DIURNAL VARIATION OF AIR-BORNE ALPHA ACTIVITY CONCENTRATYON IN BASRAH CITY ATMOSPHERE USING POLYMERS TRACK DETECTOR

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ABSTRACT

Monitoring of Radon daughters was carried in Basrah City of Iraq using the polymers CR-39 plastic track detectors . The measurements were made in residential building from November 2006 to February 2007 at height of 1.5 m. from the ground level using air-sampling radon daughters dosimeter.The investigation of the air-born activity concentration showed a large variation in day to day measurements. The correlation between humidity and the track density also discussed.

التغير اليومي في تراكيز ابناء الرادون في جو مدينة البصره باستخدام تقنية الكواشف الصلبة النووية

الخلاصة

في هذا البحث تم دراسة ومراقبة تركيز أبناء الرادون في جو مدينة البصره باستخدام تقنية الكواشف الصلبة النووية البولمرية نوع CR- 39 للفترة من تشرين الثاني2006 ولغاية شباط 2007 . الدراسة تمت في احد المباني السكنية لجامعة البصره وعلى ارتفاع 1.5 م من سطح الأرض.أثبتت الدراسة بان هناك تغير يومي كبير في تراكيز أبناء الرادون بسبب التغيرات الجوية الحاصلة في قيم درجة الحرارة و الرطوبة النسبية وتغيير سرعة الرياح واتجاهها. العلاقة الرياضية بين تركيز أبناء الرادون والرطوبة تمت مناقشتها في هذا البحث.

INTRODUCTION:

Radon and thoron are among the first of natural Radio-active elements which were discovered at the beginning of the last century. Radon is produced by the decay usually of ^{226}Ra in the uranium-radium decay series, and decays, with an alpha particle emission , to polonium isotop ^{218}Po . The decay of ^{224}Ra in the series produces thoron, which also decays via an alpha particle emission to ^{216}Po . Radon and thoron are the only elements in the uranium and thorium decay series which are in the gaseous state at room temperature. Radon is usually more important than thoron from the point of radiation dosimetry.

The short lived daughters of ^{226}Ra and ^{224}Ra are responsible for a large portion of the alpha particle dose delivered to the lung if they are inhaled with air. The long-lived daughters will be eliminated from the lungs before any significant number of disintegration of these isotopes can occur.

Numerous measurements have been carried out on radon exhalation from building material and radon concentration inside houses [1-6]. The exhalation of radon from building materials is dependent on the ^{226}Ra and ^{224}Ra concentration in that material, the emanation power and diffusion coefficient. The diffusion coefficient for building materials varies by several orders of magnitude, and for different materials, values between 10-4 and 10-7 Cm^2 sec^{-1} have been reported by UNSCEAR(1982).The magnitude of various contribution to radiation dose differ from one place to another and from indoors to outdoors. The concentration of airborne radio nuclide inside the hoses are affected by building material itself and the shape and condition governing the building. The indoor concentration of radon and its daughter products is usually much higher than corresponding outdoor concentration depending upon the ventilation rate.

Radon behavior inside and outside the soil is affected by the meteorological parameters such as pressure , temperature, humidity, wind, rain fall, etc. Increasing barometric pressure has been fond to increase the radon concentration inside the soil. However, reduction of radon concentration on the surface layer of the soil has been also observed. This may be due to pressing surface layer radon into the high depth inside the soil. The exhalation rate of radon increases with decreasing barometric pressure and vice versa [7]. The radon exhalation is also affected by the moisture content of the soil [8]. Decreasing diffusion coefficient with increasing humidity has been reported by (UNSCEAR 1982). This may be due to clustering of the daughter or clustering of water molecules on daughter atoms in the air.

The methods of measurement of radon and its products are improving continuously . The field of radon dosimetry has been extensively reviewed by Frank and Benot [9]. Two types of dosimeters are in use: active and passive. In the active method an air pump is employed to draw the air through a filter paper trapping the radon decay products. A sensitive detectors is used to measure the alpha particles emission from the collected daughter nuclei. This can be two-filter method [10] which is used to measure radon concentration in air or one filter method which is used for radon–daughter measurement. Active dosimeters are subject to some mechanical failures and the loaded filter effect . The pump and battery pack make these heavier and bulkier than the other types and also expensive. When the filter becomes clogged with dust , diesel smoke or moisture , the air flow resistance can increase and the cause reduction in their sampling rate of the pump. Therefore ,it is necessary that the dosimeter works at a constant, calibrated sampling rate. Passive detectors, are directly exposed to the air-born radon nuclei, and record the alpha-decays which occur in air. Passive detectors have number of advantages over active sampling system such as simplicity of design , small and tight in size, cheapness and do not need a power supply.

