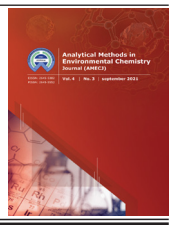
Anal. Methods Environ. Chem. J. 4 (3) (2021) 80-106

AMECJ

Research Article, Issue 3
Analytical Methods in Environmental Chemistry Journal
Journal home page: www.amecj.com/ir



A review: Effects of air, water and land dumpsite on human health and analytical methods for determination of pollutants

Ihenetu Stanley Chukwuemeka[a,*], Victor Obinna Njoku[a], Chinweuba Arinze[b], Ibe Francis Chizoruo[a], and Ekeoma Nmesoma Blessing[C]

[a] *Chemistry Department, Imo State University Owerri, Imo State Nigeria*
[b] *Chemistry Department, Chukwuemeka odimegwu Ojukwu University Uli, Anambra Nigeria*
[C] *Medicine and surgery Department, Gregory University, Uturu Abia State, Nigeria*

ARTICLE INFO:

Received 26 May 2021
Revised form 28 Jul 2021
Accepted 21 Aug 2021
Available online 30 Sep 2021

Keywords:
Environment pollutants,
Water,
Air and soil,
Analytical chemistry methods,
Human health

ABSTRACT

Environment pollutants are found here and there in developing countries and these contaminations affect the environment adversely. This is done by peculation of solid and liquid substances in the dumpsites and industrial pollutions into the soil which form toxic chemicals as well as evaporation of gases into the atmosphere. Few remediation of pollution which includes incineration which is the waste treatment process that involves the combustion of organic substances contained in waste material, the waste handling practices, the recycling resource recovery, the avoidance and reduction methods, the adsorption based on nanotechnology and the bioremediation technology which appears as a cost-effective and environmental friendly approach for cleanup. Recently researches shows that various chemicals (VOCs, BTEX, heavy metals) that might be delivered into the air or water can cause unfriendly health effects which was analyzed based on sample treatments (solid phase extraction: SPE, the liquid-liquid microextraction: LLME, the magnetic solid phase extraction: MSPE) and instruments such as ET-AAS, F-AAS and GC-FID methods. The related weight of disease can be substantial, and interest in research on health effects and intervention in explicit populations and openness circumstances is significant for the development of control systems. Pollution control and determination is thusly a significant segment of disease control, and health experts and analytical chemistry specialists need to foster associations with different areas to recognize and carry out need interventions.

1. Introduction

The environment pollution in waters and the dumpsite in soil can be described as a portion of land where waste materials and discarded. In Africa, thousands and tons of wastes are generated daily in many ways [1]. The indiscriminate and unprotected disposal of waste can instigate environmental degradation through introducing various toxicants, including heavy metals in the soil, air and water. Open dumping of municipal solid waste is a common practice in Nigeria. Chemical industries and dumpsites are important pollution sources in the environment (VOCs and heavy metals, organic and inorganic pollutants, toxic gas, organic cells, viruses) and can cause various diseases in the human body. Traditionally, dumpsites have remained the utmost regular method of waste dumping in many places around the world both in

*Corresponding Author: Ihenetu Stanley Chukwuemeka
Email: Ihenetustanley@yahoo.com
https://doi.org/10.24200/amecj.v4.i03.147

urban and rural areas. Most of the dumpsites are situated within the locality of living communities and wetlands. Some of chemical factories, oil company and petrochemical industries are located close to rivers, well waters, the agricultural soil where human activities are carried out [1]. In addition, the environmental pollutants must be removed from wastewater, water and air based on nanosorbents by chemical and physical adsorption process. Waste can be a strong material, fluid, semi-strong or holder of vaporous material [2]. Recently, the different adsorbent based on nanotechnology have positive effected on decreasing of pollutants from environment matrixes.

2. Environment pollutions

2.1. VOCs and heavy metal pollutions in water, soil, air

Volatile organic compounds (VOCs) are compounds that have a high vapor pressure and low water solubility. Numerous VOCs are human-made chemicals that are utilized and delivered in the assembling of paints, drugs, and refrigerants [3]. VOCs regularly are organic solvents, like trichloroethylene; fuel oxygenates, for example, methyl tert-butyl ether (MTBE); or side-effects delivered by chlorination in water treatment, like chloroform. VOCs are regularly parts of petrol fuels, pressure driven liquids, acetones, and cleaning specialists. VOCs are shared conviction water impurities. Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors [4]. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions [3-4]. A heavy metal is characterized as a metal with a density higher than 5 g cm^{-3} (i.e., specific gravity more noteworthy than 5). The water treatment of explosive and heavy metals co-contaminated soil was evaluated [5]. According to previous references, the expression of heavy metals is frequently utilized as a gathering name for metals and semimetals (metalloids) that have been related with pollution and potential toxicity or ecotoxicity [6]. Very as of late, we have proposed a more extensive definition for the term, and heavy metals have been characterized (natural occurring metals having atomic number more prominent than 20 and an essential density more noteworthy than 5 g×cm^{-3}). Also, determination of heavy metals in soil, vegetables and wastewater based on DLLME was obtained by the solidified deep eutectic solvent coupled to GFAAS [6]. Heavy metal harmfulness can have a few health impacts in the body. Heavy metals can harm and modify the working of organs like the brain, kidney, lungs, liver, and blood. Heavy metal harmfulness can either be acute or chronic impacts. Long haul openness of the body to heavy metal can dynamically prompt solid, physical and neurological degenerative cycles that are like diseases like Parkinson's disease, different sclerosis, strong dystrophy and Alzheimer's disease. Likewise, chronic long haul openness of some heavy metals might cause cancer [7]. Many different analytical procedures and sample preparation have been reported for VOCs and heavy metal analysis in water and human samples. The liquid-liquid extraction (LLE), supported liquid extraction (SLE), and solid-phase extraction (SPE) have existed for decades and if you're doing organic sample preparation, you're probably quite familiar with at least one of these techniques [8]. The micro solid-phase extraction (MSPE) and dispersive SPE is a technique which separates analytes, using physical or chemical adsorption interactions with a solid media. The media is mounted on a sorbent material in the form of either a disk or cartridge. The analytes are absorbed on the media as the sample passes through the sorbent material such as zeolites, silica (MSN.MCM), CNTs (MWCNTs, SWCNTs), graphene (NG, NGO, NG-COOH)

and MOF. The analytes are then eluted from the media using a solvent (HNO_3, NaOH) in which the analytes are soluble and this solution is retained for analysis before determination by F-AAS, ET-AAS, GC-FID, GC-Mass and the UV-Vis spectrometry [8]. SPE is one of the most widely used sample preparation techniques. In SPE, an aqueous sample is passed through a short column containing a suitable solid sorbent, and the solutes are adsorbed onto the column. Afterwards, small amounts of organic solvents of high elution strength are used to recover the analytes from the sorbent, which leads to their enrichment [9]. Solid phase extraction utilizes small amounts of solvent and generates little waste. As a result, it is considered an ecofriendly technique. SPME was introduced by Ayotamuno at al [10]. According to the GAC guidelines, it is a green extraction procedure because it avoids the use of organic solvents and combines extraction, enrichment and sample injection into a single step. Analytes partition between the sample matrix and the SPME fiber coating when the fiber is immersed directly in the sample (direct immersion, or DI-SPME), or between the sample headspace and the fiber coating when the fiber is placed in the space above the BTEX sample (HS-SPME/GC-FID) [10]. Partitioning continues until equilibrium is established between all phases involved. When the extraction process is completed, the SPME fiber is transferred directly to the analytical instrument of choice, typically a gas chromatograph, where analyte desorption takes place. The major advantages of SPME include low cost, simplicity, elimination of the solvent disposal costs, short sample preparation time, reliability, sensitivity, and selectivity [11]. Liquid-liquid extraction (LLE) uses huge volumes of solvents that are regularly risky according to an environmental viewpoint and the cycle is dreary and tedious. During the previous decade, this method has gone through a dynamite change with regards to high-throughput screening with the presentation of miniaturized conventions alongside progressive film based and strong help based advancements. The least difficult procedure is the utilization of the 96-well plate design related to a liquid dealing with robotic framework; it follows a similar standard as mass scale LLE [12].

2.2. Environment pollution and human health

Effects of environment pollutants and disproportionate dumpsite on human health is overwhelming and numerous to mention, especially in developing cities with the high range and production of plastic materials all over the place. All dumpsite is inclined to discharge pollutants to immediate water bodies and to the air by way of leachates and dumpsite gases correspondingly. Industrialization, population growth and unplanned urbanization have partially or totally turned our environment to dumping sites for waste materials. As many water resources have been rendered hazardous and unfit to man and other living systems as a result of indiscriminate dumping of refuse. In Nigeria, contamination and effluence of the underground and surface water by solid wastes is under disseminate thereby making them inappropriate for man's use [13] As waste management facilities are deficient in many highly populous areas in most developing and underdeveloped countries owing to the cost and lack of implementation of pertinent enactment. Poor regional and urban planning, lack of implementation of pertinent laws and announcements on waste dumping, lack of systematized landfill sites play a role to the occurrence of dumpsites within people's inhabitations in developing countries. The surface run off and leachates from dumpsites are sources of fresh water contamination. The danger pose by leachates from metropolitan dumpsites depends on the waste conformation, amount, life span and time, temperature, moisture, obtainability for oxygen, soil morphology, and the comparative distance of the locations to the living community and water body. The pollution of soil with heavy metals even at low concentrations are identified to have possible impact on environmental quality and human health as well as professing a long term danger to groundwater and ecosystems [14]. Landfill leachates have been reported to contain a wide range of metals. Source of these

heavy metals ranges from industrial to municipal generation, automobiles, agricultural and domestic practices. The conventional credence that wastes are occasionally hazardous to health cannot be overemphasized. Hazardous waste can cause and has caused pollution, damage to health and even death. Exposure to multiple chemical combinations in populations living near waste dump sites has led to series of human health disorders. It has been reported that heavy metals, VOCs and anions in dump sites leachates can initiate chromosomal disorder and inhabitants in the locality of landfill sites are disposed to mutagenic effects. The degree of contamination growing from percolation of leachates is established by a number of components that include the physicochemical properties of the leachates and soil and the hydrological condition of the surrounding location [15].

2.3. Wastewater pollution

There are four main treatment steps in the wastewater treatment process. The preliminary treatment removes all large and settleable solids from the wastewater. Secondary treatments use accelerated microbiological growth to remove organic pollutants. The tertiary treatment utilizes a combination of chemical and biological processes to reduce nutrient loading in the wastewater. The quaternary treatment removes particularly difficult emergent pollutants, like pharmaceutical compounds or other complex molecules which was used by different organic and inorganic adsorbents such as silica (MSN.MCM) and ionic liquids(ILs). Analytical testing based on instruments at each step is required to monitor key chemical parameters like the nitrogen compounds, the malondialdehyde, the formaldehyde, the phosphates, and the chlorine [16]. Monitoring silicate, calcium, and magnesium content is imperative as they form scale deposits, leading to higher maintenance costs and downtime which was determined as mg L^{-1} with atomic absorption spectrometry (FAAS, ETAAS). As the primary treatment, the treatment of wastewater by a physical or potentially chemical interaction including settlement of suspended solids, or other cycle in which the Biological Oxygen Demand (BOD) of the approaching wastewater is decreased by essentially 20% before release, and the total suspended solids content is diminished by basically half. The secondary treatment followed with the post-primary treatment of wastewater by an interaction by and large including biological or other treatment with a secondary settlement or other cycle, bringing about a BOD reduction of basically 70% and the Chemical Oxygen Demand (COD) reduction of essentially 75% [17]. Due to the tertiary treatment of public wastewater, the treatment of nitrogen or potentially phosphorus, and additionally some other poison influencing the nature of a particular utilization of water was evaluated (the microbiological pollution and shading). For organic pollution, the treatment efficiencies that characterize a tertiary treatment are the accompanying: organic pollution reduction of essentially 95% for BOD, 85% for COD, the nitrogen reduction of essentially 70%, the phosphorus reduction of essentially 80% and the microbiological reduction accomplishing a waste coliform thickness of < 1000 of every 100 ml. Moreover, explicit industrial effluents might require extra treatment for explicit determinants that may not be normal in many wastewaters [18,19].

