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Design of an Air Cooled Telephone Booth Using Solar Energy as Non-Conventional Energy Source

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ABSTRACT:

The present work reports to the execution of air cooled system of a telephone booth using non-conventional energy sources: Location-Central India region (Nagpur 21^0North latitude). Use of Solar energy as non-conventional energy which is environmental friendly and cost saving power source. Also evaporative coolers use only 18% to 25% of the energy consumed by air conditioners and evaporative coolers cost about half as much as air conditioners to install. In this view, in present work, such system is designed with total emphasis on lowest possible energy consumption to meet all the requirements.

KEYWORDS: Heat load calculations, Cooling system design, Equipment specification, Green concepts (solar energy)

TELEPHONE BOOTH DETAILS:
Outside dry-bulb temperature = +44.4°C (max.) Outside Wet bulb temperature = +23.2°C (max.)

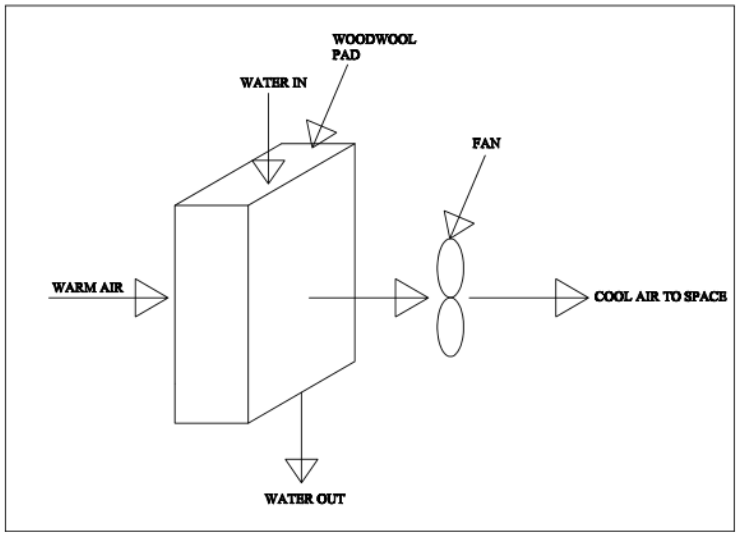
Power supply-
1) Battery-150AH, 2) Module-150W, 3) Charge Controller-10 Amp, 4) Inverter-300VA

Working hours
16 hours/day (7a.m-11p.m)

Dimension of the booth
1.83m×1.83m×2.44m (6ft×6ft×8ft) and Solar radiation assumed to be 800W/m 2 hr. and no requirement of cooler during low temperature day e.g, winter season, rainy day.

(A) Operating principle

Our design is based on Direct Evaporative Cooling. With direct evaporative cooling, outside air is blown through a water-saturated medium and cooled by evaporation. The cooled air is circulated by a blower. Direct evaporative cooling adds moisture to the air stream until the air stream is close to saturation. The dry bulb temperature is reduced, while the wet bulb temperature stays the same.



Functions: (i) Evaporative cooling reduces DX/chilled water cooling requirement for fresh air (ii) It cuts mechanical cooling cost (iii) It increases existing equipment cooling capacities (iv) It eliminates the use of conventional energy sources.

Innovative Features

The telephone Booth is operated by using Solar energy which is a innovative feature.

Application Areas:

(i) We can use our project, in areas where there is scarcity of electricity/ not available
(ii) Our system can be easily installed and work efficiently in hot and dry climates.

Characteristics that make it stand out from other comparable products / systems:

1. The unique characteristics that make our design stand from Generator is that-it runs on sunlight which saves the cost of diesel required in generator. In one word it is much more cost effective and requires no maintenance. Our system is environment friendly as it does not pollute the air which is done by the combustion of diesel fuel in Generator.
2. As compared to air-conditioning, our system uses evaporative cooling in which power consumption is limited to the fan and water pump. Because the water vapour is not recycled, there is no compressor that consumes most of the power in closed cycle refrigeration. The refrigerant used in our design is water. No special

refrigerants such as Ammonia, SO_2 or CFCs, are used that could be toxic, expensive to replace, contribute to Ozone depletion.

3. Evaporative cooling increases humidity. In dry climates this improve comfort. The cooling pad itself acts as a effective air filter when properly maintained, it is capable of removing a variety of contaminants in air, including urban ozone caused by pollution, regardless of very dry weather. Refrigeration based cooling system loses this ability whenever there is not enough humidity in the air to keep the evaporator wet while providing a constant trickle of condensate that washes out dissolved impurities removed from the air.

