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Proposed Negative Ion Generator

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ABSTRACT
Varied number of electrons is present in air, due to the cosmic radiation. This generates a negative electric field in the atmosphere. If this natural electric field increases, then the phenomena of the corona discharge can be seen. The study of this naturally generated corona discharge was used to make the changes in the geometry of our system. Many other systems were developed by different scientists, but they had various drawbacks like cost, effective working range and generation of pollutants e.g. ozone at ground level. This paper presents a method for weather modification by artificially generation of negative ion which is of low cost, more effective over wide range and eco-friendly.

Keywords
Negative ions, Positive ions, Ion Generator, Ion counter, Gerdien condenser.

1. INTRODUCTION
Air ions are a traditional research subject of the science of atmospheric electricity, since ions determine the conductivity of atmospheric air and therefore affect the processes of the global atmospheric electric circuit[1][2]. In atmospheric electricity the term "air ion" signifies all airborne particles that are electrically charged and serve as a basis of air conductivity [3]. Hence "air ions" comprise a large variety of charged particles of different chemical composition, mass and size, from molecular clusters up to large aerosol particles. Each molecule has a nucleus of positively charged protons surrounded by negatively charged electrons. Nature constantly seeks an equilibrium or balance so that there are as many electrons as there are protons so that the negative charges cancel out the positive charges. This happens in a stable molecule of air.

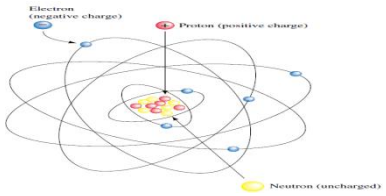

Fig.1: Structure of Atom

Air ions are created when enough energy acts upon a molecule of air and an electron is ejected from the nucleus. The displaced electron attaches to a nearby stable molecule which then becomes a negative ion. The molecule that loses an electron becomes a positive ion.

Normal ion counts in fresh country air are 2,000-4,000 negative ions per cubic centimeter. At a large water fall you might find over 100,000 negative ions. Polluted air such as in large cities might have less than 100 ions. It is observed that human being feel more refreshed near the ocean, a waterfall or even taking a shower. This is because all of these areas have a higher concentration of negative ions to positive ones. The ocean typically has 2000 negative ions and 1000 positive.

At any given time, a healthy ratio of positive to negative ions is 1.2 this ratio makes the atmosphere pleasant. Hence, to maintain or improve the above ratio it is required to increase the negative ion concentration artificially in such ion deficient places.

In this paper section 2 talks about the existing systems and the proposed system is discussed in section 3 along with experimental results. Finally in section 4 papers is concluded.

2. GENERATION OF NEGATIVE IONS

2.1 Naturally:
- Breaking down of naturally occurring radium in the earth crust which is converted into radon gas. This natural radiation causes oxygen negative ions to form.
- Lightning produces trillions of negative ions, which makes the environment refreshing.
- In Waterfalls the force or energy of the falling or splashing water causes splitting of neutral particles of air, freeing electrons which attach to other air molecules causing a negative charges.
- The evaporation of water can produce moderate amount of negative ions in the air; the small positive charges are left behind in the water.

2.2 Artificially:
Being so beneficial, these negative ions must be generated artificially. Ions can be generated by applying a high-voltage to sharp emitter points or grids to produce a strong electric field. This field will interact with electrons of adjacent gas

molecules, and will produce ions of the same polarity as the applied voltage [3]. These negative oxygen ions are called superoxides.

There are many systems available those which generate negative ions artificially three of them are described below.

1) "The Elanra ionizers" by Bionic Products (Australia) --

This company produces indoor air ionizers which is small in size, portable and plugged into any ordinary electrical socket.

2.3ELAT (Electrification Local de la Atmósfera Terrestre SA) system in Mexico [4]

This technology utilizes an electrical antenna that is suspended on a central tower about 100 feet high and peripheral posts about 25 to 30 feet high. These posts along with the central tower are erected on a plot of land approximately 900 by 900 ft. fed by a DC power supply of 1,00,000 Volts, the thin steel wire antenna releases ions to modify the number of water condensation nuclei in the atmosphere. This result in small temperature changes over the area of influence which is about a 30 mile radius from the antenna.

