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Determination of alpha emitters concentration in human urine via PM-355 SSNT Detector

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Physics

By

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Shaima' a
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Abstract

This work owes its importance to the fact that it aims at knowing and measuring the concentrations of alpha-particles emitters discrete by the human body in the urine in particular. Knowledge of these concentrations is extremely important since it reveals whether a person has received such doses of radioactive materials emitting alpha-particles that result in the occurrence of malignant tumor and mutations. This subject being so essential to the health of individuals and being a great help to physicians to make the proper diagnosis in the relevant cases, has imposed itself on us as the topic of this thesis.

Human urine samples were taken from Iraqi workers in different fields (phosphate plants, fertilizer plants, teaching staff in nuclear physics laboratory, painters, patient and reference healthy people of different ages), using PM-355 solid state nuclear track detectors. The exposure method was used by immersing PM-355 detectors in urine samples for three weeks, then etching by 6.25N NaOH for 5 hrs. The track density was measured via an optical microscope. The alpha emitters concentrations in the urine samples were calculated in comparison with standard samples that were prepared in the nuclear laboratory of physics department- College of Science AL-Nahrain University.

The obtained results show that the concentrations of alpha emitters in the urine samples of patients range from 1.81ppm to 2.87ppm , from 0.087ppm to 1.32ppm in reference healthy people, in painters from 0.77ppm to 1.46ppm, workers in phosphate plants from 0.94 ppm to 1.89 ppm, workers in fertilizer plants from 1.0ppm to1.42 ppm , and from 1.0 ppm to 1.29 ppm in teaching staff in nuclear physics laboratory .

Deductions from the results of this work regarding the dependence of concentrations on the person's occupation, years of service, sex, age and health condition have been dealt with in sufficient details as required.

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List of Symbols

Symbol	Description
λ_r	Radioactive decay constant.
λ_b	Biological decay constant.
λ_{eff}	Effective decay constant.
T	half-life.
T_{eff}	effective half – life of a radioactive substance in the body.
T_r	radioactive half – life of the substance.
T_b	biological half – life of the substance.
°C	Degree Centigrade.
C_s	Uranium concentration of standard sample .
C_x	Uranium concentration of unknown sample.
d	diameter of the etch pit.

K	Boltzman constant = 1.38×10^{-23} J mol / k .
L	length of latent track .
N	Normality.
V_B	Bulk etch rate.
V_T	Track etch rate.
θ_C	Critical angle.
ϕ	Incident angle.
η	Etching efficiency.
ρ	Track Density .
ρ_s	Track density of standard sample.
ρ_x	Track density of unknown sample.
μm	Micrometer.
μg	Microgram.

List of Abbreviations

Symbol	***Description***
SSNTDs	Solid State Nuclear Track Detectors.
TEM	Transmission Electron Microscopy.
LiF	lithium fluoride.
GERL	General Electric Research Laboratories.
HF	hydrogen fluride.
NaOH	Sodium Hydroxide.
TCC	Transition of cancerian cell.

ppm	part per million.
ppb	Part per billion.
Bq	Becquerel.
IAEA	International Atomic Energy Agency.
ICRP	International Commission of Radiation Protection.

Chapter One

Introduction and General Review

1.1. Introduction

Radiation is a fact of life. We live in a world in which radiation is naturally present everywhere. Light and heat from nuclear reactions in the sun are essential to our existence. Radioactive material occurs naturally throughout the environment, and our bodies contain radioactive materials such as carbon-14, potassium-40 and polonium-210 quite naturally. All life on Earth has evolved in the presence of this radiation. We can classify radiation according to the effects it produced on matter, into ionizing and non-ionizing radiation. Ionizing radiation include cosmic rays, X rays and the radiation from radioactive materials, Non-ionizing radiation includes ultraviolet light, radiant heat, radiowaves and microwaves [1].

1.2. Radioactivity and radiation

Although many nuclides are stable, most are not. Stability is determined mainly by the balance the number of neutrons and protons a nuclide contains. Smaller stable nuclei have about equal numbers: larger stable nuclei have slightly more neutrons than protons. Nuclei with too many neutrons tend to transform themselves to a more stable structure by converting a neutron to proton: this process, known as beta decay, results in the emission of a negatively charged electron called a beta particle. Nuclei with too many protons convert the excess protons to neutrons in a different form of beta decay: they lose positive charge through the emission of a positron, which is a positively charged electron [1,2].

These transformations often leave the nucleus with excess energy that it loses as gamma rays: high energy photons, which are discrete parcels of energy without mass or charge. The spontaneous transformation of a nucleus is called radioactivity, and the excess energy emitted is a form of radiation. The act of transformation is termed "decay" and the nuclide that changes and emits radiation is called a "radionuclide". Some heavy nuclei decay by producing an alpha particle consisting of two protons and two neutrons. Identical with a nucleus of helium, the alpha particle is much heavier than the beta particle and carries two units of positive charge [1,3].

1.3. Radioactivity in human body

Alpha-emitters like uranium, for example, enters the bodies through the food we eat ,or the water we drink and the air we breathe and also by absorption through the skin. When we breathe the dust of the α-emitting material, some of it is exhaled and some stays in our lungs. The size of these dust particles and how easily they dissolve determine where in the body the α-emitting element goes, and how it leaves our bodies.

The α-emitting element may consist of small, fine particles and coarse, big particles .The big particles are caught in the nose, sinuses, and upper part of the lung where they are blown out or pushed to the throat and swallowed. The small particles are inhaled down to the lower part of the lung. If they do not dissolve easily, they stay there for years and cause most of the radiation dose to the lung. From α-emitting elements they may gradually dissolve and go into the blood. If the particles do dissolve easily, they go into the blood more quickly[2].

A small part of the α-emitting elements we swallow will also be found in the blood and the blood carries it throughout the body. Most of it leaves in the urine in a few days, but a little stays in the kidney and bones. When

we eat foods and drink liquids containing α-emitting materials, most of it leaves within a few days in the feces and never enters the blood. A small portion will get into the blood and will leave the body through the urine within a few days. The rest can stay in our bones, urinary system, kidney, uterus, bladder, and in the prostate in the male or other soft tissues. A small amount goes to the bones and may stay there for years[2].

Most people have a very small amount of α-emitting elements like uranium in their bodies, mainly in the bones. Although uranium is weakly radioactive, most of the radiation it gives off cannot travel far from its source. If it is outside the body, such as in the soil, most of its radiation can penetrate the skin and enter the body[3]. If uranium transformation products are also present, one can be exposed to their radiation at a distance as shown in fig.(1-1).

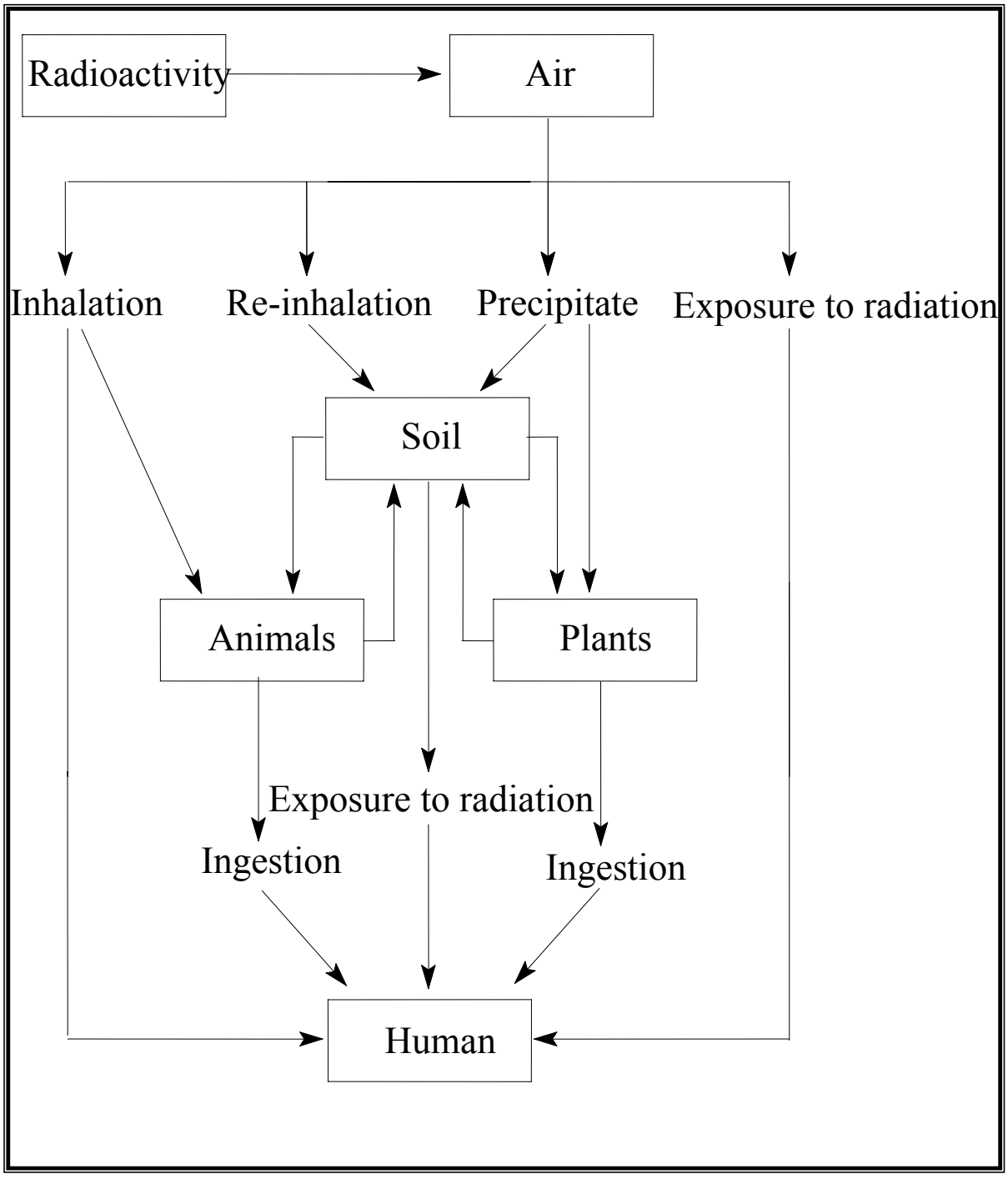


Figure (1-1):- Design of translation of radiation from air to the human body [4].

1.4. Hazards of heavy nuclide in human body

Any operation or activity that handles heavy radioactive isotopes should consider measures to protect personnel from the potential chemical and radiological hazard. The level of protection to be used and the extent of the required program will depend on:

1- The quantities of material being handled or processed.
2- The physical and chemical properties of the material (e.g. chemical form, particle size).
3- The nature of the operations being conducted.

Heavy radioactive isotopes (and for the sake of concreteness let us take uranium as an example) have both chemical and radiological toxicity with the two important target organs being the kidney and the lung[5] .

-Kidney

Retention of uranium in the kidney has been attributed to the complex proteins and phospholipids in the proximal tubules, considered to be the main site of kidney damage. Animal studies have shown that long term exposure to uranium causes nephrotoxic effects that ranged from minimal microscopic lesion in the tubular epithelium (low concentrations) to tubular necrosis (high concentrations).

Long term studies of workers chronically exposed to uranium have reported impairment of the kidneys (proximal tubular epithelium) that depended on the level of exposure. Studies of members of the public chronically exposed to uranium in drinking water have also shown similar signs of impairment of kidney function. There is some evidence that kidney function returns to normal once the source of excessive uranium exposure has been removed[6] .

-Lung

Pulmonary toxicity of uranium varies depending on the animal species studied and the chemical form of the uranium. Some early studies on animals reported pulmonary oedema and hemorrhage following exposure to some uranium compounds (e.g. uranium peroxide, uranium trioxide) but not others (uranium dioxide). However, more recent long term studies using a range of animals inhaling various uranium compounds, both soluble and insoluble, did not reveal any histological damage to the lungs.

In a number of studies on uranium miners, an increased risk of lung cancer has been demonstrated but this has been attributed to exposure from radon decay products. There is a possibility of lung tissue damage leading to a risk of lung cancer if a high enough radiation dose results from insoluble DU compounds remaining in the lungs over a prolonged period (many years) [6] .

-Skin

Erythematic or other effects on the skin should not occur even if DU is held against the skin for prolonged periods (weeks). There are established data to suggest that skin cancer occurs from skin contact with uranium dusts[6] .

-Liver and skeleton

Autupsies of individuals chronically exposed to uranium have found that the average ratio of the amount of uranium in skeleton, liver and kidney was 63:2.8:1. The uranium content in the skeleton may reflect its affinity for phosphate which is abundant in the bone. No consistent or confirmed adverse effects have been reported for the skeleton or liver. Few studies have been conducted[6] .

1.5. Disintegration of radionuclides in human body

The dose rate to any organ is proportional to the amount of radioactivity in the organ and decreases as the radioactive isotope decays or is execreted fig (1-2):-

$$\lambda_{eff} = \lambda_r + \lambda_b \qquad \text{..... (1-1)}$$

where λ_r : radioactive decay constant.

λ_b : Biological decay constant.

λ_{eff} : effective decay constant.

The radioactive decay of an isotope is exponential and it is found that the rate of excretion of most substances from the body is also considered as exponential. This means that an effective decay constant can be employed to describe the rate of a radioactive substance from the body [7].

Since the decay constant is equal to,

$$\lambda = \left(\frac{ln2}{T}\right) = \frac{0.693}{T} \qquad \text{..... (1-2)}$$

This equation becomes:

$$\frac{1}{T_{eff}} = \frac{1}{T_r} + \frac{1}{T_b} \qquad \text{..... (1-3)}$$

where:

T : half-life

T_{eff} : effective half – life of a radioactive substance in the body.

T_r : radioactive half – life of the substance.

T_b : biological half – life of the substance.

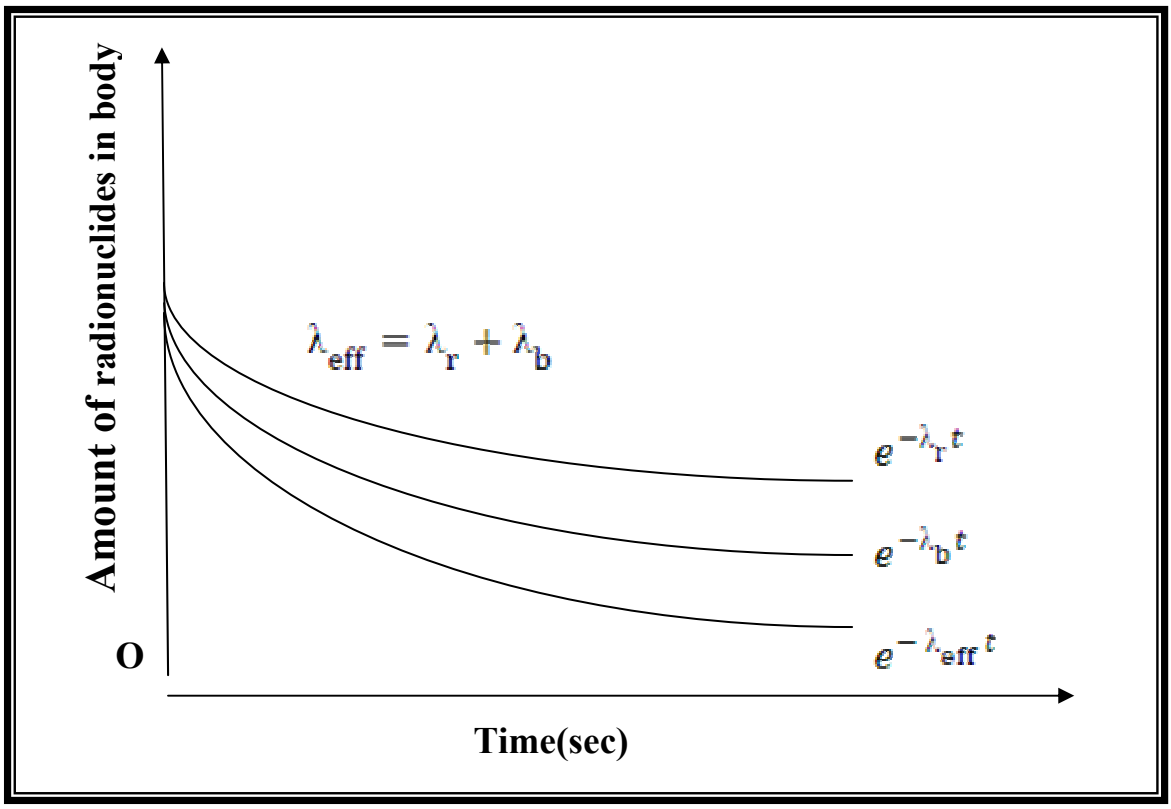


Figure (1-2):- Typical elimination curves of a radionuclide in body [7].

The initial rise in the curve covers the period during which the nuclide is being transported to the organ of interest. At the peak most of the radionuclide that is destined for the particular organ has reached it and the organ is receiving its maximum dose rate subsequently since the dose rate to the organ decreases exponentially as the radionuclide decays and is excreted [7]. The total dose received by the organ is obtained by evaluating the area under the curve fig. (1-3).

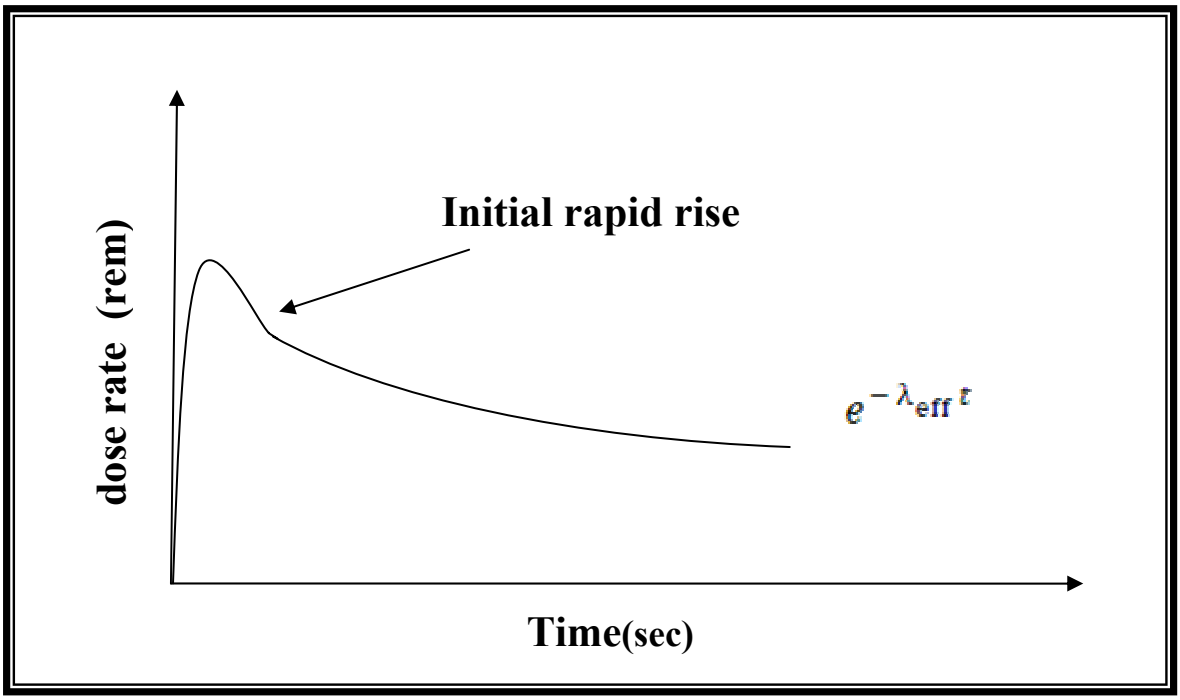


Figure (1-3):- Variation of dose rate with time following an intake of a radionuclide [7].