In this study solid state nuclear track detector (SSNTD) have been used here. The extreme sensitivity CR-39 have been used in this investigation.

EXPERIMENTAL DETAILS:

The air sampling used in to study the diurnal variation of air-born activity in Basrah City Center was portable dust sampler Type L60 manufactured by Rotheroe and Mitchell Ltd , England .A known volume of air is sucked through a glass micro-filter paper GF/A, a disk of plastic detector is set in front of the filter to register the alpha emission from the collected particle on filter paper. Filter paper and detector are separated by an annulus ring, 1.5 mm in thickness with 30 drilled holes of unit.4 mm diameter. The filter paper and plastic hold in a single

To study the day to day variation of air borne alpha activity concentration in air , it is essential to run the air sampler through the day ,such a condition was not possible in this study. Therefore to determine a sampling time to obtain reasonable track density the air sample was operated for different lengths of time at air sampling rate of 70 lit/min. The filter and CR-39 assembly was kept close for 2 hours to allow the collected radon daughters on filter paper to decay and register CR-39. The plastics were then chemically etched for 6h in 6M NaOH at 70 ^{o}C. The number of registered alpha particle tracks per detector area is manually counted in a light microscope type Letize .

RESULTS AND DISCUSSION:

Fig . 1 shows the results of the experiment between track density and the length of time at air sampling . From these results a sampling time of 3 hours was chosen. The air sampler was located 1.5 m above the ground and run every day for 3 hours , from eight to eleven in the evening . From the results of this experiment the variation of the track density (which is proportional to the air –borne activity are plotted in Figs 2 – 4.

In order to determine the relationship between the air – born activity concentration with the meteorological parameters such as temperature and humidity , the magnitude of these parameters at the time of sampling were taken from Meteorological Department of Basrah International Airport , and these are shown in Tables 1 -3. From these tables it was difficult to find out how these parameters affect the variation of air –born activity concentration in air, moreover there are other parameters which are not included in these tables.

As it is seen the variation in humidity was large , not only from one day to another but also during sampling time , therefore it was assumed that this parameter may have more effect than others. The variation of track density with humidity are plotted in Figs 5 -7. The correlation factor between track density and humidity was found to be very low (r = 0.02). It is worth noting that the above calculation neglected the effect of other parameters , so that ideally , one has to consider the variation of the air–born activity with all the meteorological parameters.

CONCLUSION

The results of the measurements of air –born activity concentration in the atmosphere of Basrah City Center showed a large variation in day to day measurements . The variation originated from daily fluctuations in the various meteorological parameters (i.e. temperature , pressure , humidity , rain fall , wind , …) in the climate of Basrah city.

The study also shows the polymer CR-39 detectors are convenient to measure the low level of the concentration of radon and its daughter products.

