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Harnessing Energy from thin air "Hygroelectricity"

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Abstract: This paper reports an attempt to explore one of the most astounding source to generate electricity. Power crisis is the talk of the world today. As the need for renewable energy is now at its peak, it seems that harnessing the power of the Sun, wind, waves, and atoms is no longer enough. We now feel the need to pull electricity out of nothing but thin air or humid air, to be more accurate. Harnessing electricity out of air could be "best thing since sliced breads" towards the journey of renewable power generation. Our personal view on this matter is that nature offers us options in plenty and why not to utilize them directly.one such option is hydroelectricity, somewhat similar to sky lightening.

Key Words: Hygroelectric Charge, Humidity Electricity, Lightening.

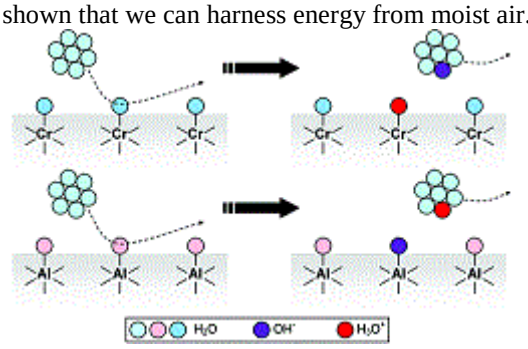
I. INTRODUCTION

It took over 100 years for technology and innovation to create our cellphones we use, every day. It was Nikola Tesla who saw wireless technologies through the use of ether or argon. Unfortunately, he also saw the use of abundant energy. The new term is hygro-electricity. Hygroelectricity is a type of static electricity that forms on water droplets and can be transferred from droplets to small dust particles. The phenomenon is common in the earth's atmosphere but has also been observed in the steam escaping from boilers. It was the basis for a proposal by Nikola Tesla to tap electricity from the air, an idea which has been recently revived. Hygroelectric charge is the likely source of the electric charge which, under certain conditions such as exist in thunderstorms, volcanic eruptions and some dust storms, gives rise to lightning.

It has been dubbed "Hygroelectricity", short for "humidity electricity", which basically means pulling electric charges that are naturally formed in humid air; scientists are already in the early stages of developing devices to harness it. As fascinating as it may seem, it is not really the novelist of ideas. In fact, scientists have been fascinated with the notion of harnessing thunderstorms and other naturally formed electricity for centuries.

Aside from lightening, they also noticed that sparks of static electricity formed as steam escaped from boilers; workers who touched the steam even got painful electrical shocks.

Nicola Tesla, the electricity genius himself, has experimented extensively with this topic. He was certain that the interaction between air and water in the atmosphere generated an electrical charge, and he dreamed of capturing and using that charge. However, up until recently, our understanding of the field of atmospheric thermodynamics was still rather elusive, and the idea of harnessing electricity out of air was deemed as one of those "pie in the sky" ideas. But now the resent studies have shown that we can harness energy from moist air.



II. HISTORY

Atmospheric electricity has been studied since 1750, In July 1750, Franklin hypothesized that electricity could be taken from clouds via a tall metal aerial with a sharp point. But Before Franklin could do in 1752 Thomas-François Dalibard erected a 40-foot (12 m) iron rod at Marly-la-Ville, near Paris, drawing sparks from a passing cloud. In June 1752, Franklin reportedly performed his famous kite experiment.

Later Nikola Tesla and Hermann Plauson investigated the production of energy and power via atmospheric electricity .Tesla also proposed to use the atmospheric electrical circuit to transceive wireless energy over large distances. In 1905, a team of construction workers by nikola tesla in the small village of Shoreham, New York labored to erect a truly extraordinary structure. Nikola Tesla experimented extensively with the topic.

III. CURRENT SCENERIO

Lightning is approximately 54,000 degrees Fahrenheit. That is six times hotter than the surface of the sun.Just

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think if we could utilize this lightening to generate power. At any given moment, there are about 1,200 thunderstorms occurring all over the Earth, and it's estimated that each second, there are about 100 lightning flashes somewhere over our planet. A typical lightning bolt contains about 15 million volts of electricity and instantly heats up the air around it to over 60,000 degrees, with some reaching more than100,000 degrees. That's why the total energy of a strong thunderstorm can exceed the energy released during an atomic explosion.

