AIR ION VARIATION DURING THE EVENING PERIOD AT RURAL STATION RAMANANDNAGAR (17° 4' N 74° 25' E) INDIA

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ABSTRACT

The atmospheric-electric processes can be understood only if it is assumed that the atmosphere is electrically conducting. The presence of aerosol in the air was found to be very greatly affecting the conductivity. Since the aerosol particles are very large compared to the ions, an ion is more likely to strike against aerosol-particle, and give up its charge to it or to adhere to the surface, than to collide with an ion of opposite sign. In this way, the rate of loss of conductivity is rapid. To measure small currents (AD549JH) amplifier is used by converting it into a voltage, which is usually linearly related to the input current. Air ion counter was indigenously developed at IITM Pune. In January average positive air ions were $11 x 10^2$ ions per cm^3, starts decreasing and reaches to minimum ($1.8 x 10^2$ ions per cm^3) in April. As January is a dry month with no rainfall activity, negative ions which, are produced immediately attach to aerosol particles. Therefore as compared to average positive air ions average negative air ions were low in January, which is harmful to human health during the evening period.

Keywords: Air Pollution, Air Quality, Aerosol, Cluster ion.

1. Introduction

The atmospheric-electric processes can be understood only if it is assumed that the atmosphere is electrically conducting. The observation of the leakage of the charge through the air from an insulated electrified body led Coulomb (1785) to the discovery that the air has a finite electrical conductivity. However, it was more than a century later, Wilson (1901) discovered the existence of ions. Later experiments on the influence of dust in the air led to the conclusion that it was due to the presence of finely divided matter, liquid or solid, in the freshly prepared gas. The presence of dust in the air was found to be very greatly affecting the conductivity. Since the dust particles are very large compared to the ions, an ion is more likely to strike against dust-particle, and give up its charge to it or to adhere to the surface, than to collide with an ion of opposite sign. In this way, the rate of loss of conductivity is rapid.

Radiation from radioactive gases exhaled from the ground and their other daughter products causes ionization in the atmosphere. The radiations of α, β, and γ released during the decay of radon and its progeny cause ionization, The amount of Radon that escapes depend on the amount of ^{222}Rn in the ground; the type of ground cover, porosity and temperature of soil (Hoppel *et al* 1986). The small air ions are naturally produced due to radioactivity. Natural radioactive ionization is the major source of ions in the atmosphere. Isotopes commonly present in air include ^{7}Be, ^{14}C, ^{22}Na, ^{32}P, ^{33}P, ^{35}S and ^{85}Kr as well as Radon isotopes and their decay products, Gamma radiation, produced from the soil, also passes through the air. Interaction between the energetic radioactive particles and molecules in the air occurs by different processes.

In addition to ionizing radiation, there are several other sources, which produce charge carriers of quite different sizes and nature on a local scale. For example, dust storms and snow storms are known to be intensely electrified (e.g. Kamra, 1972 and Simpson 1919). Charges produced in these storms can be transported up to several kilometers in altitude and over many square kilometers of the earth's surface (Kamra, 1989). Electrical discharges can cause the formation of ions in the atmosphere. This requires high electric field that generally occurs in the disturbed weather inside or in the vicinity of thunderstorms. In such conditions, field intensity is enhanced around grounded elevated objects and when it increases to breakdown value or above, a large number of uni-polar ions are injected into the atmosphere. This phenomenon of point discharge can occur at the tall trees or buildings below thunderstorms. Lightning flashes from thunderclouds also produce local but intense ionization in the atmosphere.

The goal of this paper to measure air ion variation during evening period at rural station Ramanandnagar. We also try to detect evening period is healthy or harmful to human health.

