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Review Article

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Overview of Environmental Pollution and Clean Management of Heavy Metals and Radionuclides by using Microcrystalline Cellulose

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Abstract

In recent times, environmental pollution has become a top priority for the entire world, so huge sums have been allocated to treat the effects of this pollution and to search for joint economic and environmental solutions. Among those solutions is the use of cellulosic agricultural waste as a possible absorbent for dangerous heavy metals and radionuclides from contaminated water. These solutions consider Microcrystalline Cellulose (McC) extracted from agricultural residues one of the most active of these, as well as being easily prepared. Contamination with Cobalt and Cesium and their radioactive isotopes one of the most precarious forms of ecosystem pollution, wherefore this review concentrate on different natural and economical sources of cellulose for (McC) production and heavy metals sorption by using (McC).

Keywords: Microcrystalline cellulose; Wastewater; Heavy metals; Cobalt; Cesium; Radionuclides; Adsorption; Environmental pollution.

Introduction

Undoubtedly, metal compounds are very prevalent in the environment, especially as minerals, and many of them are in the soil; also, in lagoons, rivers, estuaries, oceans, and their sediments. It is worth noting that these compounds happen as a result of natural manners or as a consequence of human activities [1]. The extensive industrialization in urban areas has significantly reduced the land area for waste disposal. Effluents poisoned with hefty metals or radionuclides, and household waste in the environment affect the quality of soil and groundwater. Soil and streams have been used for multiple purposes, including waste disposal. All our precious environmental resources have been affected by the dumping of hazardous waste. [2]. In metropolitan regions, synthetic pollutants aggregate from traffic and mechanical activities and contain high concurrences of hefty metals [3]. Because of consistent augumentation, extraordinary noxious, and substantial penetrability, weighty metal particles effectively aggregate in living beings, causing long haul harm to people and different species [4]. The word-heavy metal has been utilized to depict metallic synthetic components and metalloids which are poisonous to nature and people. Some metalloids, and lighter metals, for example, selenium, arsenic, and aluminum are serious. They have been named hefty metals, while some weighty metals are ordinarily not poisonous, for example, the element gold. Classification the heavy metals with acceding to their density as they are greater than 5 g/cm3 are (titanium-chromium-vanadium-iron-manganese-nickel-cobalt-copper-zinc-arsenic-molybdenum-silver-cadmium- platinum-tin-Mercury-gold-lead), and these elements are most prevalent in our life [5]. A radionuclide is an unsteady model of a chemical element that emits radiation as it decays and becomes more stable. Radionuclides may happen in nature or be made in a lab, and radioactive wastewater is created from different sources, For example, nuclear and isotope power plants, and uranium development plants. Radioactive wastewater from atomic force plants typically contains an assortment of nuclides (60Co, 90Sr, 137Cs, etc.) [6]. Contamination of the aquatic ecosystem with heavy metals and radionuclides has become a global problem and a cause of scientific solicitude because these minerals are non-perishable and most of them have toxic effects on living organisms and at the same time have unique importance in environmental toxicology, as they are very stable [7]. Radionuclide and heavy metal toxicity can lead to low energy levels, damage to blood formation, lungs, liver, kidneys, and other indispensable crucial organs, destruction or minimize mental and central nervous functions, or even provoke cancer. Substantial metals and radionuclides harming is bound to result from inward breath, ingestion, skin contact with the metals or mixes from the residue, vapor or materials from the work environment, or in private settings, particularly homes with lead paints or old pipes [8].

Pollution with Cobalt and Cesium

Recently, nuclear purposes have expanded abruptly, along with many nuclear power plants beginning in carrying out its activities around the world. It is worth noting that the potential impacts of radioactive pollutants emitted to the environment have received increasing attention due to nuclear disasters and the perils that may emerge from them. Soil and water pollution with radionuclides due to natural processes, as well as the global repercussions of nuclear weapons examinations, disengages from nuclear facilities, and disposal of nuclear waste, moreover, the accidental nuclear misfortunes (such as Chernobyl in 1986 and Fukushima in 2011). All of the former repercussions led to drastic problems for biological and environmental systems. Both 60Co and 137Cs are the predominant radionuclides [9-11].

The radioisotopes 137Cs and 60Co can be released from radioactive waste treatment plants and waste repositories into the environment during nuclear applications, and are toxic and dangerous metals. It is noted that both elements are positively present in the soil or aqueous medium. Besides, its chemical toxicity, if found in high concentrations and it has a high degree of solubility in water, as well as 137Cs and 60Co which have harmful effects on the organisms present in their environment due to gamma radiation emissions. It is noteworthy that the half-life of 60Co, which has a half-life (1/2 t) of 5.27 years, while 137Cs has a longer 1/2t of 30 years, both of them pose serious intimidations to human health and other organisms. Besides, radioactive cesium binds to soil particles or dissolves in surface water; consequently, it is necessary to be well knowledgeable of this and to develop techniques for treating it [12].

