DESIGN AND FABRICATION OF AIR TO WATER CONVERTOR USING RADIATIVE COOLING.

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Abstract: Extraction of water from natural air around us to help the betterment of human life. Pumping natural air into the earth and using the lower temperature along with radiative cooling to condense the dew drops. One half of the device is buried inside the earth for around 6 feet or more. The open end of the device which is exposed to the atmosphere consists of a turbine and fan setup which is used to pump humid air into the device continuously. Heat from the air is transferred to the soil around the duct. Once the air temperature falls below its condensation temperature it condenses as water droplet and is stored in the chamber below. Since the temperature of the chamber below is always less than the temperature of the atmospheric air, because of use of super hydrophobic material, we expect nominal water condensation even when the turbine is not actuated by the wind.

Keywords: Radiative Cooling, Super Hydrophobic Material, Condensation, Humidity, Turbine.

I. INTRODUCTION

Our goal of this project is to meet the increasing water demands worldwide by condensing natural humid air and provide safe clean drinking water. We have planned to do it ecofriendly without the use of electricity and chemicals.

II. PROBLEM STATEMENT

Our planet has abundance of water but most of that water is undrinkable. 97.5% water available is undrinkable, 1.75% water is frozen and only 0.75% water is good for drinking.

1 in 3 people worldwide, more than 2.3 billion don't have clean & safe drinking water.

1 in 5 people around the world, more than 1.2 billion live in areas of water scarcity.

Everyday more than 18k people die due to lack of safe drinking water.

Poor woman & children walk for hours together in order to collect safe drinking water in urban areas.

III. EXPERIMENTAL SETUP

Our device consists of a 12 inch pipe of length 0.7m, closed at one end and connected to a 350*160mm reducer at the other end. The reducer is now in turn connected to a 6inch pipe of length 3m. Now a 1&1/2 inch pipe of 3.5m, is held inside to the 6inch pipe in such a way that they form concentric circles when viewed from the top view. This 1&1/2 inch pipe is used as a return path pipe for the air which entered the system to come out.

Apart from the above illustrated setup, there is a turbine and fan setup at the open end which helps to draw air into the system. Turbine being a vertical axis open sourcing wind turbine, gets rotated even with a week windy action. Since the turbine is coupled with a fan, it enables the fan to rotate and pump air into the system.

IV. WORKING PRINCIPLE

In order to understand the working principle it is very important to understand the below mentioned basic concepts.

1. REFLECTANCE: It is the property of a material to reflect away the visible light emitted by the SUN. If we do so correspondingly the temperature of the material is going to be considerably low. Materials like titanium oxide (TiO_2) and barium sulphate ($BaSO_4$) have high reflectance. Titanium oxide has emittance in the wavelength region of 8to 13 micrometers. And barium sulphate stands for to reflect visible light. Thus this titanium oxide barium suphate coating acts as a super hydrophobic coating which means super cooled.
2. RADIATIVE COOLING: It is the property of a material to lose its temperature (heat) by emitting thermal radiation. In earth atmospheric system it refers to the process by which long wavelength (infrared radiations) is emitted and short wavelength (visible radiations) energy from the sun is absorbed. This obeys newton's law for each and every action there is a equivalent reaction. Studies showed that polyethylene has good radiative properties. Now as we have discussed above all radiative materials emit longer wavelength radiations and absorb shorter wavelength radiations. Since we are planning to coat polyethylene with super hydrophobic coating it enable it to reflect shorter wavelength radiations lying in the radiation spectrum of (8-13micro meter).
3. BLACK BODY PHENOMENON: If the above two properties are combined then it results in the formation of thermal black body (i.e) all thermal radiations entering the system is equal to the radiations exiting the system and without causing any changes to the system.
4. RELATIVE HUMIDITY: Since the process involves the conversion of atmospheric air to water relative humidity of the air plays a major role. It is the measure of water vapour present in the air relative to the temperature of the surrounding.
5. ABSOLUTE HUMIDITY: It is the measure of water content irrespective of the air temperature.

6. DEW POINT TEMPERATURE:

It is the temperature at which water vapour can no longer exist and gets converted in dew. So achieving the dew point temperature by natural means is the prime goal of our project. Now if the above explained properties are clear, then its time to take a look at the design and understand the working.