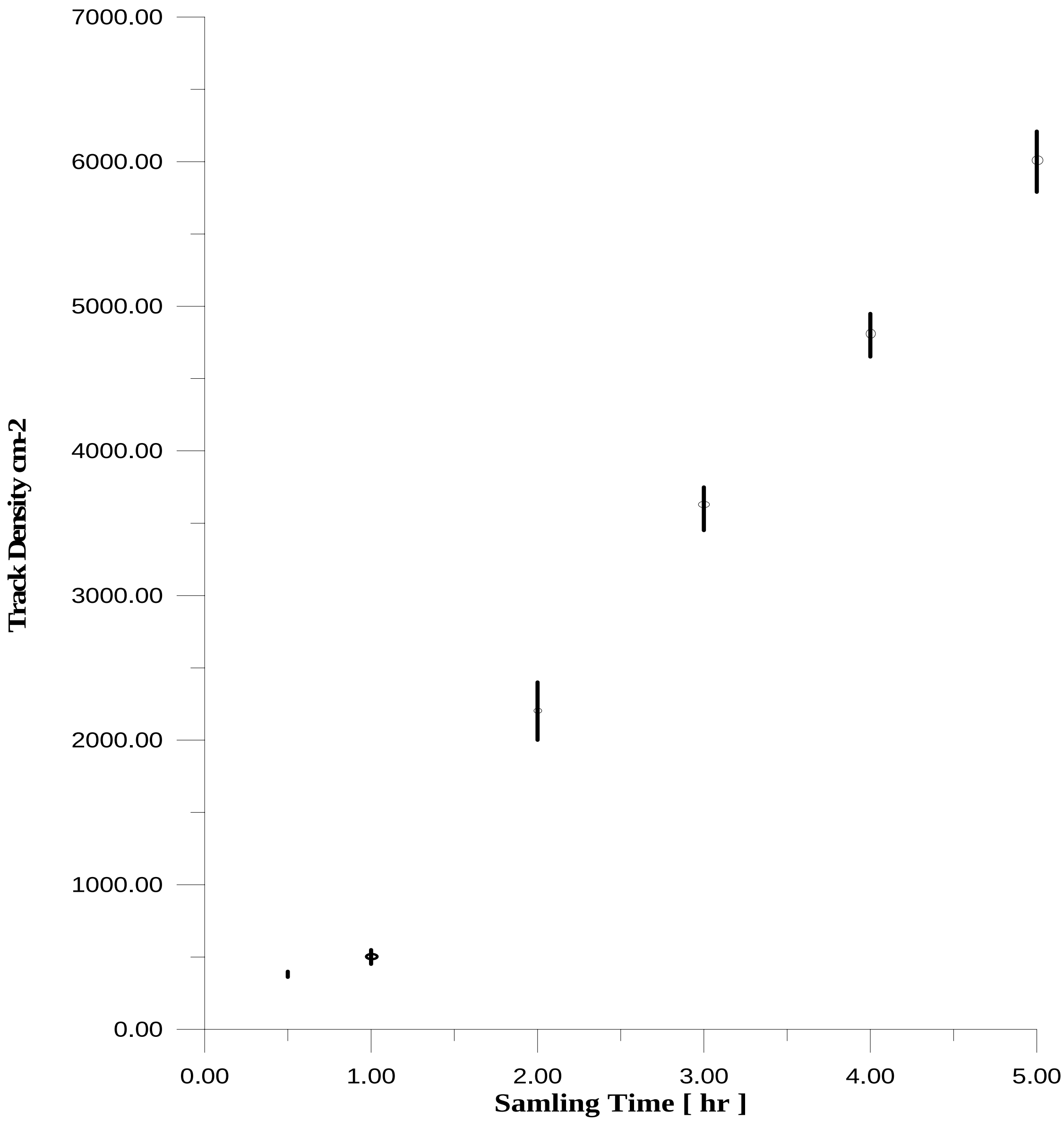

Fig -1- : Track Density vs. Sampling time.