2.4. Environment pollution sources

Pollution is the defilement of the environmental natural surface or underground water (domestic waste water, industrial, nitrates from fertilizer) or soil (with fertilizers, pesticides, radioactive wastes, etc.). Presently, about 82% of lands are polluted by the products of petroleum source (hydrocarbons, solvents etc.) used as an energy foundation in the oil industry, in addition, the chemicals were used in various industries and their wastewaters may be included the different pollutants such as, BTEX, VOCs, mercury, arsenic, nickel and vanadium which was determined by analytical methods [19]. There is a diversity of pollutants influencing water bodies, air, soil and subsoil, such as fuel and oil products, crude oil, hydrocarbon residues, other products resulting from the operation (unsaturated

and saturated aliphatic hydrocarbons, and the polycyclic and monocyclic aromatic). It also stances risks to human health, biological environment and vegetation, aromatic compounds having a strong attribute of carcinogenic and mutagenic and, not slightest, influence the environment security, presenting hazards of fire and explosion, when the floating oil reach the groundwater in the basement of various buildings [20]. Accidental oil pollution has turn out to be a common phenomenon nowadays that can cause environmental and social disasters. Potential causes of direct pollution of soil and subsoil can be enclosed by tanks, separators old from wastewater treatment plants, underground pipelines, slurries, settling basins and waste pits of tar, ramp CF loading and unloading, sewerage networks etc. Solid residues, unstored corresponding, which can contaminate the soil, come from: solid impurities concerned in crude oil, sewage sludge from different wastewater treatment plants, solid waste from cleaning of incinerator ash sludge and the maintenance, powder catalyst. Most oil pollution sources come from anthropogenic sources, but there are also some natural sources that pollute the soil and the water bodies [20]. Dumpsite generally contaminates the immediate environment where they are found and they carry hazardous organisms which affects both the environment and the inhabitants of this environment where they are found on. Dumpsite causes various diseases and it increases air borne diseases as well [21].

2.5. Soil pollution

Soil pollution is the change in the composition of soil properties is different characteristics. It involves the building up of toxic persistent substances, slats, radioactive materials, toxic chemicals and other disease causing agents in the soil which have adverse effects on the soil and probably has an adverse effect on plant growth and animal health. Soil comprises of a solid phase (organic matter and minerals matter) as well as an absorbent phase that grasps gases and water [22]. Soil is the mixture of minerals, organic matter, gases, liquids, and the countless organisms that together support life on earth [22]. The organic portion, which is obtained from the decayed remnants of plants and animals, is concentrated in the dark topmost topsoil. The inorganic fraction made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are indispensable for agriculture to furnish the world with adequate food. In a general wisdom, soil pollution definition is the existence of unhealthy chemicals (pollutants or contaminants) in soil in extreme enough concentrations to be of danger to human health and the ecosystem. In additionally, yet when the levels of contaminants in soil are not of peril, soil pollution may take place simply due to the fact that the levels of the contaminants in soil surpass the levels that are naturally present in soil (in the situation of contaminants which occur naturally in soil). Soil pollutants comprise a large variability of contaminants or chemicals (organic and inorganic), which may possibly be both naturally- occurring in soil and man-made. In both cases, the main soil pollution instigates are the human activities which might be leaks and spilling of oil, manufacturing process and dumping of toxic materials and substances in the soil [23]. The heavy metals in soil were determined by the Atomic Absorption Spectrophotometer (AAS, Perkin Elmer 2380) [24]. The Analytical methods for removal VOCs and heavy metals from soil were used by different methodology (Figure 1-3).

2.5.1. In situ soil vapour extraction

Volatile and some semi-volatile organic compounds (VOCs and Semi-VOCs) can be eliminated from unsaturated soils by a cycle known as soil vapor extraction (SVE). SVE as an in situ tidy up measure permits contaminated soil to be remediated without unsettling influence or unearthing [25]. Soil vapor extraction (SVE) is an in situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled progression of air and eliminate volatile and some semi-volatile contaminants from the soil. The gas leaving the soil might be blessed to receive recuperate or obliterate the contaminants.

The disadvantage in the utilization of SVE for remediation of contaminated site is that SVE cannot eliminate heavy oils, metals, PCBs, or dioxins from contaminated soil; it is just powerful for remediation of soil contaminated with VOCs and Semi-VOCs. Since the interaction involves the continuous progression of air through the soil, notwithstanding, it regularly advances the in situ biodegradation of low volatility organic compounds that might be available [26].

2.5.2. Excavation

Excavation (evacuation) is a crucial remediation strategy including the expulsion of debased soil/ media, which can be dispatched off-site for treatment and additionally removal, or treated nearby when pollutants are manageable to solid remediation procedures [26]. Bioremediation is one of the most viable options for remediating soil contaminated by organic and inorganic compounds considered detrimental to environmental health [27].

2.5.3.bioremediation strategy and digestion process (Determination in soil)

Biostimulation of indigenous microbes is a bioremediation strategy mostly used for remediation of contaminated soil. This involves addition of nutrients, either organic or inorganic, to enhance the activities of indigenous microbes [27]. The soil sample was digested with HNO_3 /H_2O_2 by micro wave accessory. At 200°C/ UV irradiation, the sample digested and organic compound convert to SOx and NOx and COx and exit as gas from head of microwave tube under hood conditions. The inorganic compounds determined in remained solution by FAAS. Also by headspace microwave, the VOCs extracted by new technique and online determined by GC-FID.

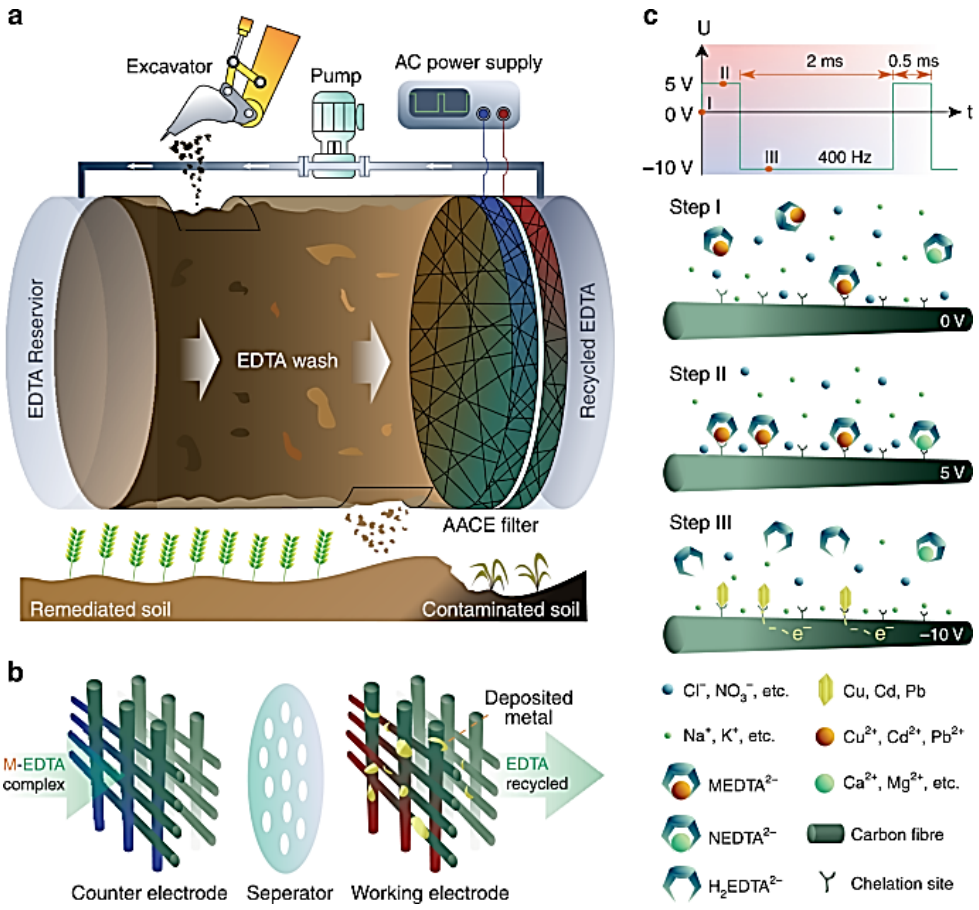


Fig. 1. Remediation of heavy metal contaminated soil by asymmetrical alternating current electrochemistry [28]

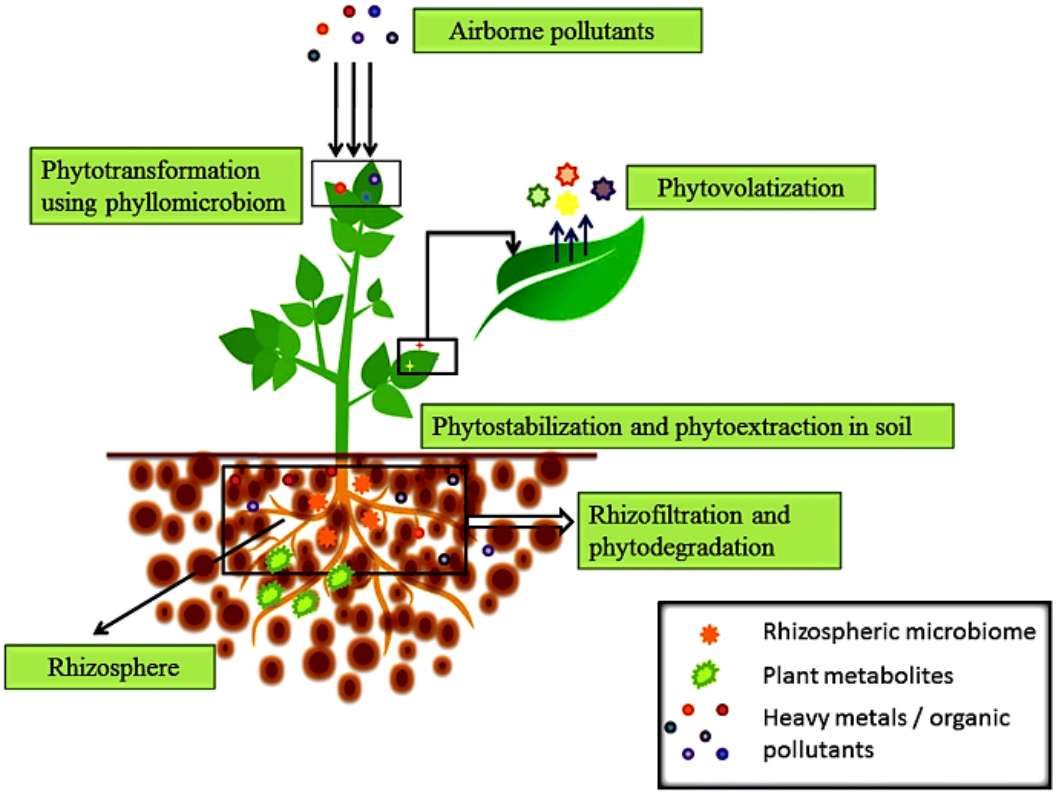


Fig.2. Biological-based methods for the removal of volatile organic compounds (VOCs) and heavy metals

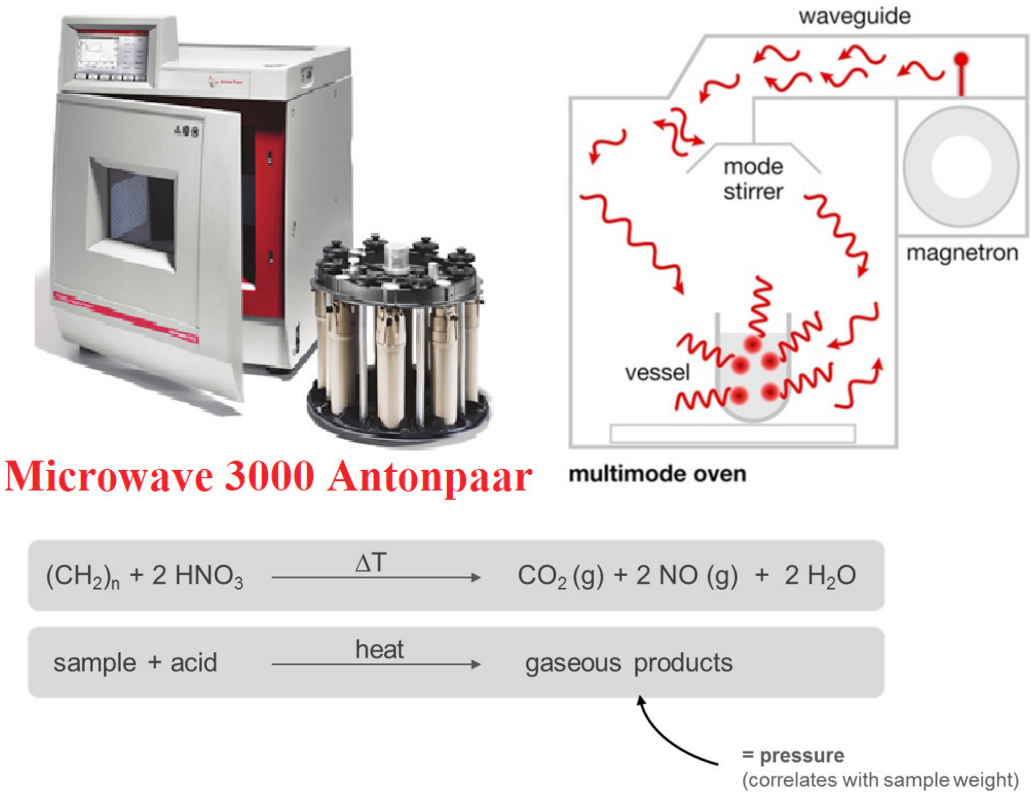


Fig.3. Microwave digestion methods for determination heavy metals and VOCs in soil