"A single bolt of lightning contains 5 billion joules of energy, enough to power a household for a month. The energy of a thunderstorm equals that of an atom bomb. If we're already generating power from unexpected sources like ocean currents in our quest to wean ourselves of polluting- and limited- fossil fuels, why not pull electricity from the air, especially when everyone can see it lightening in the sky.

In 2007, a company called Alternative Energy Holdings tried to make it happen, with a design that involved a tower, grounding wires and a capacitor. The design for the system had been purchased from an Illinois inventor named.

Steve LeRoy, who had reportedly been able to power a 60-watt light bulb for 20 minutes using the energy captured from asmall flash of artificial lightning. The method involved a tower, a means of shunting off a large portion of the incomingenergy, and a capacitor to store the rest.

According to Martin A. Uman, co-director of the Lightning Research Laboratory at the University of Florida and aleading authority on lightning, a single lightning strike, while fast and bright, contains very little energy, and dozens oflightning towers like those used in the system tested by AEHI would be needed to operate five 100-watt light bulbs for thecourse of a year. When interviewed by The New York Times, he stated that the energy in a thunderstorm is comparable tothat of an atomic bomb, but trying to harvest the energy of lightning from the ground is "hopeless.

IV. PROBLEMS ENCOUNTERED WHILE CAPTURING LIGHTENING ENERGY

(a) It delivers extremely high power, which makes capturing the energy problematic.
(b) When lightning strikes earth , much of the energy arrivesnot as electricity but as heat. This cannot be harvesteddirectly as electricity and could also damage equipment.
(c) The time available for the lightning strike and its storageis 0.2 msec, which makes it even difficult to capture.

Considering these problems just think if we have any such method so that we can trap this power before it converts into lightening and strikes , hygroelectricity gives a solution to this approach.

V. RECENT STUDIES

Electroneutrality principle statement

Water droplets in the atmosphere were electrically neutral, and remained so even after coming into contact with the electrical charges on dust particles and droplets of other liquids.

Now,recent researches shows ion imbalances.water has ion imbalances that could allow it to produce a charge. The principle of electroneutrality states that if you consider the liquid as a whole that the net charge within the liquid will be neutral . The principle does not state that if you subdivide a liquid and only consider a portion of its volume that the charge in that portion has to be neutral.

Scientists once believed that water droplets in the atmosphere were electrically neutral and remained so even after coming into contact with the electrical charges on dust particles and droplets of other liquids. But new evidence suggests that water in the atmosphere picks up an electrical charge. It may also help explain a 200-year-old scientific riddle about how electricity is produced and discharged in the atmosphere.

VI. FERNANDO GALEMBECK'S STUDY ON CHARGING OF METALS BY HUMIDAIR

What is the possibility for electricity generation using air in our planet's atmosphere?

Fernando Galembeck, of the University of Campinas in Brazil, presented a report at the 240th National Meeting of theAmerican Chemical Society that detailed a future where every house has a device on its roof that pulls cheap, clean electricity out of the air. "Just as solar energy could free some households from paying electric bills, this promising new energy source could have a similar effect".

Originally, scientists believed that water droplets in the atmosphere were electrically neutral, and remained that way even after brushing up against charges on dust particles and other liquids. However, Galembeck discovered in a series of lab experiments that water droplets do in fact pick up a charge. Research unveiled at,has defined the mechanism by which water vapor in the air become charged, a discovery which could lead to devices capable of creating electricity from the atmosphere's own charges.

What they found, and then proved in the lab, is that in fact water in the atmosphere does pick up a slight charge. Aluminum phosphate and silica are two particles found commonly in the atmosphere. By using small particles of them, researchers showed that in the presence of water vapor silica particles become more negatively charged. Aluminum phosphate grows slightly more positively charged. This building of charges in humid air can accumulate and be transferred to other objects, explaining phenomena like the charge buildup where steam escapes from boilers that had baffled scientists for centuries.

Galembeck and company call the quality "hygroelectricity," meaning "humid electricity."

