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# SOLAR HUMIDIFIER

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**ABSTRACT**

The solar humidification–dehumidification method (HDH) is a thermal water desalination method. It is based on evaporation of sea water or brackish water and consecutive condensation of the generated humid air, mostly at ambient pressure. This process mimics the natural water cycle, but over a much shorter time frame.

The simplest configuration is implemented in the solar still, evaporating the sea water inside a glass covered box and condensing the water vapour on the lower side of the glass cover. More sophisticated designs separate the solar heat gain section from the evaporation-condensation chamber. An optimized design comprises separated evaporation and condensation sections. A significant part of the heat consumed for evaporation can be regained during condensation. An example for such an optimized thermal desalination cycle is the multiple-effect humidification (MEH) method of desalination.

**HUMIDIFICATION:**

Humidification is the artificial regulation of humidity in home environments, industrial environments, and health care applications such as artificial respiration. To be comfortable, people require a certain amount of ambient moisture in the air — not too high, and not too low. Adequate humidification in a manufacturing environment stabilizes moisture in wood, paper, and textiles, while preventing warping in glue joints. In all environments, it reduces fire risk and static while making the area feel comfortable.

A humidifier is a device that increases humidity (moisture) in a single room or an entire building. Industrial humidifiers are used when a specific humidity level must be maintained to prevent static electricity build up, preserve material properties, and ensure a comfortable and healthy environment for workers or residents.

**HEATING AND HUMIDIFICATION PROCESS:**

In heating and humidification psychometric process of the air, the dry bulb temperature as well as the humidity of the air increases. The heating and humidification process is carried out by passing the air over spray of water, which is maintained at temperature higher than the dry bulb temperature of air or by mixing air and the steam.

When the ordinary air is passed over the spray of water maintained at temperature higher than the dry bulb temperature of the air, the moisture particles from the spray tend to get evaporated and get absorbed in the air due to which the moisture content of the air increase. At the same time, since the temperature of the moisture is greater than the dry bulb temperature of the air, there is overall increase in its temperature.

**INTRODUCTION**

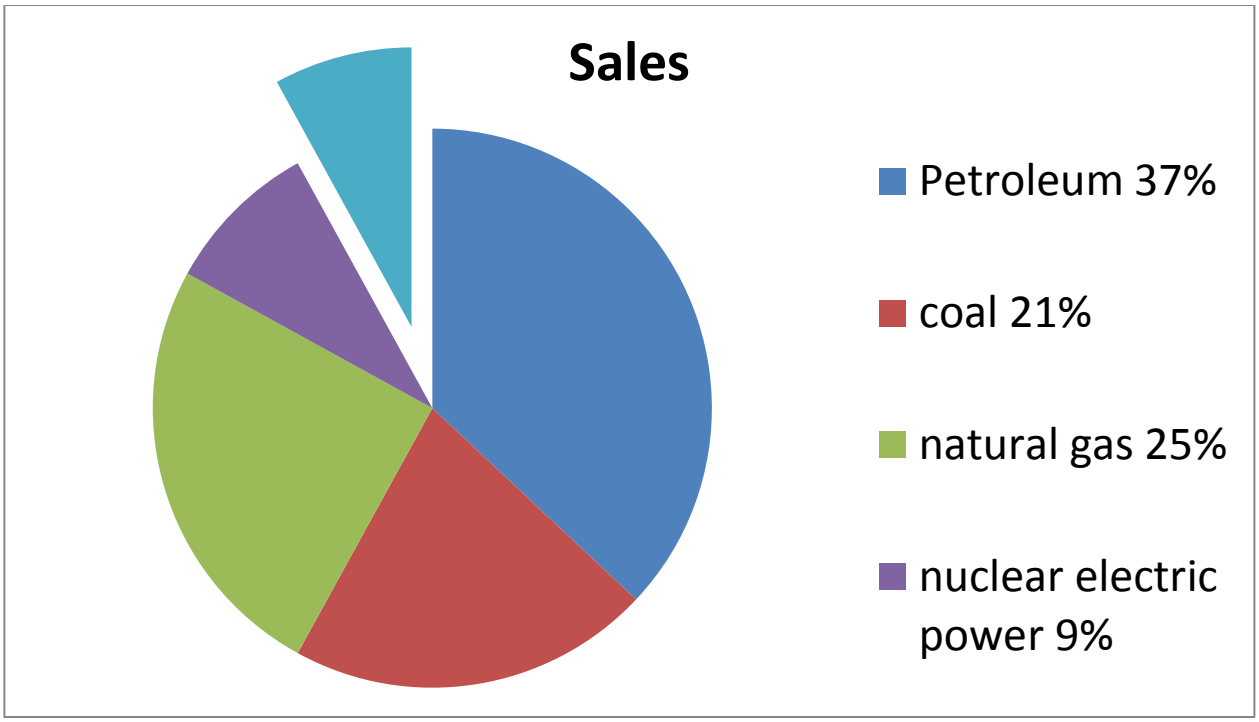
## Solar Humidification

This is a concept in which we are using a solar air heater for humidification process instead of electrical humidifier. By this concept we are trying to use alternet energy source instead of electric energy, and by this we are trying to reduce the overall cost of process and saving of electric energy.

