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Research paper

Production and Purification of Water from Humid Air by using Activated Carbon Method

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Abstract

Drinking Water scarcity is one of the leading issue in our growing world. The atmospheric air contains large amount of water in the form of water vapor, fog, mist etc.In which 30% of water is wasted.Under this situation the climatic conditions of many regions are suitable for generating water. This moisture content is processed by condensation principle to produce fresh water that may be used as distilled water in laboratory and further purification leads to drinking water purity level. Here cooling is produced by Peltier effect and hot air is passed to cooling medium and when it reaches dew point it start condensing water from air. The obtained water from air contain excess of contaminants such as bacteria, nitrate, nitrate, odor, ammonium etc.., these toxic substances are remove by using biofiltration method. In this research filter medium is constructed by extraction of Activated charcoal from coconut waste. . The main aim of our project is utilization of renewable resources that are already available in nature and turn back this energy into water. This project is design a device that can convert humid air directly into clean water.

Keywords: *Activated carbon, biofiltration, condensation, dew point temperature, humidity*

1. Introduction:

Water is the wellspring of every single living life form. The utilization of water from different sources prompts water borne sicknesses. Because of the unadulterated water shortage in numerous locales Bangladesh, Arabic inlet nations prompts the finding the elective technique for new and clean water age give focal points to numerous looks into to chip away at related subjects. [2]
Characteristic air contains substantial measure of water as vapor, dampness. Inside these there are around 30% of H2O is squandered.[3] The squandered type of vapor/Humid is changed over into water that are utilized as a part of family apparatuses and furthermore in research center purposes.In the muggy zone because of absence of precipitation we can get perfect water by gathering the vapor. [12]Be that as it may, the assets of water are constrained. In the previous years there are various things are available in advertise which use this advancement. However, on the prior research and encountering the thing development are to a great degree significant.[1] They are not minimal and since they use a compressor they have overpowering force ask for and are not Eco-obliging. [9]"Water generator water from air utilizing fluid desiccant technique" and others have endeavored to utilize liquid desiccant procedure for dehumidification. Subsequently we picked not to use this technique for dehumidification. In the wake of encountering all the open decisions we would want to use a peltier contraption to make water. [11]

1.1 Barometrical moisture

Barometrical air is a blend of different gases and water vapor. The undetectable water vapor noticeable all around is called dampness. The measure of water that can be contained in a pound of air relies on:- Temperature of the air, weight of the air .[20,14]
The measure of water show, or the level of immersion is assessed as far as Relative-dampness or Saturation Ratio. [22]At the point when air is half immersed, it contains just a large portion of the measure of water that it can contain at a similar temperature and weight. As the relative stickiness approaches 100%, the air can go up against less and less dampness and at 100% relative moistness, that air can't hold more water. In the event that air is soaked with water vapor at a given temperature, a drop in the temperature will prompt buildup of water as beads.[26] The temperature at which dampness gathers out is the dew point temperature.

1.2Cooling and dehumidification process:

The procedure in which the air is cooled sensibly and in the meantime the moisture is expelled from it is called as cooling and dehumidification process. Cooling and dehumidification process is acquired when the air at the given dry knob and dew point (DP) temperature is cooled beneath the dew point temperature.[27]

1.3 Vapor pressure refrigeration frameworks:

Vapor pressure refrigeration frameworks are the most generally utilized among all refrigeration frameworks. As the name infers, these frameworks have a place with the general class of vapor cycles, wherein the working liquid (refrigerant) experiences stage change in any event amid one process. In a vapor pressure refrigeration framework, refrigeration is gotten as the refrigerant dissipates at low temperatures. [8, 10].The contribution to the framework is as mechanical vitality required to run the compressor. Consequently these frameworks are additionally called as mechanical refrigeration frameworks. Vapor pressure refrigeration frameworks are accessible to suit all applications with the refrigeration limits running from couple of Watts to couple of megawatts.[21] A wide assortment of refrigerants can be utilized as a part of these frameworks to suit distinctive applications, limits and so on. The genuine vapor pressure cycle depends on Evans-Perkins cycle, which is likewise called as invert Rankine cycle.[15] Before the genuine cycle is talked about and examined, it is fundamental to locate the furthest reaches of execution of vapor pressure cycles. This utmost is set by a totally reversible cycle.