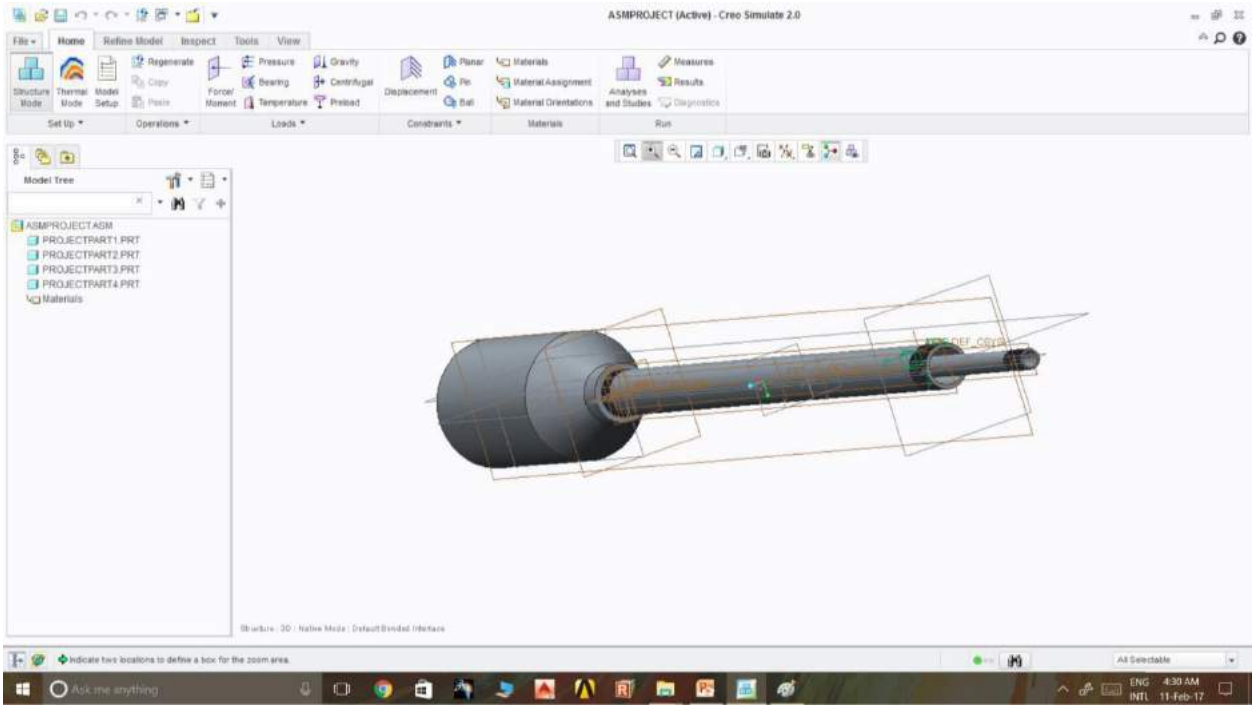

image 1

The above shown image is the detailed design of our project. Air which enters the system though the gap between the larger and smaller pipe and reaches the bottom. Since the other half of the device around 2 meters in buried vertically in the earth, it is normally at lower temperature than the earth above and we have enhanced the properties of the material with the super hydrophobic coating. Thus air which reaches the bottom of the system experiences dew point temperature and gets condensed and dew drops formed along the walls of the storage chamber. Now the air after depositing the water droplet moves out of the system through the small pipe(1&1/2 inch) and escapes into the atmosphere. As the turbine revolves continuously by the action of wind there will be continuous circulation of fresh air into the system.

Now since the temperature of the system is always at lower temperature than the outside atmosphere it is seen that dew is formed even under optimum (i.e) conditions even when the turbine and fan is not rotating.

Now the water which is collected at the bottom can be pumped up with the help of a hose and pump setup and can be used for drinking purpose. Since this process involves the condensation of natural air without use of electricity and chemicals it is the purest form of water ever available on earth.

V. CONSTRUCTION (KEY PARTS OF THE PROJECT)

The following are some of the major parts of the setup.

1. STORAGE TANK: 350mm outer diameter, 330 mm inner diameter and 0.7m height. This is a 30 liter capacity tank closed at one end with a end cap and connected to a 160mm pipe through a 350*160mm reducer.