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy. Solar energy has been providing heat and light to our planet since the beginning of time. The sun is, in fact, the source of all our energy resources on Earth. Through natural processes energy from the sun affects, creates and sustains plant and animal life, winds, rain, and even fossil fuels through human invention and new technology man has been able to harness the sun's energy and turn it into solar power to heat water, homes, buildings, pools and to create electricity.

Solar power can provide enough electrical power to meet the needs of industries, homes and entire towns. In one hour, enough of the sun's energy reaches Earth to meet the energy needs of every human being on the planet for a whole year. Basically, it can replace all the oil, gas, and electricity used in one year.

As alternative energy sources , solar power is considered one of the best. It is certainly renewable—the sun is always shining in some part of the world. It can't run out and is available to all. After the initial cost of manufacture and installation it is free to run (in some applications) and produces zero pollution.




**[ Fig: renewable energy consumption in the nation's energy supply in 2010]**

**OBJECTIVE**

The primary objective of the project is to provide humidification to the small scale industries or house hold application according to results with economically and effectively

- Provide a humidification by using renewable energy instead of conventional sources.
- Reduce the cost of operation by solar humidifier.
- Improve quality of air.

**LITERATURE REVIEW:**

**SOLAR AIR HEATER LITERATURE REVIEW:**

**P.Ramesh et al [1], 2011 published a paper on evaluation of thermal performance of wire mesh air heater.** In this study, an attempt has been made to increase the thermal efficiency of solar air heater by using a wire mesh to enhance the heat transfer, thereby increasing the efficiency. Thematrix solar air heater with a wire mesh produces higher thermal efficiency over the conventional flat plate solar air heater by employing a low carbon steel wire mesh a 5% increase in overall efficiency is observed when compared with conventional system.

**NiravSoni et al [2], 2011, published a paper on Experimental Investigation On Double Pass Air Heater With Corrugated Absorber Plate And Amul Cool** .In this study, Double pass solar air heater is also fall in category of solar air heater, which is latest and has higher thermal efficiency. To increase thermal efficiency zigzag way created on the way of air with help of Amul Cool Aluminium cans This research experimentally investigates a double pass solar air heater with aluminium cans with corrugated absorber plate. Here, mass flow rate remains constant (0.05 Kg/s).

**V.V. Tyagia, N.L. Panwarb, N.A. Rahima, RichaKotharic et al [3], 2011, published a paper on solar air heating system with and without thermal energy storage system.** In this paper an attempt has been made to present holistic view of available solar air heater for different applications and their performance. From these comprehensive reviews lot of works have been carried out globally to evaluate the performance of different types of solar air heaters. Mostly flat plate air heater produces hot air at low temperature and found suitable for drying agricultural products.

**S.S Pawar et al [4], 2013, published a paper on experimental study of Experimental study of Nusselt number and Friction factor in solar air heater duct with Diamond shaped rib roughness on absorber plate.** In this study, Thermal efficiency of solar air heater can be improved by creating artificial roughness on absorber plate which causes higher temperature to absorber plate. Experimental investigation were carried out to study heat transfer enhancement using diamond shape ribbon absorber plate of solar air heater, finally comparison of heat transfer and friction factor from both and roughened plate under the similar condition of airflow is made. Friction decreases in increase in Reynolds number.(0.0194 friction factor at 3010 Reynolds number)

**SumanSaurav, M.M.Sahu et al [5], 2013, published a paper on Heat Transfer and Thermal Efficiency of Solar Air Heater Having Artificial Roughness.** In this study, Experimental investigations appropriate to distinct roughness geometries shows that the enhancement in heat transfer is accompanied by considerable rise in pumping power. Artificial roughness applied on the absorber plate is the most efficient method to improve thermal performance of solar air heaters this paper is to review various studies, in which different artificial roughness eleents are used to enhance the heat transfer rate with little penalty of friction.

**HUMIDIFICATION LITERATURE REVIEW:**

**A.M.I. Mohamed, N.A. El-Minshawy et al [6], 2010, published a paper on Theoretical investigation of solar humidification–dehumidification desalination system using parabolic trough concentrators.** This paper deals with the status of solar energy as a clean and renewable energy applications in desalination. This paper investigates the principal operating parameters of a proposed desalination system based on air humidification–dehumidification principles. A parabolic trough solar collector is adapted to drive and optimize the considered desalination system. It review that, parabolic trough solar collector is the suitable to drive the proposed desalination system. A comparison study had been presented to show the effect of the different parameters on the performance and the productivity of the system. The productivity of the proposed system showed also an increase with the increase of the day time till an optimum value and then decreased. The highest fresh water productivity is found to be in the summer season, when high direct solar radiation and long solar time are always expected. The production time reaches a maximum value in the summer season, which is 42% of the day.