1.6. Solid State Nuclear Track Detectors

The solid state nuclear track detectors (SSNTDs) can be defined as those materials which will have, upon being exposed to a certain dose of radiation, one or more of its measurable parameters changed. The passage of heavy ionizing nuclear particles through most insulating solids creates narrow paths of intense damages on an atomic scale. These damage "tracks" can be revealed and made visible either directly by using Transmission Electron Microscopy (TEM) or indirectly by chemical etching and using an ordinary optical microscope [8].

The idea of solid state nuclear track detector began in 1958, when Young working at the atomic energy research establishment at Harwell in England, observed that when lithium fluoride (LiF) crystal held in

contact with uranium foil was irradiated with thermal neutrons, a number of pits (damage regions) were revealed after treating the bombarded crystal with chemical reagent[9]. The number of these pits showed a complete correspondence with estimated fission fragments which had recoiled into the crystal from the uranium foil. In 1959, Silk and Barnes working in the same establishment had recorded direct observations of damage regions, as hair-like tracks, in mica [10]; they were the first to be observed on a Transmission Electron Microscope (TEM). Then, in a very short period of time a number of experiments were performed which led to the discovery of etching technique and the optimum conditions of etching. These experiments led Fleischer, Price and Walker working together at the General Electric Research Laboratories (GERL) at Schenectady, New York to extend the etching technique of Young (his work was unknown to them at that time) [9]. They repeated and developed the observations published by Silk and Barnes [10] by introducing fission fragment and other heavily charged particles in many solids where they observed the tracks directly using an electron microscope [11,12]. They also showed that the fission fragments in mica can be revealed by etching with a selective chemical agent of hydrogen fluride (HF) to observe the latent tracks by an optical microscope [13,14]. The successive studies of etchable tracks observation led to a fact that the nuclear track registration and etching are a general phenomena in all dielectrics [15].

Since 1960, SSNTD have been widely used for nuclear track registration. Many types of these detectors which have been introduced are grouped in to two categories one is the inorganic detectors such as mica, glass, etc. and the other is the organic detectors (plastic) including CN-85, LR-115, CR-39, PM-355, Lexan, Mikrofol, etc. The particle properties of the detectors such as availability, ease of use and low cost

led to its rapid application in a wide variety of fields of science and technology, mostly in nuclear and particle physics, nuclear dosimetry, cosmic rays, etc. Moreover, these also are used in other fields such as geophysics, astrophysics, plasma physics, medicine, biological science and radiography. Significant nuclear physics experiments began to be carried out in an increasing speed after the discovery of track detectors. The SSNTDs have become an important tool in the investigation of uranium exploration and in the detection of radon gas environmentally. The increased importance of SSNTDs and their wide application rendered them necessary to study the tracks structure formation, their properties and the extreme influence of environmental parameters on them[16].

In 1962, Price and Walker [17,18] introduced fission fragments and other heavy charged particles in many solids (mica, plastic, etc) and observed their tracks directly by an electron microscope as well as after selective chemical etching by an optical microscope. Subsequently, they showed that this was a general phenomenon that was observed in many other dielectrics including other minerals, glasses and polymers [15,19].

1.7. Formation and revelation of tracks in nuclear tacks materials

Operation of the solid state nuclear track detectors is based on the fact that a heavy charged particle will cause extensive ionization and excitation of atoms along their path. They produce narrow trails of material damage on an atomic scale (about 10 nm in diameter).

The narrow trail of damage caused by an energetic particle penetrating some distance into a solid is illustrated schematically in fig.

(1-4). It is possible to divide the damage process into five sequential stages:

1- Electrons are stripped from the penetrating particle.
2- The region in which the particle is moving too fast to leave damage.
3- The main region of etchable damage.
4- The stage during which the particle still penetrates the solid but does not produce significant damage.
5- The point at which the particles come to rest which may be preceded by a short second region of damage [20].

Not all these stages are necessarily apparent.

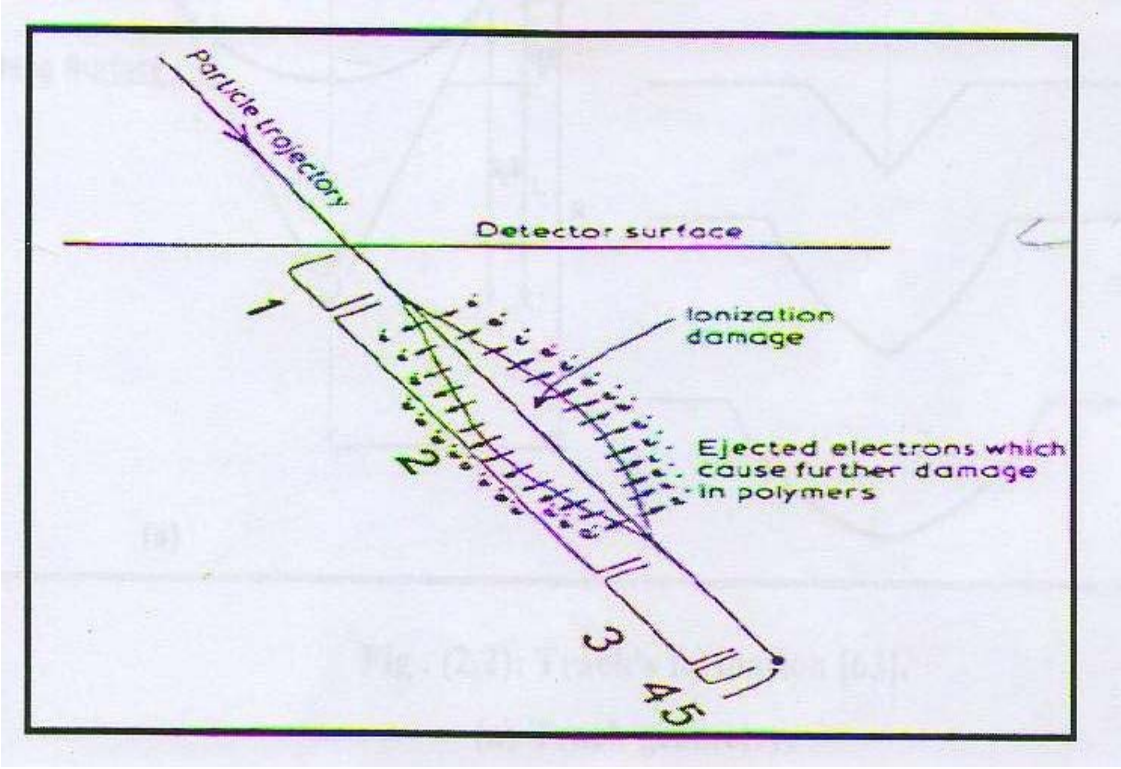


Figure (1-4):- Stages of damage process [20].

Nuclear track detectors are electrically insulating materials with specific resistance ranging from (10^6 to 10^{20} ohm.cm.). Charged

particles (protons, alpha particles and fission fragments) produce tracks by their passage through these materials wherein narrow trajectories are generated by the radioactive deterioration represented by the atomic defects lattice vacancies and molecular chains breakages [20].

These thin tracks are known as (latent tracks). The deteriorated regions can be seen by using the electronic microscope directly or by using the optical microscope after treating them with a chemical substance causing etching and revealing of the forming deteriorated regions. An important characteristic of SSNTDs is the possibility of expanding the minimum limit of deterioration (damage) density along the track or by the etching technique [21] .Figure (1-5) shows the latent track formation stages

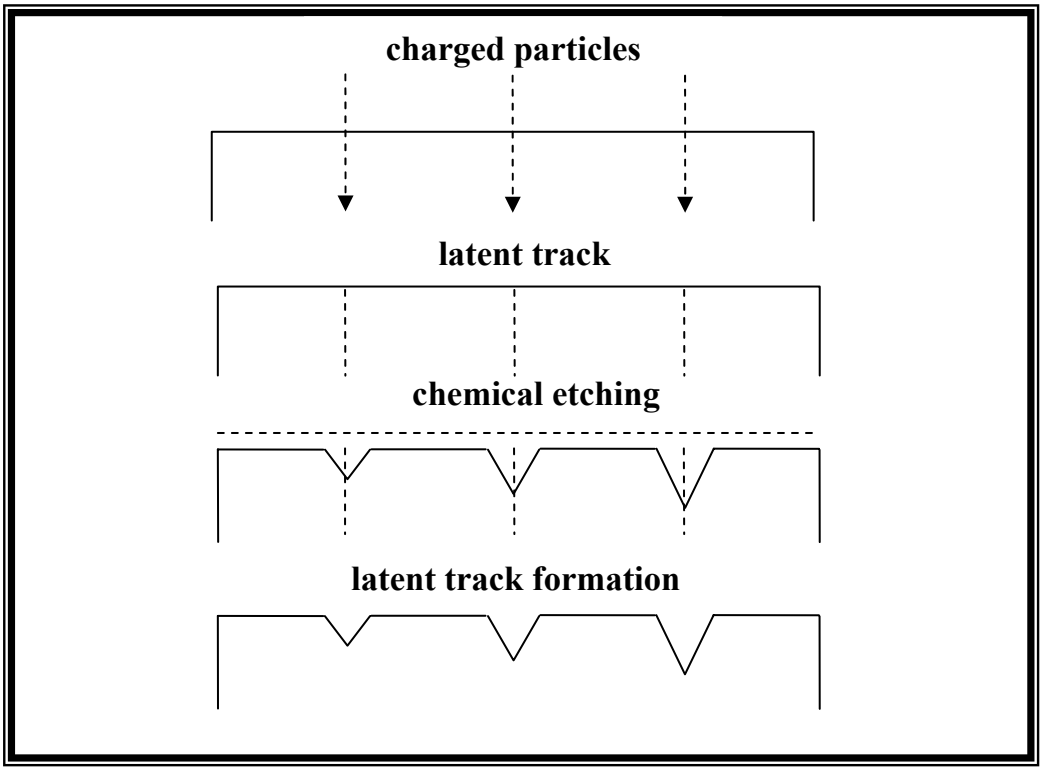


Figure (1-5):- Stages of the latent track formation [21]

The form and kind of the deteriorated (damage) region depend not only on the incident particles variables (their mass, energy, and charge) but also on the kind of the solid detecting substance [22,23].

The damage region called (latent track) was discussed by Nikezic and Yu in their study "formation and growth of tracks in nuclear tracks materials"[24].

Al-Ani, 2000 [25] discussed in his study of transfer factors of radionuclides from soil to plant, the physical and chemical properties of the damaged regions which are highly chemically reactive because they need less activation energy for chemical attack (or etching). When such a SSNTDs containing the damaged trails produced by charged particle (for reproducible results) at a constant temperature, generally(NaOH or KOH) with (1-2)N at(40-60) ^{0}C [26], its bulk material is etched away at a constant rate (called the bulk or general etch rate V_B) but the material along the damaged region is etched out at a much faster rate (called track etch rate V_T) as shown in fig. (1-6). Since V_T is greater than V_B ($V_T > V_B$) after a suitable time when the size of the damaged region, its length or diameter becomes more than 1 micron, it will become easily visible as a hollow "etch pit" or "track" in a microscope at ordinary magnifications.

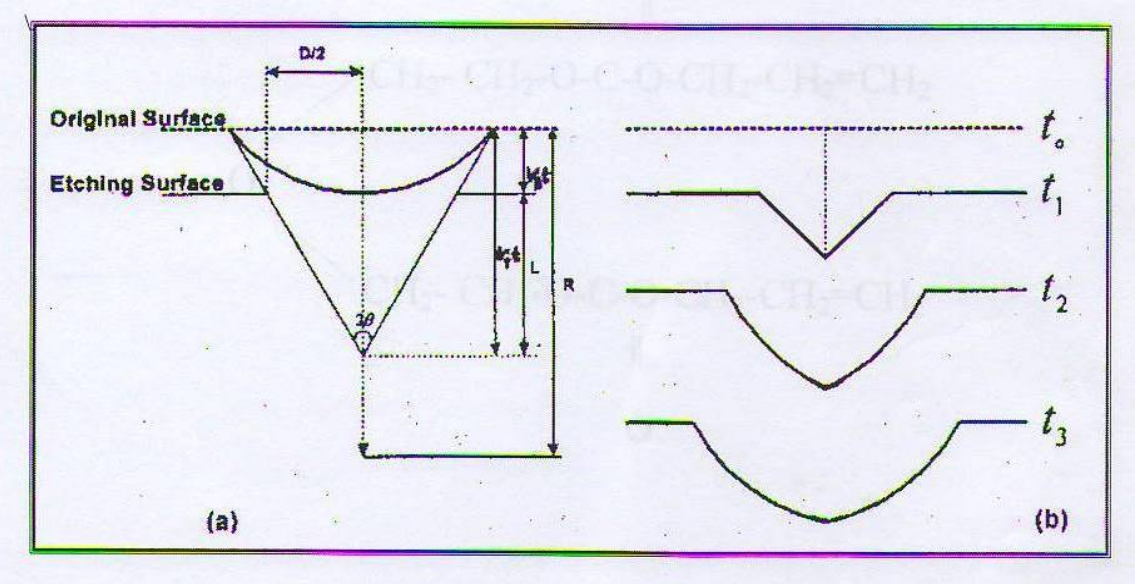


Figure (1-6):- Tracks formation. a-Tracks geometry. b- Tracks formation levels [27]**.**

There exists a great deal of scientific evidence indicating the existence of two mechanisms that can be excepted for explaining the latent track formation in insulating solid materials one for inorganic materials such as crystals and glass, and the other for organic materials such as polymers.

In the case of inorganic solid materials the (ion explosion spark) suggested by Fleischer and Walker in 1965[28] achieved success in explaining the latent track formation. It states that the heavy charged particle produces a huge number of primary ionizations along its trajectory thereby generating positive ions as in the fig. (1-7) a.

These ions intensively strike the electrons of the colliding atoms in the regions neibouring its trajectory thereby resulting in a cylindrical region filled with positive ions repelling each other intensively as shown in the Fig.(1-7)b. If the force of repulsion is greater than the force of attraction of the solid material atoms then deformation occurs to the crystal of atoms leaving behind it an empty cylindrical core that can be seen by an electron microscope, or by the optical microscope after treating it chemically by the etching process.

Fig.(1-7)c. represents the tension and the elastic pacification inside the material tissue as a result of the wide propagation of tension.

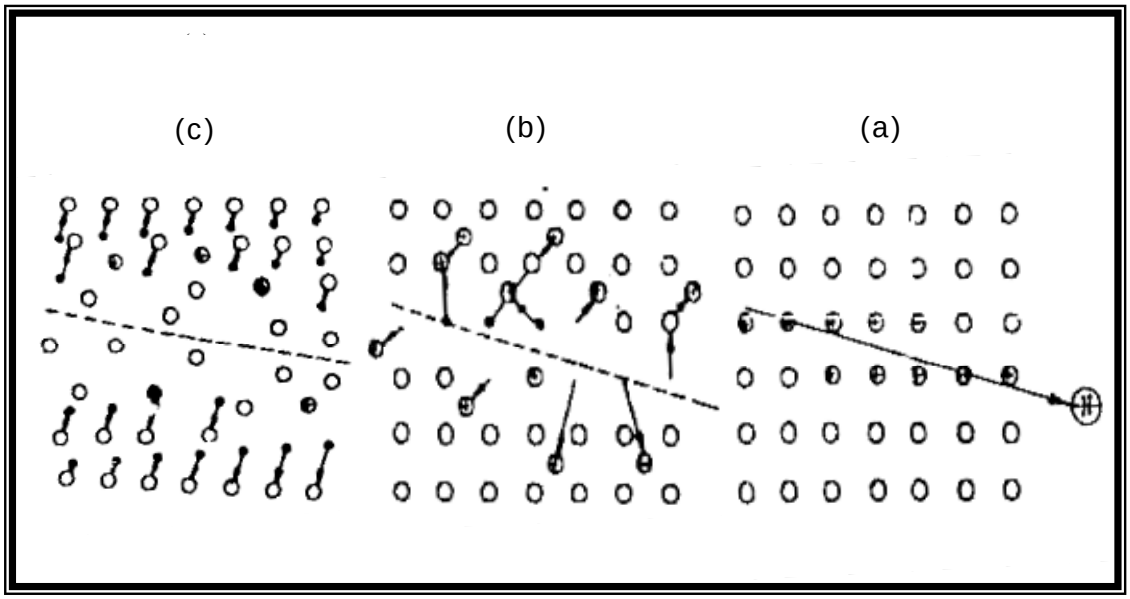


Figure (1-7):- Shows the ionic explosion spark for track formation in inorganic materials: a-ionization, b-repulsion and displacement, c- tension and pacification [29]**.**

In organic material the main effects of radiation on polymers is the dissolution or cross linking of their molecules. These two effects represent the main changes in the characteristics of polymers. Radiation incident on them results in agitation and ionization of the molecules and consequently in breaking the bonds among them, and causing damage to the material of the polymer as shown in fig**.** (1-8). These damaged regions reveal a greater ability for interacting with alkali solutions such as sodium hydroxide (NaOH) as compared with a sound (undamaged) region.

The chemical solution penetrates the irradiated regions quickly causing a track whose depth increases and diameter expands with

increase in etching time. The ionization radiation tracks after being revealed can be seen with the optical microscope [30].