Cobalt

Cobalt is element number 33 that is hard and silvery-gray at room temperature. This element is considered the most abundant as it is found in a variety of media, including air, surface water, and leachate from hazardous waste sites, groundwater, soil, and sediments. Some studies have confirmed that the sources of exposure to cobalt and its inorganic compounds are either natural or anthropogenic. Numerous elements, including wind dust, seawater fog, volcanoes, forest fires, continental and marine biological emissions, are all-natural sources. The burning of fossil fuels, sewage sludge, phosphate fertilizers, mining, smelting cobalt ores, processing cobalt alloys, and industries that use or process cobalt compounds are all anthropogenic sources [13].

Many factors influence the fate and speciation of cobalt in an aqueous environment, sediments, and soils and include organic bonds such as the main component of soil which are humic acids, as well as anions, pH, and oxidation potential. Soil composition is a major factor in the ease with which cobalt is transported in the soil, in contrast to the strength of adsorption [14]. Although the element has several different forms of it called isotopes, cobalt has one stable image of cobalt, and its atomic mass is 59. It should be noted that these isotopes are found in different weights depending on the number of neutrons that the element contains. Although the element's atomic number (number of protons) remains the same, isotopes of the same element have different atomic mass numbers (number of protons and neutrons). However, cobalt contains many unstable or radioactive isotopes, two of which are of commercial importance and they are cobalt 60 and cobalt 57, also known as 60Co and Co-57 or 57Co, and expressed as cobalt sixty and cobalt fifty-seven. All cobalt isotopes behave in the likewise chemical approach and consequently will have analogous chemical behavior in the environment, and will have similar consequences on the human body. Also, radioisotopes have various and unique properties that distinguish each radioactive element from the other, such as the half-life and the nature of the radiation they emit [15].

The decay of the radioactive element cobalt 60 is known to be associated with the emission of a beam of high-energy radiation called gamma rays [16]. Due to the gamma rays emitted from the element cobalt upon its dissolution, it is used as a source for many purposes, for example, sterilization of medical equipment and purchaser stocks, radiation therapeutics for treating carcinoma, and the manufacture of plastics. The use of 60Co irradiate food is the most essential purpose of this element controlled by the radiation dosage, so this manner can be utilized to sterilize food, slaughter pathogens, prolong food shelf lifetime, disinfect fruits and grains, delay ripening, and loiter sprouting (such as potatoes and onions) [15]

At the same time, among the negatives that may accompany the corruption of the environment nuclear accidents (such as Chernobyl), the consequences of which are the release of 58Co and 60Co into the environment, the dumping of radioactive waste into the sea or from landfills, and the operations of the nuclear power plant [17].

Throughout the development of agriculture on the volcanic plateau of North Island of New Zealand in the early twentieth century, livestock suffered from jungle disease. Volcanic soils have been found to lack the cobalt salts necessary for the livestock food chain [18]. Besides, exposure to cobalt overdoses can lead to interstitial lung disease, lung cancer, heart problems, thyroid damage, nausea, vomiting and diarrhea [8,13,17]

Cesium

Cesium is an element of the periodic chemical table that has a symbol distinguished by Cs and also an atomic number that determines its chemical properties. One of the defining properties of cesium is an alkaline silver gold, a soft with a solubility or melting degree of 28.5°C (83.3°F), making it one of only five metals that are liquid at or near room temperature. Although the radioactive isotope, especially cesium-135 (135Cs) and cesium-137 (137Cs), is extracted from the waste produced in nuclear reactors, this element has one stable isotope, cesium-133 (133Cs) [20]. After the Chernobyl disaster, the accumulation of 137Cs in lakes was a major concern [21]. At the same time, planned uses of Cesium and unplanned releases, such as the Chernobyl and Fukushima accidents, generate aqueous particles. Despite the negatives that may sometimes be out of human control, this element is used as medical, industrial, and research radioisotopes all over the world [22]. The cesium released from all nuclear reactors is monitored by a gamma count. Cesium has differentiation in conduct and physicochemical features like those of rubidium and potassium [23].

Plants diversity broadly in the absorption of cesium, sometimes manifesting a remarkable shield of its consequences. It is also well authenticated from the previous literatures that mushrooms from polluted forests in which radioactive cesium may accumulate in the fungal sporocarps. Through studies [24], it has been shown that lower amounts of cesium may cause infertility [20-25].

Cesium and cobalt represent a considerable obstacle all over the world, including Egypt, as they have different harmful effects on aquatic ecosystems [9,26].