3. Soil Pollutants, Analysis and Health Effect

3.1. Soil pollutant

There are several ways in which soil can be polluted with dumpsite, one of the ways can be through seepage from landfill. When toxic materials are buried under the soil in a portion of land that will be used for agricultural practices, the dump will invariably turn out to be noxious to any crop or plant that is around the vicinity. Before a landfill will be used for agricultural or economical practices, it should be properly treated. After treatment the soil pollutant such as heavy metal and BTEX, VOCs must be determined by analytical methods. Percolation of contaminated water into the soil is another way of polluting the soil which many communities and societies are not aware of it. Moreover, the contaminated water (pollutant) into the soil measured by the different analysis instruments. Also, solid waste seepage is one of the common way of soil pollution, which people neglect without knowing the implication on the soil [28]. The most common chemicals involved in causing soil pollution include solvents from companies, pesticides from manufacturing industries. As HSE role, the pollutants in soil of near chemical industries controlled by chemistry analyzers (AAS, UV-Vis and GC-FID). Soil pollution is instigated by the presence of human-made chemicals or other alteration in the natural soil environment. It is characteristically set off by agricultural chemicals, industrial activity, or improper disposal of waste. The most common chemicals engrossed are petroleum hydrocarbons, polynuclear aromatic hydrocarbons which include benzo (a) pyrene) and naphthalene, lead, pesticides, and other toxic heavy metals. Contamination is concurrent with the amount of industrialization and concentration of chemical usage. The dread over soil contamination stems principally from health risks, from direct interaction with the contaminated soil, depletes from the contaminants, and from optional contamination of water sources within and underlying the soil. Mapping of contaminated soil areas and the resulting cleanup are tedious and costly errands, requiring expansive measures of geology, hydrology, and chemistry, computer modeling skills, and GIS in Environmental Contamination, alongside an energy about the historical backdrop of industrial chemistry [29]. The effects of dumpsite with regards to agricultural activities include; reduced soil fertility, reduced nitrogen fixation, larger loss of soil and nutrients, deposition of silt in tanks and reservoirs, reduced crop yield, imbalance in soil fauna and flora. The major hinge on the effects of dumpsite encourages the failure of high crop yield and other activities carried out on the soil. Many farmers complain of low yield and the stunted growth of agricultural products without prior knowledge of the effects of regular dumping of garbage and other chemicals on dumpsites located close to their agricultural farm lands [29]. The TLV of heavy metal and VOCs in soil were reported by FDA, EPA and WHO organizations. The levels of heavy metals in the growing soil were highest for Fe, Zn, Pb, and Cu. In the soil samples, the Fe content ranged from 2760.1 to 2833.07 mg per 100 g dry soil, Cu ranged from 15.5 to 20.13 mg per100 g, Zn ranged from 305.95 to 308.25 mg per100 g, and Pb ranged from 224.48 to 230.39 mg per100 g. The more content of heavy metals in soil caused to toxic for human, foods and vegetables [29]. The industrial activity such as chemical factory, paint factory Oil Company caused to dispersed different pollutions such as VOCs and heavy metals (Hg, As, Ni, Co, V, Cd, Al, Mn) from their wastewaters to soils. Chemical and allied industries comprise of basic chemical manufacturing industries like inorganic/organic chemicals, food industries, bulk petrochemicals, pharmaceutical products and their intermediates, polymers and their derivatives, agricultural chemicals, acids, alkali, dyes, paper and pulp, and fertilizers [30]. The chemical industries have significant impact on the environment due to pollution issues. Wastewater from chemical industry contains mainly organic and inorganic pollutants. These pollutants are toxic, mutagenic, carcinogenic, and mostly nonbiodegradable. Complete treatment of effluents generated in the various chemical industry units in effluent treatment plant is essential

and the principles of process intensification (PI) can be used for the effluent treatment. Several physical, chemical, and biological processes have been considered for treatment of wastewater obtained from chemical, biological, food, pharmaceutical, pulp and paper, dye and textile industries. The choice of methods for treatment of wastewater is based on the type, nature, and concentration of contaminants. The treated effluent should be eco-friendly and reusable [30].

3.2. Analytical Method in Soil

For sample preparation of soil, the various analytical procedure was used. As the VOCs analysis, the soil directly analyzed by head space solid phase extraction coupled to gas chromatography spectrometer based on FID or mass detectors. In addition, for heavy metals analysis, the soil samples were oven-dried at 105°C for 10 hours until constant weight was attained and then, the soil samples digested. For soil sample, 1 g was digested in 10 mL of 1: 1 HNO_3 and heated to 95°C to dry and thereafter refluxed for 10 minutes without boiling. After cooling, 5 mL of concentrated HNO_3 was once again added and refluxed for 30 minutes till brown fumes were produced. The process of adding 5 mL of concentrated HNO_3 was repeated over and over till white fumes appeared. The solution was vaporized to about 5 on mantle set at 95°C with a watch glass over it. After cooling the resulting sample, 2 mL of H_2O and 3 mL of 30% H_2O_2 were added and the solution was placed on the heating mantle to start the oxidation of peroxide until effervescence subsided. Finally, the heavy metals determined by the Atomic Absorption Spectrophotometer (AAS, Perkin Elmer 2380) [24]. Due to Table 1, the Various analytical methods for determination pollutants in soil and water samples.

3.3. Effect of Soil Pollutants on Human Health

There are different routes in which soil or land pollution can affect human health either by short term or long term exposure. When consumed some of this harmful chemicals enters the digestive

Table 1. Various analytical methods for determination pollutants in soil and water samples

Sample	Pollutant	Instrument	method	Ref
Water	VOCs	GC-Ms	SPE	[3]
Soil Water Air	Toxic chemical VOCs Pesticides Heavy metals Phenols	GC-MS F-AAS HPLC	Nanotechnology over conventional treatment technologies Adsorption	[2]
Water	Trichloroethylene (TCE)	GC-MS	LLME–SPME	[4]
Soil	Heavy metals	F-AAS ET-AAS	SCWEP	[5]
Soil, Water, municipal wastewater	Heavy metals	CE-UV	DLLME SDES	[6]
Water Soil	Heavy metals	AAS/SPME	Adsorption based on (CNMs), (MNPs), (NIPs), (N-MOFs), (SiNPs)	[9]
Soil and water	VOCs Malondialdehyde Formaldehyde	HPLC-UV	VALLME-HDES	[16]
Water Soil Air	Aromatic hydrocarbons	GC-MS	Pretreatment techniques HS-SPME	[24]
Soil	Hydrocarbon	GC-MS	SVE	[25]

LLME–SPME: Liquid–liquid microextraction assisted solid phase microextraction, SCWEP: subcritical water extraction process, DLLME: Dispersive liquid–liquid microextraction, SDES: Solidification of deep eutectic solvent, CNMs: Carbon nanomaterials,MNPs: magnetic nanoparticles ,NIPs: Nano-imprinted polymers , N-MOFs: Nano-based metal-organic frameworks, SiNPs: Silica nanoparticles, SPME: Solid phase microextraction, VALLME-HDES: Vortex-assisted liquid-liquid microextraction based on hydrophobic deep eutectic solvent, HS-SPME: Head space solid phase microextraction, SVE: Soil vapor extraction

system, they are absorbed and taken to the liver, these chemical will only be broken down by the liver to certain extend in some cases these chemicals which are not fully absorbed remains in the guts which can be toxic on the gut lining. Direct contact of contaminated soil to the skin can lead to skin damage for example chromium which is a soil pollutant, when this chemical is absorbed by the skin it causes skin irritation [31]. Arsenic (AsIII and AsV); which includes pesticides, coal burning and wood preservative from preservative and agro chemicals etc, which can be consumed through ground water by absorbtion of the soil content into the water. Intake of this over a long time leads to GIT diseases, cardiovascular dysfunction and liver damage. As Figure 4, Dioxin includes the polychlorinated dibenzodioxins (PCDD) and the polychlorinated dibenzofurans (PCDF) from waste recycling industry and paper industry which is consumed through contaminated foods such as meat, fish and diary product which damages to the immune system and also carcinogenic. Also, cadmium (Cd^{2+}) can be gotten from pigments, sewage sludge, water pipes etc. it is mainly consumed by animals but are harmless to animal health, can affect human consuming animal product and cause to MS and cancer. Fluoride as a high level of fluoride consumption in drinking water leads to joint stiffness and pains, it causes calcification of ligaments and tendons and also leads to osteosclerosis. Mercury (Hg) consumed by consumption of contaminated food (Sea Fish as organic mercury C_2H_5-Hg and CH_3-Hg) or metallic mercury (mercury cell, vapor from petrochemical industries) leads to damage of the central nervous system(CNS), organ damage such as the liver and kidney, it also causes teratology in a fetus and poor brain development [32].

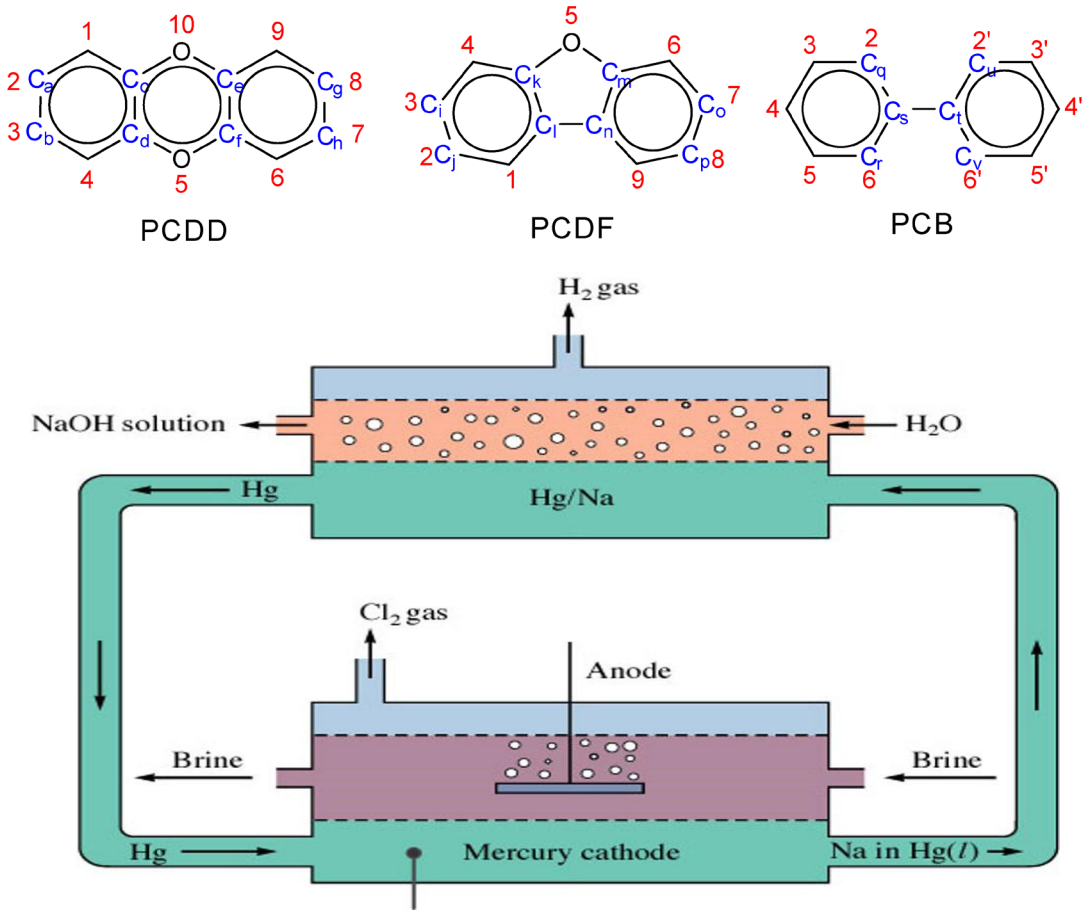


Fig. 4. Mercury cell (production NaOH and Chlotine), dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) [32]

