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DESIGN AND ANALYSIS OF ATMOSPHERIC WATER GENERATION SYSTEM FROM FRESH AIR THROUGH COOLANT HEAT

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Abstract - Water being the most essential element of the planet, ironically available in plenty but available in scarce. Fresh water availability and its demand among people have seen great changes in the graph globally, but always in opposite directions. The Atmospheric Water Generator (AWG) is one of the alternative solution for fresh water recovery from atmosphere which directly condenses the moisture content of water vapour from the air. The aim of this paper is to present the method to develop a prototype setup of an AWG that meets the requirement of increasing demand of water consumption in the society, by making an Atmospheric Water Generator inside a vehicle based on engine's cooling system while considering environment and its conditions. Using waste heat from the engine as source to generate water makes it environment-friendly. Creo parametric 3.0 has been used for designing the prototype & Ansys fluent for the analysis of various conditional changes taking place inside the prototype. Objective behind is to contribute with a little establishment of balance between need and availability of water in society.

Key Words: AWG, dew point, relative humidity.

1. INTRODUCTION

In humid areas with water shortage due to lack of rainfall we can obtain water by condensing the water vapour in air. Our AWG prototype converts atmospheric moisture into drinking water form by condensing the latent heat of water vapour into water droplets. In India there are many places which are situated in temperate region; there are desert, rain forest areas and even flooded areas where atmospheric humidity is eminent. But resources of water are limited. Using an AWG for overcoming water shortage problem is the best solution to this. But using AWG`s have major drawbacks too. Firstly, their limit to area i.e. most of the AWG`s are immobile or stationary which needs to be installed at a place with favourable humid conditions. Secondly, it requires enormous power requirement to maintain the temperature inside the device up to the dew point temperature. To overcome this problems we need a device which have great environment adaptability and is mobile, and secondly consumes minimum power and give higher output. Our AWG focuses on to develop a device which fulfils all these requirements. It is based on an AWG that is placed inside the engine compartment of a vehicle which makes it mobile with respect to the surroundings and works on the principle of water generation from atmospheric air using engine`s coolant heat. Which turns the waste heat which gets dissipated into the atmosphere through radiator; productive and useful.

2. METHODOLOGICAL APPROACH

Our AWG's area of implementation is on cooling system of engine, inside engine's compartment of a four wheeler vehicle. There might be a question arising that what's the need of implementing AWG concept in cooling system of engine inside a vehicle. For understanding that we need to first know about the cooling system of an automobile engine. The most prevailing type of cooling system found in four wheeler vehicles and which is of our interest is Forced Circulation Water Cooling System. This system is similar in construction to the Thermo-syphon system except that it makes use of a Centrifugal pump to circulate the water throughout the water jackets and radiator. The water flows from the lower portion of the radiator to the water jacket of the engine through the centrifugal pump. After the circulation water comes back to the radiator, it loses its heat by the process of radiation. This system is employed in cars, trucks, tractors, etc.

Modern AWGs which works on condensation principle uses various equipment like condenser, compressor and other usages to create required condensing environment for producing water [5]. And as we know there is a phase of coolant flow where when the temperature of engine rise above the optimum temperature or we can say the temperature of coolant rises above the optimum temperature by absorbing engine`s heat ; it passes from the thermostat valve to the radiator through hose pipe and the heat gets dissipated. The idea behind our AWG is to use the hot coolant's heat before its dissipation in raising the ambient air temperature & simultaneously use the cool coolant to bring down the heated air's temperature to its new dew point temperature. This results in formation of liquid droplets, & the liquid droplets are collected in the reservoir through a filter. This eliminates the use of condenser, compressor or any other attachment for producing the water and utilizes the waste heat. Now the question arises that why we are heating the ambient air instead of cooling it. The reason lies in the basic understanding of humidity and dew point temperature. According to the research & calculations it has been observed that if we increase the temperature of air assuming the relative humidity constant, we observed that its dew point temperature rises. For example if the temperature of air is around 30°C with 45% relative humidity, this gives out its dew point temperature to be 16.8°C. Now if we heat that air and bring its temperature up to 40°C assuming that its relative humidity remains constant, now its dew point rises up to temperature of 25.9°C.

This shows that now if we want to turn the vapours present inside air into water droplets we do not need to cool it down to 16.8°C we just need to cool it down up to 25.9°C to get desired results. It is simply the conversion of the fact that instead of cooling it we applied same amount of energy in heating it to obtain the same results. But this phenomenon helps us since we do not have to perform any extra work to heat the air because we use the waste heat generated by engine which was after all get dissipated into the atmosphere through radiator.

Area of implementation of our prototype is the hose pipe connecting the thermostat and radiator cap.