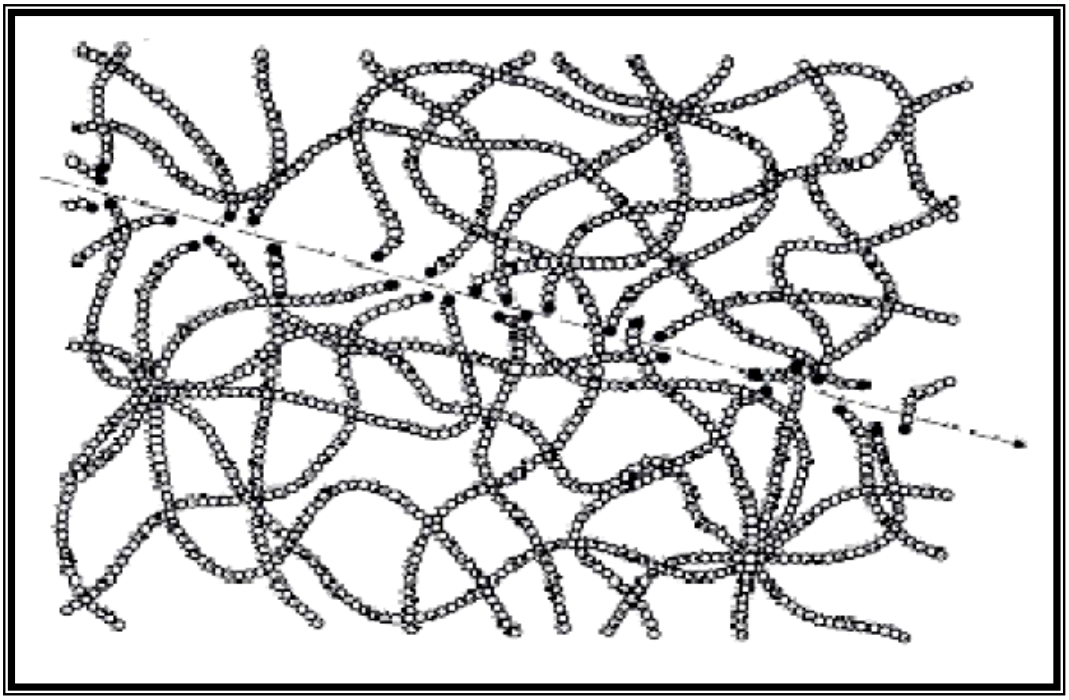


Figure (1-8):- Shows the effect of radiation on polymer chains [29]**.**

1.8. The Structure of PM-355

A polyaillyl diglycol carbonate detector, is an advanced version of the detector CR-39.

The (PM-355) detector has a high efficiency to record the tracks in comparison with other detectors and it has some specifications as:

1- Optically transparent.

2- Very sensitive to radiation.

3- Highly isotropic and homogeneous.

4- Not cross-linking after radiation damage has broken the chemical bonds.

5- Having a non-solvent chemical etchant.

6- This polymer is resistant almost to all solvents, and the thermal neutron interacting with the hydrogen atoms in PM-355 or radiator produces a recoil proton that scatters with a calculable change of interaction with the polymer by breaking the polymer cross-linking bonds and causing a damage site. When the PM-355 polymer is chemically etched with a caustic solution, fragments of the broken bond are selectively extracted .This chemical change results in the formation of a pit in the material 1993[31].

1.9. The Chemical Etching

Ionizing particles passing through polymeric track detectors produce latent tracks, which are trails of radiation damage [33]. The best means of observing the tracks is by etching the SSNTDs material with a chemical solution, which preferentially attacks the damaged material and enlarges the original track [34] to a size, which is visible in the optical microscope.

The basic properties of the nuclear track etch technique are [35]:

1- Single – particle drilling tool.
2- Adjustable hole diameter.
3- Uniform hole size, length and orientation.
4- Adjustable hole density.
5- Applies to a large variety of materials.

Essentially etching takes place via rapid dissolution of the disordered region of the track core, which exists in a state of higher free energy than

the undamaged bulk material [22]. The reagent must be capable of slightly etching the bulk material, while at the same time preferentially attacking the particle damage trails. Fig.(1.9) shows the track etching process. In fact the radiation damage trails produced by charged particles consist of disordered structure which in turn are associated with a large free energy. They, therefore, represent a region of enhanced chemical activity. These regions get preferentially dissolved and their dimensions are enlarged when they are brought in contact with an etching solution.

The etching conditions are optimized empirically for each detector material [36]. In general, etchants for polymeric detectors are frequently solutions of alkali hydroxides such as NaOH or KOH with 1-12 N at 40 – 60 ^{0}C [37,38]. For glasses and minerals, crystals such as quartz, mica, and certain pyroxenes are etched in aqueous solutions of acids such as HF with ~ 48% concentration at 20 ^{0}C [39,40].

Etching times can vary from few seconds to many hours. It vary according to the exact etching conditions; the temperature and the concentration of the etchant[41].

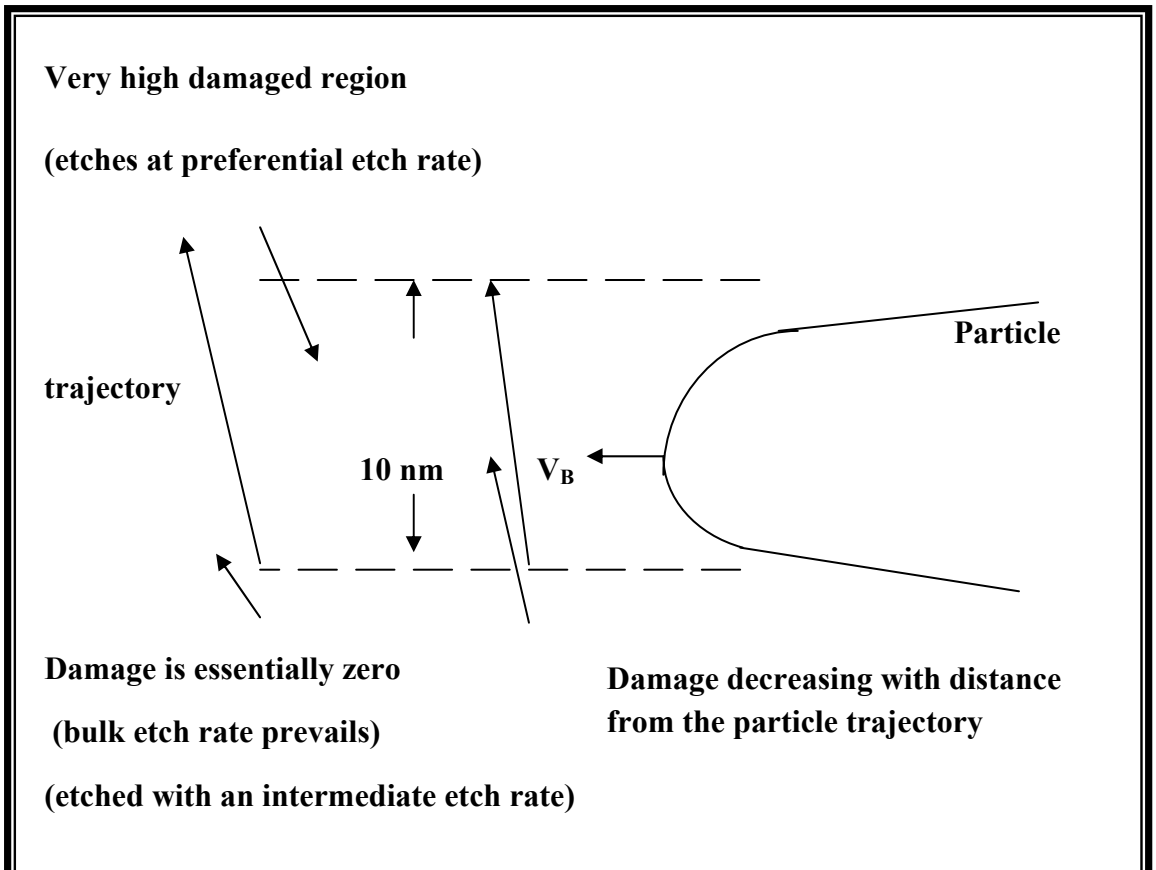


Figure (1-9) :- Track etching process [41].

1.10. Track Affecting Parameters

There are two important factors that affect the appearance of a track ; the track etch rate velocity V_T and the bulk etch rate velocity V_B .

1.10.1. The Track Etch Rate Velocity (V_T)

The track etch rate can be defined as the ratio of dissolution of a detector along the line of the track [42] . Its value depends on the detector type , etching conditions , the particle velocity and it's energy . Experiments prove that V_T increased with increasing the rate of ionization for different organic and inorganic detectors[43,44] .

The relation between V_T and the temperature of the etching solution is [22]:

$$V_T = B \exp (-E_T / K T) \qquad \text{……..…(1-3)}$$

where :

B = constant .

K = Boltzmann constant = 1.38×10^{-23} J mol/K

T = temperature of the etching solution (K).

E_T = activation energy of the track etch(J) .

1.10.2. The Bulk Etch Rate Velocity (V_B)

The bulk etch rate is the rate of dissolution of the stored detector normal to the surface and energy remote from any track [42] . It is an important parameter for determining the track sensitivity of SSNTD [45]. It depends on the construction of the plastic , the constituents of the etching solution , it's concentration and temperature [46]. It is found that for a given homogenous and isotropic solid , the bulk etch rate velocity V_B increases exponentially with etching temperature and concentration of the etching solution [29]. The bulk etch rate is found to satisfy the following relation [45]:

$$V_B = A \exp (-E_B / KT) \qquad \ldots\ldots\ldots\ldots(1\text{-}4)$$

where :

A = constant

E_B = activation energy of the bulk etch .

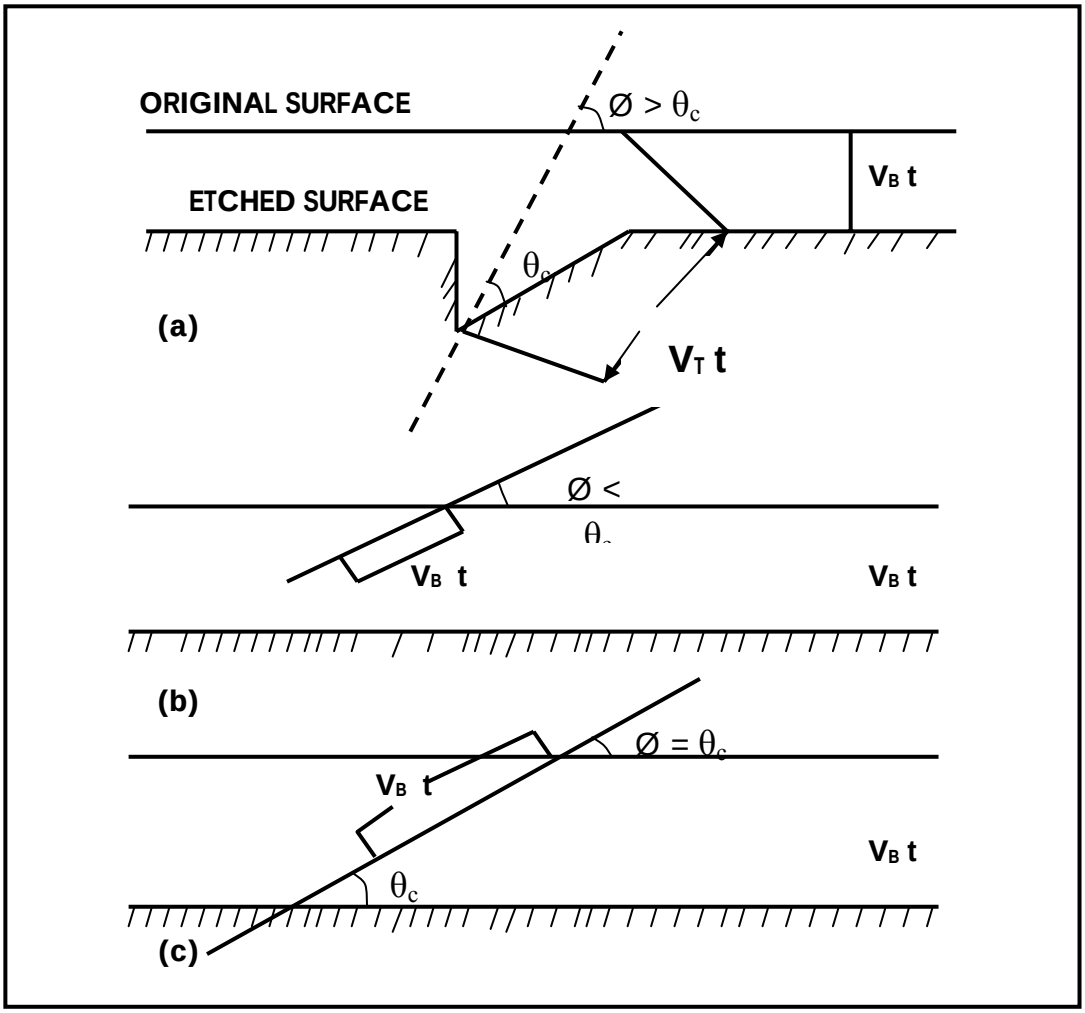
K = Boltzmann constant .

1.11. Critical Angle for Etching

For every SSNTDs etched under a given condition , there is found to exist certain minimum angle called the critical angle (θ_c) , measured from the detector surface below which if the particle enters the detector surface, its tracks cannot be observed after etching because in that case the surface etches faster than the track is formed [29]. this limitation is due to the geometry of track etching .

From the geometry of track etching fig.(1.10), one can find for constant V_B and V_T that [29]:

$$\theta_c = \sin^{-1} (V_B / V_T) \qquad \ldots\ldots\ldots\ldots (1\text{-}5)$$



Figure(1-10):- A track etching of a particle incident obliquely on the SSNTD: (a) track pit shape , its etching observed length and diameter depend on the two etch rates V_T and V_B (or their ratio V_T / V_B). (b) If the particle enters at very small angle from the surface such that the normal component of V_T is less than V_B , no etched track can be observed, as the surface is removed more rapidly than the track develops. (c) The critical value θ_c is obtained when the normal component V_T sin θ is equal to $V_B = V_T \sin \theta_c$, $\theta_c = \sin^{-1} V_B / V_T$ [28,29]

1.12. The Etching Efficiency

The etching efficiency is defined as the ratio of the counted tracks and the number of particles incident on the detector surface.

Etching efficiency = (No. of etched tracks / No. of incident particles)

The efficiency (η) depends on the track etched rate velocity V_T and the bulk etched rate velocity V_B as present in eq.(1.5) [47] :

$$\eta = 1 - (V_B / V_T) \qquad \text{……..….(1-6)}$$

or :

$$\eta = 1 - \sin \text{Ø} \qquad \text{....……. ….(1-7)}$$

1.13. Track Etching Geometry

The track etching geometry depends on the angle of incident particle which it makes with the surface detector. However, we cannot record the tracks when the angle of incident particle Ø (placed between the particle passage and detector surface) is less than the critical angle.

We can see the track when V_T is greater than V_B, i.e. $(V_T / V_B) > 1$. The incident particles on the track detector can be identified by the charge Z or effective charge Z_{eff}, the mass M and the energy E or relativistic velocity ß (= ν/ c). The difference in these parameters of the incident particles produce changes in the track etching parameters, a total

range of the particle through the detector material R(track length), the track etching velocity V_T and the variation of V_T with position along the track. The etched track has a conical shape and the easily measurable parameters are the conical etched-out length L_e and the diameter d of the etch pit opening.

The etched track formation process can be envisioned as the incident particle parameters (charge Z, mass M and energy E) representing the input parameters, while the etched track parameters (track length L_e , axes, profile and contour) represent the output parameters. The all processes in-between the above-mentioned parameters represent the damage formation and the etching principle [32]. In the simple instance is a particle penetrating a detector material to its original surface as in fig. (1-11).

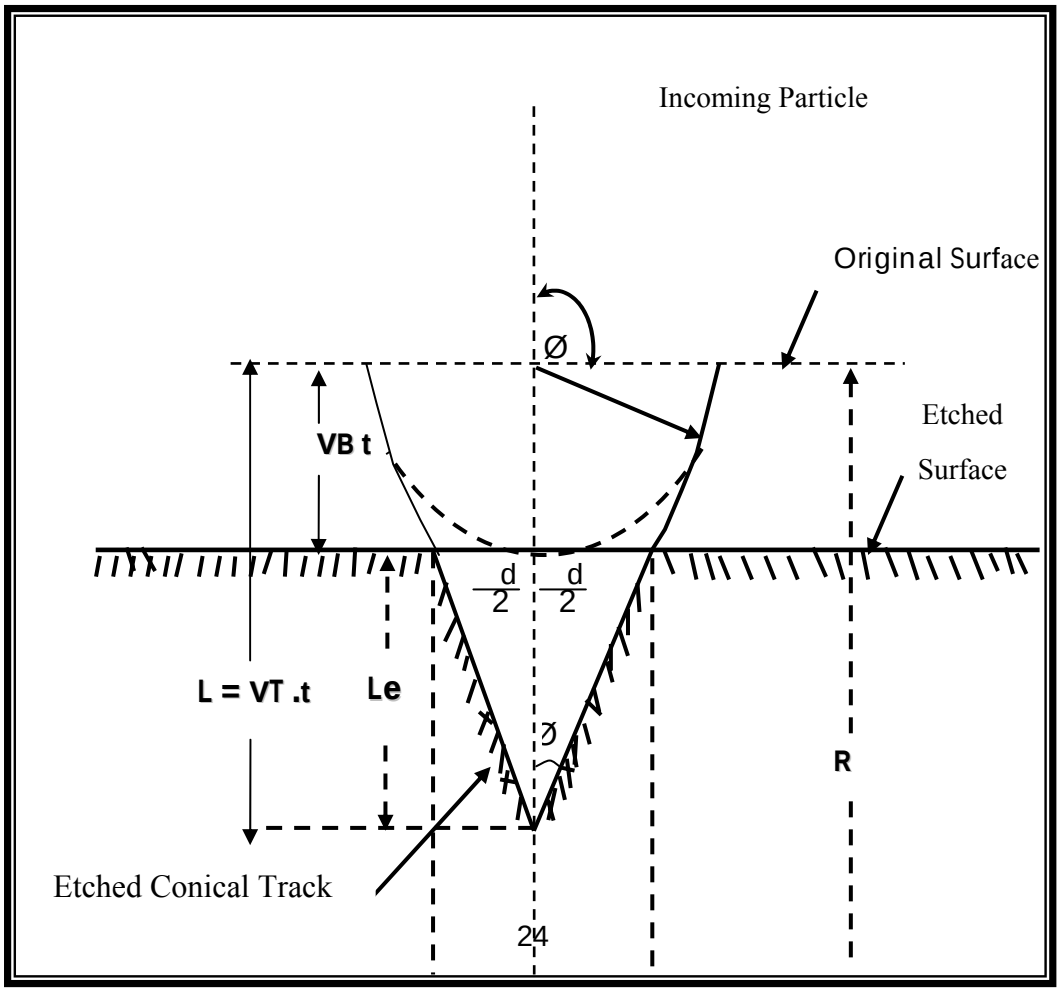


Figure (1-11):- track geometry for a particle penetrating a detector material normally [22,32].