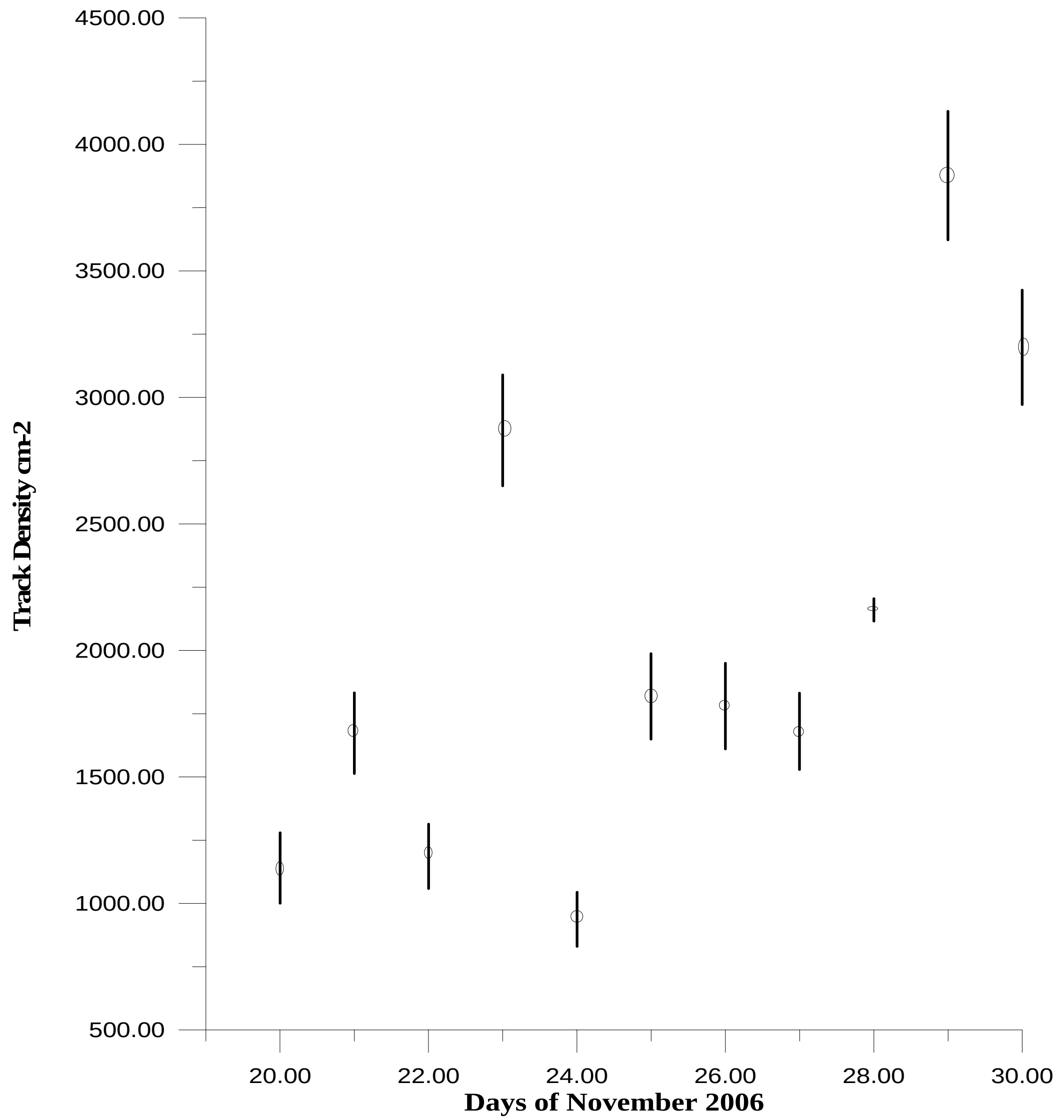

Fig -2- : Day to day variation of Track Density due to air sampling from 20 - 30 November,2006.

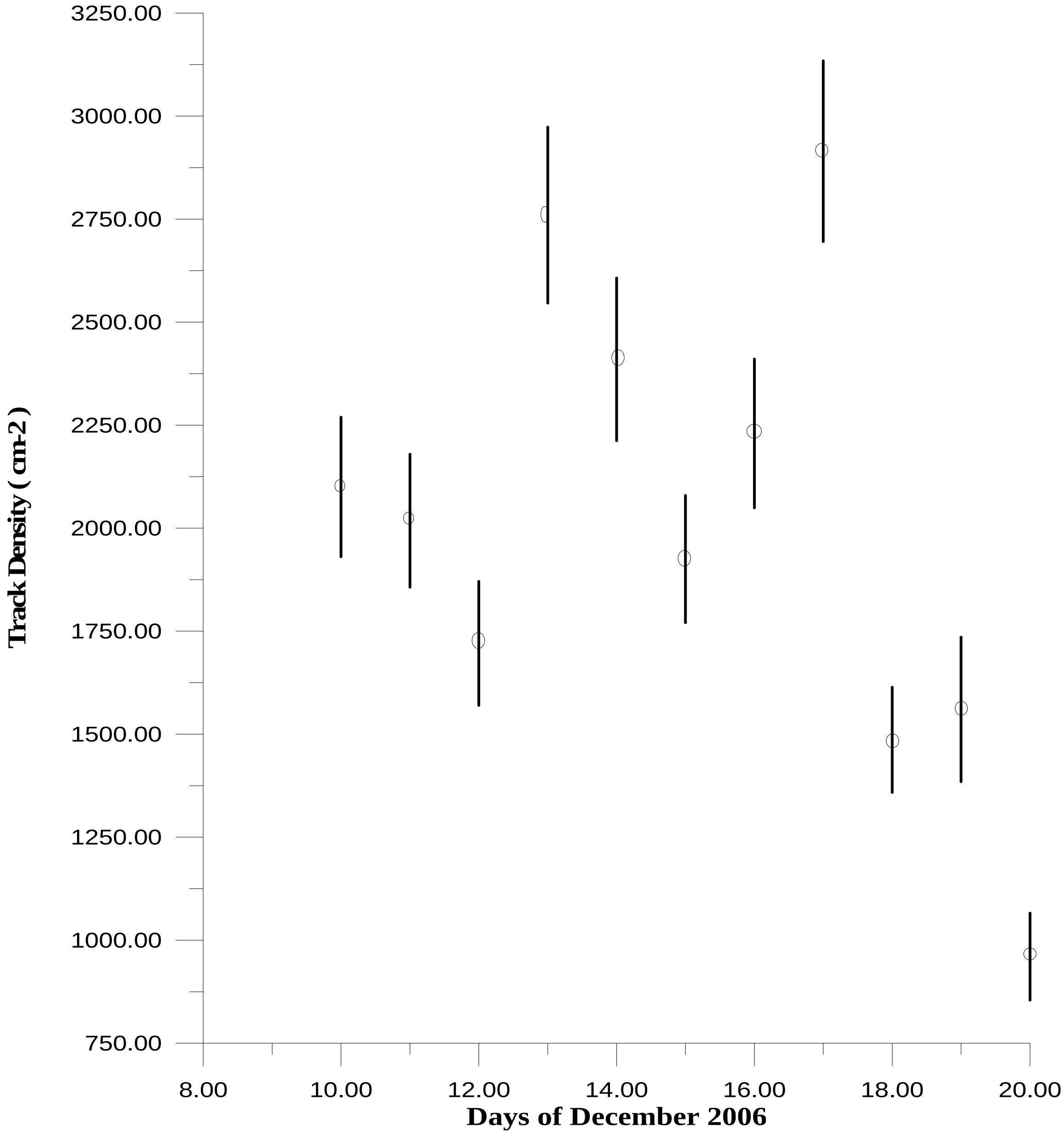

Fig -3- : Day to day variation of Track Density due to air sampling from 10 – 20 December, 2006.