2.4ILAP

This technique of artificial rain making experiment was performed by Russian firm in Dubai in September 2006-january 2007 with positive results. Based on the ILAP technology, AST clear sky manager has developed by Advanced Synoptic Technologies Ltd for managing, at local atmospheric level, humidity density in the sky in order to conduct any type of atmospheric action that may improve working/living conditions at ground level.

ILAP technology is based on the method of electrical air ionization with the emission of electrons created by high voltage ion generators. The electrons emitted from the electrode couple with neutral molecules creating negative molecular ions that in turn create an ascending atmospheric ionic flow due to the repulsion by the negative field of the earth.

This system has been successful in enhancing rainfall in this region.

Problems related to above three systems are

- Elanra system has small range.
- ELAT and ILAP System has following drawbacks
- The System uses 100KV, at such high voltages byproducts like Ozone (O_3) and Nitrogen Oxides (NO_x) are produced.
- Such high voltage generation and utilization require elaborate safety provisions.
- This system is immovable and requires large area for installation.
- It has very high capital requirement.

3. PROPOSED SYSTEM

Experimentally it is proved that if we ionize the air at value greater than 16000 Volts, some of the byproducts like Ozone and Nitrogen are generated. Their concentration goes on increasing with increase in value of voltage.

Concentration of O_3, NO, NO_2 and NO_x generated at different discharge voltage during one hour electric negative discharge is given in following table[1].

Table 1. Discharge Voltage during 1 hour electric negative discharge

Discharge voltage (kV)	Ozone (ppb)	NO (ppb)	NO_2 (ppb)	NOx (ppb)
7, 10, 15, 16	ND	ND	ND	ND
17	64.5	9.2	107	116
20	163	10.6	114	125
25	358	9.9	124	134
30	504	13.1	137	150

ND = Not Detected, ppb=parts per billion

To avoid these byproducts of ozone & nitrogen oxides (at higher voltages), which are harmful at ground level [6]. It has been decided that the system must be operated at 15 kilovolts. While developing this system, the drawbacks of Elanra, ELAT and ILAP systems are also considered.

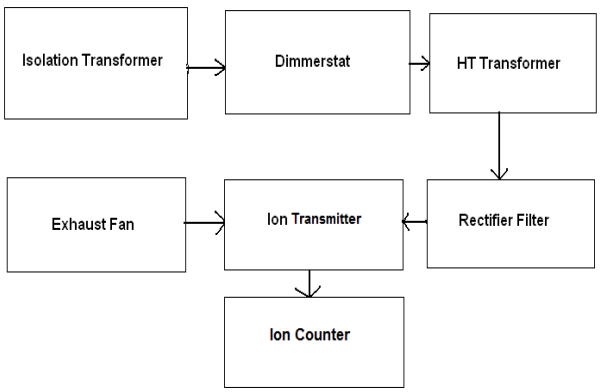

Fig.2: Block Diagram

Theoretically it is assumed that ions are generated under high electric field, but however neither ionization level nor ion drift is indicated. The calculation of the electrical quantities is performed using finite element software, COMSOL MULTIPHYSICS [7][8]. The computed values are compared with those obtained analytically to assess the accuracy of the obtained results.

After using Maxwell software it was realized that it has limited capacity as far as the objective is concerned. Nothing beyond voltage and energy level could be inferred. However unless some other means to study the pattern or direction of flow of ions is found it cannot make any positive conclusion.

With above mentioned drawbacks to achieve the objective, help of suitable software such as COMSOL multiphysics is used. This software performs equation based multiphysics modeling for different physical process by applying partial differential equations [9]. Relevant equations to the objective have studied.

Governing equations for electro hydrodynamic flow induced by corona discharge is described as follows,

The electric potential V in air is governed by the Poisson's equation which is given by:

$$\nabla^2 \boldsymbol{V} = -\boldsymbol{q}/\epsilon_{\mathbf{0}} \qquad \ldots (1)$$

Where q -space charge density,

ϵ_0 - dielectric permittivity of free space.