The line of attack down the track, i.e., V_T , is such that in an etching time t, the etch pit will extend to a distance L from the point of origin, then [29]:

$$L = V_T \cdot t \qquad \text{..... (1-8)}$$

The surface is also removed at a rate V_B, so the full length of the etch pit is [28,29].

$$L_e = V_T \cdot t - V_B \cdot t \qquad \text{..... (1-9)}$$

The diameter of the etch pit is related to V_B and V_T according to this equation [32]:

$$d = 2V_B \cdot t \left[(V_T - V_B) / (V_T + V_B) \right]^{1/2} \qquad \text{..... (1-10)}$$

and the removed surface thickness h is [55]:

$$h = V_B \cdot t \qquad \text{.....(1-11)}$$

The etching rate ratio is represented in this equation:

$$V = V_T / V_B \qquad \text{..... (1-12)}$$

It is clear from these equations that, the track diameter d and the length of the etched track L_e depend essentially on the competitive effects of V_T and V_B. When $V_B = V_T$ both L_e and d vanish, then no track is produced[32].

1.14. Application of the SSNTDs

The advantage of SSNTD over nuclear track emulsion in detecting charged particles have resulted in an almost complete replacement of the latter in many fields of application [48]. Researchers have already found numerous applications in physics, medicine, geophysics and technology [49].

The physical applications include:

1. Nuclear fission and spoliation reaction [49].
2. Lifetime of heavy unstable nuclear particle.
3. Ternary fission [50].
4. Neutron dosimeter [22].

In medicine, etched track detectors have been used to determine:

1. The deposition of inhaled UO_2 particles in rat's lung [51].
2. The micro-distribution of inhaled alpha emitters [52].
3. The concentration of radioactive nuclides in tissues and in blood [53].

In geophysics these detectors have been used in geochronology [54], also in fission track dating of lunar samples and meteorites [22].

In technology, these detectors have been used as a fine siever for the filtration of cancer blood cells [55], in aerosol filtration [56], and in

studies of personal dosimeter to measure neutron fluxes at nuclear reactors.

1.15.Urinary System

Urine, recognition and analysis of abnormalities of this substance, expelled from the body can provide information about the condition of the body - both concerning general health, and also specific medical conditions.

Biochemical analysis of urine is called "urinalysis", and is commonly used to diagnose a wide range of diseases. Examples include high levels of urinary glucose in diabetics, and high levels of urinary ketene bodies in cases of ketonuria. Immunological analysis of urine is the basis of most pregnancy tests[57].

1.16. Typical normal volume of urine

The actual quantity per person per day is affected by factors such as: recent fluid intake (water, and other food/drinks that include water) , diet , temperature , blood pressure , general health (some disease states may affect urine volume/time) ,and mental state.

However, The amount per day varies considerably. 1-2 liters / day per normal adult [58].

1.17.The characteristics of normal urine

Volume is one of the physical characteristics of urine. Other physical characteristics that can apply to urine include colour, turbidity

(transparency), smell (odour), pH (acidity - alkalinity), and density.

- **Colour**: Typically yellow-amber but varies according to recent diet and the concentration of the urine. Drinking more water generally tends to reduce the concentration of urine, and therefore cause it to have a lighter colour. The converse is also true.

- **Smell:** The smell or "odour", which is the more clinical term, of urine may provide health information. For example, urine of diabetics may have a sweet or fruity odour due to the presence of ketones (organic molecules of a particular structure). Generally fresh urine has a mild smell but aged urine has a stronger odour, similar to that of ammonia[57].

- **Acidity**: pH is a measure of the acidity (or alkalinity) of a solution. The pH of a substance (solution) is usually represented as a number in the range 0 (strong acid) to 14 (strong alkali, also known as"base"). Pure water is "neutral" in the sense that it is neither acid nor alkali, it therefore has a pH of 7. The real significance of pH in terms of physical chemistry is that pH is a measure of the activity of hydrogen ions (H+) in a solution. The pH of normal urine is generally in the range 4.6 - 8, a typical average being around 6.0. Much of the variation is due to diet. For example, high protein diets result in more acidic urine, but vegetarian diets generally result in more alkaline urine (both within the typical range 4.6 - 8).

- **Density**: ,or "specific gravity", is the ratio of the weight of a volume of a substance compared with the weight of the same volume of distilled water. Given that urine is mostly water, but also contains some other substances dissolved in the "water", its density is expected to be close to, but slightly greater than, 1.0. The density of normal urine is in the range (1.001 to 1.035)gm\ c^3 [57].

1.18. Properties and composition of normal human urine

Approximately 95% of the volume of normal urine is due to water, The other 5% consists of solutes (chemicals that are dissolved in the water). Some of these solutes are the results of normal biochemical activity within the cells of the body. Other solutes may be due to chemicals that originated outside of the body, such as pharmaceutical drugs. Solutes found in urine may be classified as ions (i.e., single elements that are positively or negatively charged due to loss or acquisition of one or more electrons from/to the outer-levels of the atom), or organic molecules (i.e., several, sometimes many atoms that have joined together to form a group of atoms called a "molecule"; "organic" molecules are formed from groups, rings, or chains of carbon atoms and are the "building blocks" of the living things on the earth - i.e., plants and animals) [58].

Organic molecules are electrically neutral and these include:

-Urea - Urea is an organic (i.e. carbon-based) compound whose chemical formula is: CON_2H_4 or $(NH_2)_2CO$. It is also known as "carbamide". Urea is derived from ammonia and produced by the deamination of amino acids. The amount of urea in urine is related to the quantity of dietary protein.

-Creatinine - Creatinine is a normal (healthy) constituent of blood. It is produced mainly as a result of the breakdown of creatine phosphate in muscle tissue. It is usually produced by the body at a fairly constant rate

(which depends on the muscle mass of the body).

-Uric acid - Uric acid is an organic (i.e. carbon-based) compound whose chemical formula is: $C_5H_4N_4O_3$. Due to its insolubility, uric acid has a tendency to crystallize, and is a common part of kidney stones.

-Other substances/molecules - Example of other substances that may be found in small amounts in normal urine include carbohydrates, enzymes, fatty acids, hormones, pigments, and mucins (a group of large, heavily glycosylated proteins found in the body).

Individual elements:

-Sodium (Na^+) : Amount in urine varies with diet and the amount of aldosterone (a steroid hormone) in the body.

-Potassium (K^+) : Amount in urine varies with diet and the amount of aldosterone (a steroid hormone) in the body.

-Chloride (Cl^-) : Amount in urine varies with diet and intake (chloride is a part of common salt, NaCl).

-Magnesium (Mg^{2+}) : Amount in urine varies with diet and the amount of parathyroid hormone in the body. (Parathyroid hormone increases the reabsorption of magnesium by the body, which therefore decreases the quantity of magnesium in urine.)

-Calcium (Ca^{2+}) : Amount in urine varies with diet and the amount of parathyroid hormone in the body. (Parathyroid hormone increases the reabsorption of calcium by the body, which therefore decreases the quantity of calcium in urine).

Small groups formed from a few different elements:

-Ammonium (NH_4^+) : The amount of ammonia produced by the

kidneys may vary according to the pH of the blood and tissues in the body.

-Sulphates (SO_4^{2-}) : Sulphates are derived from amino acids. The quantity of sulphates excreted in urine varies according to the quantity and type of protein in the person's diet.

-Phosphates ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) : Amount in urine varies with the amount of parathyroid hormone in the body - parathyroid hormone increases the quantity of phosphates in urine[58].

The composition of normal urine is given here.

1- Volume: 600- 2500 ml/24 hrs. Average: 1,200 ml.
2- Specific gravity: 1.003 - 1.030.
3- Reaction: Acidic (pH: 4.7 - 7.5) Average pH: 6.0.
4- Total solids: 30 - 70 g/liter.

Following inorganic constituents listed in table(1-1) are excreted per 24 hours [58].

Table (1.1):-Further constituents of urine

Constituent	Quantity excreted/24 hrs.
Sodium	3 - 4 g
Potassium	1.5 – 2 g
Chlorides	9 - 16g
Calcium	0.1 - 0.3 g
Inorganic phosphorus	1 - 1.5 g
Sulfur	0.7 - 3.5 g
Magnesium	0.05 - 0.2 g
Ammonia	0.3 - 1.0 g
Iodine	50 - 250 g
Arsenic	less than 50 µg
Lead	less than 50 µg
Urea	25 - 30 g
Creatinine	1 - 1.8 g
Uric acid	0.3 - 1.0 g
Creatine	60 – 150 mg
Hippuric acid	0.1 - 1.0 g
Purine bases	7 – 10 mg
Ketone bodies	3 - 15 mg
Oxalic acid	15 - 20 mg
Indican	4 - 2 mg

Allantoin	20 - 30 mg
Coproporphyrins	60 - 280 μg
Phenols	0.2 - 0.5 g
Vitamins, hormones, and enzymes	Detected in small quantities

1.19. Previous Studies

Many studies have been performed to investigate and measure the concentration of alpha emitters and radioactive elements in soil and biological samples by using different techniques, some of these studies are abstracted as follows:

- Koul and Chadderton., 1979 [59] measured the concentrations of uranium in whole blood and plasma for healthy people and other injured by leukemia using the track etch technique. The concentrations for healthy people ranged between (0.35-0.6 ppb) in whole blood, and (0.11 - 0.82 ppb) in plasma, where the concentrations ranged between (1.5 – 8.7 ppb) in whole blood, and (12 - 180 ppb) in plasma for injured by leukemia.
- Nagpaul and Parshah , 1979 [60] determined the concentrations of uranium in human blood by using track etch technique, as the concentrations ranged between (0.89 - 1.79 ppb).
- Romero et al. , 1984 [61] made a study in blood and plasma using track etch technique, They obtained uranium concentrations (1.4-1.5 ppb) in blood and (0.96- 1.6 ppb) in plasma.
- Durbin (1984) [62] suggested that uranium was excreted according to two half-lives. The first one ranges between 2-6 day, during which 92-95% of the uranium excreted, the remaining 5-8% of the uranium is excreted with half-life range of 30-340 days. This last excretion reflected the amount of uranium present in the kidney.

- Gaswami and Das , 1986 [63] studied the uranium concentrations in human blood by using track etch technique. The result was approximately ranged between 0.33 and 0.74 ppb.
- Nada et al. , 1989 [64] measured the uranium concentrations in samples from phosphatic rocks in western desert in Iraq using Lexan nuclear track detector. The concentrations were found between (6.9 – 9.83 ppm).
- Kathren., (1989) [65] studied the kidney autopsy of uranium fuel workers who spent long times working under permissible conditions and compared the results to workers not exposed to uranium . No abnormal pathological or anatomical changes were found.
- Marouf et al., 1991[66] measured the radioactive nuclide by using γ-spectroscopy in soil around Al-Tiwetha city, Iraq. and the concentrations were found between (778 – 5100 Bq / kg) .
- Othman. 1993 [67] studied the relation between uranium in blood and the number of working years in the Syrian phosphate mines. The author chose three carriers of uranium, blood, urine and hair. The results showed that uranium concentration in urine was ranged from 1.14ppb to7.06 ppb.
- Chruscielewski and Kaminski, 1999[68] measured the radon concentrations in water samples in Lodz, in Poland, the concentration was found between (200 – 11400 Bq / m^3) .
- Al-Timimi., 2000 [69] measured the concentrations of depleted uranium in the human blood and tissues by using CR-39 nuclear track detector. The concentrations ranged between (0.041 – 0.073 ppm) in the blood and (0.039 – 0.046 ppm) in the tissues.
- Dowser, 2001 [70] measured the concentration of alpha emitters in drinking water taken from different sites in Tigris River in Baghdad City in winter 2001 using CR-39 plastic track detector, The concentrations ranged between 0.32±0.07 ppm and 0.70 ± 0.08 ppm. The pre-refinement

concentrations were significantly higher ,their range is between 0.47 ± 0.06ppm and 0.92 ± 0.12 ppm.

- Aharmim et al., 2001[71]measured the radon concentrations in water samples in Morocco , the concentration was found to be 1 ppm.
- Al-Gailani, 2003 [72] made a study on human blood to determine the concentration of depleted uranium by using CR-39 nuclear track detector. The concentration of depleted uranium was (0.03 - 0.114 Bq /mol) in lymph cells.
- Ibraheem, 2003 [73] determined the concentrations of depleted uranium in injured human tissues by using CR-39 nuclear track detector,
- Hassan, 2006 [2] measured the uranium concentration in injured human blood for some governorates of Iraq (Baghdad, Basrah and Al-Ramadi) by using CR-39 nuclear track detector. The results were (0.073-0.22 ppm) in Baghdad, (0.965-1.992 ppm) in Basrah and (0.835-1.174 ppm) in Al-Ramadi.

1.20. The Aim of the Present Work

The aim of this study is to determine the alpha–emitters concentrations in urine samples for people working in phosphates and fertilizer plants, patients, painters, and nuclear laboratory staff, beside comparison with concentrations in healthy people.

The effects of working years and gender (male or female) are to be considered.

Chapter Two

Materials, Apparatus and Methods

2.1. Introduction

This chapter describes at first the collection of samples of human urine from different people in Iraq. It then explains the materials and the apparatus employed in this work. Finally it discusses the methods of estimation of alpha emitters concentrations in the samples taken.

2.2 Urine Samples

Samples of urine were collected from different people in quantities sufficient for the purpose of the research. These samples include different cases according to the following classification ;

2.2.1 Reference healthy people

Samples were taken from people with age ranging from 3months to 68 years including males and females, as shown in Table (2-1).

2.2.2 Painters

Five samples of urine were taken from painters. The painters were all males with age ranging from 14 to 27 years and with different periods of work. Some of them were smokers and inflected with diseases in the urinary system as illustrated in Table (2-2).

2.2.3 Workers in phosphates and fertilizer plants

This group contains 15 samples, 5 of which were taken from the phosphates plant and 10 from the fertilizer plant situated in Akashat district in Al-Anbar governorate. These samples belonged to the male sex

only , and were classified according to age and period of work as shown in Tables (2-3)and (2-4).

2.2.4 Teaching staff in nuclear physics laboratory

Five urine samples were taken from the teaching staff in nuclear physics laboratory in the College of Science of Al-Nahrain University, as shown in Table (2-5) .

2.2.5. Patients

Thirteen samples were taken from patients in the Hospital of Radiation and Nuclear Medicine during the interval from October\2008 to November\2008 . Diagnoses of the cases of the patients showed that they had TCC of the urinary system . Four cases were of women inflicted with TCC in uterus, kidney and bladder and nine cases were of men who suffered from TCC in bladder and prostate ,as illustrated in table (2-6), (2-7),(details concerning these patients involved age , place of residence , and occupation).

2.2.6. Study protocol

Each patient was studied through a specially constructed protocol with detailed history including personal questionnaire as well as features related to hypertensive disorder, its duration, medication and biochemical investigation , and the patients were treated with radiation and chemical doses.

2. 3. Materials and Apparatus

2.3.1 Preparing of Materials

The following units were required:

1- Plastic containers for keeping urine samples .

2-A beaker.

3- Calibrated cylinder (250ml).

4- distilled water for preparing etching solution.

5- Sensitive balance for weighing 62.5g NaOH, (type of Mettler Garantia AE163, Switzerland).

2.3.2 Measurement Apparatus :

2.3.2.a Water Bath:

Water bath of the type (Labsco, Germany) was used in the present work. It included a thermostat, which could be operated over a range of 20 °C to 110 °C. However, in this study the chemical etching was carried out at 60 °C, and distilled water was used as the bath liquid. The accuracy of regulation of temperature for the bath used was better than ± 0.1 °C.

2.3.2.b Optical Microscope:

The optical microscope is of the type (Motic, Malaysia . It is capable of giving magnifications of 40x and eye piece 10x to measure number of tracks and calculating the track density from the following equation:

Track density (ρ) = average of total track / area of field view .....(2-1)

2.3.2.c Track Detectors :

Commercially available sheets of PM-355 plastic which are presently known to be the most sensitive SSNTD and also characterized by low background were extensively used in the present work. The detector sheets of 250 μm thick were cut into small pieces. The present sheets of

PM-355 were made by Pershore Moulding LTD Company, U.K. and they were stored at normal laboratory conditions.

2.3.2.d The Etchant Solution:

Sodium hydroxide solution with 6.25 N normality has been used for the etching process, prepared as:

$W = W_{eq} \times N \times V$ ……..….. (2-2)

where:

W = the weight of NaOH needed to prepare the given normality.

W_{eq} = equivalent weight of NaOH = 40.

N = normality = 6.25.

V = volume of distilled water = 250 ml.

The etchant compartment has a volume of about 250 ml. This apparatus is a closed assembly, except for small vent at the top of the condenser tube, which prevents any change of etchant normality (concentration) during the experiment due to evaporation. The etching was performed at 60^0C while the etching time was 5 hours.

2.4. Experimental Procedure

In this research , we employed the natural exposure method for the measurement of alpha – emitters concentrations in the urine samples .

2.4.1.The natural exposure method

Before the treatment, the samples were left for (28-30)days to reach the equilibrium state for the radionuclides that exist in the samples. The

natural exposure method includes exposing the detectors to the urine samples directly for a certain period of time .

The detectors were immersed and stored in the urine samples of sufficient quantities at room temperature .The exposure times were 3 weeks and the detection geometry was 4π , and the experimental set up is shown in fig(2-1).

After the exposure period, all the detectors were etched in NaOH solution with 6.25 N at 60ºC for 5 hrs. The detectors were then washed in distilled water, dried using drier and were scanned under the optical microscope .