The consolidated fluid refrigerant, in the thermodynamic state known as a soaked fluid, is next directed through a development valve where it experiences a sudden diminishment in weight. That weight decrease brings about the adiabatic glimmer dissipation of a piece of the fluid refrigerant. The auto-refrigeration impact of the adiabatic blaze dissipation brings down the temperature of the fluid and vapor refrigerant blend to where it is colder than the temperature of the encased space to be refrigerated. [6]

The chilly blend is then directed through the loop or tubes in the evaporator. A fan courses the warm air in the encased space over the curl or tubes conveying the frosty refrigerant fluid and vapor blend. That warm air dissipates the fluid piece of the frosty refrigerant blend. In the meantime, the flowing air is cooled and in this manner brings down the temperature of the encased space to the coveted temperature. [18]The evaporator is the place the flowing refrigerant ingests and evacuates warm which is hence dismissed in the condenser and exchanged somewhere else by the water or air utilized as a part of the condenser. To finish the refrigeration cycle, the refrigerant vapor from the evaporator is again an immersed vapor and is steered once more into the compressor.

1.4. Thermoelectric (te) module:

A Thermoelectric module is likewise called a thermoelectric cooler or Peltier cooler, is a semiconductor-based electronic segment that capacities as a little warmth pump, moving warmth from one side of the gadget to the next. Thermoelectric modules are additionally some of the time used to create power by utilizing a temperature differential between the two sides of the module. Thermoelectric coolers are strong state warm pumps utilized as a part of uses where temperature adjustment, temperature cycling, or cooling underneath surrounding are required[29]. There are numerous items utilizing thermoelectric coolers, including CCD cameras (charge coupled gadget), laser diodes, microchips, blood analyzers and compact cookout coolers. This article talks about the hypothesis behind the thermoelectric cooler, alongside the warm and electrical parameters included.

1.5 Dew point temperature:

The dew point is the temperature at which air is immersed with water vapor, which is the vaporous condition of water. At the point when air has achieved the dew-point temperature at a specific weight, the water vapor noticeable all around is in harmony with fluid water, which means water vapor is gathering at a similar rate at which fluid water is dissipating[5]. Underneath the dew point, fluid water will start to gather on strong surfaces, (for example, pieces of turf) or around strong particles in the environment, (for example, tidy or salt), shaping cloud or mist. Dew point is firmly connected to relative moistness, which is the proportion of the weight of water vapor in a package of air in respect to the immersion weight of water vapor in that same bundle of air at a particular temperature[13]. Relative moistness (RH) is communicated as a rate. [24]The relative mugginess is 100 percent when the dew point and the temperature are the same. In the event that the temperature drops any further, buildup will result, and fluid water will start to frame. Contrasted with relative mugginess, dew point is as often as possible refered to as a more exact method for estimating the stickiness and solace of the air, since it is a flat out estimation (not at all like relative dampness)

2. Materials and techniques

2.1 Materials required:

Thermoelectric cooler TEC 12706, CPU cooler fan DC 12V 0.16 Amp, Heat sink 12V, control supply, Acrylic holder, Digital temperature sensor, Sterile water gathering tank, refinement segment, coconut shell, rock, sand column.

2.2 Techniques:

2.2.1 Outline for water buildup:

The working of our machine is by the high relative dampness with direct temperature air is sucked by a fan which is put at the opposite end of the machine on the section of the air we put peltier module with warmth and frosty sink appended. The peltier modules create cool and hot temperature of the two sides[4]. The frosty side is put inside other on outside. The temperature controller and Multilayer Heat sink is associated with the peltier module in icy side to keep up a dew point temperature inside.

The warmth sink which has fan on its the two sides which is filled in as constrained convection expel of overabundance warmth to keep up at suitable dew guide temperature toward start buildup. These will create water beads at that point delivered water is gathered at base segment of the compartment. The 12V battery is utilized interface every one of the gadgets for control supply. In the event that battery or sunlight based boards can use for control supply for the working of the machine. We gathered the warmth sink, peltier module and the balance in the harsh elements agree with legitimate packaging and introduce on the highest point of our packaging[7]. The posterior is furnished with net sort covering to escape air from bay. The side view where we can see a tube to gather the water from the packaging we kept a jug for water got from the tube. At the point when this gadget is kept inside a similarly damp condition and air is pushed towards the cooler side of TEC gadget, so the water vapor picks up its inactive warmth, required for the dew point temperature and hence water buildup happens; this procedure can be improved if same hot air is gone through the chilly side of TEC, with the goal that water beads doesn't frame ice and age of water happens[17]. It is basic to remember the motivation behind the get together, so the strategy to be utilized is as vital as the choice of the correct gadget.