Different Techniques Used for Heavy Metals Removal

Nowadays, heavy metals are recognized as one of the most hazardous environmental problems and one of the priority environmental pollutants that need more rigorous regulations to face them. Therefore, environmental protection policymakers have had to eliminate these toxic elements from wastewater to secure people and the environment. Factors necessary to dismiss heavy metal ions include chemical precipitation, ion exchange, absorption, phytoremediation, membrane filtration, and electrochemical treatment techniques [27-29]

Chemical precipitation

Substance precipitation strategies reliant on the coagulation-flocculation apportionment rule are ordinarily utilized for the treatment of aqueous effluents from research infrastructures, and reprocessing plants. Most radionuclides and weighty metals can be hastened, coprecipitated, and adsorbed by insoluble mixes, for example, hydroxides, carbonates, phosphates, Ferro cyanides, and antimonites, and eliminated it from solution. Analytic precipitation requires plenty of synthetic compounds to reduce metal ions to a satisfactory limited for release [26,27].

Ion exchange

The ion exchange approach relies on the reverse exchange of ions between the solution and the solid in contact with it. The method starts with ion-exchange reactions, then heavy metal ions are absorbed physically, and a complex is formed between the group of counterions and the functional groups. Finally, the reciprocating process, hydration occurs on the surface of the solution or the pores of the absorbent material [27,28]. Chemical deposition approaches undergo some disadvantages such as crucial assets and operating charges or processing and disposal of residual mineral sludge [32]. Although the principal benefits of ion exchange are chemical precipitation over restoring the mineral value, selectivity, and reducing the volume of sludge produced, this method has difficulty removing heavy metals at low concentrations [33].

Membrane filtration

The main feature of using a membrane for wastewater treatment is the ability of the membrane to scrutiny the rate of invasion of chemical species through the membrane and provide several benefits over conventional treatment. However, this effort is thwarted by a contamination obstacle, which limits its wide application due to increases in hydraulic resistance, operating and subsistence expenses, deteriorating fecundity, and recurring membrane regeneration problems [30,31]. Various factors can affect the performance of the membrane. The membrane filtration innovation incorporates five primary preparing measures: Invert assimilation (RO), Ultrafiltration (UF), Microfiltration (MF), Nano Filtration (NF), and Electro Dialysis (ED). Although these cycles are similar, they have some huge contrasts in pore structure (pore size, pore size dispersion, and porosity), layer penetrability, and material working weights. MF and UF films are penetrable and can serve at low weights. The pore sizes of ordinary MF films spread a range from 0.05 to 10 mm and weigh from about 0.1 to 2 bar. Be that as it may, UF layers have pores with sizes extending from 1 to 100 nm and working weight of around 1 to 5 bar. Invert assimilation films are not permeable and work under low working weights of around 10 to 20 bar with permeable layers under the nanometer. Among these cycles, NFs are medium-sized among UF and RO layers. NF is set off at pressures from 10 to 20 bar and pore sizes of 1 nm [26-32]. The average layer use of water treatment strategies was commonly not reasonable for eliminating these dangerous substances. Joined treatment procedures, for example, layer partition and progressed oxidation measures are an energizing and fundamental method for the total evacuation of these contaminants because every innovation supplements the favorable circumstances and defeat the difficulties of the others [37].

Biological treatment

To reduce the pollutants dissolved in the liquid waste by the action of microorganisms, biological wastewater treatment has been designed. Microorganisms use these materials to survive and propagate, and pollutants are also used as nutrients. It has been documented that the prerequisite for this decomposition activity is that the pollutants are water-soluble and non-toxic. The degeneracy process occurs in two directions, either in the presence of oxygen (aerobic therapy) or in the absence of oxygen (anaerobic treatment). Both of these naturally occurring principles of effluent treatment leading to significant variances in the technological and economic processes. In much of the literature, biological wastewater treatment is evaluated as a good strategy for industrial effluents [34,35]. The four principal kinds of reactors for natural wastewater processing are grouped by their water-powered properties as a clump, plug, total blend an arbitrary stream.

In the component rivulet, the fluid particles go through the tank and are released in a similar arrangement as they enter. The particles hold their character and stay in the tank for a period equivalent to the hypothetical maintenance time. Complete blending happens when particles entering the tank are in a flash scattered all through the tank. Particles leave the supply concerning their measurable number. The rivulet neither entering nor leaving the reactor continuously is a fact that is characteristic of a batch reactor. Particles leave the reservoir in proportion to their statistical number. The flow neither entering nor leaving the reactor continuously is a characteristic fact of a batch reactor. An arbitrary flow represents any degree between partial mixing and component flow and is difficult to describe mathematically. Consequently, exemplary plug flow or full mix flow standards are usually deemed [36,37]. Biological treatment breaks down the pollutants in the wastewater into solids that are inorganic and harmless, either by aerobic or anaerobic patterns. In aerobic systems, oxygen is supplied to wastewater through ventilation devices, which promotes activate aerobic bacteria that in turn break down the pollutants and turn them into sludge. While in the anaerobic process, a longer retention period is required. It is worth noting that in the aerobic process, the degradation rate is faster than the anaerobic process. Thus, aerobic treatment is accomplished to improve performance in waste treatment, as well as an economical way to treat concentrated, soluble, non-toxic, and organic waste [26,37,38].