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The property could lead to generators that pull charge right out of humid air to power buildings, as well as to panels that prevent lightning from striking in certain areas.

In an interview, Galembeck said the battery composed of alternating layers of paper-like cellulose fibers and thin sheets of metal similar to aluminum foil developed a top charge of 0.8 volts. That is roughly half the 1.5 volt charge of a typical AA-type battery.

In his lab, a charge formed at humidity levels above 70 percent and got stronger as the level increased, Galembeck said. He has called the effect "hygroelectricity," meaning "humidity electricity."

VII. EXPLANATION

Charge build upon metals under high humidity, as described , is a good example of electrostatic charging at the solid -gas interface, which can be understood by marking well-known behavior of solid surfaces within water,they always acquire charge by some mechanism such as specific ion adsorption or ionizable group dissociation.

Aluminium, chromium and SS acquire charge under high humidity and are also well known for their resistance to oxidation, due to the coating metal oxides that protect the highly reative metals from atmosphere. Water vapour adsorbs in the oxide layer causing a number of structural changes. Al and Cr oxides are amphoteric in nature reacting with acids and basis. Aluminum oxides on metal contain OH and O sites with Lewis acid-base properties which are independent of the oxidation procedure, but dry aluminum oxide usually shows marked acidic character .This means when the two oxides are formed together, H+ binds preferentially to Cr oxide and Al oxide rather collects hydroxyl ions from the aqueous medium.

The explanation on charge build up on metals can be given as, adsorbed water molecules contribute OH- or H+ ions to the oxide-coated metal surface, depending on its nature which imparts an excess overall charge to the isolated metal.

Thus, the adsorption and desorption of water carries charge to and from the metal surface, it depends on the acid -base nature of its oxide layer, imparting positive or negative charge to the metal. Unfortunately, the current status of knowledge on the structure and especially on the specific acid-base properties is still insuffi-cient to establish a correlation between charge build up and the metal surface structure. This was recently acknowledged as follows: “the structure of the first water layer in contact with the surface, including the possibility of dissociation into OH and H+ groups, remain largely unanswered”.

VIII. POSSIBLE APPLICATION AND QUANTITAIVE ANALYSIS

The devices known as hygropanels can be mounted on the roof tops and electricity generated can be utilized like solar panels as a supplement to solar panels.

A 5cm^2 area sheet can develop 10^{-4} C charge at RH> 60% we use 10 cm thick stacks or piles made of Aluminium or SS sheet (thickness-0.3-0.4 mm)

Stack of 10 cm thickness approx. equals to 200 sheets.

Now,let N be the number of sheets in 1 m^2 area, 10 cm thick panel

$$\text{So } 5cm2*n*10=1m2*10cm$$

$$\text{So } n=10^4/5$$

$$\text{For } N=10^4*200/5=10^5$$

Now,Energy generated by one capacitor bank =$0.8(v)*10^{-5}(C/s)$ W

This multiplied by N gives 3.2W of energy.

We have calculated the approximate cost as given below:

The hygro panel taken is of 1m^2 area 10 cm thick.Let Materials used where aluminium, stainless steel, filter paper,conducive wires, etc.

Supposing 33% of the panel is made with aluminium and another 33% by stainless steel, and the rest with filter paper, conducive wiring, etc.

Density of aluminium = 2700kg/m^3

Hence amount of aluminium used = 2700/1*1*0.1*3 = 85 kg approx..Similarly density of stainless steel = 8000 kg/m3

Hence amount of SS used = 240 kg

Rates

Aluminium = Rs 70 per kg

SS = Rs 100 per kg

Total cost on metal = 70*85+240*100= Rs 29950

Extra cost on wiring panel and filter paper = Rs 10000

Total cost of hygropanel = Rs 39500 approx

Although in this amount of money we can have a 224 W solar panel, but further researches and developments would for sure bring down the cost per unit of electricity produced.

IX. REDUCING LIGHTENING STRIKE EFFECT

If we know how electricity builds up and spreads in the atmosphere,we can also prevent death and damage caused by lightening strikes.noting that lightening causes thousands of deaths and injuries worldwide and millions of dollars in property damage. Verbally stepping into the realm of lightning is easy to do. After all, if water vapor really can carry a charge, and clouds where lightning forms are mostly water vapor, then it seems to follow that lightning must have something to do with water vapour. However, the study of lightning is old and fraught with unknowns. To this day many theories compete for how lightning forms. Hygroelectricity, can be an answer to these questions.