2. Measurements and methods

Observatory at Ramanandnagar (17° 4' N 74° 25' E) is located in sparely populated rural region. It is 210 Km southeast of Pune (Fig.1) and 370 Km southeast of Mumbai capital of Maharashtra (India). The river Krishna flows just 4 Km to the Northwest. A 20 feet road with an average traffic frequency of about 1-2 motor vehicles per minute close to the observatory (Pawar *et al* 2011). The observatory, in which we carried out the measurements, is located in the ground floor. The room was used for measurement of air ion concentration. At other times; there were no indoor activities in the laboratory.

For the measurement of atmospheric current various amplifiers are tested. As the atmospheric current is very small, therefore for the measurement of small magnitude of current a separate electrometer is necessary. Commercially available instruments exist with resolution of 1 fA, such as the Keithley 6512, but these are bulky and expensive calibration devices unsuited for field work. When measuring such small currents (Hatakeyama *et al.,* 1958), effects often considered negligible in other circumstances are comparable to the signal, such as leakage current, and also $50H_z$ interfaces caused by the ac mains supply. Care should be taken to minimize these problems whilst maximizing the time response, by careful design and component selection. To measure small currents (AD549JH) amplifier is used by converting it into a voltage, which is usually linearly related to the input current. The simplest form of i-to-v converter is resistor: for example, currents of 1 pA could be converted into 1 v by passing them through a high value resistor. However, a resistor is not ideal for current measurement because its time response is limited by the time constant of the resistor and its own capacitance. There is another way to utilize the properties of operational amplifiers. The output voltage of an op-amp is proportional to the potential difference at the inputs, with the constant of proportionality given by the gain (Keithley, 1992). In conjunction with a fixed resistance, operational amplifier can also be used to convert the voltage.

The motion of the ions in the tube; in a perfectly laminar flow they will be subjected to two forces only. An electrical force will act towards the central electrode, and the mean flow will blow the ions along the tube. In turbulent flow there is a third effect from the action of turbulent eddies, which introduce a chaotic aspect into the ionic motion. As long as the mean flow exceeds the scale of the turbulent eddies, the ionic motion predicated by theory should still hold. In terms of the design of a Gerdien condenser, the condition of laminar flow imposed by Chalmers (1967) can be relaxed, as long as it can be proved that mean flow exceeds the motion due to turbulent eddies. The air ion data collected from January 2012 to February 2013.

3. Result and discussions

In January average positive air ions were $11 x 10^2$ ions per cm^3, starts decreasing and reaches to minimum ($1.8 x 10^2$ ions per cm^3) in April. From May starts increasing and reaches to $9.9 x 10^2$ ions per cm^3 in June. In July positive air ions again decreases to $1.9 x 10^2$ ions per cm^3.Average positive air ions were 8.4 in August starts decreasing and reaches minimum ($2.1 x 10^2$ ions per cm^3) in October. From the October again starts increasing and reaches maximum ($7.6 x 10^2$ ions per cm^3) in December.

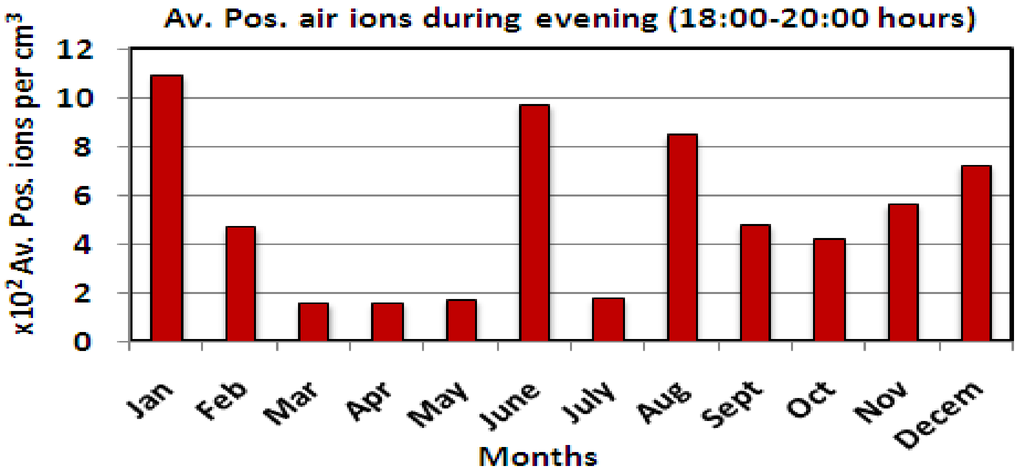

Figure 1: Average positive air ion variation during evening period.