Adsorption

Adsorption energy is critical for assessing the exhibition of a specific permeable and picking up understanding into the fundamental instruments [43]. Therefore, this method is one of the most widely used methods of treating the environment; it is mainly related to two terms (adsorbent and absorbent). It is endorsed that substance or electrochemical precipitation is the most generally utilized methodology for dispensing with hefty metals, the two of which speak to a huge issue regarding dregs removal and particle trade medicines, which don't have all the earmarks of being affordable [44]. The adsorption strategy has pulled in inescapable enthusiasm among substantial metal expulsion procedures, because of its focal points, for example, cost-adequacy, straightforwardness, effectiveness, productivity, low working expense, and reversibility [45]. Adsorption with a minimal effort elective retentive is a requesting territory as it has double advantages, for example, water treatment and waste administration. Besides, biomass enacted carbon has the benefit of offering a viable minimal effort option to non-inexhaustible coal-based granular initiated carbon gave they have comparative or better assimilation on effectiveness [46].

In the field of protection from pollutants, there are many terms, including: 1) An absorbent substance, which is the substance that absorbs another substance on its surface. For example, agricultural waste [42,43], Chitosan [45], Natural clay [48], Microorganisms [49], Algae [50], and other low-cost adsorbents can absorb and remove heavy metals and radionuclides from Wastewater. Also, 2) Adsorbate, which is the substance which is absorbed by itself on the surface of another substance called adsorbates like heavy metals and radionuclides like Cs, Co, etc., [47]. There are numerous sorts of adsorbents generated and implemented for heavy metals and radionuclides adsorption, active Carbon is the most widely recognized adsorbents. Notwithstanding such preferences, scientists encounter problems, for example, the significant expense of blend and trouble in its restoration, these arguments thwarts its application in a tremendous range of wastewater treatment. As well as, dynamic carbon sifts endure deficiencies including filtering through of particles, defective construction characteristics of non-woven filaments, and cost-viability. An adsorption channel with great potential, biodegradability, high toughness (supportability), and extraordinary power while being cost-effective is fundamental for wastewater treatment. Therefore Microcrystalline Cellulose (McC) is one of the most encouraging, financial, and ecological material in this field [48-50].

Microcrystalline Cellulose (McC)

Cellulose is the most broadly distributed and regenerative biopolymer in nature, a very promising and low-cost raw material for preparing various functional materials [55]. Cellulosic wastes have been utilized greatly in improvement of cementitious materials for immobilization of radioactive waste and construction applications [56-58]. As well as, cellulose can be classified as a febrile semi-crystalline material, consisting of amorphous matter as well as crystalline regions [59]. Crystalline cellulose can be gotten from different biomasses. Nevertheless, it may, glasslike cellulose acquired from various lignocellulosic sources for the most clutch contrasts in properties, for example, crystallinity, dampness content, surface region, sub-atomic weight, and permeable structure. Microcrystalline cellulose has extraordinary crystalline development [60], the surface of microcrystalline cellulose (McC) contains many hydroxyl groups, which leads to high activity and ability to interact with different specific groups [59], due to the presence of high specific surface areas and many reactants Superior absorption performance can be achieved. Although there are many studies that illustrate the role of cellulose modification in heavy metals adsorption [53,55,59,61-68], There are not many research papers clarify the direct role of using Cellulose or (McC) without modification in the removal of heavy metals and radionuclides from wastewater.

McC is obtained from cellulose extracted from wood or other cellulosic sources. It contains neither fibers nor amorphous parts, its molecular weight ranges between 3000-5000, and its moisture ranges between 1%-5%. In general, (McC) is used as an anti-caking agent, fat substitute, emulsifier, dilator, and bulking agent in food production. It is mostly used in a vitamin supplement or tablet, and it as an alternative to carboxymethylcellulose. Also, it is used as a valuable additive in pharmaceutical, cosmetic, and other industries.

Any substance has high cellulosic content can be used to prepare (McC) for example, those shown in Table 1.