**El-Haroun et al [7], 2012, published a paper on Desalination System with Humidification-Dehumidification of Air.**It was found that, the productivity of the unit increases with the enlargement in surface area of heat transfer in humidifier. The results show also that, using sponge as packing material will be better than clauses pieces or saw dust. The results show also that, using sponge as packing material will be better than clauses pieces or saw dust. The use of such desalination unit, in small or gross scale, will be very attractive to supply remote areas with fresh water for domestic uses or even for irrigation of lands.

**Narayan, G. Prakash et al [8], 2014 ,published a paper on The potential of solar-driven humidification-dehumidification desalination for small-scale decentralized water production.** Solar humidification dehumidification desalination technology has been reviewed in detail in this paper. From the present review it is found that among all HDH systems, the multi effect water heating system is the most energy efficient. The HDH system has other advantages for small-scale decentralized water production. These advantages include much simpler brine pre treatment and disposal requirements and simplified operation and maintenance.

**A Case study [9], Humidification systems:** A Cost and Efficiency Comparison. In this the different humidification systems are compared in terms of effectiveness, operating cost, installation cost, IAQ, etc. This case study is done for the cost comparison in US. The reasons are quantified about different parameters like Cost, IAQ, Annual operating cost, Operating Cost.

## EXPERIMENTAL SETUP


[Fig:Experimental Setup]

## CONSTRUCTION

The solar heater is having a blower for pushing air into solar air hater wit series connection for reduction of blower speed. Solar air heater consists of black coated copper pipe, glass cover and absorber plate which having high absorptivity results to heating of air due high thermal conductivity. Two digital thermometer are located at the inlet and outlet for temperature measurement. The setup is having submersible pump located in the supply water tank having water sprayer at the top of humidifier tank.

## WORKING

The air is extract in the solar collector with the help of fan and after the air is sufficiently heated by solar radiations. It is allow to pass through the humidifier tank consists of water sprayer where water mixes with hot air and air get humidified. The digital thermometer located at air inlet and outlet also sling type thermometer is used to measured wet bulb temperature and dry bulb temperature.

## RESULTS AND DISCUSSION

### SOLAR COLLECTOR

- LIST OF INPUT PARAMETER

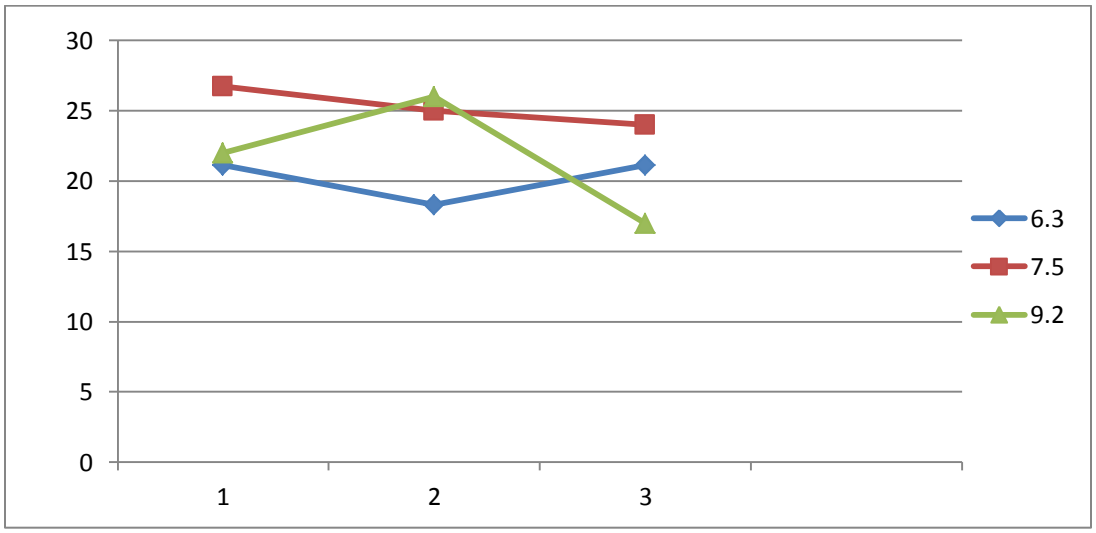
1. length = 750mm

2. width = 500mm
3. thickness =100mm
4. velocity of blower = 6.3,7.5,9.2 m/s
5. diameter of pipe = 12.5 mm
6. specific heat = 1.01 kJ/kg-K
7. solar constant = 1353 kW/$m^2$