In each January, radon concentrations are in peak (Debaje *et al*., 1996) in which large cluster-ion pairs are produced. This may be due to intense temperature inversions during the colder period (January), leading to the accumulation of more radon near the Earth's surface and increasing the ionization rate (Parsad *et al*., 2005). Therefore, as compared to all other months we observed a greater number of positive and negative cluster ions in January. The radioactive aerosol produced in the presence of radon gas (^{222}Rn), which consists of the radon daughter nuclide ^{218}Po attached to a pre-existing aerosol (Black, 1990). Radioactive aerosols acquire a charge, in general, more readily than a comparable non-radioactive aerosol. Radioactive aerosols are charged by the usual mechanism of external ion attachment (Isaelesson S., and Knudsen E.,1986), but additional external ions are created by radioactive decay particles. A further form of electrification for radioactive aerosols is self-charging. This occurs when a radioactive source is actually within the aerosol particle. The self-charging of a beta-active aerosol radioactive decay causes electrons to be emitted from the particle's surface and ions for both signs are produced. Positive ions are nothing but these radioactive aerosols (Dua *et al*., 1978), which are accumulated near the ground surface in cold temperatures (January).From January to April as temperature increases radon which is close to surface escaped to upper atmosphere. Therefore average positive air ions were decreased from January to April. In May more aerosols were introduced in the atmosphere, therefore average positive air ions were more.

Positive ions can be produced by various kinds of friction; between air masses, between the air and sand or dirt particles swept up by the wind, between weather fronts that march endlessly across the face of the globe. Friction tends to knock off the negative electrons and produce overdose of positive ions. On a dusty or humid day this overdose may be massive because the negative ions (Gabby 1990) promptly attach themselves to particles of dust, pollution or moisture and lose their charge (Pawar *et al.,* 2012). June is transition period between pre-monsoon and monsoon in India, therefore in dusty atmosphere average positive air ions were more.

July is monsoon period; therefore ground was covered with water in this month. Then emanations of radioactive radon decreases. Therefore average positive air ions were decreases in July. In August there was not continues rainfall like in July, there is occasional rainfall and sunshine in this month. Therefore average positive air ions were more in August as compared to July.

From October to December as temperature decreases radon close to the surface increases. Therefore average positive air ions increases from October and maximum was observed in December.