Cellulosic source	Reference
Rice Straw	[69], [70]
Agricultural Residues	[70]
Coffee Husk	[71]
Raw Cotton	[72]
Waste Cotton	[73]
Tea Waste	[74]
Corncob	[75]
Leaf Fiber Wastes	[76]
Olive Fiber	[77]
Jute	[78]
Bamboo	[79]
Banana Stem Fiber	[80]
Wheat-bran	[81]
Orange Peel Waste	[82]
Soybean Husk	[83]
Sugarcane Bagasse Wastes	[84]

Table 1: Different natural and economical sources of cellulose for (McC) production.

The different ways to prepare (McC)

(McC) is a most refined, non-polymer translucent polymer that has numerous mechanical employments. The noteworthy trade measures for the manufacturing of (McC) are summarized in utilize fractional acidic hydrolysis of decontaminated cellulose under conditions [85]. In which the indistinct districts are broken down and eliminated of polysaccharides. Translucent cellulose districts are not debased and can be reestablished. The acidic hydrolysis measure is commonly viewed as complete after getting an even level of polymerization of the cellulose item [85]. Microcrystalline prepares cellulose from cellulose, which is a natural polymer consisting of glucose units linked together by a beta-1-4 glycosidic bond-forming linear chain [86]. These linear cellulose chains are assembled in the form of micro fibril that they adhere together in plant cell walls. When microfibers manifest a high grade of intrinsic three-dimensional bonding, they lead to a crystalline structure insoluble in water and resistance to reagents. In contrast, the weak internal bonding of microfibers creates areas called amorphous cellulose. The crystalline portion of the cellulose is separated to produce microcrystalline cellulose [87].

There are several technologies used in the production of (McC), such as reactive extrusion, enzyme-mediated, vapor blasting, and acid decomposition. These methods remove amorphous cellulose and remain in the crystalline regions [88]. The degree of polymerization is usually less than 400. The proportion of (McC) particles with a size of fewer than 5 µm should not exceed 10%. The basic method for preparing (McC) from the purified pulp was first described in the strategy of Batista et al. Which remains the basis for many conventional (McC) manufacturing processes. The first step in this process is to repel the dissolved dry pulp [89]. The amorphous cellulose is then hydrolyzed with an acid, such as HCl or H2SO4, to dissolve. Thus, the materials are dried, milled, and packed. The fundamental method for preparing (McC) from the purified pulp was described in the strategy of Batista et al. [90] which remains the backbone for many conventional (McC) manufacturing processes. The first step in this process is to repel the dissolved dry pulp. The amorphous cellulose is then hydrolyzed with an acid, such as HCl or H2SO4, to dissolve, thus, the materials are dried, milled, and packed.

Another method to prepare (McC) from materials containing lignin, hemicellulose, and cellulose by a group of reactive extruders in the presence of a base solution followed by reactive extrusion in the presence of the acid. Extrusion is performed in the first step, in the presence of NaOH, at temperatures ranging from 140°C to 170°C [91]. The second step is extruded, in the presence of an acid, at 140°C, the final extruded product is bleached with hydrogen peroxide or hypochlorite before being spray-dried to (McC) powder [91].

Heavy Metals Sorption by Using (McC).

Due to the strong bonds present on the surface of MAC greatly contribute to the formation of its remarkably crystalline construction, MAC has unique mechanical and chemical properties and can be used as an inlaid frame to assemble heavy metals and radionuclides [53]. The strength of refined (McC) based materials was examined for efficient and expeditious elimination of low-concentration heavy metals from aqueous solution, displaying excellent performance as manifested in Table 2.

Grafted Modification	Adsorbate	Maximum capacity (mg.g-1)	Reference
Tetrafluorotreph thalonitril	Pb2+,Cu2+, Cd2+	9.39, 8.90, 7.39	[60]
Acrylic acid	Cd2+	595.92	[62]
Oxalic acid	Cu2+, Pb2+ Zn2+, Ni2+, Cd2+	227.27, 204.08, 196.08, 238.10, 172.41	[92]
Ammonium Phosphomolybd ate	Cs+	61.21	[93]
carboxymethyl	Cs+	80.5	[94]
Woody charcoal	Cs+	1.7	[95]
Bone Char	Pb+2	115.7	[96]
Butanetetracarb oxylic Acid	Pb+2	1155	[97]
Citric Acid	Pb+2	255	[98]
Aminomethylpyr idine	Co+2	55.8	[99]
Pyridone diacid (PDA)	Co+2	122.7	[100]
Silica gel	Co+2	438	[101]
glycidyl methacrylate	Cu+2	343	[102]
Iron Oxide	As+3, As+5	13.866, 15.712	[103]
Chitosan	Cr+4	3.8	[104]
Diethylenetriami nepentaacetic Acid	Hg+2	476.2	[105]

Table 2: Maximum adsorption capacities for heavy metals by using (McC) adsorbent.