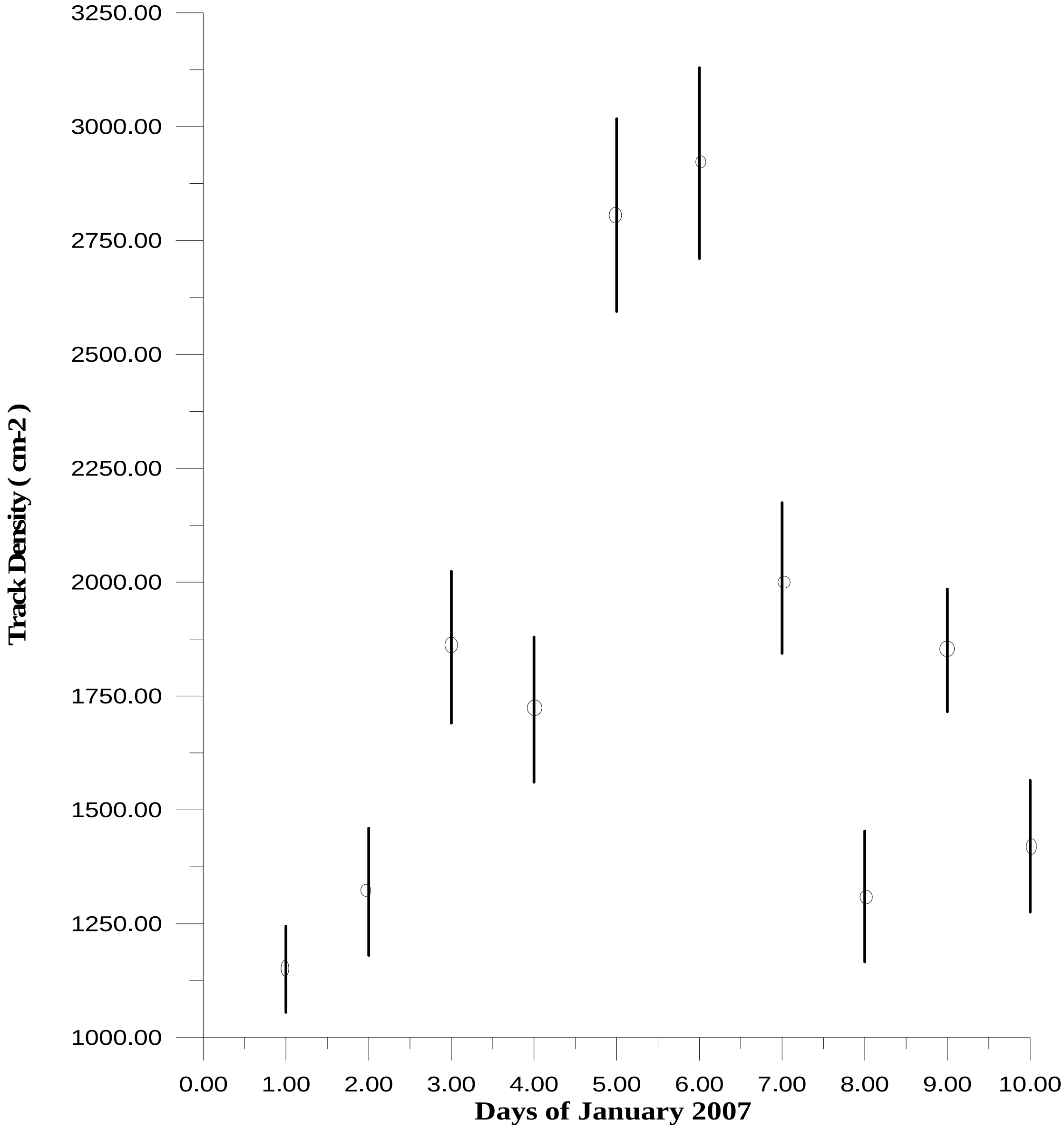

Fig -4- : Day to day variation of Track Density due to air sampling from 1 – 10 January, 2007.