4. Water Pollutants, Analysis and Health Effect

4.1. Water pollutants

Water contamination is an animated change in the nature of the water, which makes it unbefitting or hazardous as concerns food, agriculture, human and animal health, fishing, and industry or recreation interest. The chemical hazards are the Copper, Manganese, Lead, Cadmium, Phosphate, Nitrate and so on, as the public health concern, the ground water ought to be liberated from physical and chemical hazards. Individuals in and around the dumping site are relying on the ground water for drinking and other homegrown purposes. Other high-hazard bunch incorporates population living near a waste dump and those, whose water supply has gotten polluted either because of waste dumping or leakage from landfill sites expands danger of injury, and disease [33] Water is one of the determinants of human earth framework. Diseases may jump up through water contamination, particularly groundwater tainting, and quickly spread past human desire as a result of its stream instrument. One of the main considerations that make the earth tenable for humans is the presence of water. Framing the significant segment of plant and animal cells, it is the premise of life and thusly the advancement of water assets is a significant segment in the coordinated improvement of any territory [33]. Most water pollution does not continuously begin in the water itself. Practically every human activity has a consequence on the quality of the water environment. Dumpsites that are seen in water ways and places that are close to water bodies run off to the water bodies during rainfall and assimilation to the soil which eventually find it way to the water bodies. The causes of water pollution nevertheless, relatively surprisingly sometimes include: Sewage from household and from close industries that channel their sewage directly or indirectly to the water bodies, nutrients for agricultural farms that are dumped close to water bodies are also an avenue for water contamination and pollution, Heavy metals, the xenobiotic compounds in wastewater, Land or air pollution are also part of the notifiable avenue for water contamination. [34]. The amount of debris in some waste sites as seen in Owerri in groups (Table 2).

4.2. Analytical method in Water

For determination of heavy metals in water sample preparation was used. First, 2 mL of concentrated HNO_3 and 5 mL of concentrated HCl to a 100 mL aliquot of collected water sample. The solution was covered with a watch glass and heated at 95°C till volume reduced to 15 mL before being allowed to cool. Thereafter, the final volume was adjusted to 100 mL with reagent water and replicates were processed on a routine basis to determine precision. The concentrations of Cu, Zn, Fe, and Pb in the filtrate of water were estimated using the AAS. For determination VOCs any reagents have not added to water samples. The metal concentration in the water decreases in the following sequential order: As > Pb > Zn > Cu = Al = Cr > Cd = Hg. Also, in the sediment, the sequential order is as follows: Cr > Zn > Cu > Pb > As > Cd > Hg [35]. For evaluation of surface and groundwater on land and coastal sea waters, we usually selected the heavy metals (Cd,

Table 2. The amount of debris in some waste sites as seen in Owerri in groups

Material	Highly seen	Moderately seen	Not seen
Plastics	√		
Rubber	√		
Cloth		√	
Glass/ceramics		√	
Paper/cardboard	√		
Metal	√		
Wood		√	
Other		√	

Hg, Pb) as priority hazardous substances, and then, the heavy metals (Cu, Zn, As, Cr) were chosen as specific pollutants. Aluminum was chosen as toxic to a wide range of aquatic ecosystems [36]. Due to the Hazardous Substances in Water, the chemical and ecological status were determination with environmental quality standards(EQS) for priority hazardous substances (PHS) and specific pollutants (SP). According to EQS, the values of metals in the surface waters for cadmium, mercury, copper, chromium, zinc were obtained 0.04, 0.0025, 1.0, 1.2, zinc µg L-1, respectively [35]. Nsibande et al used fluorescence detection of pesticides based on quantum dot (CQDs) in water samples [37]. Cao et al reported Metal–organic framework (MOF) for extraction insecticides in water samples by dispersive solid phase extraction (DSPE) [38]. Selahle and Kachangoon used magnetic solid phase extraction (MSPE) based on porphyrin organic polymer and hydrophobic deep eutectic solvent(HDES) based DLLME for determining of insecticide in water [39, 40]. Bessonova and Ykowska reported the role of ionic liquids for determination of pesticides and VOCs in waters by DLLME [41, 42]. Also, the determination pesticide, heavy metals and VOCs in waters followed by DLLME –GC-MS and HPLC-MS/MS [43,44]. Moreover, the analytical methods for determination heavy metals and other pollutants in waters followed by zeolitic imidazolate framework (ZIF-7) based on MSPE and the biosensors in waters [45-48]. Recently. The researchers used SPE, MSPE, LLME, LLE, Liquid-phase membrane extraction (LPME) for metal, pesticides, carboxylic acids, phenol in water matrixes [49-52]. Also many metals and VOCs were determined by different ionic liquids and adsorbents (Table 3 and 4). Cloud point extraction (CPE) has been utilized for the preconcentration of cobalt, mercury and nickel, after the arrangement of a complex with 1-(2-thiazolylazo)-2-naphthol (TAN), and later examination by flame atomic absorption spectrometry utilizing octylphenoxypolyethoxyethanol (Triton X-114) as surfactant. The chemical factors influencing the detachment stage and the viscosity influencing the detection cycle were enhanced. Under the ideal conditions, preconcentration of just 50 ml of sample within the sight of 0.05% Triton X-114 permitted the detection [53]. The current work depicts a straightforward, dependable analytical strategy that satisfies the assurance of benzene and toluene, in environmental water samples. The technique depended on the cleanse of BTEX (a gathering of unstable natural mixtures (VOCs)) from water samples to a particular volume of acetonitrile preceding making the analysis by superior liquid chromatography outfitted with a photo diode array detector. The created method was upgraded utilizing full factorial design, and the subsequent ideal boundaries were applied in the examinations of approval which affirm method dependability; recuperation was somewhere in the range of 94 and 106% with a maximum relative inclination of 5.9%, relative standard deviation was under 7.7% (n = 10), and cut off of detection varied from 0.18 to 0.6 µg L−1 [53].

4.3. Effect of Water Pollutants on Human Health

Since water have a wide range of usage all over the world, the contaminated water makes gives ill damages and causes serious health damage. Poor or developing countries or communities are at risk because their homes are often close to polluting industries. Water borne pathogens are present in the water due to fecal contamination and consumption of untreated water. This lead to bacteria diseases, pollutant, viral diseases and parasitic diseases which was explain as below text.

Bacteria: such as typhoid which is caused by S*almonella typhimurium* bacteria, which mostly infects the lining of the gastrointestinal tract leading to constipation or diarrhea including high fever it also affects organs such as the liver and spleen. Cholera caused by *vibrio cholerae* , and Dysentary caused by *shigella, camphylobacter, E. coli* and salmonella bacteria species which leads to intestinal infection causing dehydration, excessive expulsion of water, blood and nutrient through vomiting and excretion , this leads to body weakness and stomach pains [75].

Table 3. Determination of heavy metal pollutants in water samples using ionic liquids or adsorbent

Metal	Sample	preparation method	Analysis	ILs	Volume (mL)	Heavy metal interferences	Recovery (%)	Ref.
Co^{2+}	Tap and lake Water	ISFME	FAAS	[HMIM][BF_4] and $NaPF_6$	5.0	Mn^{2+}, Cd^{2+}, Ni^{2+}, Zn^{2+}	97.8	[54]
As^{3+}	Industrial wastewater	LLME	LC-MS	[HMIM][PF_6]	20	Cu^{2+}, Zn^{2+}, Cd^{2+}	More than 95%	[55]
Co^{2+}	Mineral, tap, and river water	DLLME	F-AAS	[HMIM][PF_6] with [HMIM] [Tf_2]	10	Ni^{2+}, Mn^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Rh^{2+},	100.3	[56]
Cd^{2+}	Lake and waste water	DLLME	F-AAS	[BMIM][PF_6] with PAN	15	Fe^{3+}, Zn^{2+}, Pb^{2+}, Na^{+}, K^{+}, Ca^{2+} and	99.3	[57]
Cu^{2+}	River and lake water	IL-UADLLME-SAP	LC	Cyphos IL	15	Mn^{2}, Zn^{2+}, Cd^{2+}, Sn^{2+}, Pb^{2+},	99.5	[58]
Ni^{2+}	Tap and mineral water	DLLME	UV-Vis	[HMIM][Tf_2N] and PAN	10	Pb^{2+}, Cr^{3+}, Al^{3+}, Sb^{3+}, Cu^{2+}, Cd^{2+},	98.0	[59]
Cr^{3+}	Mineral, sea, and river water	LLME	F-AAS	[BMIM][BF_4] and DPC	10	Zn^{2+}, Co^{2+}, Cu^{2+}, Ni^{2+}, Cd^{2+}, Bi3+,	98.4	[60]
Pb^{2+}	Ground and surface water	UA-ILDME	F-AAS	[BMIM][PF_6] with Dithizone	10	Co^{2+}, Ni^{2+}, Zn^{2+}, and Cd^{2+}	98.3	[61]
Cd^{2+}	river, and well water	UA-MR- IL-DLLME	F-AAS	[BMIM][PF_6] and APDC	10	Mn^{2+}, Cu^{2+}, Zn^{2+}	99.4	[62]
Cd^{2+}	Water	SFM-μ-SPE	AT-FAAS	CNTs@DHSP	20	Ni^{2+}, Mn^{2+}, Cu^{2+}, Zn^{2+}, Al^{3+}, Hg^{2+}	98.0	[63]
Se^{4+}	Water	SPE	F-AAS	Dried activated sludge (DAS)	100	Ni^{2+}, Co^{2+}, Cu^{2+}, Zn^{2+}, Hg^{2+}, Mn^{2+}	96.0	[64]
Ni^{2+}	Water	USA-D-μ-SPE	ET-AAS	$(BDC)_2(DABCO)$ (MOF)	25	Ag+, Cu^{2+} Mg^{2+}, Co^{2+} Pb^{2+}, Zn^{2+}	98.8%	[65]

IL-HLLME: Ionic liquid for homogeneous liquid-liquid microextraction
LLME*:* Liquid-liquid microextraction
DLLME*:* Dispersive liquid-liquid microextraction
IL-UADLLME-SAP*:* Ionic liquid - Ionic liquid ultrasound-assisted dispersive liquid-liquid microextraction based on solidification of the aqueous phase
UA-MR- IL-DLLME: Ultrasound-assisted magnetic retrieval-linked ionic liquid dispersive liquid–liquid microextraction
SFM-μ-SPE*:* Syringe filter membrane- micro solid-phase extraction

Pollutant: The diseases of air pollution include the ischemic heart disease(IHD), the respiratory infections(RI), the chronic obstructive pulmonary disease (COPD), cancer. Heavy metals such as Hg, V, Ni, Co and Pb created autoimmune diseases in human. The autoimmune disease may indicate the production of autoantibodies, infiltration of destructive inflammatory cells into different target organs. The most of autoimmune diseases is due to extra concentration heavy metals in the environment which is produced by industrial pollutants. Also, the volatile organic compounds (VOCs) are entered

Table 4. Determination of VOCs pollutants in water samples using ionic liquids or adsorbent

VOCs	Sample	preparation method	Analysis	ILs	Volume (mL)	LOD(μg/L)	Recovery (%)	Ref.
Benzene	PTI	LTTMs	GC-FID	Sulfolane IL	-----	-----	98.25	[66]
DDD	Rain water	DLLME	HPLC	[BMIM][PF_6] and [HMIM][PF_6]	5.0	0.35	96.3	[67]
Estradiol benzoate (EB)	River water	DLLME	HPLC	BMIM][BF_4] and [NH_4][PF_6]	160	0.045	105.1	[68]
Phenol	Water	LE	Color reaction	[BMIM][Tf_2N] [HMIM][Tf_2N]	10	-----	99.9	[69]
BTEX	Water	CPBDDE	Voltammetry	Carbon Nanoadsorbent	10	3.0×10^{-7} mol L^{-1}	98.9-99.4	[70]
Ethanol, Heptane	Water	Solvent extraction	GC	Nanostructure	-----	0.023	95.4-102%	[71]
Xylene	Water	Solid liquid separation	GC	MOF/ zeolites	15	-------	95%	[72]
Benzene	Water	D – μ-SPE	SHS-GC-MS	CNTs@PhSA	-----	-------	96.8-102	[73]
Benzene Toluene	Water	SPE	HS-GC	CuONPs	------	--------	98.7%	[74]

CPBDDE: Cathodically pretreated boron-doped diamond electrode
LTTMs*:* Low transition temperature mixtures
PTI: Petrochemical industry

from environment to the human body and caused to cancer. VOCs as hazardous chemicals can cause to irritation, headaches, fatigue, nausea and dizziness problems. High concentrations of VOCs cause lungs cancer and damage the liver, kidney and CNS. Viral: such as viral hepatitis A caused by hepatitis A virus which infects the liver leading to jaundice in some part of the body especially the sclera, loss of appetite, fatigue and high fever. Poliomyelitis caused by poliomyelitis virus leading to sore throat, fever and paralysis of the limbs. Gastro enteric diseases caused by rotavirus, adenovirus and other viruses that are found in water contaminants.