There is a study that demonstrated the importance of microscopic cellulose in protecting against gamma radiation. The microcrystalline cellulose powder was packed in glass tubes and irradiated to γ at a dose rate of 50 Gy/min in the Cobalt 60 equipment. After irradiation, all samples were stored at room temperature in the dark, and the relative humidity was 60% ± 5%[106]. Gamma irradiation caused the decomposition of microcrystalline cellulose, which reduced the degree of polymerization and diminished thermal stability. However, the crystal structure of microcrystalline cellulose was not easily damaged. Radiation degradation resulted in the generation of carbonyl groups containing the compounds and further reduction of the sugar content. The consequence of irradiation on the structural and mechanical properties of microcrystalline cellulose to a large extent, thus favoring the nanotherapy. The radiative effects of cellulose, such as reducing the degree of polymerization, will benefit in moving forward as enzyme hydrolysis to generate biofuels [106].

We can conclude from the former that the exterior of MAC-based adsorbents has often been characterized as bumpy, tough, and spongy with countless microfibers. Moreover, the nanoparticles in some circumstances, which are promising for dyes and heavy metal absorption, indicating good absorption capabilities for (McC)-based adsorbent.

Conclusion

Several wastes play a remarkable role in environmental pollution. Interest in the issue of pollution increases day after day, particularly with modern waste, as a result of the industrial boom and the steadily growing number of the population, and the consequent increase in the amount of liquid, solid and gaseous pollutants and other environmental pollutants. Contamination with heavy elements such as iron, zinc, copper, lead, and cadmium are considered the most dangerous type of pollution due to its accumulation in the tissues of the organism. Heavy metals are dangerous because they are not able to decompose and cause acute and chronic damage to various organisms. Nuclear explosions have a tremendous effect on the climate, as they throw massive quantities of nuclear- dust into the atmosphere that can be enough to block the sunlight for several months, especially in the northern hemisphere (nuclear winter). Additionally, cause damage to the ozone layer, and these explosions can to badly offend the drywall. Nuclear explosions destroy plant life by being deposited on plant surfaces to be absorbed by leaves. Besides, sudden accidents in nuclear power plants such as the Chernobyl accident and the disposal of radioactive nuclear waste pose the uttermost risk of radioactive pollution to the surrounding environment. Although some consider nuclear energy to be clean energy as it does not release pollutants such as carbon dioxide into the atmosphere, there is always great concern about the potential danger arising from emergency accidents at these stations and the resulting nuclear waste. Microcrystalline cellulose is a product of the pure polymerization of cellulose, and it is a kind of ideal health food additive. All sorbents that can be applied without any pre-treatment belong to natural sorbents, which are chemicals that can selectively absorb gases, vapors, or other substances from the surrounding space. Activated carbon is the most effective of these sorbents, which is best used to exacerbate short-term use. All other natural sorbents can be used for a long time without consequences for the body. The various properties of microscopic cellulose are measured to determine its suitability for use, such as particle size, density, compression index, angle of repose, porosity, hydration swelling capacity. Also, among those characteristics of (McC) are the extent of moisture absorption, moisture content, crystallization index, crystal size, and mechanical properties such as hardness and tensile strength and thermal analysis to predict the thermal stability of microscopic cellulose to ensure its stability during the manufacturing processes in which it is used.