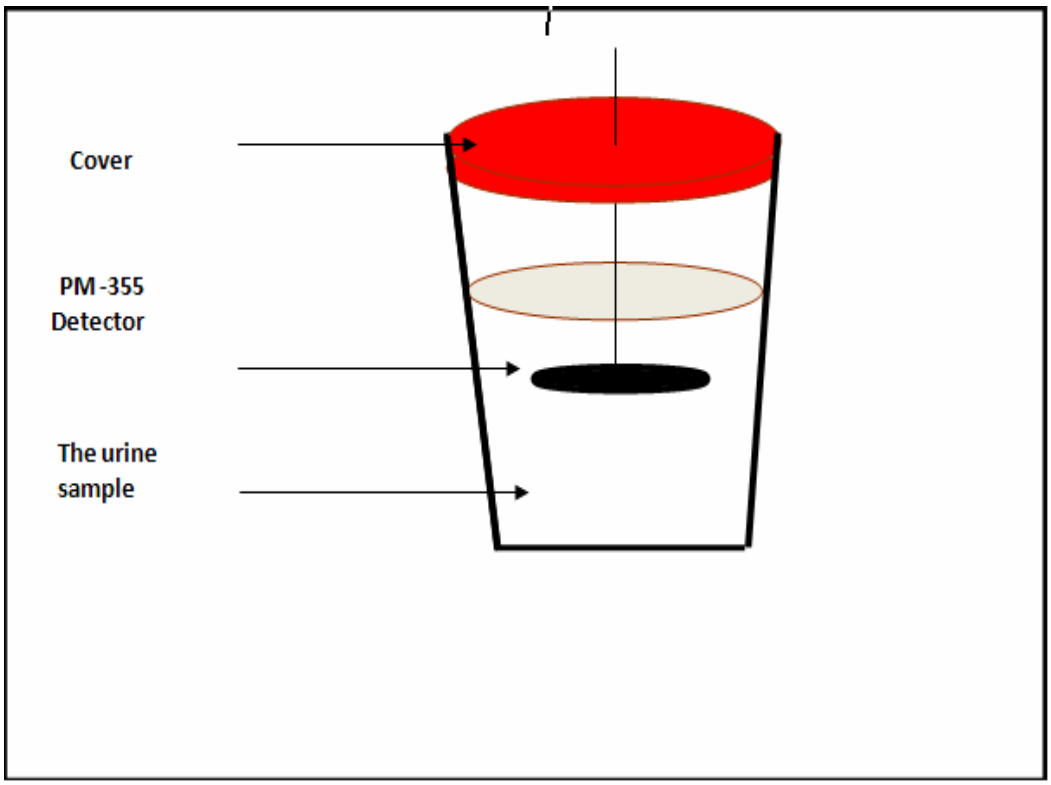


Fig. (2-1) the apparatus of alpha – emitters estimation by using PM-355 detector for urine samples.

Table (2-1); Urine samples of reference healthy people

Serial No. of Sample	Age	Gender
S1	3 months	male
S2	8 years	male
S3	13 years	male
S4	19 years	male
S5	24 years	male
S6	37 years	male
S7	68 years	male
S8	16 years	female
S9	16 years	female
S10	18 years	female
S11	22 years	female
S12	23 years	female
S13	36 years	female
S14	46 years	female
S15	54 years	female
S16	60 years	female

Table (2-2); Urine samples of painters

Serial No. of Sample	Age (years)	Period of work
S17	14	3 months
S18	16	18 months
S19	20	3years
S20	27	4 years
S21	32	7 years

Table (2-3); Urine samples of workers in phosphate plant

Serial No. of Sample	Age (years)	period of work(years)
S22	30	5
S23	38	6
S24	47	16
S25	45	18
S26	48	23

Table (2-4); Urine samples of workers in fertilizer plant

Serial No. of Sample	Age (years)	Period of work(years)
S27	39	5
S28	32	6
S29	29	7
S30	28	8
S31	30	8
S32	30	9
S33	38	9
S34	56	16
S35	46	17
S36	48	18

Table (2-5); Urine samples of nuclear physics laboratory staff

Serial No. of Sample	Gender	Age (years)	Period of work(years)
S37	female	26	3
S38	female	28	7
S39	female	28	3
S40	male	31	3
S41	male	33	5

Table (2-6); Urine samples of female patients

Serial No. of Sample	Age (years)	Organ inflicted	Occupation	Place of residence
S42	49	uterus	housewife	Nassiriyah
S43	57	bladder	housewife	Umarah
S44	59	bladder	housewife	Mahmudiyah
S45	63	bladder	housewife	Baghdad

Table (2-7); Urine samples of male patients

Serial No. of Sample	Age (years)	Organ inflicted	Occupation	Place of residence
S46	58	bladder	worker	Baghdad
S47	64	prostate	farmer	Ramadi
S48	66	bladder	pensioned military man	Baghdad
S49	68	bladder	pensioned military man	Baghdad
S50	67	bladder	driver	Basrah
S51	70	prostate	pensioned officer	Baghdad
S52	69	bladder	pensioned military man	Baghdad
S53	70	prostate	worker	Umarah
S54	80	bladder	worker	Baghdad

2.4.2. Calibration Curve

A standard urine sample of different uranium concentrations was prepared for calibrating our samples under study. Using known concentrations of different volume of standard uranium mixing with urine samples and using equ. (2-3), we put the detectors (PM-355) in the standard urine samples for 3 weeks. After that the detectors were subjected to chemical etching and then read under the microscope to measure the track densities.

$$V_1 \times C_1 = V_2 \times C_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2\text{-}3)$$

where :

V_1 : volume of urine standard sample (l).

C_1 : uranium concentration in standard sample (ppm).

V_2: volume of urine unknown sample (l).

C_2: uranium concentration in urine sample which prepared (ppm).

The density of the alpha tracks (ρ) in the samples was calculated using [90] :

Track density (ρ) = Average of total tracks / Area of field view...….. (2-4)

Figure (2-2) represents the calibrations curve for uranium standard samples and track density.

The concentrations of alpha emitters in the urine samples were measured by comparison between track densities registered on the detectors and that of the standard urine sample from the relation [6,7,91]:

C_X (sample) / ρ_X (sample) = C_S (standard) / ρ_S (standard) …… (2-5)

$$C_X = C_S \cdot (\rho_X / \rho_S) \quad \text{……..…..} \quad (2\text{-}6)$$

where :

C_X : uranium concentration of urine in unknown sample (ppm).

C_S : uranium concentration of urine in standard sample (ppm).

ρ_X: track density of unknown sample (tracks/mm^2).

ρ_S: track density of standard sample (tracks/mm^2).

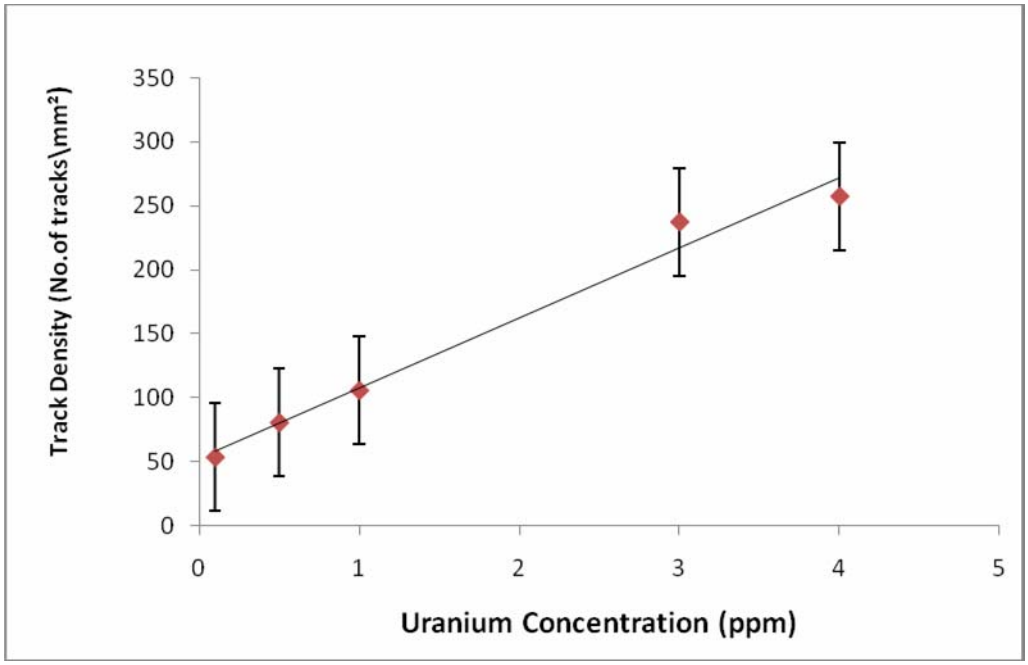


Fig.(2.2) The relation between track density and uranium concentration (ppm) for standard urine samples.

Chapter Three

Results and Discussion

3.1. Introduction

In this study, 54 urine samples were collected from workers from phosphates and fertilizer plants, painters, patients, teaching staff in nuclear physics laboratory and reference healthy people for males and females and were classified in 6 groups. For each sample, the number of working years, age of the worker, nature of work and chronic diseases if any were recorded.

The measurements of alpha-emitters concentration in urine samples were obtained using PM-355 solid state nuclear track detectors using the natural exposure method.

In this chapter, the results that include the measurement of the average concentrations of alpha-emitters are presented. Moreover, discussion and conclusions extracted from the present results and suggestions for future work are also presented.

3.2. Results of alpha-emitters concentration in urine samples of reference healthy people

The alpha-emitters concentration obtained for 16 urine samples for male and female reference healthy people are presented in Tables (3-1) and (3-2). The average of alpha-emitter concentration in urine samples for reference healthy male was 0.75ppm and for female was 0.7ppm, as shown in Figs.(3-1a,b,c).

We noticed that the alpha-emitters concentration in urine samples of reference healthy people of both gender at different ages increases with age and is higher in men than in women. The relation between concentration and age is shown in Figs.(3-2a,b). We further observed a higher concentration percentage of alpha-emitters in one of the females' samples. We also observed an increase of concentration in one of the men's samples. These later appeared to be due to heavy smoking.

Table (3.1) :-Alpha-emitters concentration in urine samples of reference healthy male people

Serial No. of Sample	Track density $\rho \times 10^3$ (No. of tracks /mm^2)	Concentration(ppm)
S1	5.547±0.640	0.09±0.01
S2	20.216±3.157	0.32±0.05
S3	24.408±3.166	0.39±0.06
S4	33.037±4.729	0.52±0.07
S5	43.885±2.033	0.69±0.03
S6	53.007±3.952	0.84±0.06
S7	83.333±4.410	1.32±0.07
Average		0.75±0.06

Table (3-2) :- Alpha-emitters concentration in urine samples of reference healthy female people

Serial No. of Sample	Track density $\rho \times 10^3$ (No. of tracks /mm^2)	Concentration(ppm)
S8	27.859±2.885	0.44±0.05
S9	27.859±3.665	0.44±0.06
S10	29.832±3.353	0.47±0.05
S11	35.009±4.806	0.55±0.08
S12	37.827±4.392	0.60±0.07
S13	48.076±2.800	0.76±0.04
S14	55.719±3.157	0.88±0.05
S15	73.964±8.875	1.17±0.14
S16	58.925±4.132	0.93±0.07
Average		0.69±0.06

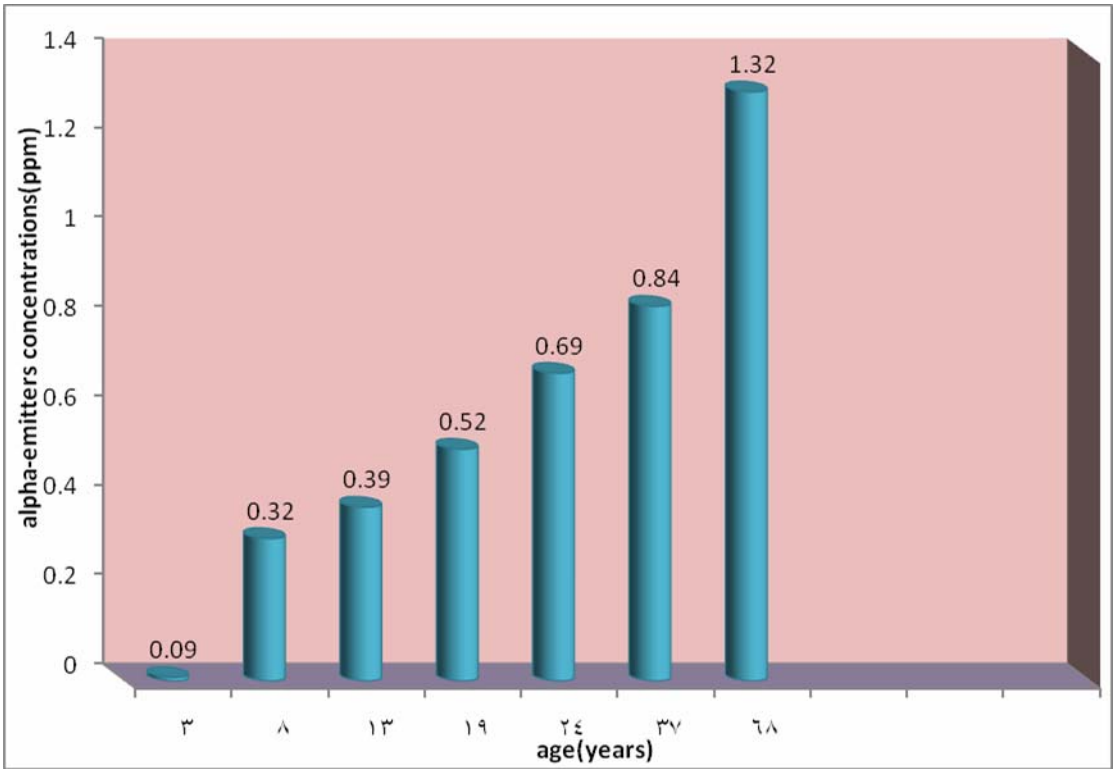


Figure (3-1)a:- Alpha-emitters concentration in urine samples of reference healthy male people.

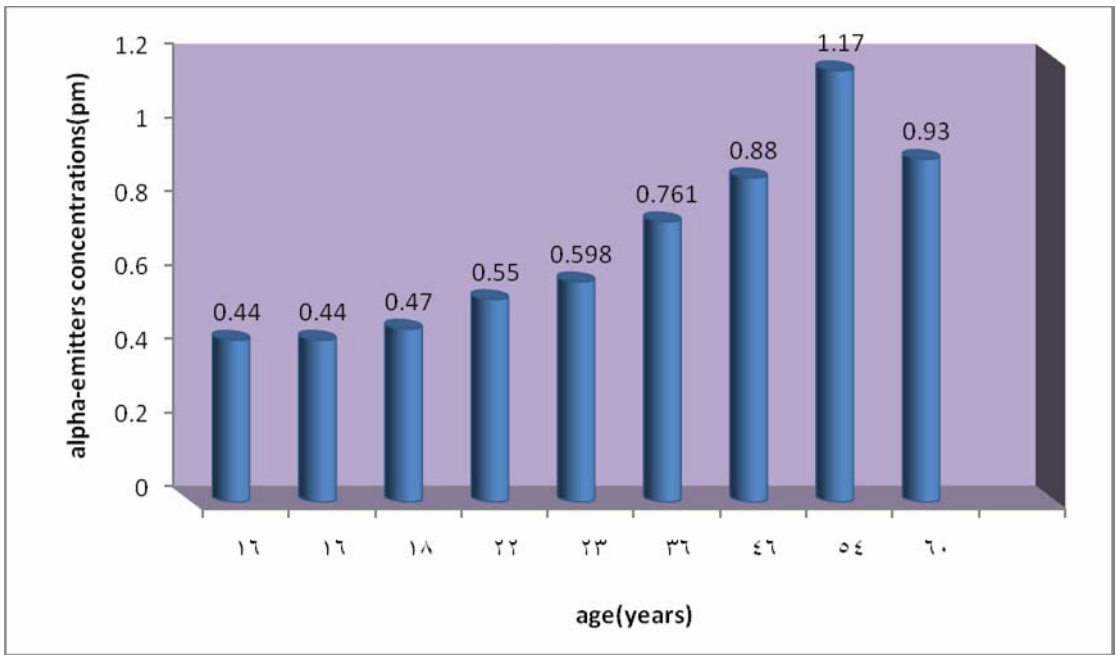


Figure (3-1)b:- Alpha-emitters concentration in urine samples of reference healthy female people.

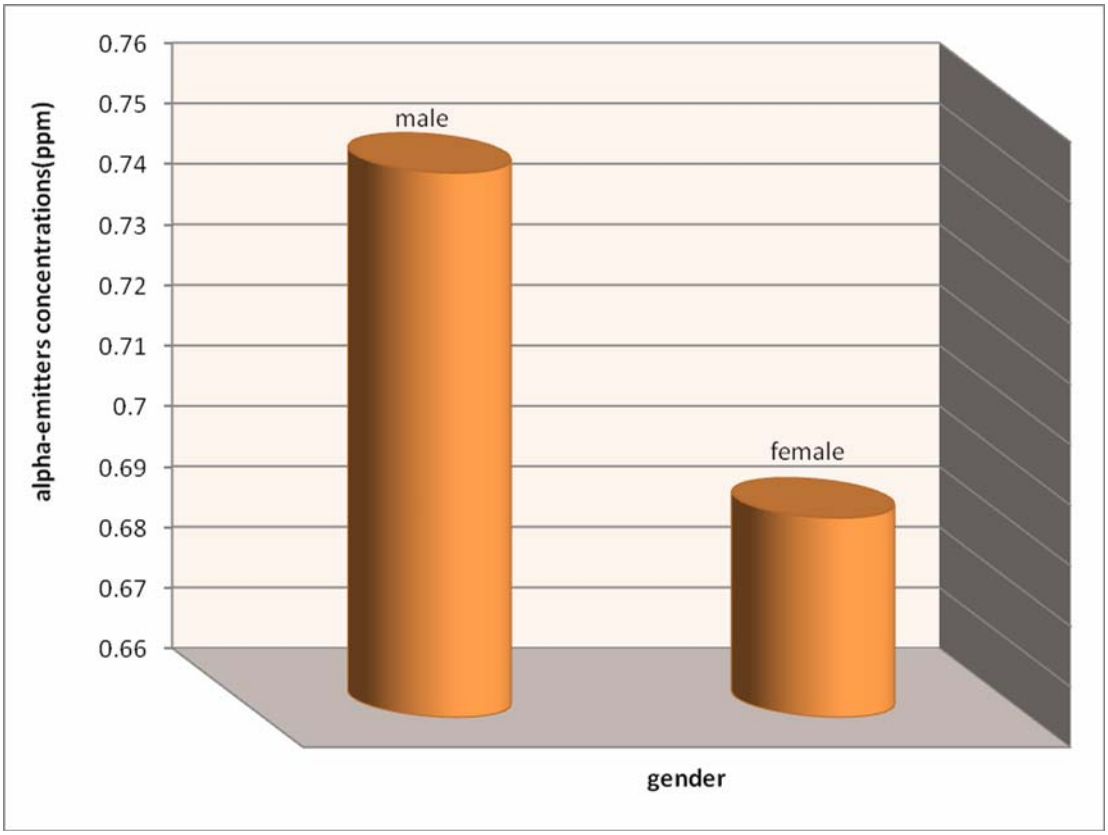


Figure (3-1)c:- Alpha-emitters concentration in urine samples of average of male and female reference healthy people.