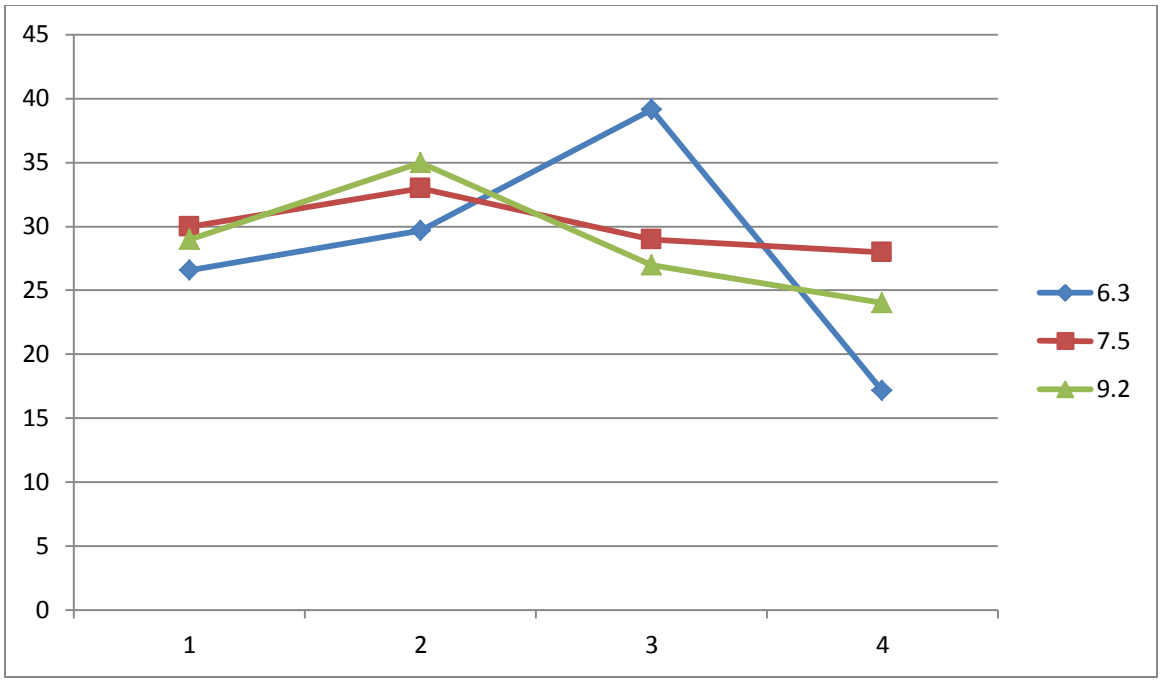
**RESULT DISCUSSION**

- By varying the various parameters and see their effect on the output is discussed

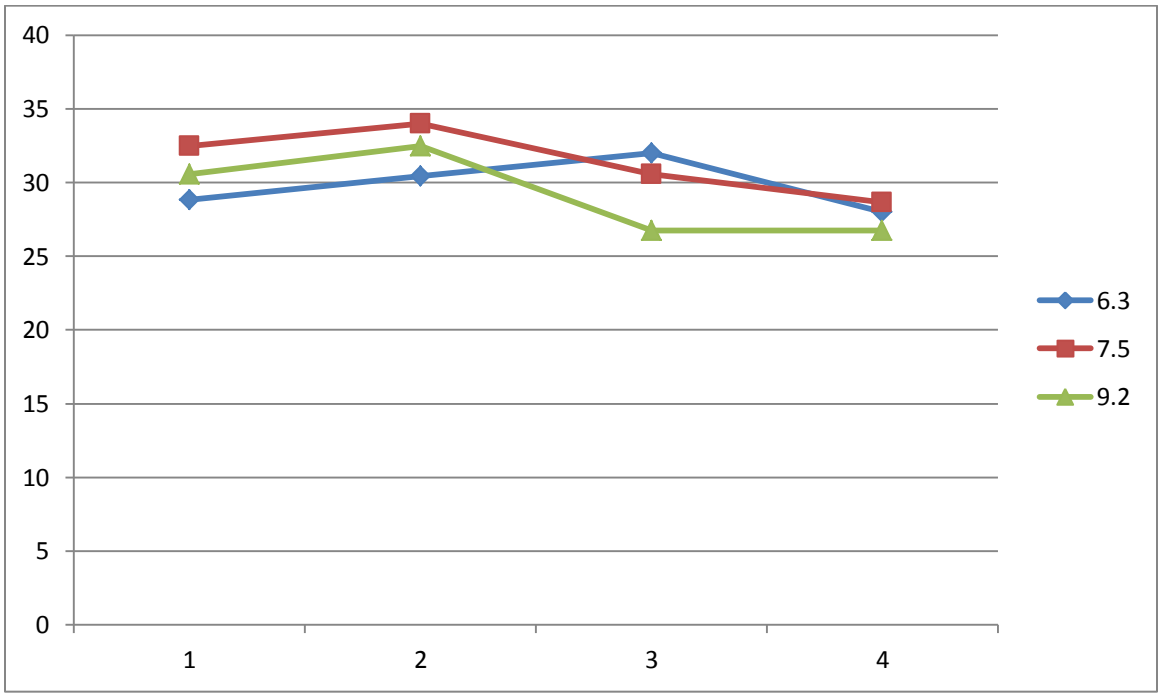
**VELOCITY VS. EFFICIENCY CHART:**




[Fig:Velocity vs. Efficiency chart ]




[Fig:Velocity vs. Efficiency chart ]




[Fig:Velocity vs. Efficiency chart ]