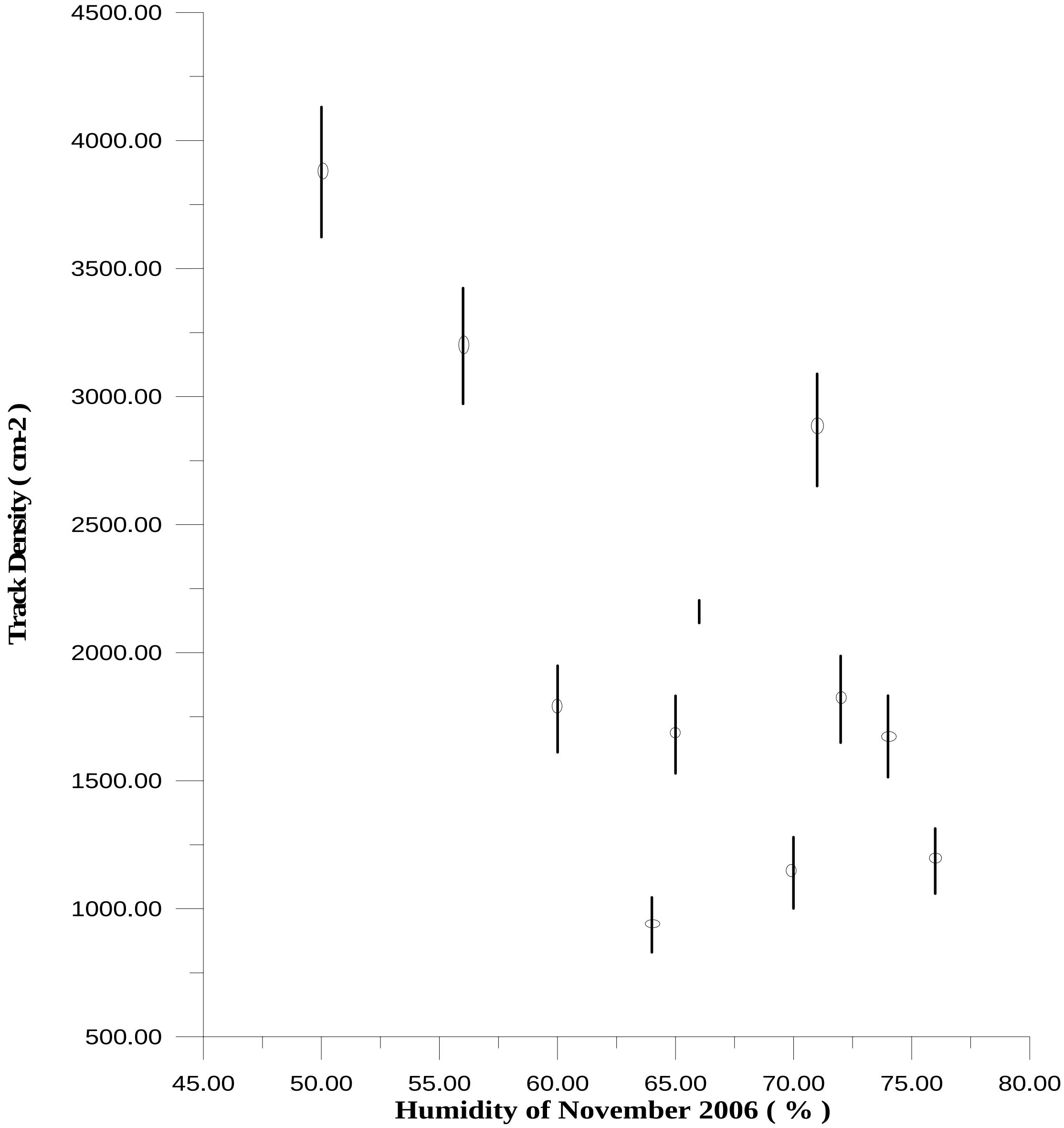

Fig -5- : Track Density vs. Humidity of November 2006.