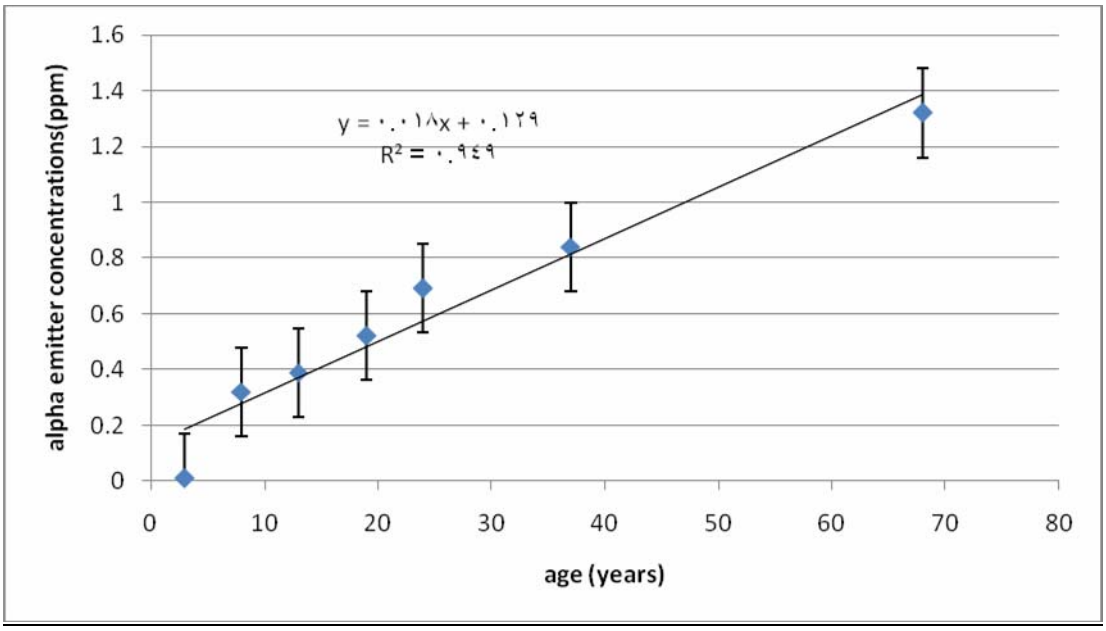


Figure (3-2)a:- The relation of increase of concentration in males urine with age.

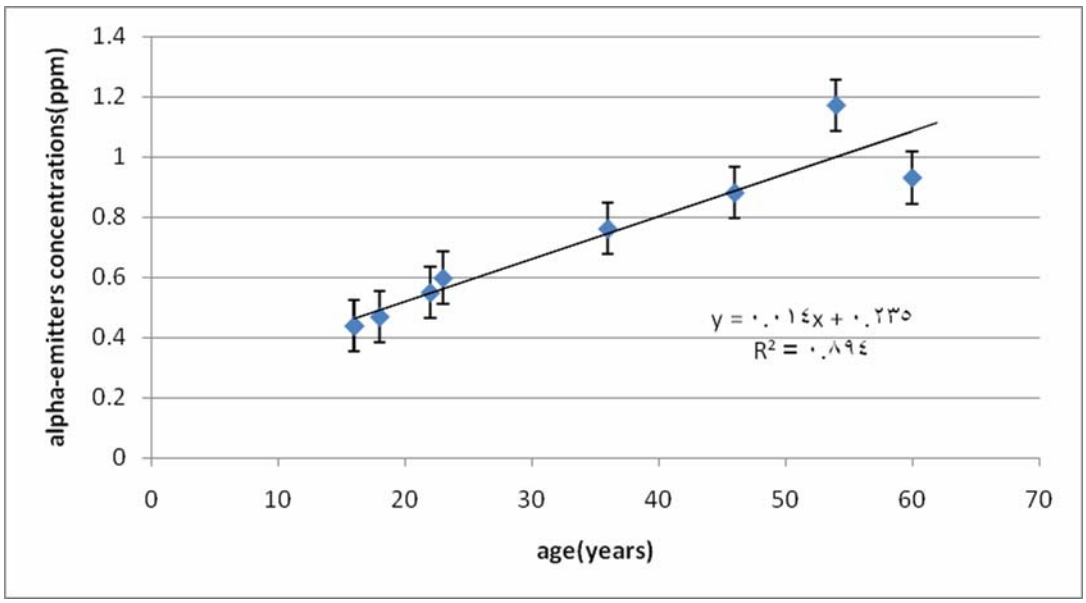


Figure (3-2)b:- **The relation of increase of concentration in females urine with age.**

3.3. Results of alpha-emitters concentration in urine samples of painters

The values of alpha-emitters concentration in urine samples for painters are presented in Table (3-3). The concentration was ranged from 0.769ppm to 1.459ppm as shown in Fig. (3-3)a. The average of alpha-emitter concentration was 1.179ppm.

We studied five cases of painters urine samples and noticed the existence of high concentrations of alpha emitters due to paints which contained high percentages of lead that was absorbed through the skin circulated with the blood and reached the kidneys, and also the inhalation of lead with the vapours of paints by lungs, and following the same course.

We found that the concentrations in those painters urine were high as compared with their healthy counterparts. We also noticed the existence of linear increase in these concentrations with period of work in this field, Fig. (3-3)b.

Table (3-3) :-Alpha-emitters concentration in urine samples of painters

Serial No. of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S17	48.578±3.128	0.769±0.05
S18	62.130±9.624	0.983±0.15
S19	79.388±13.682	1.256±0.22
S20	90.236±10.390	1.428±0.16
S21	92.209±8.042	1.459±0.13
Average		1.179±0.14

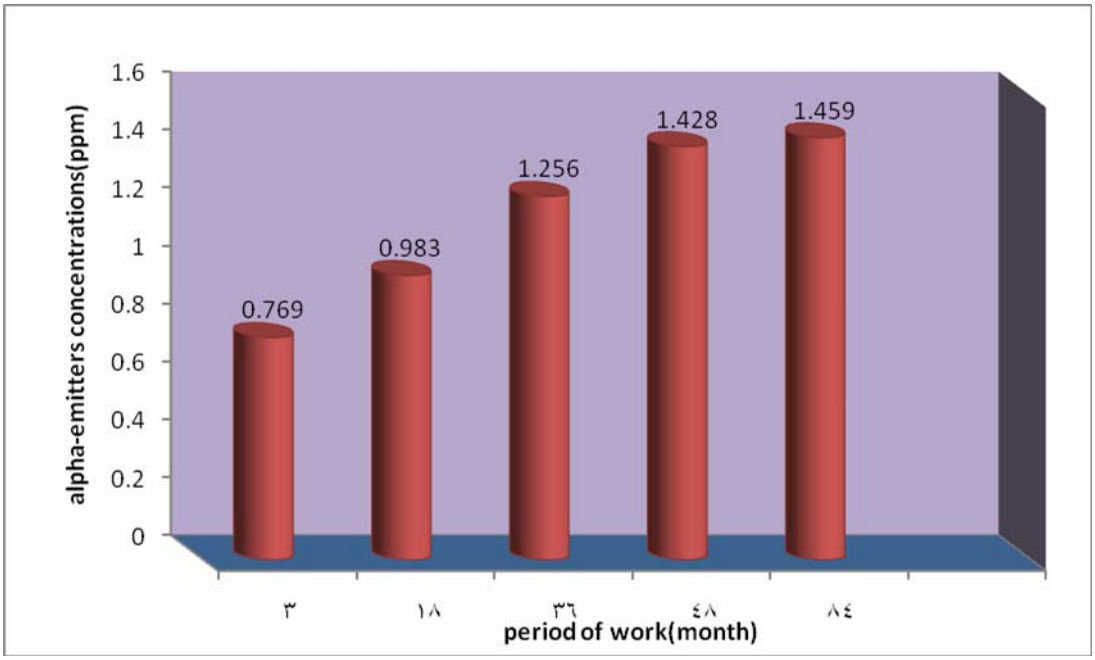


Figure (3-3)a:- Alpha-emitters concentration in urine samples of painters.

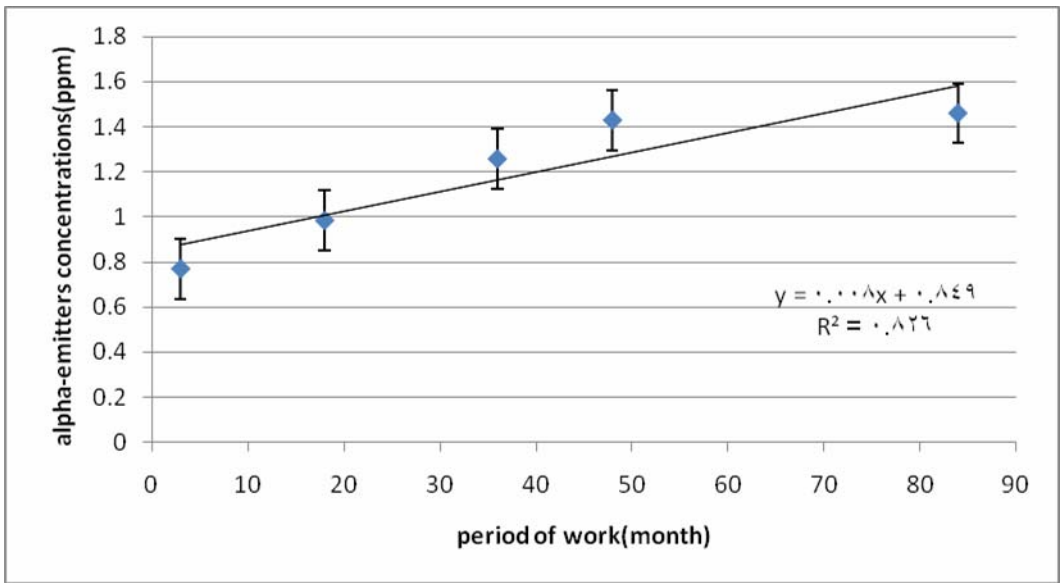


Figure (3-3)b :- The relation of increase of concentration in painters urine with period of work.

3.4. Results of alpha -emitters concentration in urine samples of workers in phosphates plants

The alpha-emitters concentrations obtained from 5 urine samples for workers in phosphates plant are presented in Table (3-4). Alpha-emitter concentration in urine samples for workers in phosphates plants was ranged from 0.936ppm to 1.889ppm as shown in Fig. (3-4)a. The average of alpha-emitter concentration was 1.33ppm.

The concentrations of alpha emitters were found to be very high in urine samples of staff and laborers working in these plants .The concentrations increase linearly with age and numbers of working years Fig. (3-4)b. These high concentrations as compared with the healthy counterparts are due to the inhalation of vapours ascending from phosphoric acid and also due to absorption.

Table (3-4) :- Alpha-emitters concentration in urine samples of workers in phosphates plants

Serial No. of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S22	59.171±2.338	0.94±0.04
S23	63.609±2.767	1.01±0.04
S24	78.402±2.767	1.24±0.04
S25	100.221±4.360	1.59±0.07
S26	119.353±4.836	1.89±0.08
Average		1.33±0.05

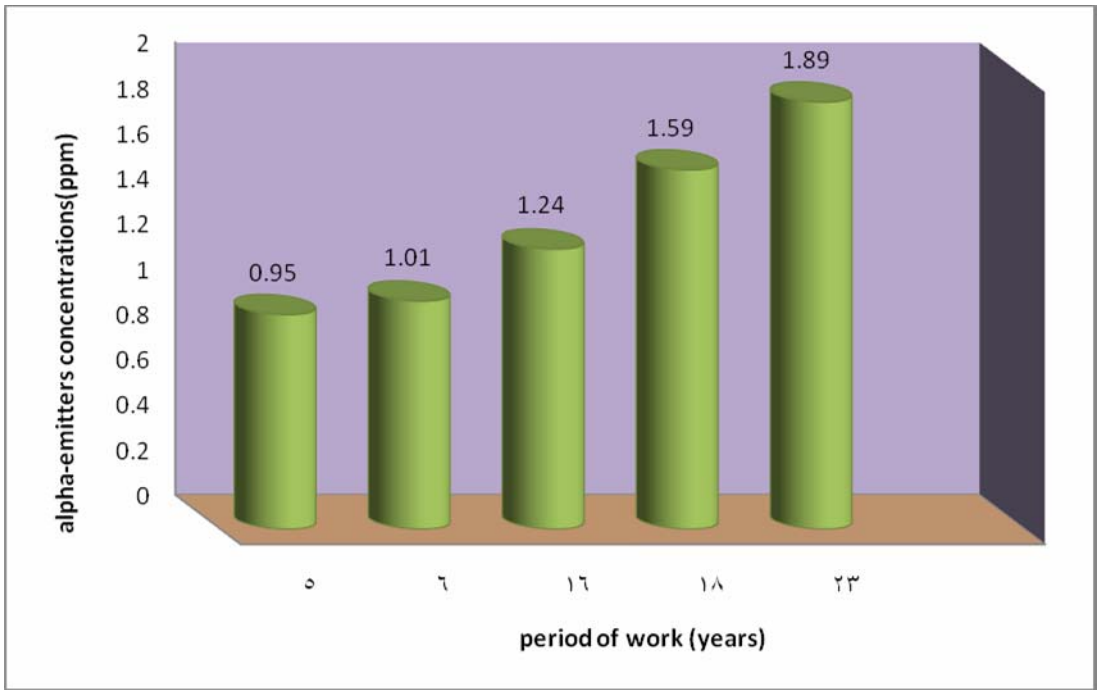


Figure (3-4)a:-Alpha-emitters concentration in urine samples of workers in phosphates plants.

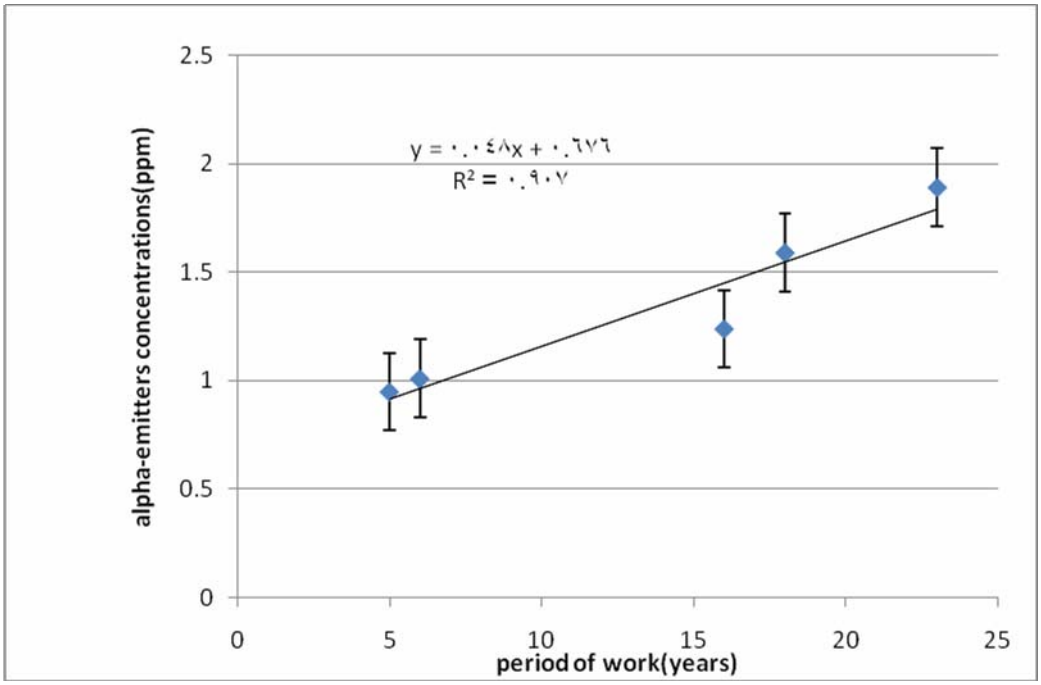


Figure (3-4)b:- The relation of increase of concentration in workers in phosphates plants urine with period of work .

3.5.Results of alpha -emitters concentration in urine samples of workers in fertilizer plants

The alpha-emitters concentrations obtained in 10 urine samples for workers in fertilizer plants are presented in Table (3-5), The concentrations range from 0.980ppm to1.416ppm as shown in Fig. (3-5)a, with an average of 1.14 ppm.

As in the case of workers in phosphate plant, the concentrations of alpha-emitters found in urine samples of staff and laborers working in this plant were also very high. Samples S30 and S31 belong to workers having the same period of work but are of different ages revealing the fact that the concentrations increase with age, in addition to their increase with the number of working years. The same deduction is asserted by samples S32 and S33 as shown in Fig. (3-5)b. These high concentrations as compared with the healthy counterparts are due to the period of work

to show affection to increase dose from the inhalation and absorption of vapours ascending from fertilizer.