While cooling down the engine to its optimum level for working, the coolant absorbs the cylinder heat and itself gets heated. As the thermostat valve opens the hot coolant flows from hose pipe to the radiator cap, after which it flows to radiator and heat gets dissipated into the atmosphere. Since the hose pipe is made up of hard rubber, which makes it a heat insulator, so we need to replace it by a good heat conductor pipe such as aluminium of same dimensions so that it can transfer heat from hot coolant to the incoming ambient air. The hot air rising being low in density rises up quickly and pass through a semi-permeable membrane. The Function of this membrane is to allow only water vapours to pass through it & blocks other particles like water. As the water vapours comes in contact with the wall they start to cool down & dew point temp. is achieved. Now the water droplets fall down due to gravity and gets collected in the reservoir after passing through filters to make it potable.

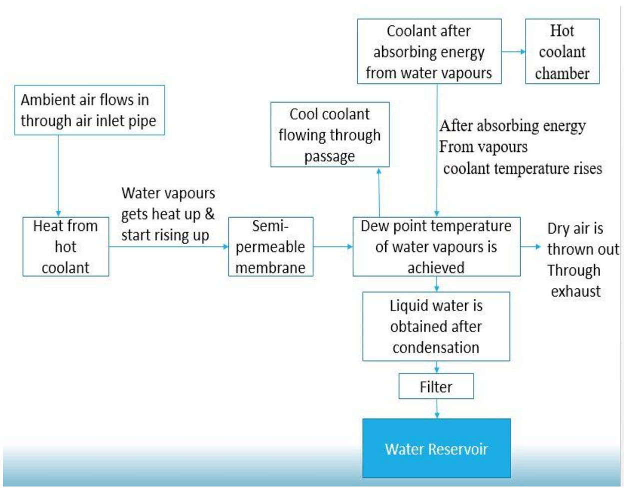
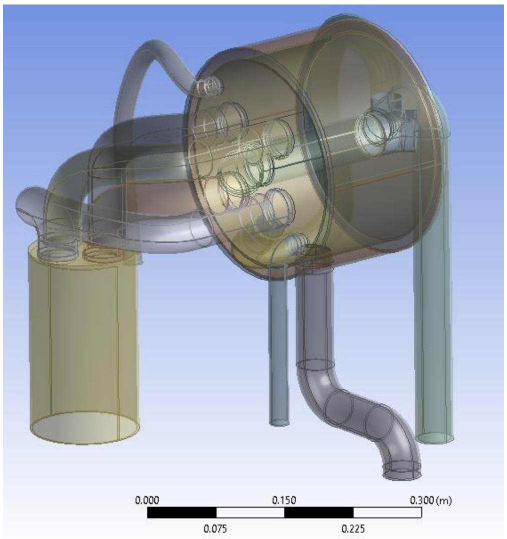


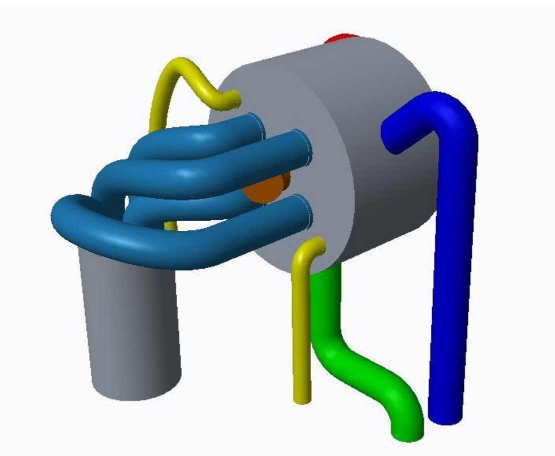
Figure 01: Block Diagram of Working Procedure of Device

2.1. DESIGN APPROACH

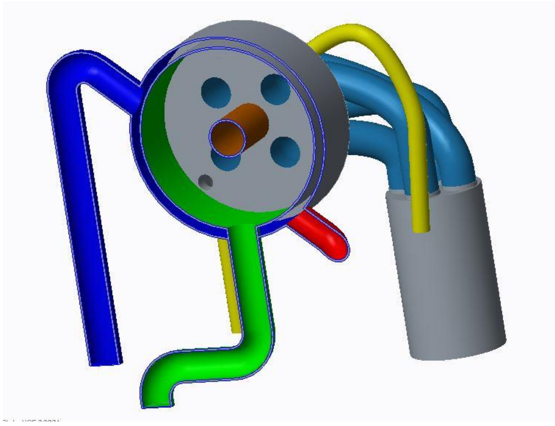
A number of CAD models of AWG were built on CREO PARAMETRIC 3.0, rebuild or refined through the simulation to get the appropriate model. The model shown in this paper is the best model selected for building the prototype and doing the experiments.



(a)Transparent View of Device



(b)Perspective view of Device



(c)Section view of Device

Figure 02: Design

Note: ◆Inlet pipes for ambient air
◆Exhaust pipes for dry air
◆Inlet for Cool coolant
◆Exhaust for Hot coolant
◆Hot coolant hose pipe
◆Water collector pipe

2.2. CALCULATION AND ANALYSIS

2.2.1. Dew point temperature calculations

The dew point is the saturation temperature for water in air. The dew point is associated with relative humidity. A high relative humidity implies that the dew point is closer to the current air temperature. Relative humidity of 100% indicates the dew point is equal to the current temperature and that the air is maximally saturated with water. When the moisture content remains constant and temperature increases, relative humidity decreases.

