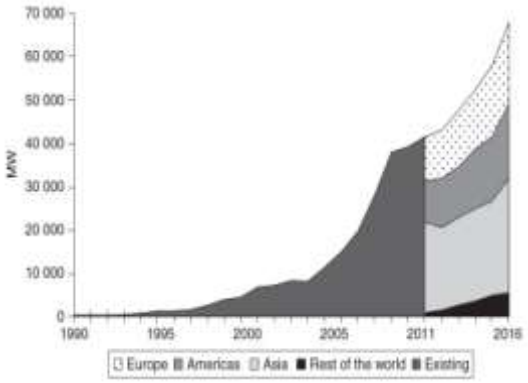

Figure 1.1- Development of Installed Wind Power During The Period 1990-2011 And Forecast Up To 2016.[4]

It has been discussed in later sections about a material carbon Nanotubes which is lighter than any material used till now and even stronger. It has been attracting researchers a lot for its incredible mechanical properties.

II. WIND TURBINE ROTOR BLADES

The wind turbine rotor has some important parts namely(blades,hubs,gearbox,generators,nacelle,tower etc). The part which provides weather protection is nacelle. These are low weight, strength and corrosion resistant. Typically nacelles are made of glass fiber composites.

Wind turbine rotor blades are the most important composite based part of a wind turbine. These rotor blades determine the lifetime and performance of the wind turbine. As stated by Mohamed and Wetzel in 2006 , the rotor blades are the costliest part of a wind turbine. Still the failure rates of rotor blades are of the order of 20% as stated by Richardson in 2010.

Wind turbines rotor blades are subjected to external loading which include flap wise and edgewise bending loads, gravitational loads, inertia forces, loads due to acceleration and torsional bending. Wind pressure causes flap wise loading whereas gravitational and torque load causes edgewise bending.

The wind turbine rotor blades are also subjected to cyclic loadings caused by wind vibrations, wind turbulence and wind shear.

The different parts of a wind turbine has its specific functions.

The wind blades are made with multiaxial fabrics. Often +/- 45^0 laminates are used in blade skin and shear web. In the root area triaxial fabrics are used which are +/- $45/90^0$ [3]. In unsupported parts of wind shell, sandwich composites are used.

The core of the sandwich bears shear load while the composite skin resists the bending stresses[4].The sandwich structures ensure much higher stiffness than monolithic composites.

The main requirements of wind turbine blades are :

1. High strength(To withstand high speed wind)
2. High fatigue resistance and reliability(For stable functioning and approx lifetime of 10^8 cycles)
3. Low weight(To reduce load on the tower)
4. High stiffness(To ensure stability of aerodynamic shape under extreme conditions)

The development in Wind turbine blades in recent times is shown in figure below.

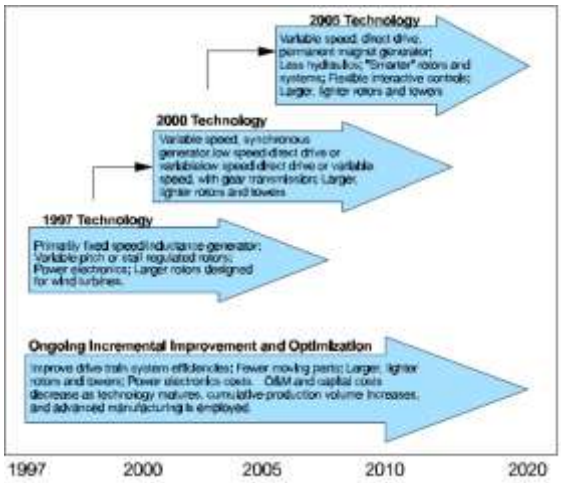

Fig 2.1- Development in Wind turbine blades[2]

In order to have a good durable, reliable and safe rotor blade of a wind turbine long carbon fibers based composites are used. These composites are discussed below.

2.1 Fibers

The stiffness of composites is determined by the stiffness of fibers and their volume content. Most often, E-glass (i.e., borosilicate glass called “electric glass” or “E-glass” for its high electric resistance) fibers are used as main reinforcement in the composites. The main properties of E-glass fibers are as follows: Young modulus E 70…77 GPa, density 2.55…2.64 kg/m3, diameter 8…15 μm, failure strain 4.5…4.9%.

With increasing the volume content of fibers in UD composites, the stiffness, tensile and compression strength increase proportionally, yet, at high volume content of fibers (after 65%), there might be dry areas without resin between fibers and the fatigue strength of the composite reduces. Typically, the glass/epoxy composites for wind

blades contain up to 75 weight % glass.