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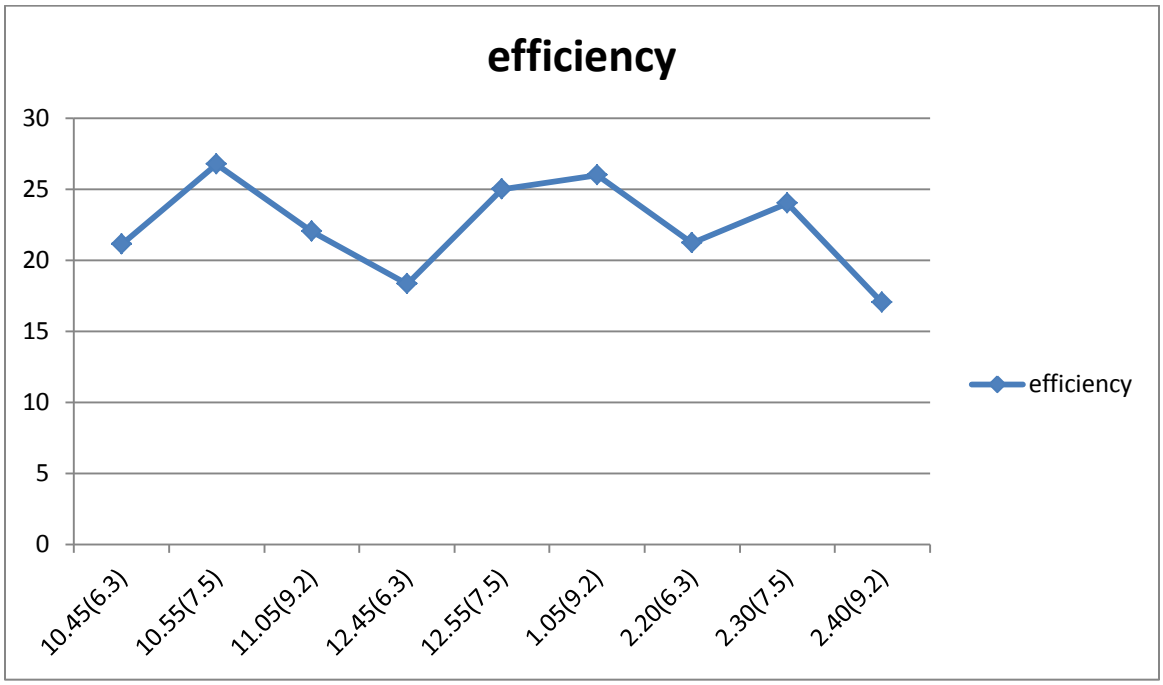
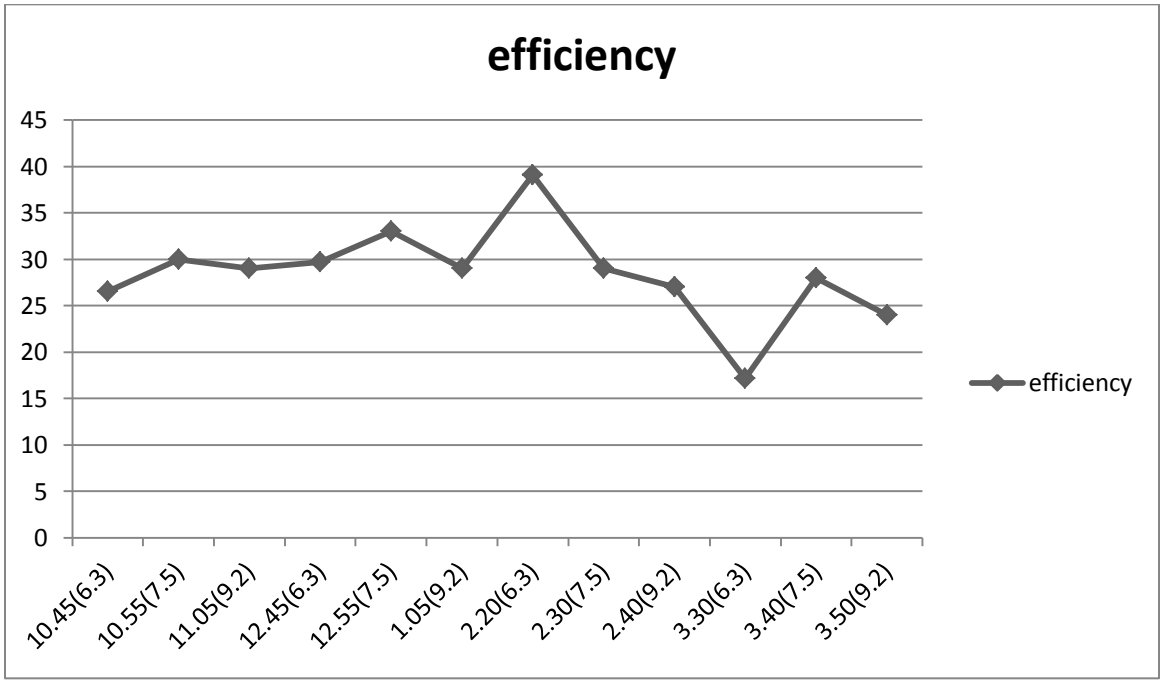
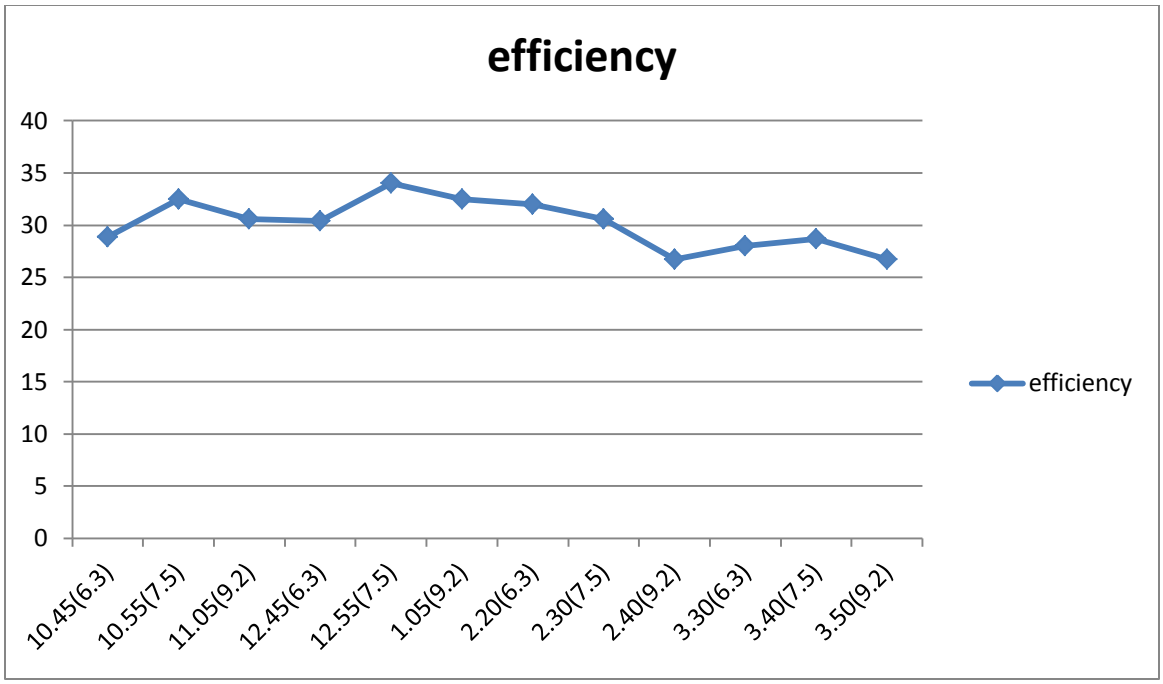