This calculation forms an important part of this paper as this helps us to determine at temperature our device must be maintained in order to condense the humidity present in air at the given atmospheric condition.

A well-known approximation used to calculate the dew point, T_{dp}, given just the actual ("dry bulb") air temperature, *T* and relative humidity (in percent), *RH*, is the ***Magnus formula***[1]:

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

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

(Where, b = 17.67 & c = 243.50 °C and T is in °C)
The above formulas is used to calculate the dew point temperature for different atmospheric conditions at which the device may be subjected to operate. With the help of Microsoft excel the operating parameters are calculated and tabulated.

Sample Calculations:
(for DBT=35°C and RH=45%)

$$\gamma(35,45) = ln(\frac{45}{100}) + \frac{17.67 \times 35}{243.5 + 35}$$

$$= 1.4221$$

$$T_{dp} = \frac{243.5 \times 1.4221}{17.67 - 1.4221} = 21.31°C$$

The table for the dew point temperature calculation for different atmospheric conditions is as follows:

Table-01: Dew point temperature calculations at 25°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
25	45	12.2557778
25	50	13.86761705
25	55	15.34330528
25	60	16.7053573
25	65	17.97104364
25	70	19.15391329
25	75	20.2647991
25	80	21.31250362
25	85	22.30428051
25	90	23.24618059
25	95	24.14330594
25	100	25

Table-02: Dew point temperature calculations at 30°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
30	45	16.78839075
30	50	18.45805415
30	55	19.98700927
30	60	21.39850393
30	65	22.71037374
30	70	23.9366131
30	75	25.08841249
30	80	26.17486623
30	85	27.20346931
30	90	28.18047457
30	95	29.111155
30	100	30

Table-03: Dew point temperature calculations at 35°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
35	45	21.31300525
35	50	23.04141369
35	55	24.62450138
35	60	26.08625702
35	65	27.44508752
35	70	28.71543768
35	75	29.90885968
35	80	31.03474302
35	85	32.10082685
35	90	33.11356845
35	95	34.07841379
35	100	35

Table-04: Dew point temperature calculations at 80°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
80	45	61.67807084
80	50	63.97584158
80	55	66.0844401
80	60	68.03485178
80	65	69.85088514
80	70	71.55124774
80	75	73.15091871
80	80	74.66208644
80	85	76.09480758
80	90	77.45748127
80	95	78.75719787
80	100	80

Table-05: Dew point temperature calculations at 85°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
85	45	66.12385197
85	50	68.48931685
85	55	70.66049304
85	60	72.66917706
85	65	74.53980434
85	70	76.29157768
85	75	77.93987472
85	80	79.49720961
85	85	80.97390895
85	90	82.37859824
85	95	83.71855969
85	100	85

Table-06: Dew point temperature calculations at 90°C and different relative humidity conditions

Dry bulb temperature (in °C)	Relative humidity (%)	Required Dew point temperature (in °C)
90	45	70.56186328
90	50	72.99589174
90	55	75.2304693
90	60	77.29820985
90	65	79.22418066
90	70	81.02808376
90	75	82.7256986
90	80	84.32986783
90	85	85.85119031
90	90	87.29851993
90	95	88.6793324
90	100	90

2.2.2. Amount of water (in L) present in 1m^3 of air for different humidity and temperature conditions

Saturation Pressure (P_s) is the pressure of a vapour which is in equilibrium with its liquid (as steam with water) i.e. the maximum pressure possible by water vapour at a given temperature. The saturation pressure of water at different atmospheric temperature is obtained from the commercially available steam tables.

Air is a mixture of both air molecules and water molecules. **Partial Pressure of water (P_w)** is the pressure of water vapour present in a mixture of air and water vapour

Relative Humidity (RH) is the ratio of partial pressure of water (P_w) to that of saturation pressure (P_s) i.e.

$$RH = \frac{P_w}{P_s} \text{ x } 100$$

Humidity Ratio gives the volume of water (in m^3) present in 1m^3 of air. Humidity ratio can also be expressed in terms of partial pressure of water (P_w) as

$$\text{Humidity Ratio} = .622 \text{ x } \frac{P_w}{P_a - P_w}$$

(Where P_a is the atmospheric pressure i.e. P_a=1.01325 bar)

Humidity ratio gives the amount of water (in m^3) present in 1m^3 of air. Also we know that 1m^3 is equal to 1000 litres. Thus multiplying humidity ratio by 1000 gives the maximum amount of water (in litres) that is present in 1m^3 of air.