The electric potential is defined from electric field intensity E as

$$\boldsymbol{E} = -\boldsymbol{\nabla V} \qquad \ldots (2)$$

Electric current in the drifting zone is a combination of three effects

- Conduction (motion of ions under electric relative to entire airflow)

- Convection (transport of charges with airflow)

- Diffusion

Therefore current density is given by

$$\mathbf{J} = \boldsymbol{\mu} \mathbf{E_q} + \mathbf{U_q} - \mathbf{D}\nabla\mathbf{Q} \qquad \ldots (3)$$

Where μE_q - the air ions mobility in an electric field

U_q - Velocity vector of airflow

D - Diffusivity coefficient of ions

Q – Charge of Electron

Current continuity condition gives equation for current density

$$\boldsymbol{\nabla} \cdot \mathbf{J} = \mathbf{0} \qquad \ldots (4)$$

Hydrodynamic part of the problem is described by Navier-Strokes equations and continuity equation for steady state incompressible air flow

$$\boldsymbol{\rho U} \cdot \boldsymbol{\nabla U} = \boldsymbol{\nabla}_{\mathbf{p}} + \boldsymbol{\mu} \boldsymbol{\nabla^2 U} - \boldsymbol{q \nabla V} \qquad \ldots (5)$$

$$\boldsymbol{\nabla} \cdot \boldsymbol{U} = \mathbf{0} \qquad \ldots (6)$$

Where ρ-air density

p - Air pressure

μ - Air dynamic viscosity

Combining all we can obtain the following charge transport equation.

$$\boldsymbol{\nabla} \cdot (-\mathbf{D}\boldsymbol{\nabla}_{\mathbf{q}} - {}_{\boldsymbol{\mu}}\mathbf{E}\boldsymbol{\nabla}\mathbf{V}_{\mathbf{q}}) - \mathbf{U} \cdot \boldsymbol{\nabla}_{\mathbf{q}} = \mathbf{0} \qquad \ldots (7)$$

Thus, electro hydrodynamic flow for model is described by system of equations with appropriate boundary conditions to apply for simulation and for the shape of the model.

The gap between corona and collecting electrodes can be divided into two regions, the ionization and drift zones.

By trying different permutation and combination on dimensions of shield, spacing between emitter and extractor and by different combination of voltages applied to emitter and extractor. The model of ion transponder is finalized with following shape and specifications.

Table 2. Dimensions of the Model

PARAMETER	SHIELD	EMITTER	EXTRACTOR
LENGTH (mm)	338.05	270.44	270.44
DIAMETER (mm)	3	0.05	2

A. Number of electrodes used: 3

B. Shape of electrodes: Trapezoidal (basket).

C. Material used for all electrodes: Stainless steel

D. Distance between horizontal conductors: 67.61mm

E. Angle of with respect to ground: Variable.

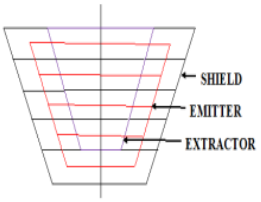

Fig.3: Ion transponder

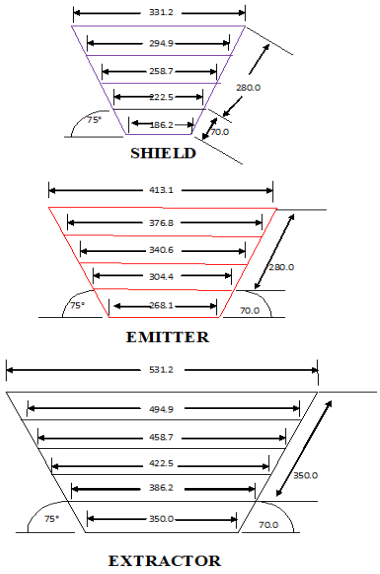

Fig.4: Estimation of specifications

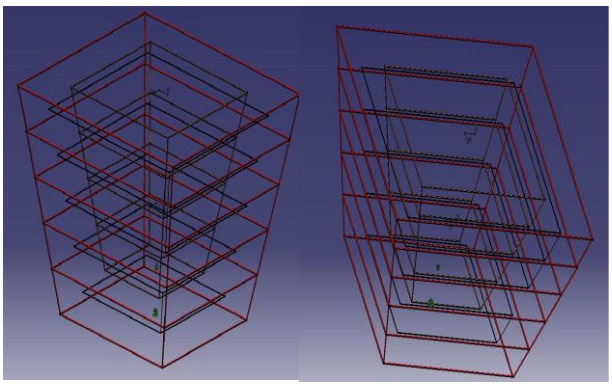

Fig.5: Finalized model

(MODEL GENERATED USING CAD SOFTWARE)