2.3 Sanitization process

Water sanitization is the way toward evacuating unfortunate chemicals, natural contaminants, suspended solids and gases from water. The objective is to deliver water fit for a particular reason. Most water is sanitized for human utilization (drinking water), yet water cleaning may likewise be intended for an assortment of different purposes, including satisfying the prerequisites of restorative, pharmacological, substance and modern applications.[25] The strategies utilized incorporate physical procedures, for example, filtration,sedimentation,and refining; natural procedures, for example, moderate sand channels or organically dynamic carbon; synthetic procedures, for example, flocculation and chlorination and the utilization of electromagnetic radiation, for example, bright light.

Purging water may diminish the grouping of particulate issue including suspended molecule, parasites, microscopic organisms, green growth, infections, parasites, and also lessening the centralization of a scope of disintegrated and particulate issue.

The gauges for drinking water quality are normally set by governments or by universal guidelines. These principles more often than exclude least and greatest groupings of contaminants, contingent upon the proposed reason for water utilize.

2.4 Initiated carbon filtration:

Granular activated carbon (GAC) is normally utilized for evacuating natural constituents and leftover disinfectants in water supplies. This not just enhances taste and limits wellbeing risks, it secures other water treatment units, for example, turn around osmosis films and particle trade pitches from conceivable harm because of oxidation or natural fouling.

The two vital components by which enacted carbon expels contaminants from water are adsorption and synergist decrease. Organics are evacuated by adsorption and lingering disinfectants are expelled by reactant diminishment. Creation of actuated carbon from coconut shell utilizing concoction initiation process.

Making great quality Coconut charcoal by enhancing the creation procedure .For this an earthenware (mud) pot is utilized to consume the coconut shell. This pot has open base so air can originate from the base while consuming[16]. This makes the consuming procedure simpler and contamination free. The chamber is kept in a plastic tub utilizing three blocks. The base is secured with earthenware (mud) plate so coconut shell won't tumble down. This game plan enables air to enter to the pot from the base while consuming. The coconut shell is scorched in the pot .When the consuming procedure relatively finished, water is poured to the tub so air can't enter to the pot from the base. The highest point of the pot is shut with cover. Presently there is no oxygen supply inside the pot. The consumed coconut shell ought to stay hot for 3 to 4 hours without oxygen/air. Presently Water is poured to cool the charcoal. It is dried to get great quality coconut charcoal. The charcoal created is blended with sodium chloride (table salt).

The quality is enhanced again by including calcium chloride in certain condition with the goal that the iodine esteem is come to past 810. Srip off coconut shells, wash altogether with clean water and enable them to dry totally, at that point include them in the consuming sink (or drum). Measure the temperature and ensure it is changed in accordance with around 600 – 900 F. consume consistently for around 4 ½ hours or until the point when the coconut shells transform into cinder[28]. After the cinder has chilled off, take it out deliberately from the sink and move into a spotless plastic bucket. At that point, pour the 25 percent concentrated arrangement of calcium chloride or zinc chloride into the plastic bucket.

The measure of calcium chloride or zinc chloride arrangement ought to be with the end goal that the fiery remains is doused totally into the arrangement. Cover the bucket with a top and leave for 20 - 24 hours. Amid this procedure, the chemicals are impregnated into the fiery debris and it will change the slag into enacted charcoal[23]. This is called as substance initiation which makes it exceptionally permeable and adsorbent. The following stage is expelling the charcoal from the substance arrangement and moving it into a depleting plate. Enable the treated charcoal to deplete for around 60 minutes. For expulsion of follow chemicals from the charcoal, you can wash and flush it over and again with disinfected water. Intensive washing is basic with a specific end goal to dispose of the concoction arrangement, which generally will stay in the charcoal. Subsequent to washing, keep the charcoal in the plate for depleting water. Following this, move charcoal into a broiler, setting the temperature to around 215 - 230 F and heat for around 3 hours.

In the wake of heating for the stipulated time, expel the charcoal from the stove and smash it with the assistance of a blender. You can likewise pound the charcoal into powder frame by utilizing a sledge. For sometime later, store the powdered charcoal into zipper packs or sealed shut compartments.

2.5 Purging column preparation:

Initiated charcoal carbon channels are best at expelling:

- sediment
- chlorine
- volatile natural mixes (VOCs)
- Taste and scent from water

GAC (granulated dynamic carbon) channels are settled and free bed carbon channels. It contains an external lodging which is generally molded like a chamber and conveys carbon. The proportion for the channel is chosen in view of the speed of water that goes through it, to limit weight drop, particularly in gravity based application.