Sample Calculations: (For atmospheric temperature 30°C and relative humidity 50%)

Saturation Pressure of water vapour (P_w) at 30°C is obtained from steam table as 0.04246 bar.

Thus Partial pressure of water, P_w

$$= \frac{RH}{100} \times P_s = \frac{50}{100} \times 0.04246 = 0.02123 \text{ bar}$$

$$\text{Humidity Ratio} = 0.622 \times \frac{P_w}{P_a - P_w}$$

$$= \frac{0.02123}{1.01325 - .02123} = 0.01331129$$

Therefore amount of water (in litres) present in 1m^3 of atmospheric air

= Humidity ratio×1000
= 0.0133129×1000 = **13.3129 litres**

The amount of water present in 1m^3 of air consisting of the above mentioned calculations for different atmospheric conditions are tabulated below:

Table-07: Amount of water which can be obtained by processing 1m^3 of air at 25°C for various relative humidity

Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
25	45	0.0142605	0.008879003	8.8790032
25	50	0.015845	0.009881232	9.8812318
25	55	0.0174295	0.01088665	10.88665
25	60	0.019014	0.011895272	11.895272
25	65	0.0205985	0.012907115	12.907115
25	70	0.022183	0.013922193	13.922193
25	75	0.0237675	0.014940522	14.940522
25	80	0.025352	0.015962118	15.962118
25	85	0.0269365	0.016986996	16.986996
25	90	0.028521	0.018015172	18.015172
25	95	0.0301055	0.019046662	19.046662
25	100	0.03169	0.020081483	20.081483

Table-08: Amount of water which can be obtained by processing 1m^3 of air at 30°C for various relative humidity

Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
30	45	0.019107	0.011954572	11.9545719
30	50	0.02123	0.013311284	13.311284
30	55	0.023353	0.014673816	14.6738156
30	60	0.025476	0.016042204	16.042204
30	65	0.027599	0.017416487	17.4164872
30	70	0.029722	0.018796703	18.7967033
30	75	0.031845	0.020182891	20.1828909
30	80	0.033968	0.021575089	21.5750887
30	85	0.036091	0.022973336	22.973336
30	90	0.038214	0.024377672	24.3776722
30	95	0.040337	0.025788137	25.7881373
30	100	0.04246	0.027204771	27.2047714

Table-09: Amount of water which can be obtained by processing 1m^3 of air at 35°C for various relative humidity

Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
35	45	0.25326	0.207276043	207.27604
35	50	0.2814	0.239162123	239.16212
35	55	0.30954	0.273598329	273.59833
35	60	0.33768	0.310903326	310.90333
35	65	0.36582	0.351451184	351.45118
35	70	0.39396	0.395683961	395.68396
35	75	0.4221	0.444127886	444.12789
35	80	0.45024	0.497414398	497.4144
35	85	0.47838	0.556307813	556.30781
35	90	0.50652	0.62174223	621.74223
35	95	0.53466	0.694871435	694.87143
35	100	0.5628	0.777137529	777.13753

Table-10: Amount of water which can be obtained by processing 1m^3 of air at 80°C for various relative humidity

Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
80	45	0.213255	0.165806799	165.806799
80	50	0.23695	0.189853021	189.853021
80	55	0.260645	0.215413384	215.413384
80	60	0.28434	0.242635552	242.635552
80	65	0.308035	0.271687032	271.687032
80	70	0.33173	0.302758628	302.758628
80	75	0.355425	0.336068635	336.068635
80	80	0.37912	0.371867977	371.867977
80	85	0.402815	0.410446534	410.446534
80	90	0.42651	0.452141016	452.141016
80	95	0.450205	0.497344813	497.344813
80	100	0.4739	0.546520441	546.520441

Table-11: Amount of water which can be obtained by processing 1m^3 of air at 85°C for various relative humidity

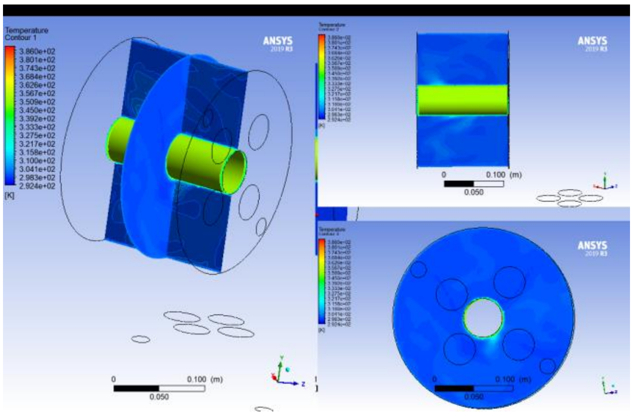
Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
85	45	0.260235	0.214957431	214.957431
85	50	0.28915	0.248379091	248.379091
85	55	0.318065	0.284580982	284.580982
85	60	0.34698	0.323925075	323.925075
85	65	0.375895	0.36683903	366.83903
85	70	0.40481	0.413831799	413.831799
85	75	0.433725	0.465513912	465.513912
85	80	0.46264	0.522624144	522.624144
85	85	0.491555	0.586065057	586.065057
85	90	0.52047	0.656951053	656.951053
85	95	0.549385	0.736674399	736.674399
85	100	0.5783	0.826997586	826.997586