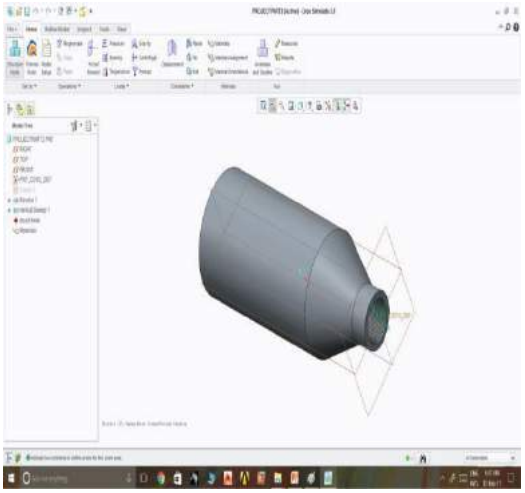

Image 2

2.AIR INLET: 160mm outer diamter, 150mm inner diameter and 3m height. This is the only part of the system through which air enters into the the system and reaches the bottom. One of this pipe is fitted to the bottom chamber and the other has a fan coupled with a turbine.

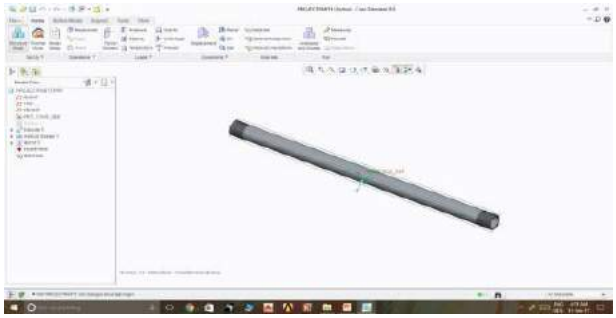

Image 3

3. AIR OUTLET: 40mm outer diameter, 35mm inner diameter and 4m height. This the part of the system through which the air which entered the system leaves after getting a part of it condensed as dew.

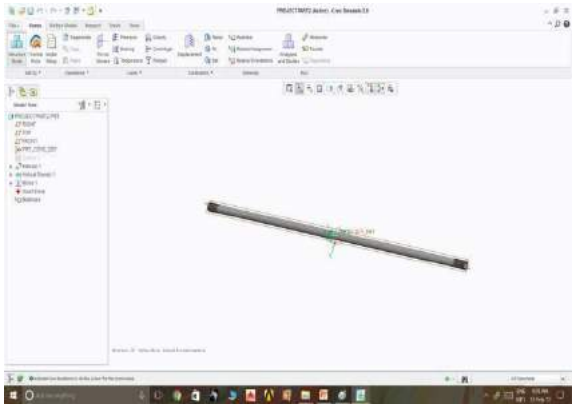

Image 4

4. FAN AND TURBINE: Fan center is 40mm dia and total blade diameter of 320mm diameter. The center of the fan is fitted exactly on the 40mm dia inner pipe (air outlet) so that the blades revolve in the gap between the smaller pipe and the larger pipe. The bearing used is a deep grove ball bearing 6203-2Z 17mm ID, 40mm OD.

Image 5

VI. PROPERTY ENHANCEMENT The following are the salient properties which needs to be achieved for best results and we have achieved it as explained above.

Maximize long wavelength emitting properties of the condensing surface.

Minimise the short wavelength absorption

Lower wind speed

Increase the condensation time

VII.SOURCE OF MOTIVATION:

Design concept of this project was a inspiration from "GIRIJA SHARAN". Her project on reducing global warming by using natural heat exchanger in Kolkata paved way for our project. She burried a 50m pipe horizontally in the earth around 3m deep. One end of the pipe was fitted to a blower and the other end was set free. So air enters the pipe at one end and leaves the pipe at the other end much cooler thus reduces global warming.

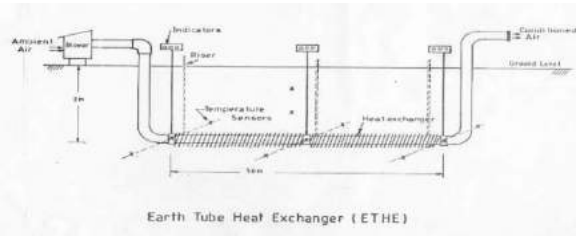

Image 6

Thus we decided to cool the air further more cooler and condense it to obtain water.

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