Parasitic: which includes tapeworm intestinal infestation, pinworms and round worms (*Ascaris lumbricoids*) the eggs of this parasitic worms are harmful to the human health, when their eggs consumed through contaminated water or ingested through contaminated food infects the gastrointestinal system, digested eggs produces live parasitic worms inside the body system, these worms begin to compete for nutrient causing abdominal pains and discomforts, retarded growth and body weakness [76].

5. Air Pollutants, Analysis and Health Effect

5.1. Air pollutants

Air contaminant or poison is a waste matter that pollutes the air. Any material or chemical waste product, which adjudicates the air and other natural reserves harmful or generally impracticable. There are several factor that promote the severity of air pollution, they include its persistence, chemical nature and the concentration. Solid waste makes a few noxious gases, for example, Hg^{o}, VOCs,

BTEX, H_2S, suspended Sulfur Dioxide (SO_2), oxides of Nitrogen (NO_X), Carbon Monoxide (CO), Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM). The residue delivered from different sources can create a gathering of sicknesses going from a straightforward cold to hazardous illnesses like cancer [77].

5.2. Analytical Methods in Air

Benzene, Toluene, Ethylbenzene and Xylenes isomers (BTEX) are a group of highly volatile gaseous pollutants frequently found in indoor and outdoor air. It is known from the literature that these compounds have a negative impact on the environment since they contribute to the formation of ozone and other photochemical oxidants. Moreover, BTEX are either known for being, or suspected to be, irritants, neurotoxins, allergens or carcinogens and their exposure on a long term basis presents a serious threat to the human health. Therefore, implementing effective strategies for pollution control is of paramount importance to limit human exposure and prevent the environment degradation [78]. These days, various techniques dependent on physicochemical or biological cycles have been produced for gaseous pollutant's expulsion like thermal, plasma, synergist or photocatalytic oxidation, condensation, membrane division, biological degradation, absorption and adsorption. Notwithstanding, the pollutant fixation in indoor air or mechanical conditions is generally low, running from sub ppb level to 100 of ppm. It is qualified to make reference to that not all evacuation techniques can be successful at such low focus ranges. Moreover, a portion of these methods are costly or require normal upkeep restricting their utilization at homegrown scale. Among them, adsorption has been shown to be a method that displays a decent trade off among cost and proficiency for BTEX evacuation at low fixations [78]. Since BTEX focuses are typically exceptionally low, the combination of preconcentration gadgets is for the most part expected to expand the affectability of these methods. Along these lines, in the referenced pre fixation unit, an adsorbent is utilized to trap pollutant particles and concentrate the example that is destined to be, thusly, dissected by ordinary gas chromatography. The adsorbent prerequisites in pollutant evacuation just as gas investigation incorporate a negligible leap forward, huge adsorption limit, thermal solidness and selectivity to the designated pollutants. Furthermore, the desorption temperature ought to be moderate to empower a powerful, modest and quick adsorbent recovery [79]. Carbon monoxide (CO) has a characteristic infrared absorption near 4.6nm. The absorption of infrared radiation by the carbon monoxide molecule can therefore be used to measure the concentration of carbon monoxide in the presence of other gases. The Non-dispersive infrared photometry method [NDIR] is based on this principle. Most commercially available NDIR analyzers incorporate a gas filter to minimize interferences from other gases. They operate at atmospheric pressure, and the most sensitive analyzers are able to detect minimum carbon monoxide concentrations of about 0.05 mg m^{-3} (0.044 ppm). Interferences from carbon dioxide and water vapour can be dealt with so as not to affect the data quality. Also, the another sensitive method for measuring low background levels of carbon monoxide (CO) is gas chromatography This technique is an automated, semi-continuous method in which carbon monoxide is separated from water, carbon dioxide and hydrocarbons other than methane by a stripper column. Carbon monoxide and methane are then separated on an analytical column, and the carbon monoxide is passed through a catalytic reduction tube, where it is converted to methane. The carbon monoxide (converted to methane) passes through a flame ionization detector, and the resulting signal is proportional to the concentration of carbon monoxide in the air. This method has been used throughout the world. It has no known interferences and can be used to measure levels from 0.03 to 50 mgm^{-3} (0.026 to 43.7 ppm). Nitrogen oxides are one of the primary pollutants

just as the evaluation standards of the air quality. Nitrogen oxides (NO) in the atmosphere adversely affect people principally through the respiratory system, which might cause intense and constant health issues. In this manner, the investigation of examination and detection methods for nitrogen oxides will be critical. There are numerous methods for the determination of nitrogen oxides like ion chromatography, chemiluminescence, fluorescence, and colorimetric micro determination. Among these methods, the fluorescence strategy has attracted a lot of consideration and been applied generally for the location of nitrite for the high sensitivity, selectivity, low limit of recognition and straightforward activity. As per the writing, NO_2^--natural colors and $NO_2^-KBrO_3^-$-natural colors are the fundamental frameworks for the assurance of nitrite by the fluorescence spectrometry. Methods for deciding degrees of sulfur dioxide (SO_2) in the air incorporate ion chromatography, titration, calorimetry, mass spectrometry, conductimetry, amperometric detection, flame photometric detection, and turbidimetry. Ion chromatography is by all accounts the most sensitive of these methods with a detection cutoff of 3 µg per sample for sulfur dioxide. Sulfur dioxide has additionally been estimated in stack gases. Methods for estimating sulfur dioxide in stack gases incorporate beat fluorescence detection and titration. Sulfur dioxide isn't found in water since it is decreased to sulfuric corrosive in water. Colorimetry, titration, and either corrosive distillation (AD) or soluble base extraction (AE) ion exclusion chromatography (IEC) with electrochemical detection (ED) can be utilized to gauge sulfur dioxide in food and beer. The analytical methods in air was shown in (Table 5.)

5.3. Ways of Air pollution

Dumpsite emit poisonous gases which enter the air and become detrimental to man and the environment at large. These surface fires emanate particulate matter, which include black carbon or dust, popularly refers to as smut, which is a short-term climate pollutant with global warming prospective. While drenching such fires is comparatively easy, subsurface fires are not. This happens when biodegradable waste decomposes anaerobically and produces landfill gases. The major constituent of landfill gas— methane — catches fire when it comes in acquaintance with air. Chemical factories, oil company, petrochemical Company and industrial chemical activities caused to relapsed VOCs, BTEX, the metallic and inorganic mercury, H_2S in air [79].

5.4. Effect of Air Pollution on Human Health

Air pollution is determined by presence of particles in the air which are known as pollutants and are presents in large quantities for long periods of time. Such pollutants include particles hydrocarbons, carbon monoxide, carbon(IV) oxide, lead nitrogen oxide(NO) and sulfur oxide. This pollutant when inhaled into the body system either due to long term or short term effect causes serious health implications such as respiratory disorders, cardiovascular dysfunction, neurogenic instability such as and pathological diseases [80].

Carbon Monoxide: When there is exposure to this gas it leads to tiredness, dizziness, headaches, nausea, confusion, and impaired vision. Long term exposures can lead to brain damage, heart dysfunction, breathing difficulties and muscle weakness. When inhaled it combines with

Table 5. The analytical methods in air

Air pollutant	Type	Ref
$S0_2$	Cu–Ce catalysts supported on activated carbon	[2,88]
Dust, H_2S	Fluorinated MOF	[83-85]
0_3, Oxidant	Adsorbent	[20, 79]
Hydrocarbons	Metamodel to a spatially-distributed housing stock	[79]
NO, NO_2	2D Hybrid Nanomaterials	[82,78]
CO	Gas sensors	[81]
CO_2	Gas sensors	[81]

hemoglobin in the blood by displacing oxygen and forming carboxyhemoglobin which causes the cell and organs to become hypoxic (lacking of oxygen). The brain and heart consumes large amount of oxygen but due to the toxicity of carbon monoxide the brain and heart cells will lack adequate oxygen for proper functioning [81].

Nitrogen Oxide: Nitrogen oxide are pollutants that mainly affects the respiratory system and causing respiratory metaplasia, short term exposure to this can increase a person chance of respiratory infections and asthma. Long term exposures can lead to chronic lung diseases. When inhales the respiratory airways response effectively leading to allergic reaction causing increase in airway neutrophilia and bronchial hyper responsiveness, it reduces the antioxidant effects of tissues, it replaces type I alveolar epithelial cells and ciliated epithelial cells with more oxidant resistant type II and non- ciliated cara cells [82].

Sulfur Dioxide: High concentrations of sulfur dioxide causes skin irritation, irritation of mucus membranes of the eyes, nose, lungs etc. it reduces the function of the lungs it makes breathing difficult, people living with asthma and children are sensitive to this [83]. Also, the exposure of NO_2 and SO_2 cause to many diseases such as the respiratory system, skin irritation and irritation of mucus [83-85].

6. Urban Effects for Pollutants

Urban effects of dumpsite have been monitored in developed cities while in some area, the effects of this dumpsite are still overlooked which in turn leads to clogging of drains, Inundation of areas, public health problems, pollution of drinking water sources, foul smell and release of gases, ecological imbalance, release of pollutant gases, release of radioactive rays causing health problems, increased salinity, reduced vegetation and other effects. Pollution runs off into rivers and executes the fish, plants and other aquatic life, crops and grain developed on dirtied soil may give the contaminations to the customers, contaminated soil may presently don't develop crops and grub, soil structure is harmed (clay ionic structure impaired), consumption of establishments and pipelines, debilitates soil solidness, may deliver fumes and hydrocarbon into structures and basements, may make poisonous tidies, may poison children playing in the region [86].

7. Remediation of Pollution

7.1. Incineration

Incineration is a waste treatment measure that includes the burning of organic substances encased in waste materials. Incineration and other high-temperature waste treatment frameworks are depicted as "thermal treatment". Incineration of waste materials changes over the waste into ash, flue gas, and heat. The ash is generally formed by the inorganic constituents of the waste, and may appear as strong bumps or particulates conveyed by the flue gas. The flue gases must be destroyed of gaseous and particulate contaminations before they are scattered into the environment. In certain conditions, the heat created by incineration can be utilized to deliver electric force. Incineration with energy repossession is one of a few waste-to-energy (WtE) advances such as pyrolysis, anaerobic digestion and gasification [87]. In certain nations, incinerators manufactured only a couple many years prior frequently did exclude a materials detachment to eliminate dangerous, cumbersome or recyclable materials before burning. This implies that while incineration doesn't totally supplant landfilling, it altogether diminishes the vital volume for removal. Dump trucks frequently diminish the volume of waste in an underlying compressor before conveyance to the incinerator. Then again, at landfills, the volume of the uncompressed trash bin be decreased by around 70% by utilizing a stationary steel compressor, yet with a huge energy cost. In numerous nations, more straightforward waste compaction is a typical practice for compaction at landfills.

Incineration has especially solid advantages for the treatment of certain waste sorts in specialty areas such as clinical wastes and certain perilous wastes where microbes and poisons can be devastated by high temperatures. Denmark and Sweden have been pioneers in utilizing the energy created from incineration for more than a century, in restricted joined heat and force offices supporting region heating plans [88].