Table-12: Amount of water which can be obtained by processing 1m^3 of air at 90°C for various relative humidity

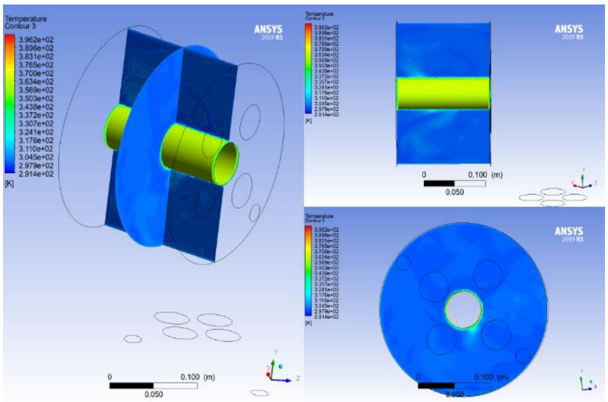
Dry bulb temperature (in °C)	Relative humidity (%)	Partial pressure of water-Pw(in bar)	Humidity ratio(amount of water in 1m^3 of air)	Amount of water in L
90	45	0.31563	0.281416616	281.41662
90	50	0.3507	0.329236133	329.23613
90	55	0.38577	0.382400937	382.40094
90	60	0.42084	0.441860333	441.86033
90	65	0.45591	0.508802562	508.80256
90	70	0.49098	0.584735022	584.73502
90	75	0.52605	0.671599138	671.59914
90	80	0.56112	0.77193869	771.93869
90	85	0.59619	0.889153072	889.15307
90	90	0.63126	1.027890049	1027.89
90	95	0.66633	1.194676755	1194.6768
90	100	0.7014	1.398976431	1398.9764

After the solution is converged the temperature and velocity profiles for various inlet and temperature conditions are plotted. The profiles are plotted for the mid plane and also for the total body. The results are displayed below:

I. At inlet velocity 30kmph(8.33m/s) and inlet temperature 25°C



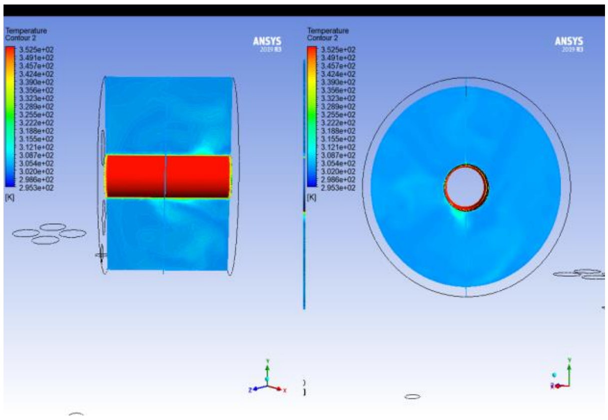
(a). inner wall temperature (coolant temperature) is 80°C



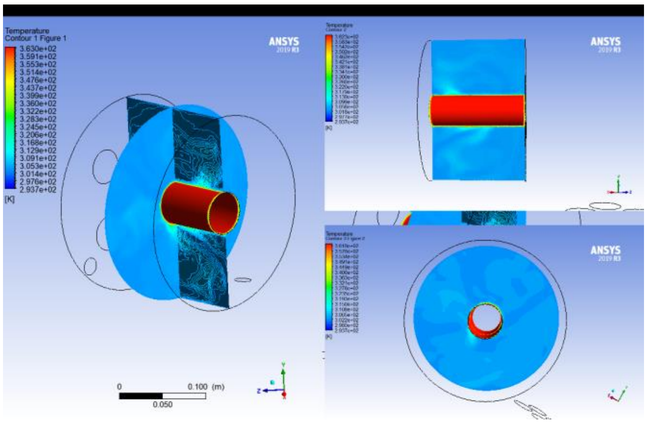
(b). inner wall temperature (coolant temperature) is 90°C

Figure 03

II. At inlet velocity 30kmph(8.33m/s) and inlet temperature 30°C



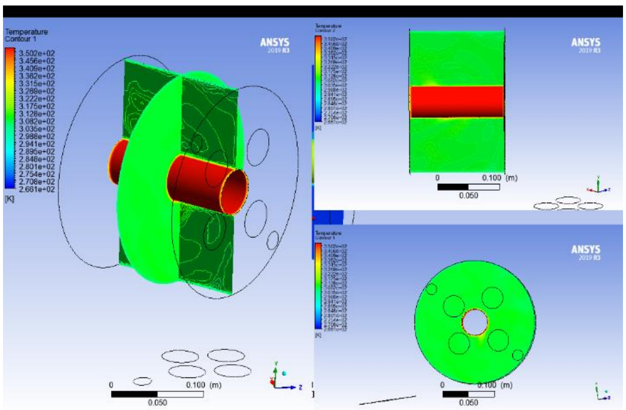
(a). inner wall temperature (coolant temperature) is 80°C