References

1. Cook J (1977) Environmental pollution by heavy metals. Int J Environ Stud 10: 253–266.
2. Stevanović V, Gulan L, Milenković B, Valjarević A, Zeremski T, et al. (2018) Environmental risk assessment of radioactivity and heavy metals in soil of Toplica region, South Serbia. Environ Geochem Health 40: 2101–2118.
3. Jeong H, Choi JY, Lee J, Lim J, Ra K (2020) Heavy metal pollution by road-deposited sediments and its contribution to total suspended solids in rainfall runoff from intensive industrial areas. Environ Pollut 265: 115028.
4. Wu Y, Hongwei P, Yue L, Shujun Y, Dong F, et al. (2018) Environmental remediation of heavy metal ions by novel-nanomaterials: A review. Environ Pollut 246: 608–620.
5. Briffa J, Sinagra E, Blundell R, Heliyon (2020) Heavy metal pollution in the environment and their toxicological effects on humans. Heliyon 6: 1-26.
6. Liu X, Wu J, Wang J (2019) Removal of nuclides and boric acid from simulated radioactive wastewater by forward osmosis. Prog Nucl Energy 114: 155–163.
7. Geneva (2011) Adverse Health Effects of Heavy Metals in Children. WHO.
8. WHO Joint, WHO (2007) Health risks of heavy metals from long-range transboundary air pollution. Copenhagen: WHO Regional Office for Europe.
9. Saleh HM (2012) Water hyacinth for phytoremediation of radioactive waste simulate contaminated with cesium and cobalt radionuclides. Nucl Eng Des 242: 425–432.
10. Saleh HM, Bayoumi TM, Mahmoud HH, Aglan RF (2017) Uptake of cesium and cobalt radionuclides from simulated radioactive wastewater by Ludwigia stolonifera aquatic plant. Nucl Eng Des 315: 194-199.
11. Saleh HM, Moussa HR, Mahmoud HH, El-Saied FA, Dawod M et al. (2020) Potential of the submerged plant myriophyllum spicatum for treatment of aquatic environments contaminated with stable or radioactive cobalt and cesium. Prog Nucl Energy 118: 103147.
12. Saleh HM, Moussa HR, El-Saied FA, Dawoud M, Nouh ESA et al. (2020) Adsorption of cesium and cobalt onto dried myriophyllum spicatum L from radio-contaminated water: Experimental and theoretical study. Prog Nucl Energy 125: 103393.
13. McMahon G (2005) Geography for a changing world: A science strategy for the geographic research of the US Geological Survey 1281.
14. Greenwood P, Haley S, Zehringer M, Kuhn NJ (2019) Science of the Total Environment A prototype tracing-technique to assess the mobility of dispersed earthworm casts on a vegetated hillslope using caesium-134 and cobalt-60. Sci Total Environ 654: 1–9.
15. Kim JH, Gibb HJ, Howe PD, WHO (2006) Cobalt and inorganic cobalt compounds 69.
16. Sundermann CA, Estridge BH (2010) Inactivation of giardia lamblia cysts by cobalt-60 irradiation. J Parasitol 96: 425–428.
17. Jiménez-Reyes M, Solache-Ríos M (2016) Chemical behavior of cobalt and cesium in the presence of inorganic components of a semiarid soil using water of nuclear purity. Process Saf Environ 102: 288-293.
18. Snook LC (1962) Cobalt: its use to control wasting disease. J Dep Agric West Aust Ser 4 3: 844–852.
19. Altamirano-Lozano M, Detmar B, Dean EC, Bruce AF, Bice F, et al. (2006) Cobalt in hard metals and cobalt sulfate, gallium arsenide, indium phosphide and vanadium pentoxide. IARC Monogr Eval Carcinog Risks to Humans 86: 1-294.
20. Delmore JE, Snyder DC, Tranter T, Mann NR (2011) Cesium isotope ratios as indicators of nuclear power plant operations. J Environ Radioact 102: 1008–1011.
21. Okamura Y, Fujiwara K, Ishihara R, Sugo T, Kojima T, et al. (2014) Cesium removal in freshwater using potassium cobalt hexacyanoferrate-impregnated fi bers. Radiat Phys Chem 94: 119–122.
22. Rogers H, Bowers J, Gates-anderson D (2012) An isotope dilution – precipitation process for removing radioactive cesium from wastewater. J Hazard Mater 243: 124–129.
23. Hamilton TF, Roger EM, Steven RK, Michael HBH, Iris JS, et al. (2016) A preliminary assessment on the use of biochar as a soil additive for reducing soil-to-plant uptake of cesium isotopes in radioactively contaminated environments. J Radioanal Nucl Chem 307: 2015–2020.
24. Karaman MA, Novaković MS, Matavul MN (2012) Fundamental fungal strategies in restoration of natural environment, fungi: types. Environmental Impact and Role in Disease 5: 167-214.
25. Vinichuk M, Taylor AFS, Rosén K, Johanson KJ (2010) Accumulation of potassium, rubidium and caesium (133Cs and 137Cs) in various fractions of soil and fungi in a swedish forest. Sci Total Environ 408: 2543–2548.
26. Saleh HM, RF Aglan, Mahmoud HH (2020) Qualification of corroborated real phytoremediated radioactive wastes under leaching and other weathering parameters. Prog Nucl Energy 119: 103178.
27. Qu J, Fan M (2010) The current state of water quality and technology development for water pollution control in China. Crit Rev Environ Sci Technol 40: 519–560.
28. Saleh HM, Aglan RF, Mahmoud HH (2019) Ludwigia stolonifera for remediation of toxic metals from simulated wastewater. Chem Ecol 35: 164–178.
29. Saleh HM, Mahmoud HH, Aglan RF, Bayoumi TA (2019) Biological treatment of wastewater contaminated with cu(Ii), fe(ii) and mn(ii) using ludwigia stolonifera aquatic plant. Environ Eng Manag J 18: 1327-1336.
30. Azimi A, Azari A, Rezakazemi M, Ansarpour M (2017) Removal of heavy metals from industrial wastewaters: A Review. ChemBioEng Rev 4: 37–59.
31. Fu F, Wang Q (2011) Removal of heavy metal ions from wastewaters: A review. J Environ Manage 92: 407–418.
32. Rengaraj S, Yeon KH, Moon SH (2001) Removal of chromium from water and wastewater by ion exchange resins. J Hazard Mater 87: 273-287.
33. Khanna VK (2012) 5 'S' experience: A case study 2012 Proc Portl Int Cent Manag Eng Technol Manag Emerg Technol PICMET'12 36: 3322–3334.
34. Zularisam AW, Ismail AF, Sali R(2006) Behaviours of natural organic matter in membrane filtration for surface water treatment-a review. Desalination 194: 211–231.