Further Research can give as an exact idea how this energy can be utilized and lightening strike which causes billions of property damage can be prevented.but new researches have proved that there is something to to do with the charge and humidity, where metals are getting up charged in the presence of high humidity and which can be further useful for electricity generation.

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X.ADVANTAGES

If this technology could be leveraged as a way to create and use energy it would provide three key advantages over other methods of clean-energy generation.

(a) Unlike solar , wind power or hydroelectricity, hyrgroelectricity can work in a closed,dark environment.Itdoes not require sunlight or wind for generation and does not require the large outdoor spaces needed for large-scalesolar plants or wind farms.
(b) It uses common easily acquired materials. Thismeans that unlike batteries which require substances such as lithium or biofuels which rely on resources that are alsoused for other purposes, hygroelectricity is not nearly as vulnerable to changes in market demand.
(c)The kinds of material available are variable enough that the generatorscould simply be inserted into existing structures, without the difficult process of purchasing land, building facilities.

XI.THE LOWDOWN

Every technology has its flip side too so does the theory of hygroelectricity. Verbally stating the laws is easy but the practical implementation of the theory has many hitches.

(a)Despite these advantages hygroelectricity does require generators to be located in places where there is significant amount of water and humidity present. So areas such as theAmerican Southwest where humidity is rare would have a hard time implementing the technology.
(b)In addition current estimates cited by Galembeck state the maximum amount of electricity created by hygroelectric
generation would be lower than what researchers commonlyexpect from most solar power systems.
(c)Even though lightning is a form of hygroelectricity Galembeck and his team of researchers have intentionally shied away from using the phenomenon because he said they believed it was far too dangerous and unreliable.
(d)And how exactly do we gather this charge?The scientists need to solve all these puzzles to make the theory work.

XII.THE IMPACT

For centuries the scientists have been trying to capture the power of thunderstorms. Nikola Tesla, the famous inventor was among those who dreamed of capturing and using electricity from the air. Finally, the scientists are trying to make this dream come true through hygroelectricity and route its power to homes and business firms to minimize the use of non-renewable sources of energy for generating electricity. The scientists are trying to harness the power of this renewable source of energy in regions experiencing higher humidity levels. The scientists have a long way to go the benefits of the harnessing would be substantial. The finding for the best metal that has the greatest potential for capturing atmospheric electricity and preventing lightning strikes is on and when discovered would be a big day in human history.
This is supposed to be a revolution in the field of electricity generation. Once this process comes to be in complete fashion, this will allow the mankind to live in light, mostly always. This means will be comparatively cheaper when will be brought for mass production.

XIII.HOPES

A safety payoff could even arise with successful development and adaptation of the technology. By installing networks of energy harvesting devices in areas prone to thunderstorms, the buildup of electrical charge could conceivably be captured and redirected before it builds up to critical levels that lead to damaging and sometimes deadly lightning strikes.

Areas

Just as solar cells work best in sunny areas of the world, hygroelectrical panels would work more efficiently in areas with high humidity, such as the northeastern and southeastern United States and the humid tropics.

XIV.CONCLUSION

Perhaps a solution to the global energy problem could lie within the charged particles that comprise Earth's atmosphere. The naturally occurring electric potential between the negatively charged Earth and the positively charged atmosphere could provide enough electricity to power our homes and businesses. This electromagnetic network includes thunderstorms (lightning/pressure), the humidity in air, and the polar Aurora effects (northern lights) that is a direct result of atmospheric electricity. Unlike other renewables such as solar cells or wind turbines, this is a source of energy that is available any time of day under most weather conditions. These studies concluded that atmospheric electricity contained as low as the troposphere and as high as the ionosphere builds up a charge that can be transferred to any conducting material it comes in contact with. Identifying a feasible way to collect or store this humid electricity for use in the residential or commercial sectors could also reduce lightning strikes or other extreme weather by draining a region of its electric potential.

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