[Fig:Time vs. Efficiency chart ]

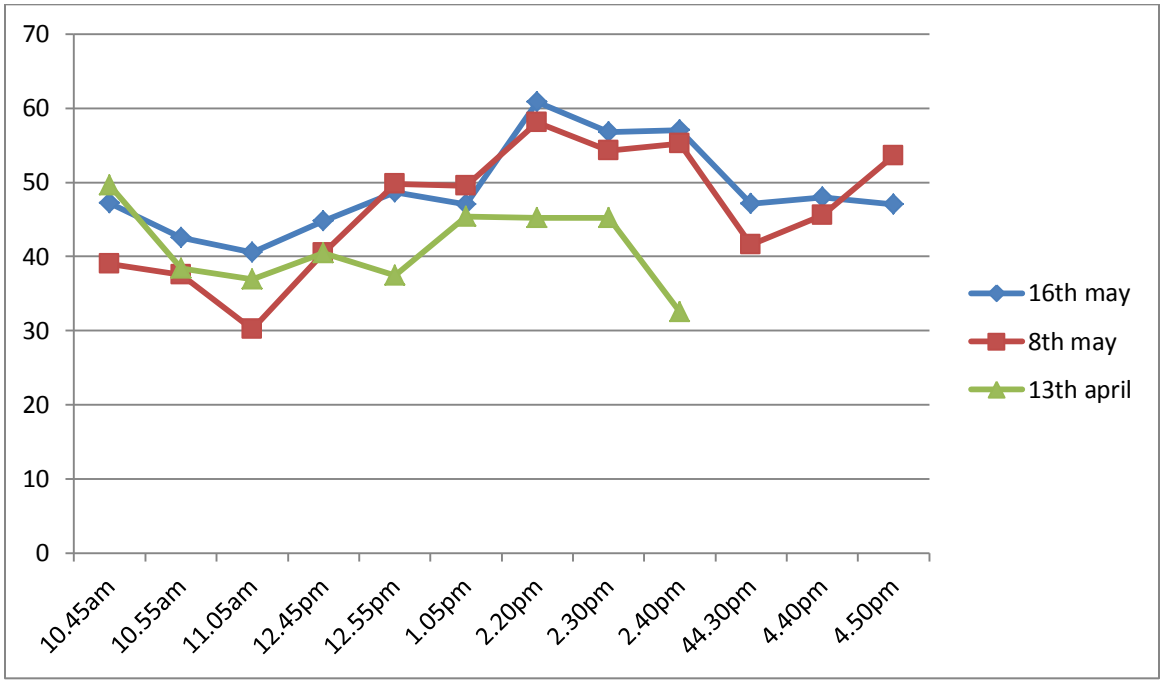



[Fig:Time vs. Efficiency chart ]