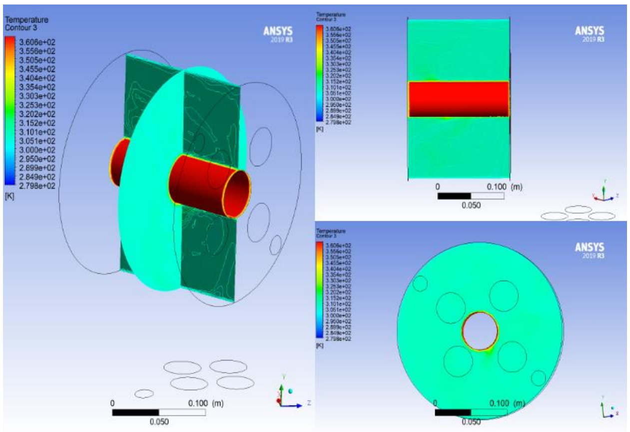
(b). inner wall temperature (coolant temperature) is 90°C

Figure 04

III. At inlet velocity 30kmph(8.33m/s) and inlet temperature 35°C



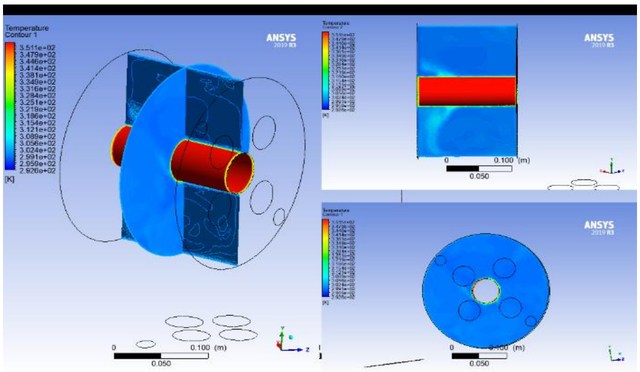
(a). inner wall temperature (coolant temperature) is 80°C



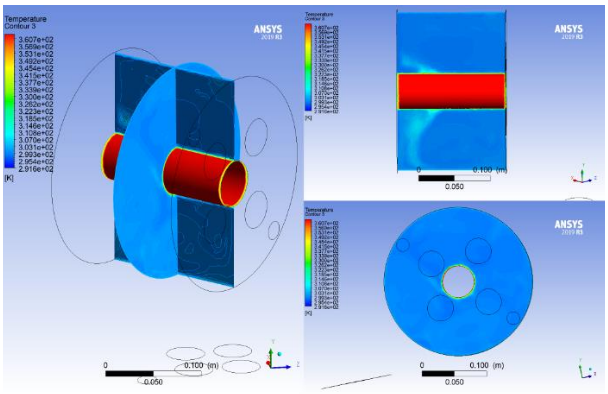
(b). inner wall temperature (coolant temperature) is 90°C

Figure 05

IV. At inlet velocity 40kmph(11.11/s) and inlet temperature 25°C



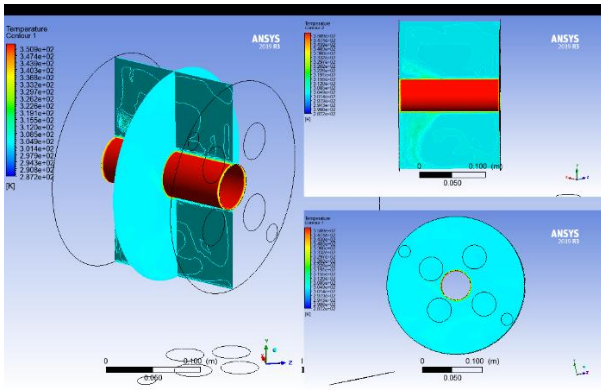
(a). inner wall temperature (coolant temperature) is 80°C



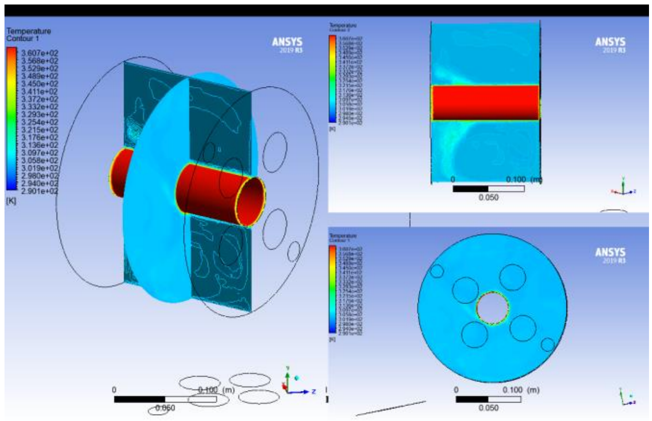
(b). inner wall temperature (coolant temperature) is 90°C