Table (3-5) :- Alpha-emitters concentration in urine samples of workers in fertilizer plants

Serial No. of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S27	63.239±3.027	0.980±0.05
S28	63.979±2.425	1.012±0.04
S29	64.349±2.666	1.018±0.04
S30	66.869±5.584	1.058±0.09
S31	73.964±2.338	1.170±0.04
S32	69.979±5.164	1.107±0.08
S33	74.704±3.049	1.182±0.05
S34	79.142±4.736	1.252±0.07
S35	80.621±5.681	1.276±0.09
S36	89.497±1.653	1.416±0.03
Average		1.140±0.06

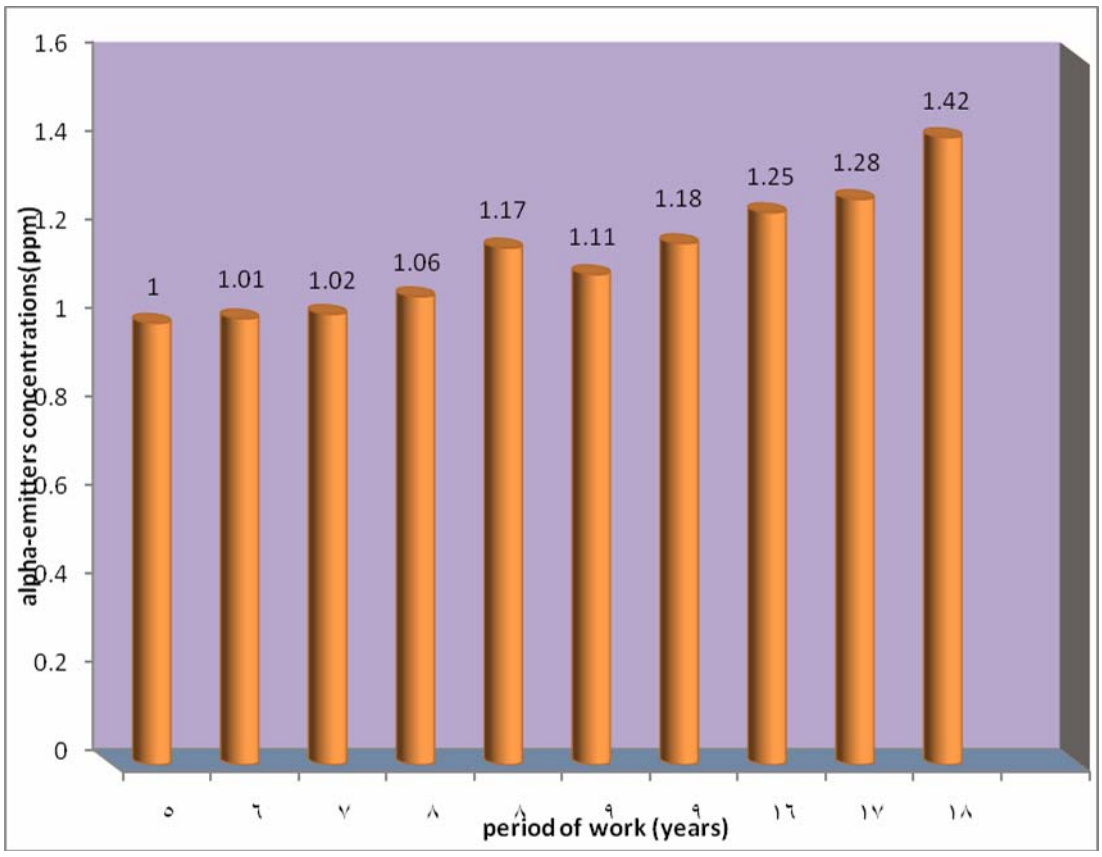


Figure (3-5)a:- Alpha-emitters concentration in urine samples of workers in fertilizer plants

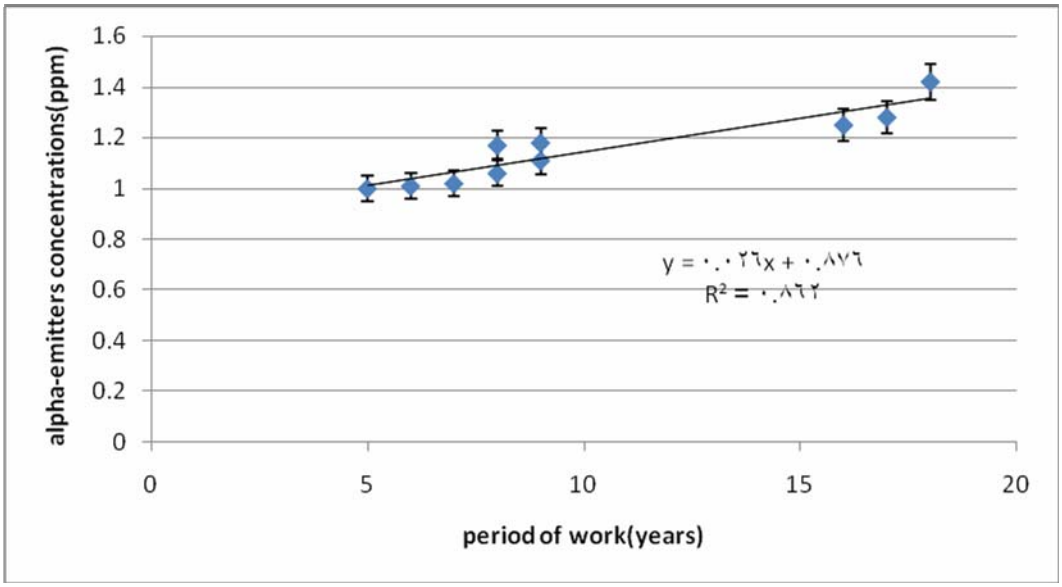


Figure (3-5)b:- The relation of increase of concentration in workers in fertilizer plants urine with period of work.

3.6. Results of alpha-emitters concentration in urine samples of teaching staff in nuclear physics laboratory

The alpha-emitters concentrations obtained for 6 urine samples of teaching staff in nuclear physics laboratory are presented in Table (3-6). The alpha-emitter concentration was ranges from 1.000ppm to 1.293ppm as shown in Fig. (3-6), with an average of 1.0948 ppm.

Higher concentrations were found as compared with their healthy counterparts increase of concentrations with age and period of work was found .

Table (3-6) :- Alpha-emitters concentration in urine samples of teaching staff in nuclear physics laboratory

Serial No.of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S37	63.232±3.037	1.000±0.05
S38	63.489±2.125	1.005±0.03
S39	65.689±1.335	1.039±0.02
S40	71.842±2.336	1.137±0.04
S41	81.691±4.321	1.293±0.07
Average		1.095±0.03

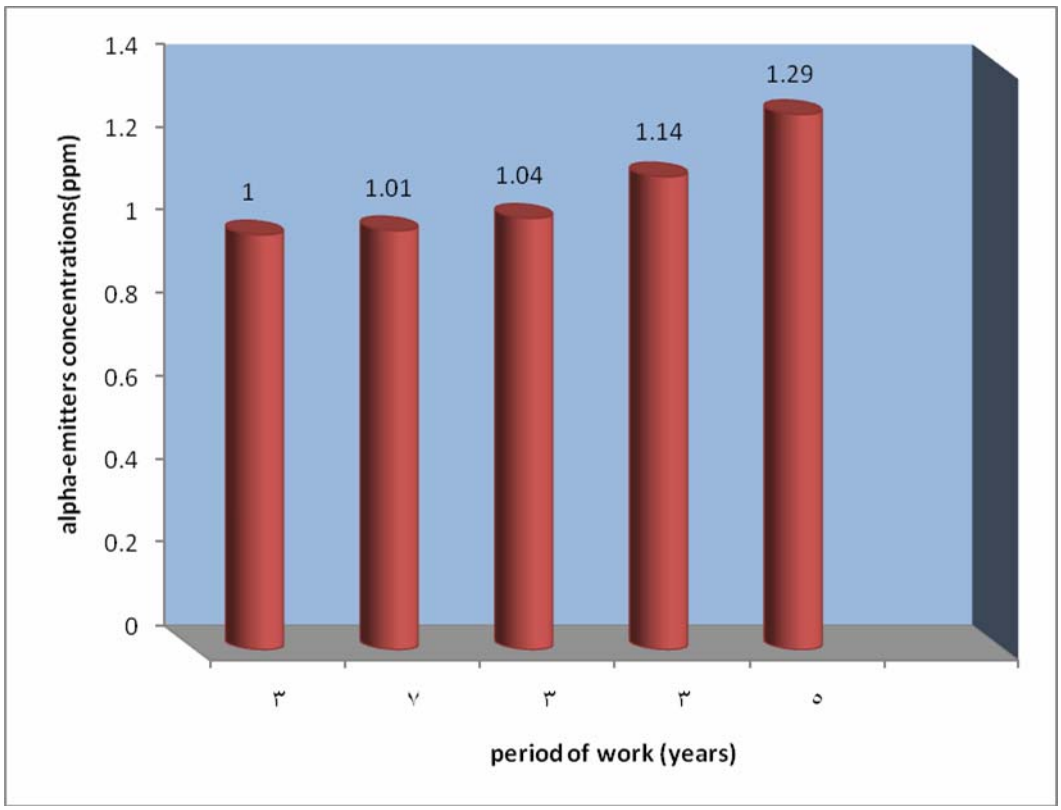


Figure (3-6):- Alpha-emitters concentration in urine samples of teaching staff in nuclear physics laboratory.

3.7. Results of alpha-emitters concentration in urine samples of patients

The alpha-emitters concentration obtained in 10 urine samples for male and female patients are presented in Tables (3-7) and (3-8). Alpha-emitter concentration in urine samples for patients range from 2.113ppm to1.814ppm for female and 2.87ppm to 2.23ppm for male as shown in Figs. (3-7) and (3-8). The averages were 1.999ppm, and 2.470ppm respectively as shown in Fig.(3-9). The relation between concentration and age is shown in Figs.(3-10a,b).

Table (3-7) :- Alpha-emitters concentration in urine samples of female patients

Serial No. of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S42	114.644±1.653	1.814±0.02
S43	130.917±2.739	2.072±0.04
S44	126.109±3.965	1.996±0.06
S45	133.505±2.840	2.113±0.04
Average		1.999±0.04

Table (3-8) :- Alpha-emitters concentration in urine samples of male patients

Serial No. of Sample	Track density ρ×103 (No. of tracks /mm2)	Concentration(ppm)
S46	141.272±9.028	2.236±0.14
S47	155.695±2.840	2.464±0.04
S48	155.325±4.051	2.458±0.06
S49	158.284±4.184	2.505±0.07
S50	158.495±3.908	2.509±0.06
S51	146.819±7.497	2.324±0.12
S52	145.819±2.675	2.308±0.04
S53	161.612±3.527	2.558±0.06
S54	181.582±10.531	2.874±0.17
Average		2.470±0.08

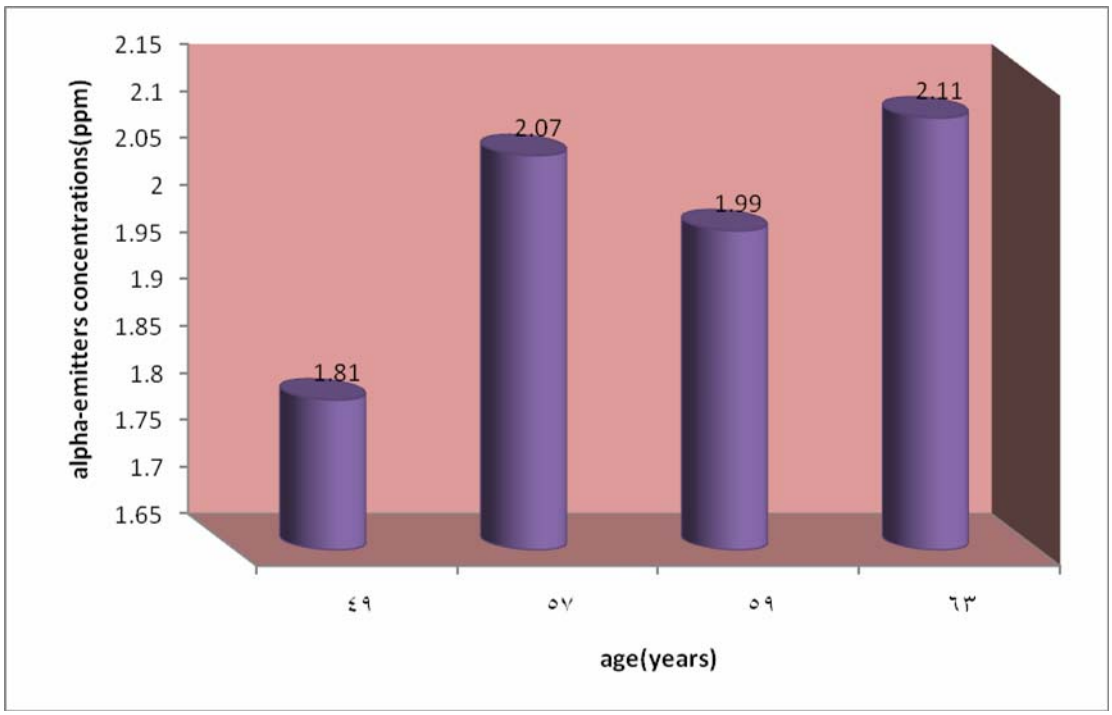


Figure (3-7) :- Alpha-emitters concentration in urine samples of female patients.

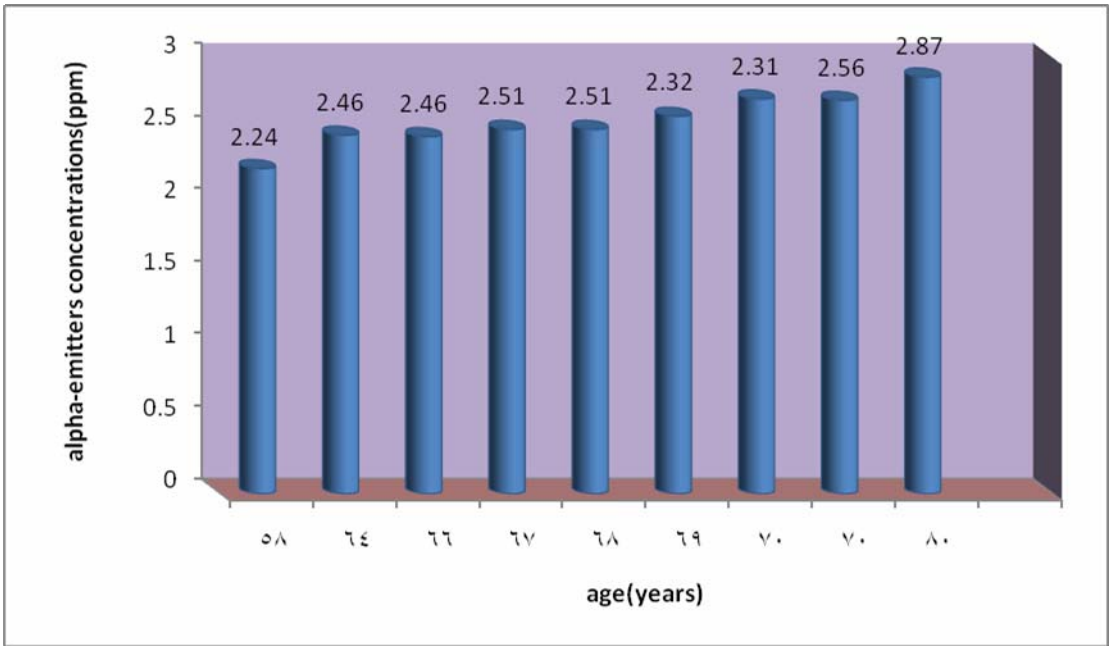


Figure (3-8) :-Alpha-emitters concentration in urine samples of male patients.

Figure (3-9) :- Alpha-emitters concentration in urine samples of average male and female patients

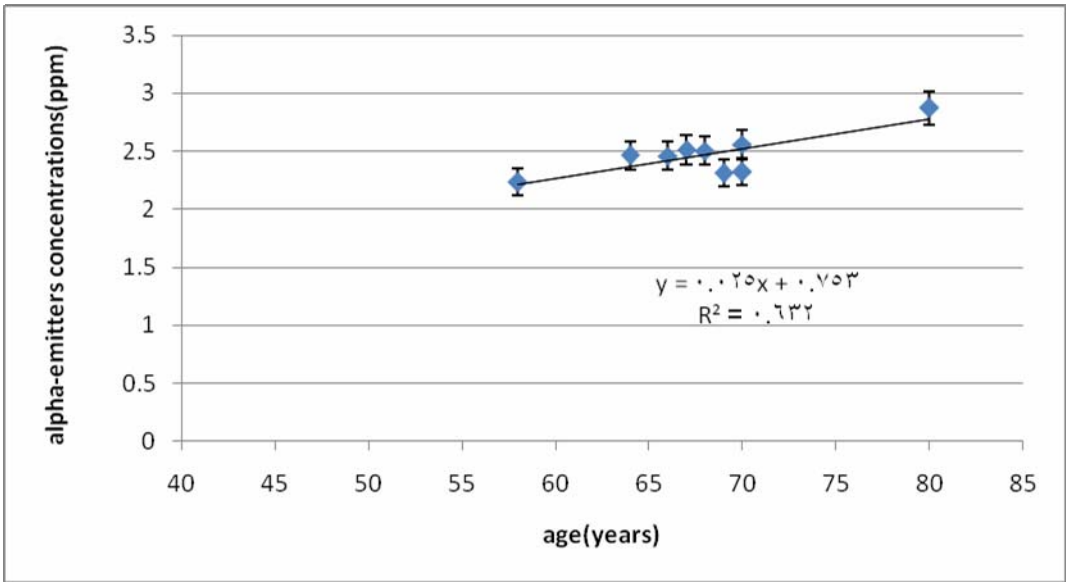


Figure (3-10)a:- The relation of increase of concentration in patient males' urine with age.

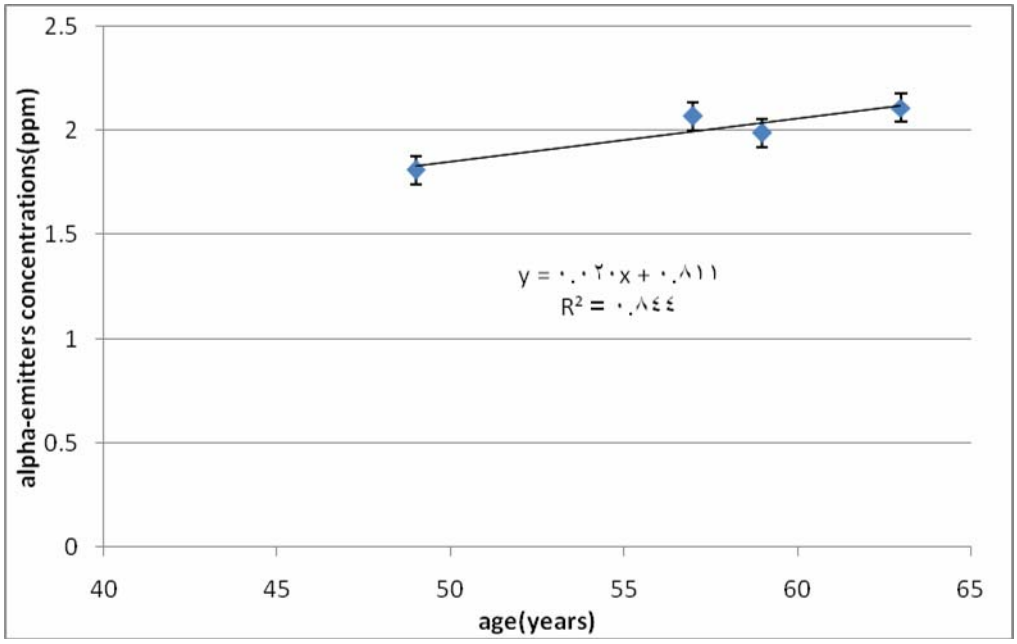


Figure (3-10)b:- The relation of increase of concentration in patient females' urine with age.