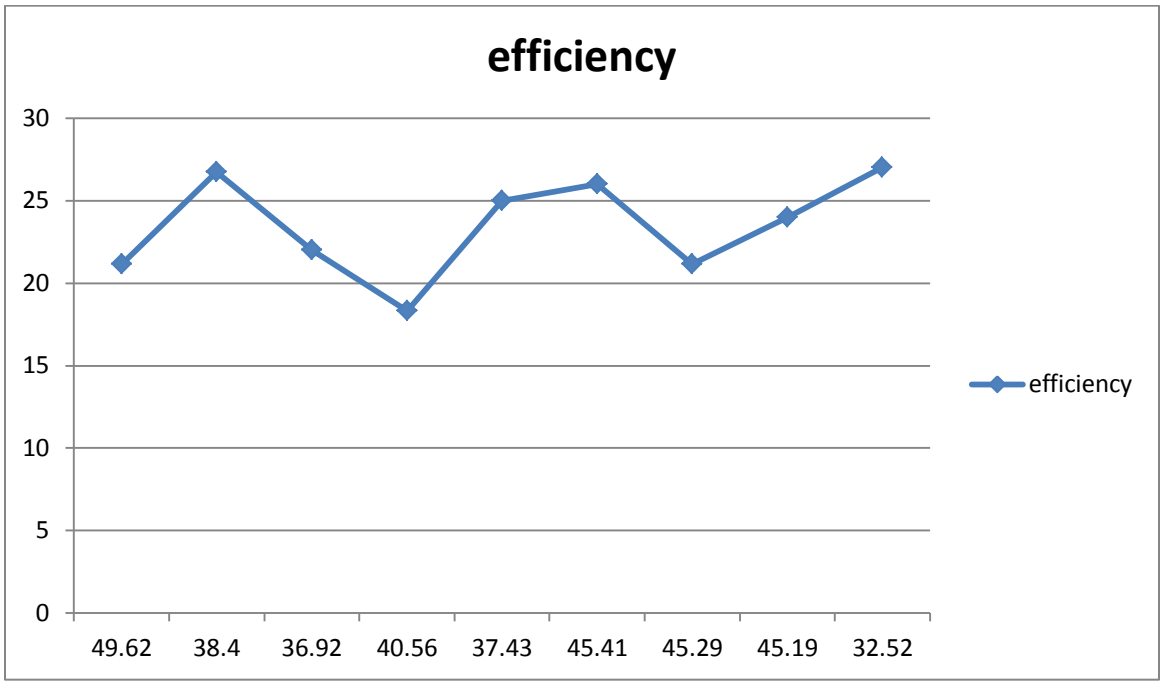

[Fig:Time vs. Efficiency chart ]