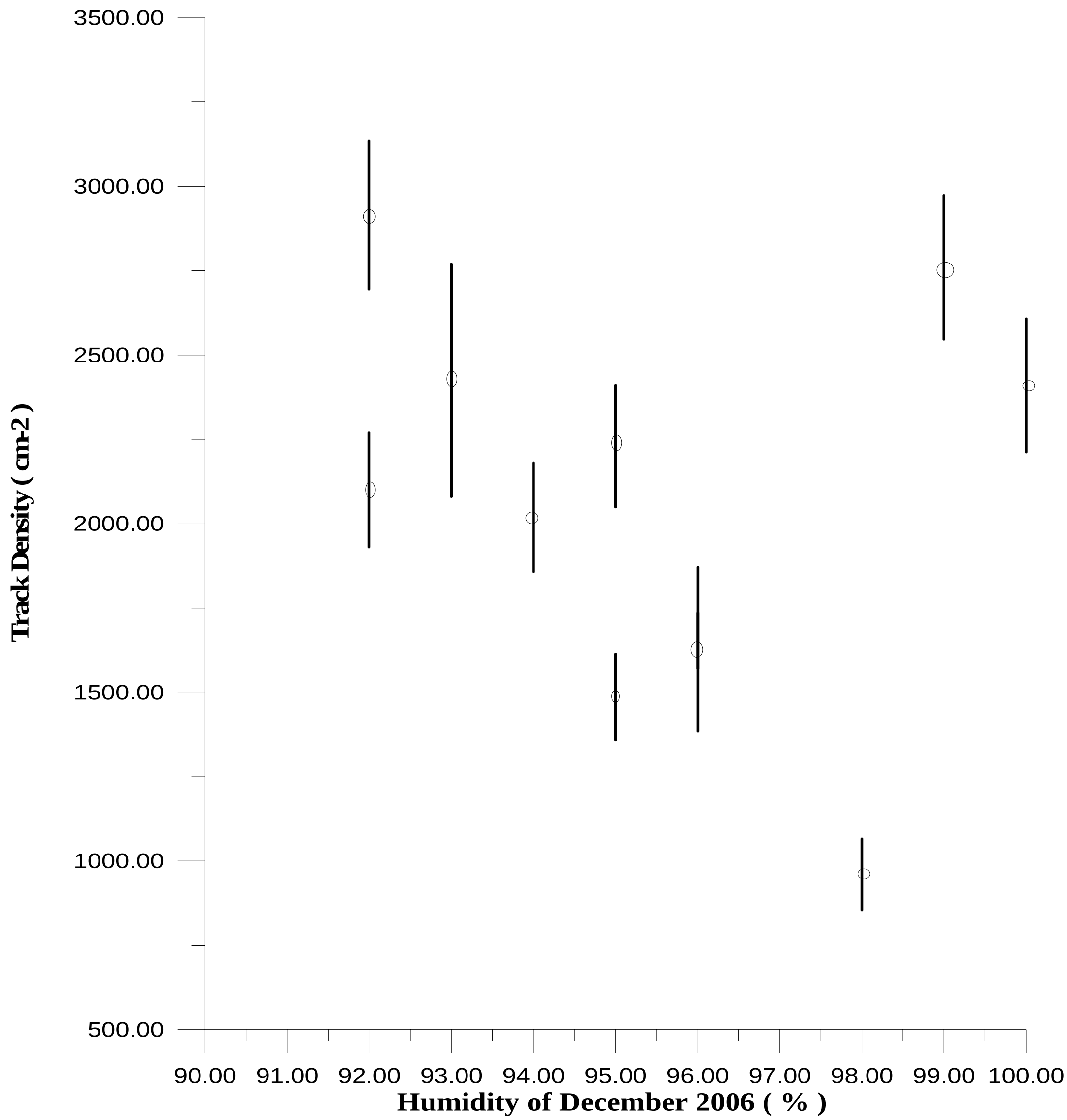

Fig -6- : Track Density vs. Humidity of December 2006.