2.1.1 S-glass

(High strength glass, S means “Strength” here) developed in the 1960s for military applications, has 40% higher tensile and flexural strengths, and 10...20% higher compressive strength and flexural modulus, than the E glass. The main properties of Sglass are: Young modulus E 86-90 GPa, density 2.46…2.49 kg/m3, failure strain 5.4…5.8%. Still, the S-glass is much more expensive than E-glass. **S2 glass** was developed in the 1968 by Owens Corning company as a commercial, non-military version of S-glass. S glass and S2 glass fibers have the same composition (magnesium alumino-silicate). The main differences are in sizing and certification procedure. The price of S2-glass is around 10 times of that of E-glass. **R-Glass** fibers, introduced by Vetrotex in 1968, are produced with a calcium aluminosilicate glass with less silica and added oxides. The main properties of R-glass are: Young modulus E 84-86 GPa, density 2.55 kg/m3, failure strain 4.8 % (Fecko, 2006). Some other special glasses developed by Owens Corning are ECRGLAS (in 1980) and Advantex (in 1997). Relatively recently, in 2006, Owens Corning company developed **WindStrandTM** glass fibers, which have 15 percent higher stiffness and up to 30 percent higher strength when compared to traditional glass fiber reinforcements, and show very good fatigue properties under both tension and compression loading (Ashwill, 2009).

2.2. Carbon Fibers/Carbon Nanotubes

It attracted large interest of industry and research community as a very promising alternative to the glass fibers. Carbon fibers have much higher stiffness and lower density than the glass fibers (Young modulus E = 220-240GPa, density 1.7-1.8 kg/m3; failure strain 0.7%), thus, allowing the thinner blade profile as well as stiffer and lighter blades. However, they have relatively low damage tolerance, compressive strength and ultimate strain, and are much more expensive than the E glass fibers (7...20 times, see Grande, 2008). Furthermore, carbon fiber reinforced composites are very sensitive to the fiber misalignment and waviness: even small misalignments lead to the strong reduction of compressive and fatigue strength. In some cases, the problem of efficient wetting carbon fibers in vacuum infusion has been observed, thus, leading to the use of more expensive prepreg technology for the producing carbon fiber based composites.

2.3. Matrix

Due to the low weight requirement to the wind blades, polymers are the main choice as the matrix material for the wind blade composites. As noted above, matrix of composite controls fracture toughness, delamination strength and out-of-plane strength and stiffness of the composite, and influences the fatigue life of the composites. Typically, thermosets (epoxies, polyesters, vinylesthers) or (more seldom) thermoplastics are used as matrixes in wind blade composites.

2.4 **Thermosets**

It is based composites represent around 80% of the market of reinforced polymers (Nijssen, 2007, Joncas, 2019). The advantages of thermosets are the possibility of room or low temperature cure, and lower viscosity (thus, allowing better impregnation and adhesion). Initially, polyester resins were used for composite blades. With the development of large and extra-large wind turbines, epoxy resins replaced polyester and are now used most often as matrixes of wind blade composites. While polyester is less expensive and easier to process (needs no post-curing), epoxy systems are stronger (high tensile and flexural strength) and more durable as compared with polyester resins. Epoxy matrixes ensure better fatigue properties of the composites. The production of epoxy based composites is more environmentally friendly. Still, recent studies (e.g., by Swiss company DSM Composite Resins) support arguments for the return to unsaturated polyester resins, among them, faster cycle time and improved energy efficiency in the production, stating that the newly developed polyesters meet all the strength and durability requirements for large wind blades.

2.5 Thermoplastics

It represents an interesting alternative to the thermoset matrixes. The important advantage of thermoplastic composites is their recyclability. Their disadvantages are the necessity of high processing temperatures (causing the increased energy consumption and possibly influencing fiber properties) and, difficulties to manufacture large (over 2 m) and thick (over 5 mm) parts, due to the much higher viscosity. The melt viscosity of thermoplastic matrices is of the order 102-103 Pax s, while that for thermosetting matrix is around 0.1-10 Pax s. Thermoplastics (as differed from thermosets) have melting temperatures lower than their decomposition temperatures, and, thus, can be reshaped upon melting. While the fracture toughness of thermoplastics is higher than that of thermosets, fatigue behavior of thermoplastics is generally not as good as thermosets, both with

carbon or glass fibers (Nijjssen, 2007). Other advantages of thermoplastics include the larger elongation at fracture, possibilityof automatic processing, and unlimited shell life of raw materials (Lystrup et al, 1998).

III. CONCLUSION

It was observed above that the wind turbine blades are needed to be made light and strong so that they can resist maximum bending torque and are cheap.

For the above purpose it was seen that glass fibers, composite matrices and thermosets and thermoplastics plays an important role. But above all carbon fibers and carbon nanotubes plays the most vital role.

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