**TIME VS HEAT ADDED:**

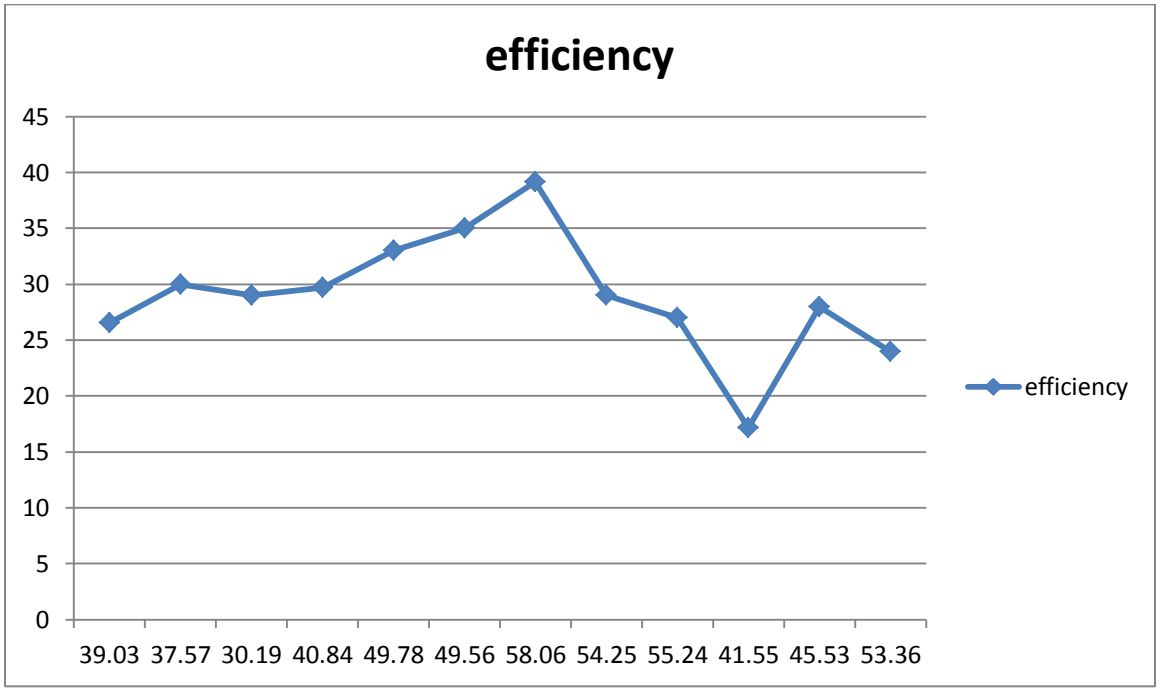



[Fig:Time vs. Heat added chart]

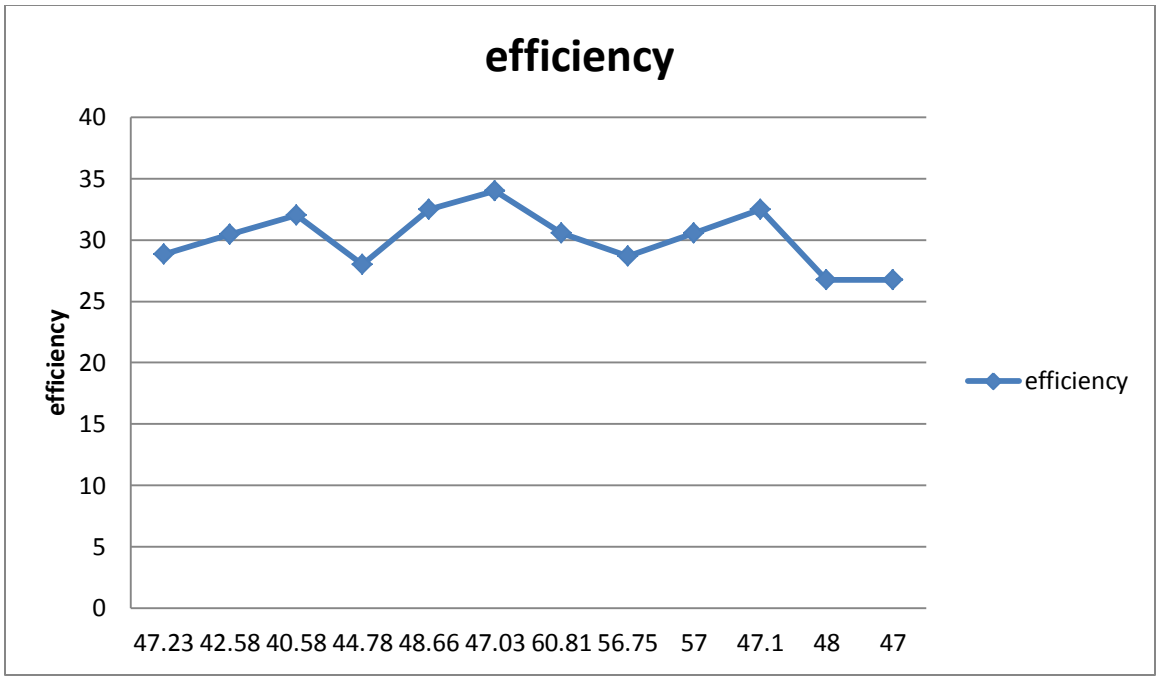
**HEAT ADDED VS EFFICIENCY:**




[Fig:Head added vs. Efficiency chart ]




[Fig:Head added vs. Efficiency chart ]




[Fig:Head added vs. Efficiency chart ]

**SUMMARY OF PROJECT**

**LIMITATION:**

- Solar energy is not available during night and monsoon so productivity is less.
- Size of the system is occupies more space.
- Many factors affect the efficiency of solar air heater i.e. dust on collector .
- Cost is more for less area.

**FUTURE ENHANCEMENT:**

- In future it will also use as dehumidifier by dehumidification arrangement.
- It will serve to purpose humidification and dehumidification.
- By placing a spoung horizontally in the humidifier tank it will absorb water and after absorbing water pump will be cut off and hot air passed over it and it will humidify.
- By solar cell attachment it will not consume any electrical energy.

**CONCLUSION:**

We have completed our project work based heating of air with solar air heater for humidification process that we have done with preplanning scheduling related with time constrains and result oriented progress in project development.

From our project it found that heating of air with solar air heater is beneficial for humidification process from cost prospective. Humidification process works efficiently with solar air heater. Although it's difficult to analyses the behavior of air because of non-uniform characteristics of the air.

**REFERENCE:**

1. Google.com
2. Wikipedia.com
3. Refrigeration and Air Condition by R.S.Khrumi