Table (3-9)a:-Percentage increase in averages of alpha emitters concentrations in males' urine samples in miscellaneous groups

No. of groups	Groups	Average concentration(ppm)	Concentrations Increase percentage
1	reference healthy males	0.75	0%
2	painters	1.179	75%
3	phosphate plant workers	1.33	77%
4	fertilizer plant workers	1.416	88.8%
5	nuclear physics laboratory male staff	1.215	62%
6	male patients	2.47	229%

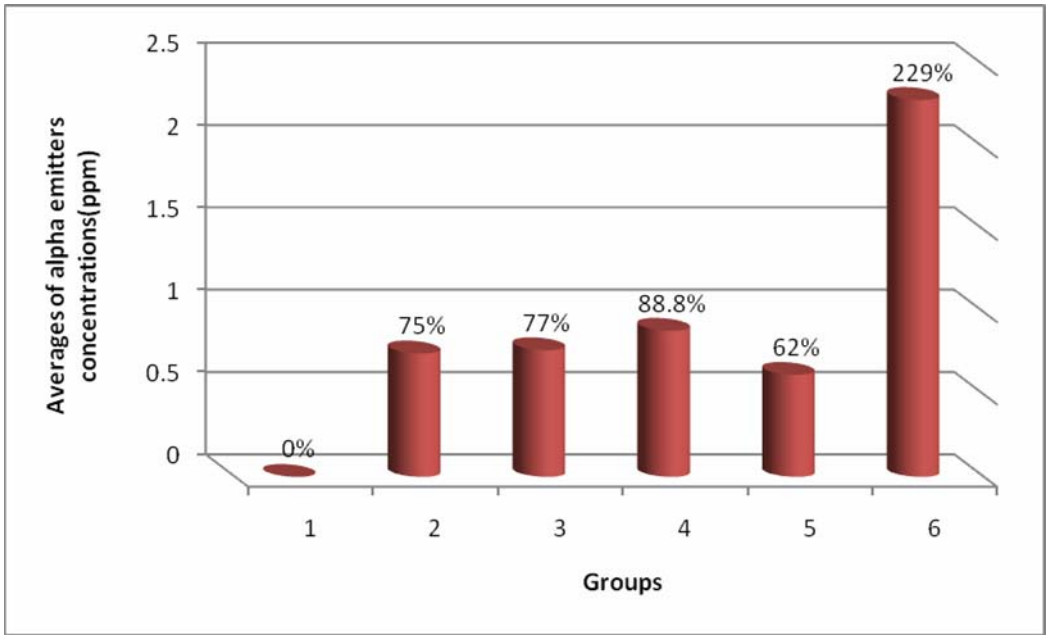


Figure (3-11)a:- Percentage increase of averages alpha emitters concentrations in males' urine samples.

Table (3-9)b:-Percentage increase in Averages of alpha emitters concentrations in females' urine samples in miscellaneous groups

No. of groups	Groups	Average concentration(ppm)	Concentrations Increase percentage
1	Reference healthy females	0.69	0%
2	nuclear physics laboratory female staff	1.014	46%
3	female patients	1.999	190%

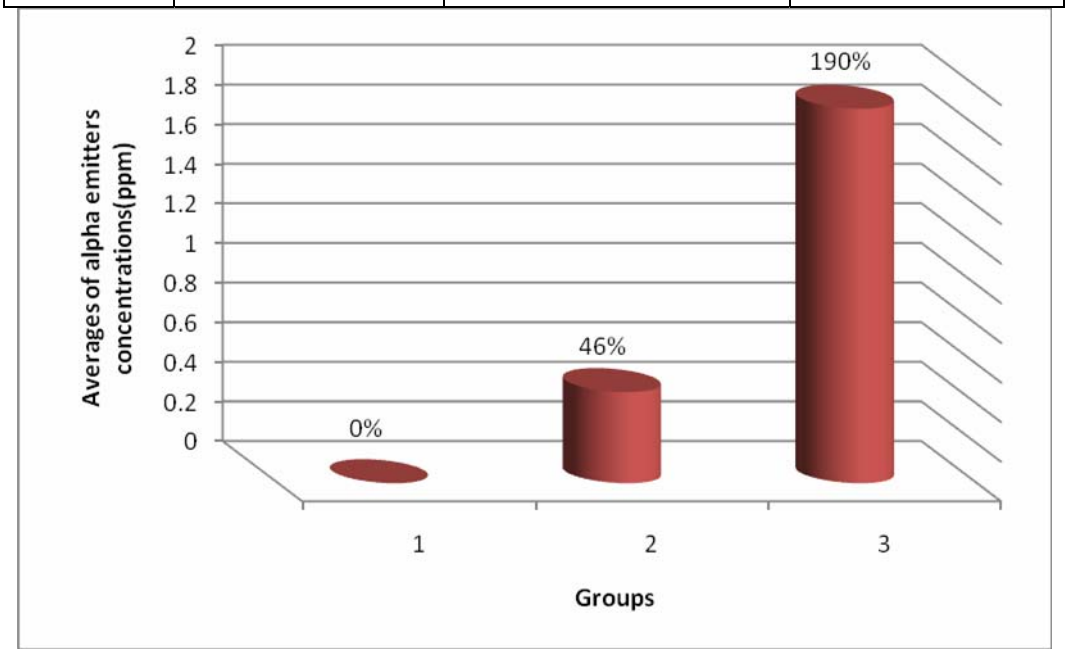


Figure (3-11)b:- Percentage Increase of averages alpha emitters concentrations in females' urine samples.

From the results obtained we notice that the concentration of alpha-emitters in urine samples for patients and workers in phosphates and fertilizer plants are very high as compared with concentration of reference healthy people.

Small quantities of heavy elements as well as actinides are absorbed by living organisms through the food chain. However , normal physiological functions of the body help in excreting all the surplus quantities of these elements.

3.8.Conclusions

In view of the results presented in this study, the following conclusions can be made,

1- The averages of alpha emitters concentrations in urine of reference healthy male and female persons are 0.75 ppm and 0.69 ppm respectively. It follows that the gender of persons has a significant effect on the concentration of alpha emitters in their urine. The average concentration is higher in reference healthy males than in reference healthy females.

2- From this work it can be deduced that age has a noticeable effect on alpha emitters concentration in the urine of persons. The concentration accumulates with age.

3- Values of alpha-emitters concentration for workers in phosphate and fertilizer plants increase in urine with the increasing number of working years .

4- The percentages of increase in the average alpha emitters concentrations in the urine of painters, workers of the phosphate and fertilizer plants as compared with reference healthy persons are 75%, 77% and 88.8% respectively.

The percentages of increase in the average alpha emitters concentrations in the urine of the male and female staff of nuclear physics laboratory as compared with reference healthy persons are 62% and 46% respectively .

The percentages of increase in the average alpha emitters concentrations in the urine of the male and female patients as compared with reference healthy persons are 229% and 190% respectively.

3.9.Future studies

1- Measurement of concentration of alpha emitters in urine specimens taken from patients inflected with cancer disease before and after their treatment with chemical and nuclear therapy.
2- Measurement of lead percentage in the blood and urine of painters and employees working in the field of paint industries .
3- Measurement of concentration of alpha emitters in urine specimens taken from workers of tile and granite factories.

References

[1] International Atomic Energy Agency, IAEA, ***"Radiation, People and the Environment"***, Austria, 2004.

[2] Hassan S.F., ***" Determination of Uranium Concentration in Human Blood in Some Governorates of Iraq "***, M.Sc. Al- Nahrain University, 2006.

[3] " ***Mc Graw-Hill Encyclopedia of Sciences and Technology "***, 6th Ed., **19**, (1987), 75 -81.

[4] Agency for Toxic Substances and Disease Registry, ATSDR,*" **Natural Uranium"***, Atlanta, GA, U.S, Department of Health and Human Services, Public Health Services, 1999.

[5] International Commission of Radiation Protection, ICRP-54, 1988 .

[6] International Commission of Radiation Protection, ICRP-78, 1997.

[7] Martin A., Harbison**,** and S.A. ***"Radiation Protection",*** page110**.**

[8] Hushemi S.R. and Durrani S.M., ***" Nuclear Tracks "***, **3**, (1981), 189.

[9] Muller R.F. and Young I.D., ***"Emery's Elements of medical Genetics"***, 10th Ed., USA, Harcourt brace and company limited, (1998) 75-100, 125-175

[10] Silk E.C.H. and Barnes R.S., ***"Phil. Mag. "***, **4**, (1959) 970.

[11] Price P.B. and Walker R.M., ***"Phy. Rev. Lett. "***, **8**, (1969) 217.

[12] Price P.B. and Walker R.M., ***"J. Appl. Phy. "***, **33**, (1962) 2625.

[13] Fuji M. and Yokota R., ***"Nuclear Tracks and Radiation Measurement"***, **15**, (1990) 107.

[14] Fleischer R.L. and Price P. B., ***"J. Appl. Phy. "***, **34**, (1963) 2903.

[15] Fleischer R.L., Price P.B., Walker R.M., and Hubbard E.L., ***"Phy. Rev. "***, 133A, (1964) 1443.

[16] Fleischer R.L., Price P.B. and Walker R.M., ***"Ann. Rev. Nucl. Sci."***, **15**, (1965) 15.

[17] Price, P.B. and Walker, R.M. "***Phys.Rev.Lett.***", **8,** (1962) 217.

[18] Price, P.B. and Walker, R.M. "***Appl.Phys.***", **33,** (1962) 3400.

[19] Fleischer, R.L. and Price, P.B. "***Science***", **140,** (1963) 1221.

[20] Hepburn C. and Windle A.H., ***"Journal of Material Science"***, **15**, (1980) 279-301.

[21] Singh N.P., Singh N., Singh S. and Virk H.S, ***"Nuclear Tracks"***, **12**, (1986) 793-697.

[22] Durrani S. A. and Bull R. K, ***"Solid State Nuclear Track Detection Principles, Methods & Application"***, (1983).

[23] Kobayashi, T. and Fuji, M **,*"Nucl. Tracks"***, **15**, (1988) 175.

[24] D. Nikezic, K.N. Yub, ***"Formation and growth of tracks in nuclear track materials"***,(2004).

[25] Al-Ani, Z.K., **"*A Study of Transfer Factor of Radio Nuclides from Soil to Plant*"**, M.Sc. thesis, Al- Nahrain University, (2000).

[26] Fleischer R.L., Price P.B. and Walker R.M., "***Science***", **149**, (1965) 383.

[27] Durrani S. A., ***"Proceedings of the international symposium on application and technology of ionizing radiation"***, **3**, 1527,(1982).

[28] Durrani S. A. and Bull R. K, ***"Solid State Nuclear Track Detection Principles, Methods & Application"***, (1987).

[29] Fleischer R.L., Price P. B. and Walker R.M., ***"Nuclear Tracks in Solids"***, Principle & Applications, Univ. of California Press, Ltd., (1975).

[30] Young D.A., ***"Etching of Radiations Damage in Lithium Fluoride Nature"***, **182**, (1958) 375-377.

[31] United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR "***Sources, Effect, and Risks of Ionizing Radiation***", Report to the general Assembly with Scientific Annexes, United Nations, (1993).

[32] Durrani, S.A. and Bull, R.K. "***Solid State Nuclear Track Detection: Principles, Methods and Applications***", Pergammon Press, U.K. (1987).

[33] Kobayashi, T. and Fujii, M. "***Nucl. Tracks***", **15,** (1988) 175.

[34] Tsoulfanidis N., "***Measurement and Detection of Radiation***", Pergammon Press, University of Missouri-Rolla, U.K., (1983).

[35] Fischer, B.E. and Sphor, R. "***Rev.Mod.Phys.***", **55,** (1983) 129.

[36] Benton, E.V. "***Radia. Effect.***" **2,** (1970) 273.

[37] Fleischer, R.L., Price, P.B. and Walker, R.M. ***"Ann .Rev. Nucl. Sci."***, **15,** (1965) 1.

[38] Fleischer, R.L., Price, P.B. and Walker, R.M. ***"Science"***, **149,** (1965) 383.

[39] Fleischer, R.L. and Price, P.B. "***Appl.Phys.***", **34**, (1963) 2903.

[40] Hushemi, S.R. and Durrani, S.A. "***Nucl.Tracks***", **5,** (1981) 189.

[41] Fremlin, J.H. and Wilson, C.R. "***Nucl.Instr.Meth.***", **173**, (1980) 201.

[42] Hepburn, C. and Windle, A.H. "***Material Sci.***", **15,** (1980) 279.

[43] Price, P.B., Lai, D., Tamtance, A.S. and Perelygin, V.P. "***Earth Planet Sci.Lett.***" **19,** (1973) 377.

[44] Fleischer, R.L., Price, P.B. and Woods, R.T. "***Phys.Rev.***", **88,** (1969) 563.

[45] Yammamoto, M. and Yasuda, N. "***Radia. Measur.***", **28,** (1997) 227.

[46] Blanford, G.E., Walker, R.M. and Wefel, J.P. "***Radia.Effects***", **3,** (1970) 267.

[47] Durrani, S.A. "***Nuclear Track Detection***", Pergammon Press, London (1976).

[48] Scharama, S.C.L. and Metha, G.K. "***Nucl. Instr. Meth.***", **178**, (1980), 217.

[49] Cieslak, E., Piekarz, J. and Akrzewski, J.Z. "***Nucl. Instr Meth.***", **39,** (1966) 244.

[50] Vater, P., Becker, H.J., Brandt, R. and Freiesleben, H. "***Phys. Rev. Lett.***", **39,** (1963) 594.

[51] Gore, D.J., Thorne, M.C. and Watts, R.H. "***Phys. Med. Bio.***", **23**, (1978) 149.

[52] Fews, A.P. and Henshaw, D.L. "***Proc. of the 10th Inte. Confer. on SSNTDs***", Bristol, (1979) 705 .

[53] Henshaw, D.L., Fews, A.P. and Webstar, D.J. "***Proc. of the 11th Inte. Confer. on SSNTDs***", Lyon, (1981) 649-654.

[54]Fleischer, R.L., Price, P.B. and Walker, R.M. "***Geochim. Cosmochim. Acta.***", **29,** (1965) 161.

[55] Seal S.H., ***"Cancer"***, **17**, (1964) 37.

[56] Tress, G., Ellinger, M., Khan, E.U., Khan,H.A., Vater, P., Brandt, P. and Kadner, M. "***Nucl.Tracks***", **6,** (1982), 87.

[57] Guyton and Hall ***"Text Book of Medical Physiology"***(1998) 385.

[58] William F. G.***"Ganong"***, Lang medical publication, University of Michigan, (1977) 411.

[59] Koul S.L. and Chadderton L.T.,***" Uranium in Blood"***, Rad. Eff. **50**, (1979) 19.

[60] Parhad R. and Nagpaul K.K, ***"Determination of Trace Content of Uranium in Normal Human Blood of Particle Track Etch Technique"***, Health Phys., **38**, (1980) 409.

[61] Romero M., Sanchez M. and Sanchez M. and Segovia N., ***"Nuclear Tracks*** and ***Rad. Meas.*** *"*, **8**, (1984) 457-459.

[62] Durbin. P. A. *"* ***Metabolic Models of Uranium In Biokinetics and Analysis of Uranium in Man"***. USUR-05, Hanford Environment Health Federation, Richland, WA. (1984*).*

[63] Das K.C., Hanifa A. and Goswami T.D., **"** ***Nuclear Tracks & Rad. Meas. ",*** **12**, (1986) 769- 792.

[64] Tawfiq, N.F. "***Determination of Uranium Concentrations in Rocks by Using (SSNTDs)***", M.Sc. thesis, University of Baghdad, (1989).

[65] Kathren, R. L. Mcinroy, J. F., Moor, R. H. and Dietert, S. E ***"Determination of Uranium in the Tissues of An Occupationally Exposed Individuals"***. Health Physics, **1** (1989) 157.

[66] Marouf, B.A., Al-Haddad, I.K., Tomma, N.A., Mahmood, J.A. and Tawfiq, N.F. "***Monitoring of Environmental Radioactivity Around the Tuwaitha Site***", Environmental Management and Health, **3**, (1991) 14-17.

[67] Othman. I., Al-Hushari. M. and Raja. G. ,Radiation exposure levels in phosphate mining activities, J. Environ. Radioactivity, **18,** (1993) 151-161.

[68] Chuscielewski, W. and Kaminski, Z. "***Occup. Medic. Environ. Health***", **12**, (1999) 229.

[69] Al-Timimi W.A.K., ***"Determination of Depleted Uranium Concentration in Biological Sample "***, M.Sc. Thesis, Al-Mustansiriyah University, 2000.

[70] Dowser H.G., ***"Measurement of Alpha Emitters Concentration in Tigris River Water in Baghdad City Using CR-39 Plastic Track Detector "***, M.Sc. Thesis, Al- Nahrain University, 2002.

[71] Aharmim, B., Marah, H. and Sabir, A. " ***Proc. Of the 20th Inter.Conf. on SSNTDs*** ", Slovenia, (2000) 111.

[72] AL- Gailani A.W., ***"Investigation of Biological Effects of Depleted Uranium on The Blood "***, M.Sc. Al- Mustansiriyah University, 2003.

[73] Ibraheem M.F., ***"Determination of Depleted Uranium Concentration in Leukemia Sample "***, M.Sc. Al- Mustansiriyah University, 2003.

الخلاصة

هذا البحث يستهدف معرفة وقياس تراكيز باعثات ألفا التي يطرحها الجسم البشري في الإدرار. إن معرفة هذه التراكيز في غاية الأهمية لكونها تكشف عما إذا كان الشخص قد استلم جرعات من المواد المشعة لجسيمات الفا التي يترتب عليها حصول أمراض خبيثة أو طفرات وراثية. وبما إن هذا الموضوع أساسي لصحة الأفراد ولكونه عون كبير للأطباء يمكنهم من التشخيص المناسب للحالات ذات العلاقة موضوعا لهذا البحث.

أختيرت عينات من الإدرار البشري من مجموعه كبيره من العاملين في مجالات مختلفة وهي (معامل الفوسفات و معامل الأسمدة والكادر التدريسي في مختبر للفيزياء النووية ، الصباغون ، الأشخاص المرضى والأصحاء) مستخدمين كواشف الأثر النووية في الحالة الصلبة من نوع PM-355 .

أستخدامت طريقة التعرض الطبيعي وذلك بتنقيع كواشف PM-355 في عينات الإدرار لمدة ثلاثة أسابيع ومن ثم قشطها بواسطة هيدروكسيد الصوديوم 6.25 N NaOH لمدة خمس ساعات، ومن ثم قياس كثافة الأثر بواسطة الميكروسكوب البصري.كما جرى تعيين تركيز مشعات دقائق ألفا في عينات الإدرار بمقارنتها بعينات قياسية تم إعدادها مختبريا.

بينت النتائج التي تم الحصول عليها إن تركيز باعثات ألفا في عينات الإدرار المأخوذة من المرضى تتراوح بين 1.81 و2.87 جزء من المليون ومن 0.087 إلى 1.32 جزء من المليون في الأصحاء، ولدى الصباغين من 0.77 إلى 1.46 جزء من المليون، ولدى عمال مصانع الفوسفات من 0.94 إلى 1.89 جزء من االمليون.لدى عمال مصانع الأسمدة من 1.0 إلى 1.42 جزء من المليون، ولدى الهيئة التدريسية في مختبر الفيزياء النووية في كلية العلوم \اجامعة النهرين من 1.0 إلى 1.29 جزء من المليون.

الاستنتاجات المستخلصة من هذه النتائج توضح اعتماد التركيز على مهنة الشخص وسنوات خدمته وجنسه وعمره وحالته الصحية أو المرضية.

جمهورية العراق
وزارة التعليم العالي
والبحث العلمي
جامعة النهرين
كلية العلوم

قياس تركيز باعثات ألفا في الإدرار البشري باستخدام كاشف الأثر النووي في الحالة الصلبة PM-355

رسالة

مقدمة إلى كلية العلوم، جامعة النهرين كجزء من متطلبات

نيل شهادة الماجستير علوم في الفيزياء

من قبل

سيماء ذياب عطية العبودي

بكالوريوس – جامعة النهرين

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