Pulverize your charcoal into little bits, from powder up to the span of aquarium gravel.Obtain or design a round and hollow compartment (taller is superior to more extensive) with open ends.Fill the litter opening with firmly pressed grass or a bit of texture (if the two closures are a similar breadth pick it is possible that one) to keep the charcoal from dropping out or going through with the water. Or on the other hand on the off chance that you are utilizing a jug that still has its top, jab a little gap in the top before putting your texture or grass.Pack the squashed charcoal into the compartment firmly[19]. The thought here is to make as fine a framework as workable for the water to dribble through gradually, in this manner catching greater dregs. In the event that the water runs as opposed to trickles through the channel, you should pack your charcoal more tightly. You ought to have enough pulverized charcoal to fill your barrel about midway up. It is a smart thought to put a few crawls of stuffed down grass or sand, or another bit of material over the charcoal to keep it from getting to be uprooted when you include your water. Place your channel on a compartment to get your water. Slowly empty the untreated water into your channel, filling the rest of your chamber with water and enabling it to gradually permeate through. Keep in mind, the water should trickle gradually out the base of your filter.After the majority of the water has go through the channel, pour it back through the same number of times as expected to make it clear. It is normally done no less than a few times. Once the coveted clearness has been accomplished, heat water to the point of boiling for a couple of minutes keeping in mind the end goal to ensure it is totally cleaned. Keep in mind, bubbling is the best way to guarantee security from pathogens. Also, that is it. Clear water at your administration!

3. Results:

3.1 Dew point temperature calculation:

To figure the dew point, T dp , given only the genuine ("dry knob") air temperature, T and relative stickiness (in percent), RH, is the Magnus equation:

$$\gamma(T, RH) = \ln\left(\frac{RH}{100}\right) + \frac{bT}{c + T} \quad (1)$$

$$RH = \frac{P_W}{P_s} \times 100 \quad (2)$$

(Where, b = 17.67 & c = 243.5 0 C and T is in 0 C)
Dew point temperature calculations at 30 ^{0} C with different relative humidity

3.2 Different parameters of atmospheric condition for the condensation to occur:

Altitude above sea level (i,e) default atmospheric pressure 101.325 or 1 atm. Then it corresponds to 0m above the sea level.
Parameter values corresponds to room temperature level 25 °C.
Dry Bulb temperature = 25 (°C)
wet bulb temperature = 22.18 (°C)
Relative humidity = 72 %
Dew point temperature = 20.6 (°C)
Enthalpy = 65.01 (k/kg)
Density = 1.17 (kg/m3
Specific volume = 0.868 (m3/kg)
atmospheric pressure = 101325 (pa)
Vapour pressure = 2403 (pa)
Absolute humidity = 17.406080 (g/m3)

Table 1: Conditions

Temperature in (in c)	Relative Humidity in (%)	Required dew point temperature (in c)
30	50	18.46356201
30	60	21.40183613
30	70	23.93889215
30	80	26.17645367
30	90	28.18136311
30	100	30
40	50	27.71659839
40	60	30.84512049
40	70	33.54644632
40	80	35.92888592
40	90	38.06360964
40	100	40

Relative Humidity (RH) is the ratio of partial pressure of water (P w) to that of saturation pressure (P s)

$$P_W = \frac{RH}{100} \times P_s \quad (3)$$

From the above equation ,saturation pressure (Ps) and relative humidity (RH) data partial pressure of water (Pw)
can be obtained as

$$0.622 \times \frac{P_W}{P_a - P_W} \quad (4)$$

By calculating the humidity ratio from the formula ,volume of water (in m 3) present in 1m 3 of air is obtained as follows,

$$T_{dp} = \frac{C\gamma(T, RH)}{b - \gamma(T, RH)} \quad (5)$$

(Where P a is the atmospheric pressure i.e. P a =1.01325 bar)
we know that 1m3 is equal to 1000 liters. Thus multiplying humidity ratio by 1000 gives the maximum amount of water (in liters) that is present in 1m3 of air.

Table 2: Amount of water obtained by processing 1m3 of air at different relative humidity for different temperature conditions.