Figure 06

V. At inlet velocity 40kmph(11.11/s) and inlet temperature 30°C



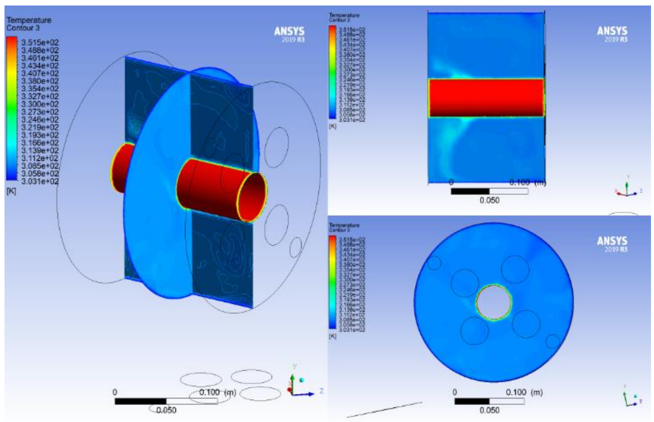
(a). inner wall temperature (coolant temperature) is 80°C



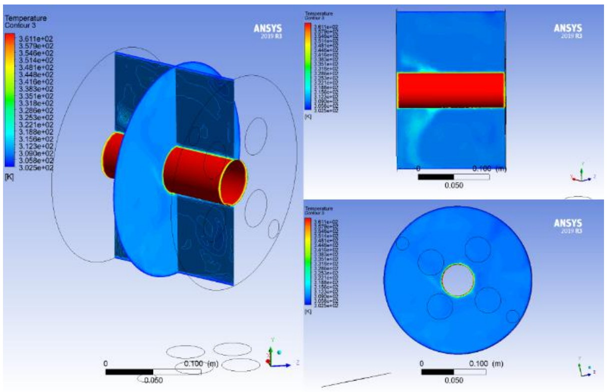
(b). inner wall temperature (coolant temperature) is 90°C

Figure 07

VI. At inlet velocity 40kmph(11.11/s) and inlet temperature 35°C



(a). inner wall temperature (coolant temperature) is 80°C



(b). inner wall temperature (coolant temperature) is 90°C

Figure 08

2.3. RESULTS

After carrying out various calculations the results obtained are tallied and analysed. Earlier we had calculated the dew point temperatures required for different atmospheric conditions. Tables 1, 2, 3, 4, 5 and 6 shows the results obtained. Then we calculated the least temperatures that can be obtained from our device by specifying the boundary conditions in FLUENT workbench. The results of the analysis are shown in figures 22, 23,24,25,26 and 27. Both these results are then tallied. The conclusions are:

- Velocity of air at inlet = 30 Kmph
  Temperature of ambient air at inlet = 25 °C
  Coolant temperature = 80 °C

  Min. temp. = 292.4k (19.25 °C)
  Max. temp. = 389k (115 °C)

The temperature of device falls down upto **19.25 °C** and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 30 Kmph
  Temperature of ambient air at inlet = 25 °C
  Coolant temperature = 90 °C

  Max. temp. = 396k (122.85 °C)
  Min. temp. = 291.4k (17.85 °C)

The temperature of device falls down upto **17.85 °C** and if we see the dew point temperatures of air at 90 °C in Table 06, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 30 Kmph
  Temperature of ambient air at inlet = 30 °C
  Coolant temperature = 80 °C

  Max. temp.= 353k (79.85°C)
  Min. temp.= 295k (21.85 °C)

The temperature of device falls down upto **21.85** °C and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 30 Kmph Temperature of ambient air at inlet = 30 °C Coolant temperature = 90 °C

  Max. temp. = 363k (89.85 °C)
  Min. temp. = 294k (20.85 °C)

The temperature of device falls down upto **20.85** °C and if we see the dew point temperatures of air at 90 °C in table 06, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 30 Kmph
  Temperature of ambient air at inlet = 35 °C
  Coolant temperature = 80 °C

  Max. temp. = 353.15k (79.85 °C)
  Min. temp. = 266.098k (-7 °C)

The temperature of device falls down upto **-7 °C** and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 30 Kmph
  Temperature of ambient air at inlet = 35 °C
  Coolant temperature = 90 °C

  Max. temp. = 363k (89.85 °C)
  Min. temp. = 280k (6.85 °C)

The temperature of device falls down upto **6.85°C** and if we see the dew point temperatures of air at 90 °C in Table 06, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph
  Temperature of ambient air at inlet = 25 °C
  Coolant temperature = 80 °C

  Max. temp. = 351k (77.85°C)
  Min. temp. = 293k (19.25 °C)