7.2. Recycling

Recycling is viewed as a helpful recuperation practice which alludes to the assembly and reuse of waste materials which incorporate beverage holders, water compartment and so forth. The materials from which the things are made can be measure again into new items. Material for recycling may be gathered autonomously from general waste utilizing assortment vehicles and devoted receptacles. In specific spots and networks, the maker of the waste is required to isolate the materials into various receptacles which may be paper canister, plastics container, metals container and so on, prior to its assortment [89]. While I a few spots and networks, every recyclable substance and materials are unloaded in a solitary assortment canister and are sorted later by focal office. The most extreme famous customer items reused comprise of steel from food and aerosol cans, copper such as wire, old steel furnishings or equipment, aluminum such as beverage cans, polyethylene and PET bottles, newspapers, glass bottles and jars, paperboard cartons, light paper and magazines and corrugated fiberboard boxes. The recycling of unpredictable and complex materials such as computers and electronic equipment is more testing, because of the additional destroying and division required [90]. The category of material acknowledged for recycling varies by city and nation. Every city and nation has different recycling programs set up that can deal with the countless sorts of recyclable materials. In any case, exact variety in gathering is reproduced in the resale estimation of the material whenever it is reprocessed [91].

7.3. Resource recovery

Resource recovery is the methodical digression of waste, which was envisioned for disposal, for a precise next use. It is the handling of recyclables to achieve or recover materials and resources, or transform to energy. These actions are accomplished at a resource retrieval facility where the machines or equipment for recovery are readily available. Resource retrieval mechanism is not only environmentally imperative, but it is correspondingly cost effective. It reduces the amount of waste products for disposal, it also saves space in landfills mechanism and preserves natural resources. This method of waste management can be used in developing countries in order to generate and maintain their economy. As an example of how resource recycling can be beneficial, many of the items thrown away contain precious metals which can be recycled to create a profit, such as the components in circuit boards [91].

7.4. Avoidance and reduction methods

This method includes finding possible ways to minimize the generation of waste which will eventually be dumped at the dumpsites. The reduction on the use of plastic, rubber, nylon and polythene will go a long way in waste reduction. An imperative method of waste dump management is the preclusion of waste material being fashioned, also known as waste reduction [53]. Approaches that can be followed to avoid these waste include the reuse of second-hand materials and products, fixing and maintaining of broken items instead of purchasing new ones, trying to produce material sand products that re reusable or refillable for instance cotton instead of plastic shopping bags), aiding consumers to always use products that are reusable and not always disposable such as cutlery etc [92].

7.5. Bioremediation Technology

The bioremediation is seen as the usage of living microorganisms to lower the environmental

pollutants and chemicals into less contaminated and poisonous forms (Fig.5). It makes use of naturally stirring bacteria, fungi or plants to decontaminate substances hazardous to human health and the environment in general. It is also seen as the use of biological systems to reduce the concentrations of crude oil wastes from contaminated soil [93]. Bioremediation approach can be as unpretentious as applying a garden fertilizer to an oil-contaminated soil, or as multifaceted as an engineered treatment "cell" where soils or other media are manipulated, aerated, heated, or treated with various chemical compounds to promote degradation [93].

7.6. Chemical adsorption Process

An adsorbent is an insoluble material covered by liquid on the surface, including vessels and pores. A material is supposed to be adsorbent when it has the ability to contain an unmistakable measure of liquid in little chambers like a wipe. Adsorbents assume an indispensable part in chemical absorption, which happens when a specific substance is caught on a material's surface. Adsorbents that are equipped for adsorbing carbon dioxide incorporate carbon materials (like initiated carbon and carbon filaments), silica gel, actuated alumina, zeolites (like 5A and 13), mesoporous silicas (like SBA and MCM), metal-natural frameworks, metal oxides (like calcium oxide and magnesia), particle trade resins, and layered twofold hydroxides, (for example, hydrotalcites). Be that as it may, the adsorbents including physisorption show immaterial adsorption limit with respect to carbon dioxide at high temperatures. The adsorption limit and selectivity are determinants of adsorbent separating the CCS measures [94]. Graphene is a carbon-based nanomaterial with a two-dimensional design, high explicit surface region and great substance strength. It is accessible in different structures, for example, perfect graphene, graphene oxide and decreased graphene oxide. Graphene might be oxidized to add hydrophilic gatherings for heavy metal expulsion. adsorbed chromium onto the outer layer of graphene oxide and the most extreme adsorption limit found was around 92.65 mg/g at an ideal pH of 5. This adsorption of chromium on graphene oxide was observed to be endothermic and unconstrained [95]. The graphene, MWCNTs and nanoparticles of metals such as AgNPs were used for adsorption pollutants from air and water samples by chemical or physical adsorption of adsorbents with high surface area. Ashori et al showed that a novel nanosorbent based on IL@

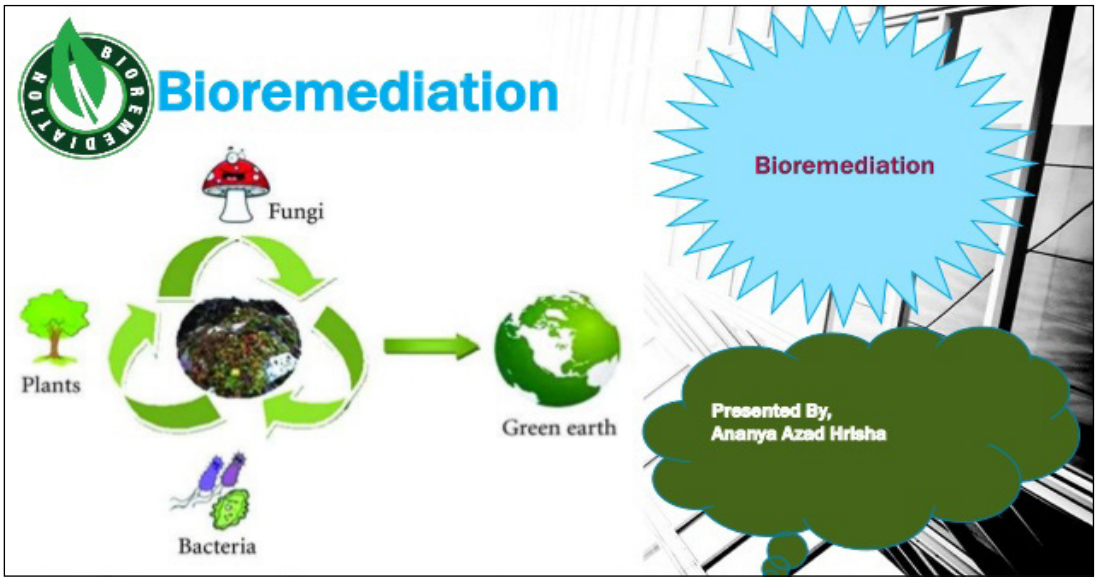


Fig. 5. Bioremediation Technology [92]

MWCNTs for benzene removal from air (Fig. 6a and 6b). Osanloo et al used the AgNPs for removal mercury from air [96]. Shirkhanloo et al used the silver nanoparticles on glassy balls for removal mercury vapor from air [96]. Khaligh et al reported the carboxyl-functionalized nanoporous graphene (NG-COOH) as adsorbent for extraction and speciation of inorganic and organic mercury (Hg (II) and R-Hg ; CH_3Hg^+/ $C_2H_5Hg^+$) in water samples by the US-D-IL-μ-SPE procedure [97]. Mousavi et al showed an amine-functionalized mesoporous silica UVM-7 can be extracted the manganese (II, VII) ions from water samples by the US-D-μ-SPE procedure which was determination by the AT-FAAS [98]. Rashidi et al used the hybrid nanoadsorbent which was prepared by depositing graphene on the zeolite clinoptilolite by chemical vapor deposition for adsorption of lead(II) and cadmium(II) in water samples by the USA-DMSPE procedure [99]. Rakhatshah et al reported the styrene adsorption in water samples based on task-specific ionic liquid (TSIL) immobilized on multi-walled carbon nanotubes (MWCNTs@[Hemim][BF_4]) which was determined by USA-DCC-μ-SPE procedure coupled to GC-FID. The styrene affected on human body and caused cancer, problem in CNS and liver [100].

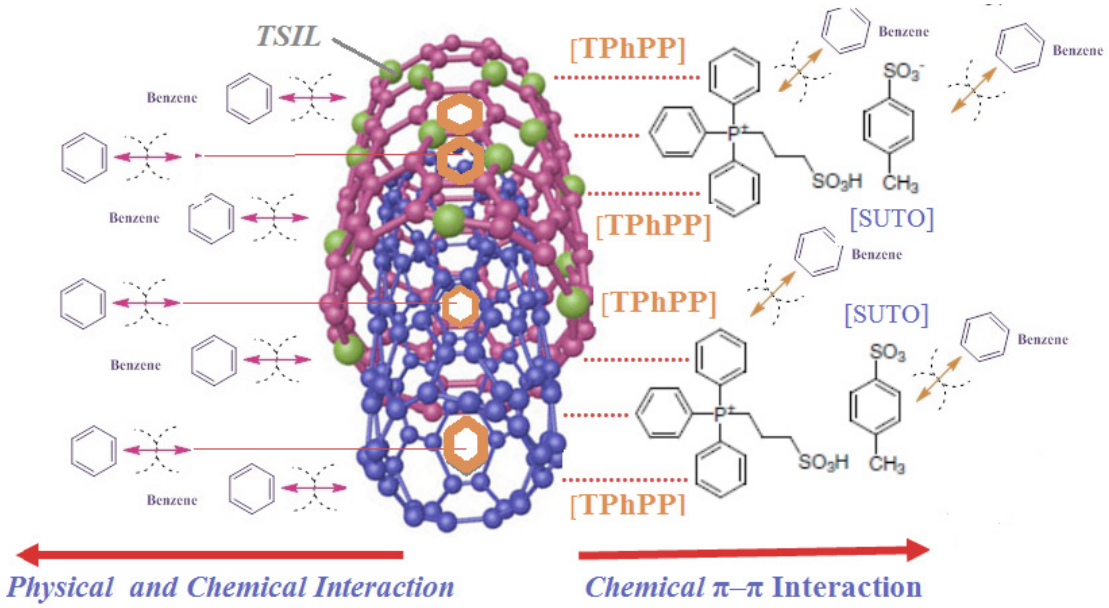


Fig.6a. Adsorption benzene from air by ask-specific ionic liquid coated on MWCNTs [101]

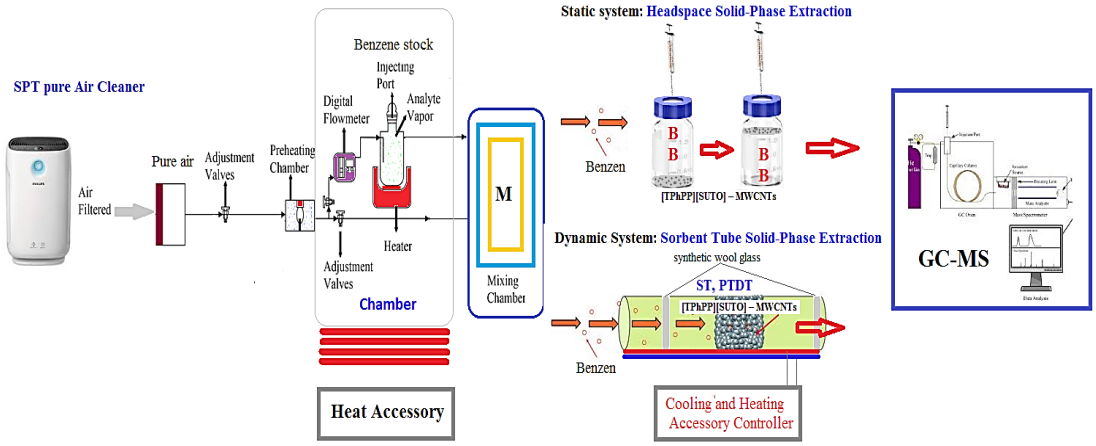


Fig.6b. Mechanism of adsorption benzene from air by ask-specific ionic liquid coated on MWCNTs [101]

8. Conclusions

Pollution caused by chemical industries and dumpsite is the most prevalent problem in the environment especially when it comes to soil pollution caused by manmade pollution. The release of waste materials into the environment is receiving worldwide attention. The effect of dumpsite pollution on soil properties was investigated by reviewing studies done in Owerri in Nigeria. The various analytical methods were used for water, soil and air analysis. The pollutant can be removed from environment by different techniques such as Bioremediation, Biodegradation, adsorption, oxidation and reduction.