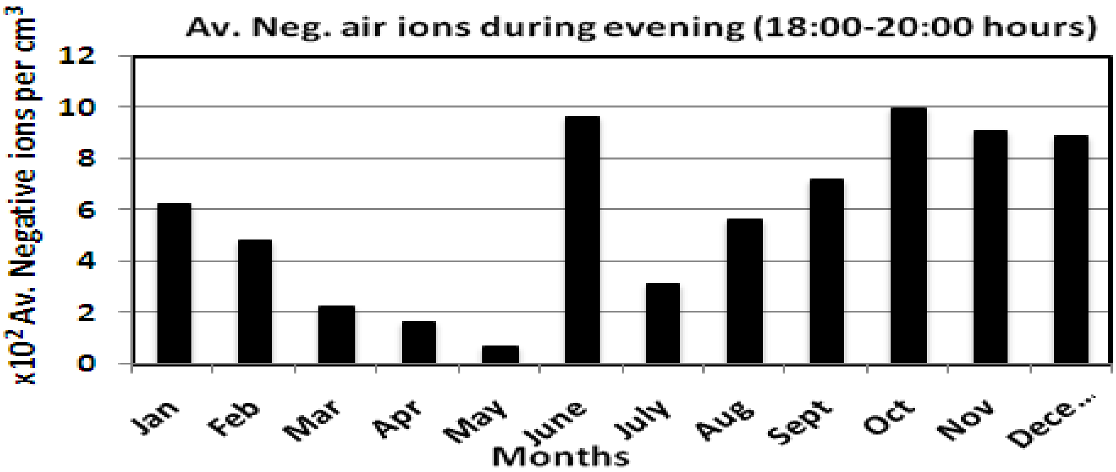

Figure 2: Average negative air ion variation during evening period.

Average negative air ions were 6.15 x10^2 ions per cm^3 in January. In February average negative air ions were 4.85 x10^2 ions per cm^3. From February starts decreasing and reaches minimum (0.7 x10^2 ions per cm^3) in May. In June average negative air ions were 9.75 x10^2 ions per cm^3. Average negative air ions were 3.2 x10^2 ions per cm^3 in July. From July average negative air ions starts increasing and reaches maximum (10 x10^2 ions per cm^3) in October. From October average negative air ions starts decreasing and reaches minimum (9 x10^2 ions per cm^3) in December.

As January is a dry month with no rainfall activity, negative ions which, are produced immediately attach to aerosol particles. Therefore as compared to average positive air ions average negative air ions were low in January, which is harmful to human health (Krueger and Reed 1976). The pre-monsoon period is a much-polluted and dusty, which results in more negative ions attached to aerosol particles (Flanagan, 1966). Therefore, as shown in Fig. 2, the average of negative ions decreases from March to May 2012. In the month of June, few thunderstorms were observed, which generated a corona discharge of negative air ions from trees (Harrison, 1992). This additional source of negative ions results greatly increased the concentration of negative ions (Orville and Spencer, 1979; Turman and Edgar, 1982). Therefore, in June the average negative ion count (Fig.2) shows sharp increases (Gunn, 1956) as compared to May.

During summer, the gases move upward carrying radon with it, thereby reducing ionization (Parsad *et al*., 2005) near the earth's surface. Therefore, average (Fig. 2) negative ions decreases, from February to April. May is a very hot month of the year, so agricultural crops are few; hence plant transpiration (Bondietti *et al*., 1984) of radon and thoron is lowest. Therefore, average negative air show the lowest values in May. The main cause of reduction of the ion concentration is increasing aerosol (Laakso *et al*., 2003), which removes ions, due to the aerosol acquiring charge (Harrison, 1992). From this, it can be seen that increasing the aerosol concentration reduces negative air ion concentration. Many observations have been carried out in atmospheric air research since polluted- or fog-laden air is known to have a lower ion concentration than clean mountain air (Reiter, 1986). Therefore, as shown in the Fig. 2, the average negative air ion concentrations are decreasing from January to May.

4. Conclusions

In January average positive air ions were 11x10^2 ions per cm^3, starts decreasing and reaches to minimum (1.8 x10^2 ions per cm^3) in April. From May starts increasing and reaches to 9.9 x10^2 ions per cm^3 in June. Average negative air ions were 6.15 x10^2 ions per cm^3 in January. As compared average positive air ions average negative air ions low in the January, this is harmful to human health during the evening period. In February average negative air ions were 4.85

$x10^2$ ions per cm^3. From February starts decreasing and reaches minimum (0.7 $x10^2$ ions per cm^3) in May. As January is a dry month with no rainfall activity, negative ions which, are produced immediately attach to aerosol particles. Therefore as compared to average positive air ions average negative air ions were low in January during the evening period. The pre-monsoon period is a much-polluted and dusty, which results in more negative ions attached to aerosol particles during the evening period. Therefore, the average of negative ions decreases from March to May 2012, which is harmful to human health. Therefore evening period is harmful to human health.

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