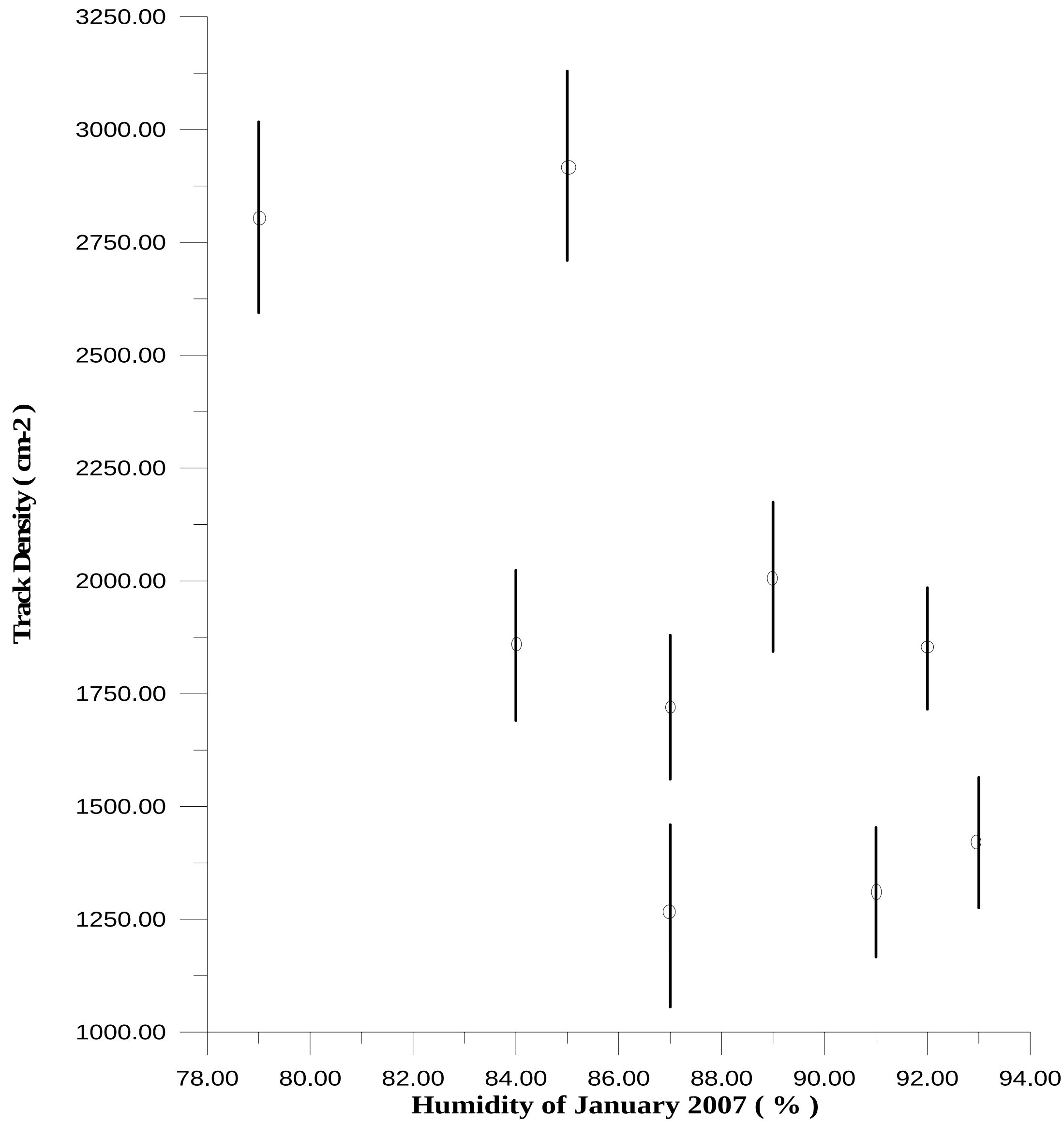

Fig -7- : Track Density vs. Humidity of January 2007.

Date	Temperature (˚C)	Humidity (%)	Track Density (cm^{-2})
20 / 11 / 2006	15	70	1140 ± 140
21 / 11 / 2006	16	74	1673 ± 160
22 / 11 / 2006	17.1	76	1186 ± 128
23 / 11 / 2006	17.4	71	2870 ± 220
24 / 11 / 2006	17.9	64	937 ± 108
25 / 11 / 2006	19.1	72	1818 ± 170
26 / 11 / 2006	18.5	60	1780 ± 170
27 / 11 / 2006	18.4	65	1680 ± 152
28 / 11 / 2006	17.1	66	2160 ± 45
29 / 11 / 2006	17.1	50	3877 ± 255
30 / 11 / 2006	18	56	3198 ± 227

Table -1- : Day to day magnitude of temperature, humidity and track density of November 2006.

Date	**Temperature (˚C)**	**Humidity (%)**	**Track Density (cm^{-2})**
10 / 12 / 2006	**14.9**	**92**	**2100 ± 170**
11 / 12 / 2006	**8.4**	**94**	**2018 ± 162**
12 / 12 / 2006	**14.3**	**96**	**1720 ± 151**
13 / 12 / 2006	**9.5**	**99**	**2760 ± 214**
14 / 12 / 2006	**10.9**	**100**	**2410 ± 198**
15 / 12 / 2006	**12.5**	**93**	**1930 ± 150**
16 / 12 / 2006	**10.4**	**95**	**2230 ± 181**
17 / 12 2006	**7.8**	**92**	**2915 ± 220**
18 / 12 / 2006	**8.2**	**95**	**1486 ± 128**
19 / 12 / 2006	**11.6**	**96**	**1560 ± 176**
20 / 12 / 2006	**7.1**	**98**	**960 ± 106**

Table -2- : Day to day magnitude of temperature, humidity and track density of December 2006.

Date	Temperature (˚C)	Humidity (%)	Track Density (cm^{-2})
1 / 1 / 2007	7.4	87	1150 ± 95
2 / 1 / 2007	8.4	87	1320 ± 140
3 / 1 / 2007	8.8	87	1857 ± 167
4 / 1 / 2007	10.4	87	1720 ± 160
5 / 1 / 2007	11.3	79	2806 ± 212
6 / 1 / 2007	11.9	85	2920 ± 210
7 / 1 / 2007	11.4	89	2009 ± 166
8 / 1 / 2007	11.6	91	1310 ± 144
9 / 1 / 2007	8.3	92	1850 ± 135
10 / 1 / 2007	9.3	93	1420 ± 145

Table -3- : Day to day magnitude of temperature, humidity and track density of January 2007.

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