Sl. No	Temperature in (°C)	Partial pressure of water, Pw (in Pascal)	Saturation pressure, Ps (Pascal)	Relative humidity, RH (%)	Humidity ratio	Amount of water (in Litre)
1	25	0.012668	0.03167	40	0.007874913	7.874912801
2	35	0.022496	0.05624	40	0.014123094	14.12309413
3	25	0.014251	0.03167	45	0.008873332	8.873319633
4	35	0.025308	0.05624	45	0.015933705	15.93370461
5	25	0.015835	0.03167	50	0.009874897	9.874896608
6	35	0.02812	0.05624	50	0.017754652	17.75465167
7	25	0.017418 5	0.03167	55	0.010879659	10.87965886
8	35	0.030932	0.05624	55	0.019586024	19.58602408
9	25	0.019002	0.03167	60	0.011887622	11.8876216
10	35	0.033744	0.05624	60	0.021427912	21.42791162
11	25	0.020585 5	0.03167	65	0.0128988	12.89880015
12	35	0.036556	0.05624	65	0.023280405	23.28040512
13	25	0.022169	0.03167	70	0.013913201	13.91320992
14	35	0.039368	0.05624	70	0.025143596	25.14359645
15	25	0.023752 5	0.03167	75	0.014930866	14.93086642
16	35	0.04218	0.05624	75	0.027017579	27.01757855
17	25	0.025336 0	0.03167	80	0.015951785	15.95178528
18	35	0.044992	0.05624	80	0.028902445	28.90244542
19	25	0.026919 5	0.03167	85	0.016975982	16.97598219
20	35	0.047804	0.05624	85	0.030798292	30.79829219

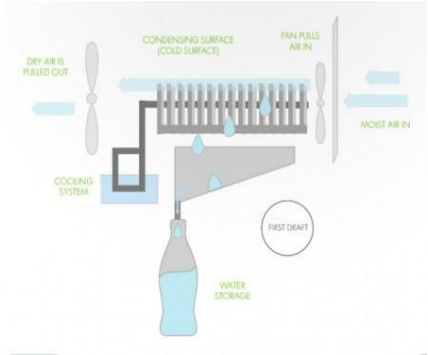

Fig. 2: Display planning for extraction of water from air

Fig. 3: Prepared plan for water production

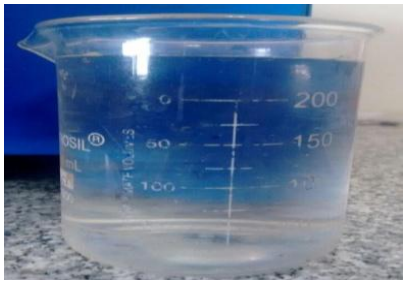

Fig. 4: gathered water from the model

Fig. 5: Hydrophobic surface containing model for water extraction

Activated carbon preparation and results for purification process:

Fig. 6: Coconut shells were collected and dried completely for the preparation of activated carbon.

Fig. 7: Dried shells was burnt under high flame to become crushed carbon.

Fig. 8: Crushed carbon grinded completely to develop into activated carbon.

3.3 Purification Column

Refinement materials are pressed under segment for filtration process .The segment demonstrating the purging of water .Here the segment was stuffed with two layers of pressing material.Packing arrangement:
Gravels
sand
activated carbon
gravels
sand
activated carbon

Fig 10: Purification column

4. Conclusion

Subsequently by creating water in light of this strategy will prompt meet the water needs in our home hold apparatuses and the further change in this procedure will meet the water shortage in dry season territories. In view of our count the stickiness of a locale must stay

over half for appropriate working of the gadget. So we expect that the water yield may increment if the gadget is tried in beach front zones where the moistness is high.In the future the model may join various number of Peltier to build the water output.In request to expand the yield later on, a wiping system might be fused in the gadget in order to build the buildup rate. Since, crisp drinkable is accessible in nature itself as vapour, so we use it in legitimate way bring its incentive for humanity.

5. Discussion

In view of our figuring the stickiness of a district must stay over half for legitimate working of the gadget. So we expect that the water yield may increment if the gadget is tried in beach front territories where the dampness is high.

Until further notice, we have utilized just a single Peltier gadgets in the model. Later on the model may fuse various number of Peltier to expand the water yield.

On watching the different tests from the outline , the cool surface region of the Peltier gadget is less. So we utilized a huge copper surface in contact with the cooling surface of the Peltier gadget as a result of its high conductivity expecting that the chilly surface region will increment in this way expanding the buildup region.

In any case, at long lst in the model when we utilized the copper plate legitimate warm contact between the chilly Peltier surface and the copper plate couldn't be accomplished. This might be the conceivable purpose behind low proficiency.

This use of this innovation may bring about answer for water supply issues by and large without high framework setup cost and time required. It could make extra consumable water without exhausting existing assets. Consequently it causes us to handle the issue of accessibility of unadulterated savoring water remote areas, mining locales and occasions where water scaling is an issue.

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