Ion transponder is made up of stainless steel and is in the form of fine wire. Due to its special structure, electrode ionizes the air near it. As high negative voltages are applied to electrode, it causes electric breakdown producing corona discharge.

Ions are accelerated first at the time of production at emitter electrode and second time it is accelerated by extractor electrode placed slightly above emitter. An extracting electrode consisting of an electrical conductor enabling continuous drain flow of electrons and ions from ionizing electrode and causing persistent ion flow into the atmosphere

As the shield electrode is grounded it further helps in providing an upward drift which is at ground potential. The diameter of shield electrode is 3mm and extractor electrode is 2mm.

3.1 Power Supply

The voltage applied to emitter and extractor is -15KV to -12KV respectively. Power system requires high voltage. There are alternate ways. To produce high voltage like multipliers, but it requires many diode-capacitor pairs of high ratings & also its output current is low [10, 11]. Hence transformer based circuit is selected. All safety precautions are taken into consideration while designing the power supply.

Two separate power supply are designed, first power supply is used for emitter and second power supply is for extractor. Both are High Voltage Power Supply (HVPS)

a) HVPS with rectifier for 15KV, 10mA,

b) HVPS with rectifier for 7KV, 8mA

Power supply unit consists of following blocks:

- Isolation Transformer
- Dimmer stat
- HT Transformer
- Rectifier Filter

The isolation transformer is used to isolate earth, high voltage pulses during operation of the high voltage power supply from mains supply. By using it the noise is suppressed and the interference is reduced. For high voltage transformer ferrite core with double E shape is selected as performance factor is better choice for this frequency.

The generated ions are spread in the atmosphere so that they could react with the pollutants to transport them [12]. Negative ions are used to enhance our mood, stimulate our senses, improve appetite and sexual drive, provide relief from hay fever, sinusitis, bronchial asthma, allergies, migraines, and even post operative pain and burns. Negative ions help to increase our resistance towards any disease. Negative ions promote alpha brain waves and increased brain wave amplitude which results in a higher awareness level. As more and more negative ions are inhaled, the blood cells in our body get ionized. It creates repulsion in the in between the cells which leads to formation of more space between them. This leads to more absorption of the oxygen into the body and makes us feel more energetic and healthy.

1. It can be used in green house for enhancement of growth of plants.
2. Enhances human resistance to disease.
3. It can be used in Poultry farm for the enhancement of growth of birds.

Table 3. Experimental Results

Inclination angle (in degrees)	Distance between conductors (mm)	Extractor voltage (KV)	Ionizer voltage (KV)	Voltage at maximum distance (KV)
45	50	-12	-15	-3.7
45	60	-12	-15	-5.6
45	70	-12	-15	-5.6
60	50	-12	-15	-4.3
60	60	-12	-15	-4.3
60	70	-12	-15	-5
70	50	-12	-15	-3.13
70	60	-12	-15	-2.5
70	70	-12	-15	-2.5
75	70	-12	-15	-8.13

Observations:

From the observation table (3) it can be clearly seen that of all the combinations we get the best results from the following combination:

Angle: 75 deg

Dist. Between Electrodes: 70mm

Emitter Voltage: -15Kv

Extractor Voltage: -12Kv

Theoretically it is assumed that ions are generated under high electric field, but however neither ionization level nor ion drift is indicated.

4. CONCLUSION

Configuration discussed above generates a high electric field, achievable in the ionization zone. In this case where the ionization source acts as a charged electrode electrically coupled, free electrons produced by ionization and accelerated in the electric field may achieve a velocity sufficient to ionize air molecules in their path. This paper reviewed the previous work carried out for generation of negative ions. The suggested the system which will be efficient, environment friendly and low cost with respect to existing systems.

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