ASSUMPTIONS:

1. We assumed the climatic condition with maximum temperature of 44.4 ^{0} C and dimension of telephone booth as 1.83m×1.83m×2.44m (6ft×6ft×8ft), effective solar radiation available between 9 a.m-5 p.m and the telephone booth is opened from 7 a.m to 11 p.m.
2. Solar radiation assumed to be 800W/m 2 hr. and no requirement of cooler during low temperature day e.g, winter season, rainy day.

Major challenges faced and steps taken to overcome them:

1. We can run our system (Telephone Booth) by: a) Normal Inverter, which requires 12-16 hrs for charging, so there is a need of electricity to charge it. (b) Generator, it also requires extra cost of Diesel for running. Considering all these in mind, we are using renewable energy source i.e, SOLAR ENERGY which fulfils all our requirements and removes the difficulties too.
2. If we use electricity then there is a need of poles and wire ropes, but if we use solar then there is no need of such wire ropes and poles. Also the investment in solar equipments is one time and the life of solar equipments is nearly about 20 years or more.
3. Provision of MSEB i.e, state electricity may not be available continuously but solar energy with battery gives uninterrupted power supply at any time.

Specific learnings of the project and their value:

1. As we are using solar energy as renewable energy sources for running our system (telephone booth) hence it is much cost effective compared to other sources since once installed the solar energy system with battery, the life of such is about 20years or more with one time installation charge. Also through this project we got familiar with solar and heat load calculations.
2. A more professional outlook to the air-conditioning and solar power industry, as such with this knowledge we can implement it both in our studies and this experience would also help us during campus interviews.

International or National Standards employed in the project:

(1) International Standards:

A. IEC 62124, 2004 Ed1.
B. 2004 ASHRAE handbook HVAC systems and equipments chapter-19.

(2) National Standards:

A. I.S-277 Galvanised Steel (G.S-Plain and corrugated).
B. I.S 655 Metal Air Ducts.

Impact of our innovative design addressing the constraints faced in / needs of consumers in the Indian subcontinent:

A. We can use our system in the areas where electricity is not available and also in case of unavailability of sunlight for a particular period we can use the energy stored in the battery to meet the power requirement.
B. Our design is a one-time investment, so the customer does not need to worry about electricity/electricity bills because solar energy is freely available.
C. Our design is based on evaporative cooling which works best in hot and dry climates. Since the humidity, almost always, decreases proportionally as the temperature increases, the cooling power of evaporative system increases as the temperature increases.

Environment friendliness:

A. Since evaporative cooling does not use chlorofluorocarbons (CFCs), it does not contribute to ozone depletion. Evaporative cooling is healthy and comfortable because it brings in outside air and exhausts stale air, smoke, odours and germs, it also helps to maintain natural humidity levels.
B. Solar energy is Green energy i.e, it does not cause pollution.

Energy and cost saving:

Though the initial cost of solar system is Rs. 30800/-and that of cooler is Rs. 13000/-, it is much more cost saving, since solar system once installed will have a life span of more than 20 years. Also evaporative coolers use only 18 to 25% of the energy consumed by air conditioners and evaporative coolers cost about half as much as air conditioners to install.

TECHNICAL SPECIFICATIONS OF THE SYSTEM:

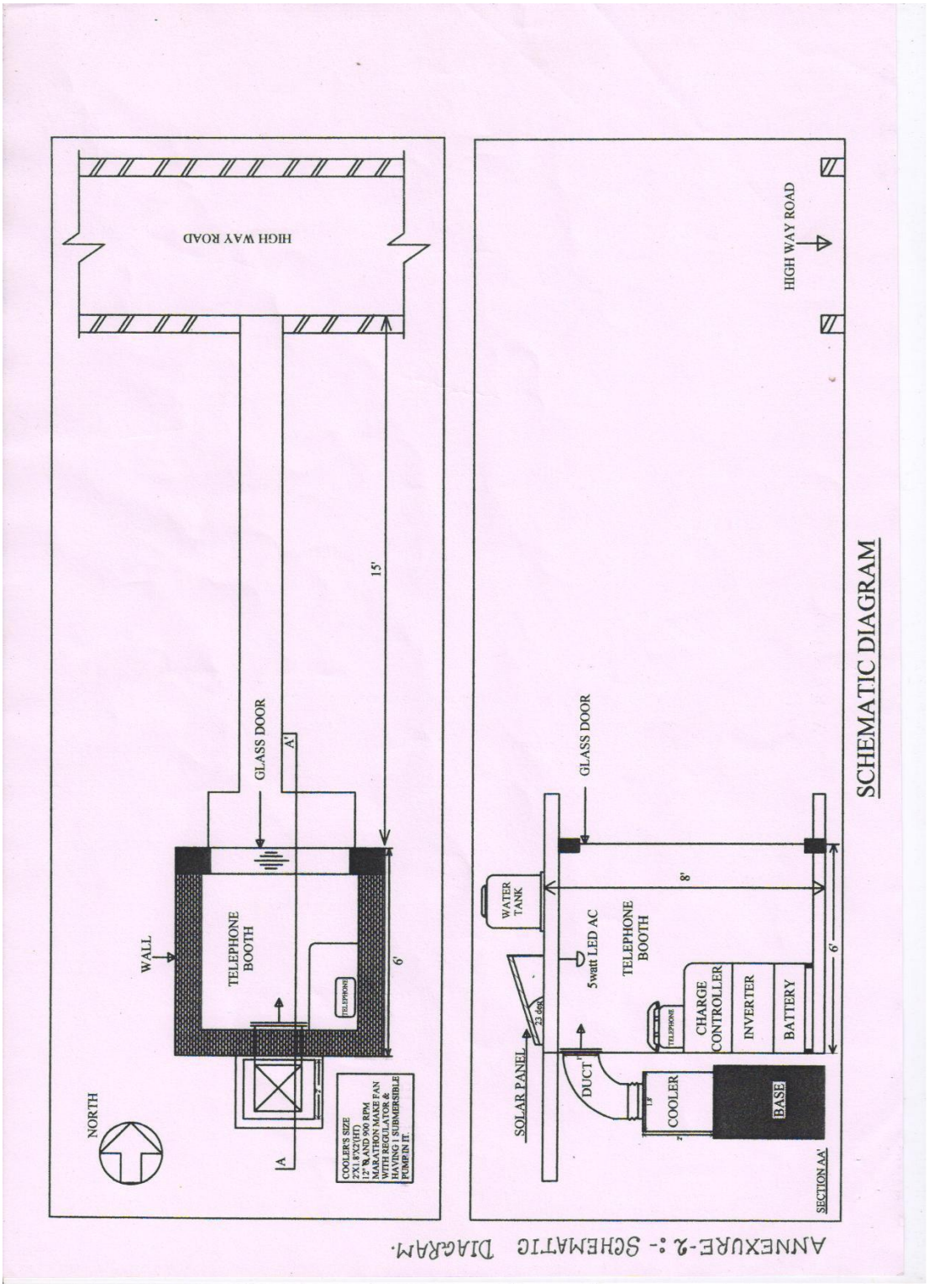
A) COOLER SPECIFICATION:-

Size-2'×1.8'×2'(ht)
Duct size:-12" diameter
Fan-900 rpm marathon make fan with regulator
Pump-One submersible pump

B) SOLAR EQUIPMENT SPECIFICATION:-

Module-150W
Charge Controller-10Amp
Battery-150Ah
Inverter-300VA

SCHEMATIC LAYOUT:



Cost of Solar equipments/components:

Name of Equipments	**Cost (Rs.)**
Module	10500
Charge Controller	1400
Mounting Frame	600
Battery	10000
Inverter	5800
Wire, Box and Labour	2500
Total	**30800**

Cost of Cooler equipments/components:

Name of Equipments	**Cost (Rs.)**
Complete cooler assembly with 12” dia. 900 rpm fan along with pump and internal piping supply and installation	10000
FRP (Fibre Reinforced plastic for anticorrosion) lining for cooler water tank	1000
0.63 mm G.I ducting supply fabrication and installation	800
Thermocouple insulation with chicken mixmerh and sand cement plaster	400
Aluminium power coated grille	800
Total	**13000**

References:

[1] ISHRAE Refrigeration Handbook, Indian Society of Heating, Refrigerating and Air-Conditioning Engineers
[2] Refrigeration and air-conditioning-C.P.Arora
[3] Solar Energy-Sukhatme.