9. Acknowledgements

The authors wish to thank the Chemistry Department, Imo State University Owerri, Imo State Nigeria; Chemistry Department, Chukwuemeka odimegwu Ojukwu University Uli, Anambra Nigeria and Medicine Department, Gregory University, Uturu Abia State, Nigeria.

10. References

[1] K. T. Semple, B. J. Reid, T. R. Fermor, Impact of composting strategies on the treatment of soils contaminated with organic pollutants, Environ. Pollut., 112 (2011) 269-283.

[2] R.K. Ibrahim, M. Hayyan, M.A. Al-saadi, A. Hayyan, S. Ibrahim, Environmental application of nanotechnology; air, soil, and water, Environ. Sci. Pollut., 23 (2016) 13754–13788.

[3] A. Andrade-Eiroa, M. Canle, V. Leroy-Cancellieri, V. Cerdà, Solid-phase extraction of organic compounds: A critical review (Part I), TrAC- Trends Anal. Chem., 80 (2016) 641–654.

[4] M. Zhang, P. de B. Harrington, Determination of Trichloroethylene in Water by Liquid–Liquid Microextraction Assisted Solid Phase Microextraction, Chromatogr., 2 (2015) 66-78.

[5] M.N. Islam, H.Y. Jung, J.H. Park, Subcritical water treatment of explosive and heavy metals co-contaminated soil: Removal of the explosive, and immobilization and risk assessment of heavy metals, J. Environ. Manag., 163 (2015) 262–269.

[6] M.H. Habibollahi, K. Karimyan, H. Arfaeinia, N. Mirzaei, Y. Safari, R. Akramipour, H. Sharafi, N. Fattahi, Extraction and determination of heavy metals in soil and vegetables irrigated with treated municipal wastewater using new mode of dispersive liquid–liquid microextraction based on the solidified deep eutectic solvent followed by GF-AAS, J. Sci. Food Agric., 99 (2019) 656–665.

[7] F. Gianì, R. Masto, M.A. Trovato, P. Malandrino, M. Russo, G. Pellegriti, P. Vigneri, R. Vigneri, Heavy metals in the environment and thyroid cancer, Cancers, 13 (2021) 4052.

[8] S. Dugheri, A review of micro-solid-phase extraction techniques and devices applied in sample pretreatment coupled with chromatographic analysis, Acta Chromatogr., 12 (2020) 35.

[9] W. A. Khan, Nanomaterials-based solid phase extraction and solid phase microextraction for heavy metals food toxicity, Food Chem. Toxicol., 145 (2020)111704.

[10] W. Setyaningsih, T. Majchrzak, T. Dymerski, J. Namie´snik, M. Palma, Key-Marker volatile compounds in aromatic rice (Oryza sativa) Grains: An HS-SPME extraction method combined with GC × GC-TOFMS, Molecules, 24 (2019) 4180.

[11] NR. Biata, KM. Dimpe, J. Ramontja, N. Mketo, PN. Nomngongo, Determination of thallium in water samples using inductively coupled plasma optical emission spectrometry (ICP-OES) after ultrasonic assisted-dispersive solid phase microextraction, Microchem. J., 137 (2018) 214-22.

[12] SZ. Mohammadi, A. Sheibani, F. Abdollahi, Speciation of Tl(III) and Tl(I) in hair samples by dispersive liquid–liquid microextraction based on solidification of floating organic

droplet prior to flame atomic absorption spectrometry determination, Arab. J. Chem., 9 (2016) S1510-S5.

[13] O. B. Ifeoluwa, Harmful effects and management of indiscriminate solid waste disposal on human and its environment in Nigeria: A Review, Glob. J. Res. Rev., 6 (2019) 1-7.

[14] S. C. Ihenetu, F. C. Ihenetu, G. I. Kalu, Determination of heavy metals and physicochemical parameters of crude oil polluted soil from Ohaji Egbema Local Government in Imo State, Open J. Yangtze Gas Oil, 2 (2017) 161-167.

[15] S. Zhu, J. Zhou, H. Jia, H. Zhang, Liquid–liquid microextraction of synthetic pigments in beverages using a hydrophobic deep eutectic solvent, Food Chem., 243 (2018) 351–356.

[16] A. Safavi, R Ahmadi, A. M. Ramezani, Vortex-assisted liquid-liquid microextraction based on hydrophobic deep eutectic solvent for determination of malondialdehyde and formaldehyde by HPLC-UV approach, Microchem. J., 143 (2018) 166–174.

[17] S. McMichael, P. Fernández-Ibáñez, J. Byrne, A review of photoelectrocatalytic reactors for water and wastewater treatment, Water, 13 (2021) 1198.

[18] D. Alrousan, A. Afkhami, K. Bani-Melhem, P. Dunlop, Organic degradation potential of real greywater using TiO_2 based advanced oxidation processes, Water, 12 (2020) 2811.

[19] R. Ahmadi, G. Kazemi, A. M. Ramezani, A. Safavi, Shaker-assisted liquid-liquid microextraction of methylene blue using deep eutectic solvent followed by back-extraction and spectrophotometric determination, Microchem. J., 145 (2019) 501–507.

[20] K. Maheep, P. Vijay, Review on solid waste: Its Impact on air and water quality, J. Pollut. Control, 8 (2020) 242-252.

[21] L. O. Odokumaand, A. A. Dickson, Bioremediation of a landfilll polluted tropical rain-forest soil, Global J. Environ. Sci., 2 (2003) 29–40.

[22] A. M. Ramsay, P. J. Warren, A. T. Duke, R. Hill, Effect of bioremediation on the microbial community in oiled mangrove sediments, Marine Pollut. Bull., 41 (2000) 413-419.

[23] J. Sabate, M. Vinas, A. M. Solanas, Laboratory-scale bioremediation experiments on hydrocarbon-contamined soil, J. Int. Biodeter. Biodegr. J., 54 (2014) 19-25.

[24] N. Raza, B. Hashemi, K.H. Kim, S.H. Lee, A. Deep, Aromatic hydrocarbons in air, water, and soil: sampling and pretreatment techniques, TrAC- Trends Anal. Chem., 103 (2018) 56–73.

[25] C. Labianca, Remediation of a petroleum hydrocarbon-contaminated site by soil vapor extraction: A full-scale case study, Appl. Sci., 10 (2020) 4261.

[26] M. Schaefer, F. Juliane, The influence of earthworms and organic additives on the biodegradation of oil contaminated soil, Appl. Soil Ecol., 36 (2007) 53-62.

[27] K. Van Gestel, J. Mergaert, J. Swings, Coosemans, J. Ryckebore, Bioremediation of diesel oil-contaminated soil by composting with biowaste, Environ. Pollut., 5 (2001) 361-368.

[28] N. Vasudevan, P. Rajaram, Bioremediation of oil sludge- contaminated soil, Environ. Int., 26 (2001) 409-411.

[29] D. Hou, D. O'Connor, A. D. Igalavithana, Metal contamination and bioremediation of agricultural soils for food safety and sustainability, Nat. Rev. Earth Environ., 1 (2020) 366–381.

[30] G. Qin, Soil heavy metal pollution and food safety in China: Effects, sources and removing technology, Chemosphere, 267 (2021)129205.

[31] M. Walter, K.S.H. Boyd-Wilson, D. McNaughton, G. Northcott, Laboratory trials on the bioremediation of aged pentachlorophenol residues, J. Int. Biodeter. Biodegr., 3 (2005) 121-130.

[32] B. A. Wrenn, A. D. Venosa, Health effects of pollution, Can. J. Microbiol., 42 (1996) 252–258.

[33] K. Yones, F. Kiani, L. Ebrahmi, The effect of land use change on soil and water quality in northern Iran, J. Mountain Sci., 9 (2012) 798–816.

[34] P. Roccaro, M. Sgroi, F. G. Vagliasindi, Removal of xenobiotic compounds from wastewater for environment protection: Treatment processes and costs, Chem. Eng. Trans., 3 (2013) 32-50.

[35] Regulation for determining the status of surface waters; ministry of agriculture and rural development, Ministry of health and the ministry of sustainable development and tourism: Podgorica, Montenegro, 1–39, 2019.

[36] Government of the republic of Montenegro: rulebook on classification and categorization of surface and ground water, 2021. https://www.morskodobro.com/dokumenti/uredba_klasifikacija_kategorizacija_podzemnih_voda.pdf.

[37] S. A. Nsibande, P. Forbes, Fluorescence detection of pesticides using quantum dot materials e a review, Anal. Chim. Acta, 945 (2016) 9–22.

[38] X. Cao, Z. Jiang, S. Wang, S. Hong, H. Li, C. Zhang, Metal–organic framework UiO-66 for rapid dispersive solid phase extraction of neonicotinoid insecticides in water samples, J. Chromatogr. B, 4 (2018) 1077–1078.

[39] S. K. Selahle, N. J. Waleng, A. Mpupa, P. N. Nomngongo, Magnetic solid phase extraction based on nanostructured magnetic porous porphyrin organic polymer for simultaneous extraction and preconcentration of neonicotinoid insecticides from surface water, Front. Chem., 6 (2020) 8-22.

[40] R. Kachangoon, J. Vichapong, Y. Santaladchaiyakit, R. Burakham, S. Srijaranai, An eco-friendly hydrophobic deep eutectic solvent-based dispersive liquid–liquid microextraction for the determination of neonicotinoid insecticide residues in water, soil and egg yolk samples, Molecules, 12 (2020) 27-85.

[41] E. A. Bessonova, V. A. Deev, L. A. Kartsova, Dispersive liquid–liquid microextraction of pesticides using ionic liquids as extractants, J. Anal. Chem., 8 (2020) 99-129

[42] I. Ykowska, J. Ziemblińska, I. Nowak, Modern approaches in dispersive liquid–liquid microextraction (DLLME) based on ionic liquids: A review, J. Mol. Liq., 2 (2018) 319–393.

[43] A. Szarka, D. Turková, S. Hrouzková, Dispersive liquid–liquid microextraction followed by gas chromatography–mass spectrometry for the determination of pesticide residues in nutraceutical drops, J. Chromatogr. A, 3 (2018) 126–134.

[44] I. Timofeeva, A. Shishov, D. Kanashina, D. Dzema, A. Bulatov, on-line in-syringe sugaring-out liquid–liquid extraction coupled with HPLC-MS/MS for the determination of pesticides in fruit and berry juices, Talanta, 3 (2017) 76-117

[45] M. Nasiri, H. Ahmadzadeh, A. Amiri, Sample preparation and extraction methods for pesticides in aquatic environments: A review, TrAC – Trends Anal. Chem., 123 (2020) 115-172.

[46] E. A. Songa, J. O. Okonkwo, Recent approaches to improving selectivity and sensitivity of enzyme-based biosensors for organophosphorus pesticides: a review, Talanta, 5 (2016) 289–304.

[47] E. Bulska, A. Ruszczyńska, Analytical techniques for trace element determination, Phys. Sci. Rev., 2 (2017) 1–14.

[48] S. Zhang, W. Yao, J. Ying, H. Zhao, Polydopamine-reinforced magnetization of zeolitic imidazolate framework ZIF-7 for magnetic solid-phase extraction of polycyclic aromatic hydrocarbons from the air-water environment, J. Chromatogr. A, 4 (2016) 18–26.

[49] L. Prakel, B. Schuur, Solvent developments for liquid–liquid extraction of carboxylic acids in perspective, Sep. Purif. Technol., 9 (2019) 35–57.

[50] N. N. Hidayah, S. Z. Abidin, The evolution of

mineral processing in extraction of rare earth elements using solid–liquid extraction over liquid–liquid extraction: a review, Min. Eng., 3 (2017) 103–113.

[51] J. M. Kokosa, Selecting an extraction solvent for a greener liquid phase microextraction (LPME) mode-based analytical method, TrAC – Trends Anal. Chem., 2 (2019) 238–247.

[52] J. Đorđević, G. T. Vladisavljević, T. Trtić-Petrović, Liquid-phase membrane extraction of targeted pesticides from manufacturing wastewaters in a hollow fibre contactor with feed-stream recycle, Environ. Technol., 3 (2017) 78–84.

[53] C. Zheng, L. Zhao, X. Zhou, Z. Fu, A. Li, Treatment technologies for organic wastewater, Water Treat., 11 (2013) 250–286.