The temperature of device falls down upto **19.25 °C** and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph Temperature of ambient air at inlet = 25 °C Coolant temperature = 90 °C

  Max. temp. = 360.7k (87.55 °C)
  Min. temp. = 291.6k (18.45 °C)

The temperature of device falls down upto **18.45 °C** and if we see the dew point temperatures of air at 90 °C in Table 06, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph
  Temperature of ambient air at inlet = 30 °C Coolant temperature = 80 °C

  Max. temp. = 351k (77.85 °C)
  Min. temp. = 287k (13.85 °C)

The temperature of device falls down upto **13.85°C** and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph
  Temperature of ambient air at inlet = 30 °C Coolant temperature = 90 °C

  Max. temp.= 360.7k (87.55 °C)
  Min. temp.= 290k (16.85 °C)

The temperature of device falls down upto **16.85°C** and if we see the dew point temperatures of air at 90 °C in Table 06, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph
  Temperature of ambient air at inlet = 35 °C Coolant temperature = 80 °C

  Max. temp. = 351k (77.85°C)
  Min. temp. = 303k (29.85 °C)

The temperature of device falls down upto **29.85°C** and if we see the dew point temperatures of air at 80 °C in Table 04, we can see that the device works better at **35 %** and above relative humidity.

- Velocity of air at inlet = 40 Kmph Temperature of ambient air at inlet = 35 °C Coolant temperature = 90 °C

  Max. temp. = 361.1k (87.95 °C)
  Min. temp. = 302.5k (29.35 °C)

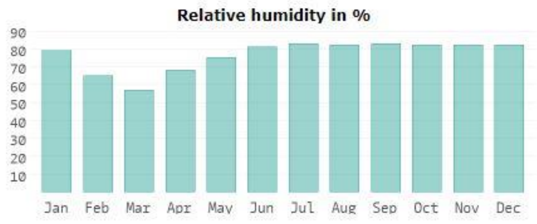
The temperature of device falls down upto **29.35°C** and if we see the dew point temperatures of air at 90 °C in Table 06, we can see that the device works better at **35 %** and above relative humidity.

3. CONCLUSIONS

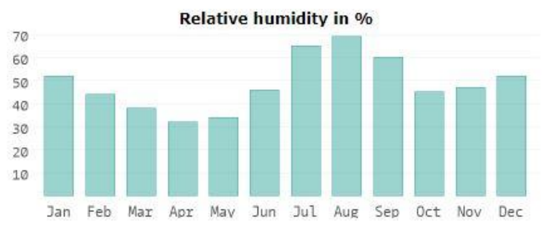
From this we can conclude that the prototype suits better in areas with relative humidity greater than 35%. The data does not deny the feasibility of our AWG in areas below 35% relative humidity, but on the analysis of the climatic data of various states in India, a note can be made that probability of relative humidity of a place going below 35% is questionable. Our AWG will be good for the regions with moderate relative humidity but will be greatly applicable in deserts, coastal regions and rainforests areas.

Climatic data of five major States were recorded which reportedly have experienced range of fixed climate throughout the year, like **Meghalaya**(eastern state; experiences excess rainfall throughout the year), **Rajasthan**(western state, experience shortage of rainfall throughout the year), **Maharashtra**(coastal state, experiences variable rainfall throughout the year), **Madhya Pradesh** (Center state, Experiences moderate rainfall throughout the year), **Delhi**(Northern state, experiences moderate rainfall throughout the year); and it can be clearly observed that the average relative humidity is greater than 35%.

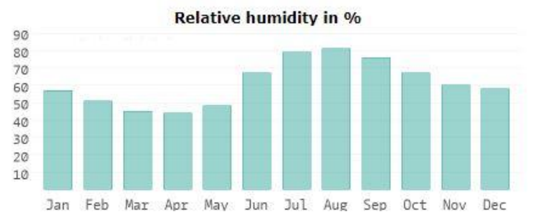
All data correspond to the average monthly values of the last 20 years.[7]



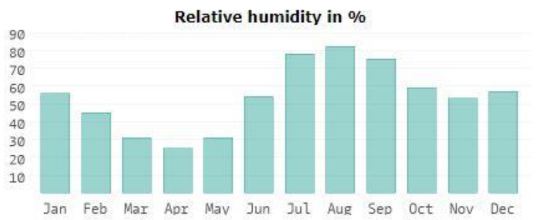
(a) Meghalaya



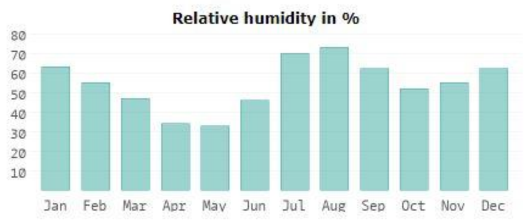
(b) Rajasthan



(c) Maharashtra



(d) Madhya Pradesh



(e) Delhi

Figure 09

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