[54] M. Hosseini, N. Dalali, S. Moghaddasifar, Ionic liquid for homogeneous liquid-liquid microextraction separation/preconcentration and determination of cobalt in saline samples, J. Anal. Chem., 69 (2014) 1141–1146.

[55] L. Fischer, T. Falta, G. Koellensperger, Ionic liquids for extraction of metals and metal containing compounds from communal and industrial waste water, Water Res., 45 (2011) 4601–4614.

[56] M. Mirzaei, N. Amirtaimoury, Temperature-induced aggregation ionic liquid dispersive liquid-liquid microextraction method for separation trace amount of cobalt ion, J. Anal. Chem., 69 (2014) 503–508.

[57] S. Khan, M. Soylak, T. G. Kazi, Room temperature ionic liquid-based dispersive liquid phase microextraction for the separation/preconcentration of trace Cd^{2+} as 1-(2-pyridylazo)-2-naphthol (PAN) complex from environmental and biological samples and determined by FAAS, Biol. Trace Elem. Res., 156 (2013) 49–55.

[58] J. Werner, Ionic liquid ultrasound-assisted dispersive liquid-liquid microextraction based on solidification of the aqueous phase for preconcentration of heavy metals ions prior to determination by LC-UV, Talanta, 182 (2018) 69–73.

[59] R. Khani, F. Shemirani, Simultaneous determination of trace amounts of cobalt and nickel in water and food samples using a combination of partial least squares method and dispersive liquid–liquid microextraction based on ionic liquid, Food Anal. Methods, 6 (2013) 386–394.

[60] B. Majidi, F. Shemirani, Salt-assisted liquid-liquid microextraction of Cr(VI) ion using an ionic liquid for preconcentration prior to its determination by flame atomic absorption spectrometry, Microchim. Acta, 176 (2012) 143–151.

[61] S. Nizamani, T. G. Kazi, H. I. Afridi, Ultrasonic-energy enhance the ionic liquid-based dual microextraction to preconcentrate the lead in ground and stored rain water samples as compared to conventional shaking method, Ultrasonics Sonochem., 40 (2018) 265–270.

[62] L. Yao, X. Wang, H. Liu, Optimization of ultrasound-assisted magnetic retrieval-linked ionic liquid dispersive liquid–liquid microextraction for the determination of cadmium and lead in water samples by graphite furnace atomic absorption spectrometry, J. Ind. Eng. Chem., 56 (2017) 321–326.

[63] J. Rakhtshah, Separation and determination of cadmium in water samples based on functionalized carbon nanotube by syringe filter membrane- micro solid-phase extraction, Anal. Methods Environ. Chem. J., 4 (2021) 5-15.

[64] M. Ghazizadeh, Speciation and removal of selenium (IV, VI) from water and wastewaters based on dried activated sludge before determination by flame atomic absorption spectrometry, Anal. Methods Environ. Chem. J., 4 (2021) 36-45.

[65] N. Motakef Kazemi, Zinc based metal–organic framework for nickel adsorption in

water and wastewater samples by ultrasound assisted-dispersive-micro solid phase extraction coupled to electrothermal atomic absorption spectrometry, Anal. Methods Environ. Chem. J., 3 (2020) 5-16.

[66] S. Ma, J. Li, L. Li, X. Shang, S. Liu, C. Xue, Liquid–liquid extraction of benzene and cyclohexane using sulfolane-based low transition temperature mixtures as solvents, experiments and simulation, Energy Fuels, 32 (2018) 8006–8015.

[67] X. Wang, Q. C. Xu, C. G. Cheng, R. S. Zhao, Rapid determination of DDT and its metabolites in environmental water samples with mixed ionic liquids dispersive liquid–liquid microextraction prior to HPLC-UV, Chromatographia, 75 (2012) 1081–1085.

[68] R. Zhang, X. Cheng, J. Guo, H. Zhang, X. Hao, Comparison of two ionic liquid-based pretreatment methods for three steroids' separation and determination in water samples by HPLC, Chromatographia, 80 (2017) 237–246.

[69] O.G. Sas, I. Domínguez, Á. Domínguez, B. González, Using bis(trifluoromethylsulfonyl) imide based ionic liquids to extract phenolic compounds, J. Chem. Thermodynamics, 131 (2019) 159–167.

[70] G. Garcia de Freitas Junior, TM. Florêncio, RJ. Mendonça, GR. Salazar-Banda, Rt. Oliveira, Simultaneous voltammetric determination of benzene, toluene and xylenes (BTX) in water using a cathodically, pre-treated boron-doped diamond electrode, Electroanal., 31(2019) 554-559.

[71] X. Li, Z. Jia, J. Wang, H. Sui, L. He, OA. Volodin, Detection of residual solvent in solvent extracted unconventional oil ore gangues, J. Eng. Thermophys., 28 (2019) 499-506.

[72] N. Sun, SQ. Wang, R. Zou, WG. Cui, A Zhang, T. Zhang, Q. Li, ZZ. Zhuang, YH. Zhang, J. Xu, MJ. Zaworotko, Benchmark selectivity p-xylene separation by a non-porous molecular solid through liquid or vapor extraction, Chem. Sci., 10 (2019) 8850-8854.

[73] S. Teimooria, A. H. Hassanib, M. Panaahie, Extraction and determination of benzene from waters and wastewater samples based on functionalized carbon nanotubes by static head space gas chromatography mass spectrometry, Anal. Method Environ. Chem. J., 3 (2020) 17-26.

[74] L. Mohammadi, E. Bazrafshan, M. Noroozifar, A. Ansari-Moghaddam, F. Barahuie, D. Balarak, Adsorptive removal of benzene and toluene from aqueous environments by cupric oxide Nanoparticles: kinetics and isotherm studies, Hindawi, J. Chem., 2017 (2017) 206-219.

[75] N. Ariffin, M. M. Abdullah, M. R. R. Zainol, M. F. Murshed, M. A. Faris, R. Bayuaji, Review on adsorption of heavy metal in wastewater by using geopolymer, In proceedings of the MATEC web of conferences, Ho Chi Minh, Vietnam, 10-23, 2016.

[76] A. S. Mohammed, A. Kapri, R. Goel, Heavy metal pollution: Source, impact, and remedies. In biomanagement of metal contaminated soils; Springer, Berlin/Heidelberg, Germany, 1–28, 2011.

[77] M. M. Hussain, J. Wang, I .Bibi, M. Shahid, N. K. Niazi, J. Iqbal, I. A. Mian, S. M. Shaheen,. S. Bashir, N. S. Shah, Arsenic speciation and biotransformation pathways in the aquatic ecosystem: The significance of algae, J. Hazard. Mater.,4 (2020) 12-27.

[78] C.Y. Lu, M.Y. Wey, Simultaneous removal of VOC and NO by activated carbon impregnated with transition metal catalysts in combustion flue gas, Fuel Processing Technol., 88 (2007) 557–567.

[79] J. Taylor, C. Shrubsole, P. Symonds, I. Mackenzie, M. Davies, Application of an indoor air pollution metamodel to a spatially-distributed housing stock, Sci. Total Environ., 667 (2019) 390–399

[80] Burden of disease from the joint effects of household and ambient air pollution, WHO:

Geneva, Switzerland, 2018.
[81] A. Molina, V. Escobar-Barrios, J. Oliva, A review on hybrid and flexible CO2 gas sensors, Synth. Met., 270 (2020) 116602.
[82] A. Chen, R. Liu, X. Peng, Q. Chen, J. Wu, 2D Hybrid Nanomaterials for Selective Detection of NO2 and SO2 using light on and off strategy, ACS Appl. Mater. Interfaces, 9 (2017) 37191–37200.
[83] L. Barelli, G. Bidini, L. Micoli, E. Sisani, M. Turco, 13X Ex Cu zeolite performance characterization towards H2S removal for biogas use in molten carbonate fuel cells, Energy, 160 (2018) 44− 53.
[84] Y. Belmabkhout, P.M. Bhatt, K. Adil, R.S. Pillai, A. Cadiau, A. Shkurenko, G. Maurin, G. Liu, W.J. Koros, M. Eddaoudi, Natural gas upgrading using a fluorinated MOF with tuned H2S and CO2 adsorption selectivity, Nat. Energy, 3 (2018) 1059−1066.
[85] H.Y. Zhang, C. Yang, Q. Geng, H.L. Fan, B.J. Wang, M.M. Wu, Z. Tian, Adsorption of hydrogen sulfide by amine-functionalized metal organic framework (MOF-199): An experimental and simulation study, Appl. Surf. Sci., 497 (2019) 143815
[86] S.T. Magwaza, L.S. Magwaza, A.O. Odindo, A. Mditshwa, Hydroponic technology as decentralised system for domestic wastewater treatment and vegetable production in urban agriculture: A review, Sci. Total Environ., 698 (2020) 134154.
[87] H. Xiao, Q. Cheng, M. Liu, L. Li, Y. Ru, D. Yan, Industrial disposal processes for treatment of polychlorinated dibenzo-p-dioxins and dibenzofurans in municipal solid waste incineration fly ash, Chemosphere, 243 (2020) 12535.
[88] M.Y. Wey, C.H. Fu, H.H. Tseng, K.H. Chen, Catalytic oxidization of SO2 from incineration flue gas over bimetallic Cu–Ce catalysts supported on pre-oxidized activated carbon, Fuel, 82 (2003) 2285–2290.
[89] O. Maass, P. Grundmann, Added-value from linking the value chains of wastewater treatment, crop production and bioenergy production: A case study on reusing wastewater and sludge in crop production in Braunschweig (Germany), Resour. Conserv. Recycl., 107 (2016) 195–211.
[90] J. M. Tobin, J. C. Roux, Mucor biosorbent for chromium removal from tanning effluent, Water Res., 32 (1998) 1407–1416.
[91] V. Prigione, M. Zerlottin, D. Refosco, V. Tigini, A. Anastasi, Varese, Chromium removal from a real tanning effluent by autochthonous and allochthonous fungi, Bioresour. Technol., 10 (2009) 2770–2776.
[92] C. Chen, B. Liang, A. Ogino, X. Wang, M. Nagatsu, Oxygen functionalization of multiwall carbon nanotubes by microwaveexcited surface-wave plasma treatment, J. Phys. Chem. C, 113 (2009) 7659–7665.
[93] K. H. Goh, T.T. Lim, Z. Dong, Application of layered double hydroxides for removal of oxyanions: A review, Water Res., 2 (2008) 1343–1368.
[94] L. Huang, M. He, B. Chen, B. Hu, Magnetic Zr-MOFs nanocomposites for rapid removal of heavy metal ions and dyes from water, Chemosphere, 4 (2018) 435–444.
[95] D. Park, Y. S. Yun, J. M. Park, The past, present, and future trends of biosorption, Biotechnol. Bioprocess Eng., 15 (2010) 86–102.
[96] H. Shirkhanloo, M. Osanloo, M. Ghazaghi, H. Hassani, Validation of a new and cost-effective method for mercury vapor removal based on silver nanoparticles coating on micro glassy balls, Atmos. Pollut. Res., (2017) 359-365.
[97] H. Shirkhanloo, A. Khaligh, H. Zavvar Mousavi, A. Rashidi, Ultrasound assisted-dispersive-ionic liquid-micro-solid phase extraction based on carboxyl-functionalized nanoporous graphene for speciation and determination of trace mercury in water samples, Microchem. J., 130 (2016) 245-254.

[98] H. Shirkhanloo, A. Khaligh, HZ. Mousavi, A. Rashidi, Ultrasound assisted-dispersive-micro-solid phase extraction based on bulky amino bimodal mesoporous silica nanoparticles for speciation of trace manganese (II)/(VII) ions in water samples, Microchem. J., 124 (2015) 637–645.

[99] HZ. Mousavi, A.M. Rashidi, Ultrasound-assisted dispersive solid phase extraction of cadmium (II) and lead (II) using a hybrid nanoadsorbent composed of graphene and the zeolite clinoptilolite, Microchim. Acta, 182 (2015) 1263-1272.

[100] J. Rakhtshah, N. Esmaeili, A rapid extraction of toxic styrene from water and wastewater samples based on hydroxyethyl methylimidazolium tetrafluoroborate immobilized on MWCNTs by ultra-assisted dispersive cyclic conjugation-micro-solid phase extraction, Microchem. J., 170 (2021) 106759.

[101] R. Ashouri, Dynamic and static removal of benzene from air based on task-specific ionic liquid coated on MWCNTs by sorbent tube-headspace solid-phase extraction procedure, Int. J. Environ.Sci. Technol., 18 (2021) 2377–2390.