35. Chen JC, Li Q, Elimelech M (2004) In situ monitoring techniques for concentration polarization and fouling phenomena in membrane filtration. Adv Colloid Interface Sci 107: 83–108.
36. Basile A, Cassano A, Rastogi NK (2015) Advances in membrane technologies for water treatment: materials. processes and applications.
37. Ganiyu SO, Van Hullebusch ED, Cretin M, Esposito G, Oturan MA (2015) Coupling of membrane filtration and advanced oxidation processes for removal of pharmaceutical residues: A critical review. Sep Purif Technol 156: 891–914.
38. Simstich B, Beimfohr C, Horn H (2012) Lab scale experiments using a submerged MBR under thermophilic aerobic conditions for the treatment of paper mill deinking wastewater. Bioresour Technol 122: 11–16.
39. Jung H, Pauly D (2011) Water in the Pulp and Paper Industry. Treatise Water Sci 4: 667–683.
40. Wei Y, Van Houten RT, Borger AR, Eikelboom DH, Fan Y (2003) Comparison performances of membrane bioreactor and conventional activated sludge processes on sludge reduction induced by Oligochaete. Environ Sci Technol 37: 3171–3180.
41. Henze M (1989) The influence of raw wastewater biomass on activated sludge oxygen respiration rates and denitrification rates. Water Sci Technol 21: 603–607.
42. Ratsak CH, Maarsen KA, Kooijman SALM (1996) Effects of protozoa on carbon mineralization in activated sludge. Water Res 30: 1–12.
43. Qiu H, Lv L, Pan BC, Zhang QJ, Zhang WM et al. (2009) Critical review in adsorption kinetic models. J Zhejiang Univ Sci A 10: 716–724.
44. Argun ME, Dursun S, Ozdemir C, Karatas M (2006) Heavy metal adsorption by modified oak sawdust: Thermodynamics and kinetics. J Hazard Mater 141: 77–85.
45. Foroutan R, Peighambardoust SJ, Mohammadi R, Omidvar M, Sorial MA et al. (2020) Influence of chitosan and magnetic iron nanoparticles on chromium adsorption behavior of natural clay: Adaptive neuro-fuzzy inference modeling. Int J Biol Macromol 151: 355–365.
46. Yagub MT, Sen TK, Afroze S, Ang HM (2014) Dye and its removal from aqueous solution by adsorption: A review. Adv Colloid Interface Sci 209: 172–184.
47. Hansen HK, Arancibia F, Gutiérrez C (2010) Adsorption of copper onto agriculture waste materials. J Hazard Mater 180: 442–448.
48. Dong W, Lu Y, Wang W, Zhang M, Jing Y et al. (2020) A sustainable approach to fabricate new 1D and 2D nanomaterials from natural abundant palygorskite clay for antibacterial and adsorption. Chem Eng J 382: 122984.
49. Franzetti A, Isabella G, Giuseppina B, Emilio PS, Claudia C, et al. (2020) Plant-microorganisms interaction promotes removal of air pollutants in Milan (Italy) urban area. J Hazard Mater 384: 121021.
50. Lin Z, Li J, Luan Y, Dai W (2020) Application of algae for heavy metal adsorption: A 20-year meta-analysis. Ecotoxicol Environ Saf 190: 110089.
51. Shabir F, Imran A, Yuguang Z, Riaz A, Redmond RS et al. (2019) Recent updates on the adsorption capacities of adsorbent-adsorbate pairs for heat transformation applications. Renew Sustain Energy Rev 119: 109630.
52. Keshavarz ST, Imani M, Farahmandghavi F (2020) Adsorption and solidification of peppermint oil on microcrystalline cellulose surface: An experimental and DFT study. J Mol Struct 1205: 127558.
53. Garba ZN, Lawan I, Zhou W, Zhang M, Wang L et al. (2020) Microcrystalline cellulose ((McC)) based materials as emerging adsorbents for the removal of dyes and heavy metals – A review. Sci Total Environ 717: 135070.
54. Bursić V, Gorica V, Tijana Z, Dušan M,Sonja G, et al. (2016) Advantages and disadvantages of active carbon in QuEChERS sample preparation method for Pesticide Residues. Sci Bull Ser Biotechnol 20: 191-194.
55. Rafieian F, Mousavi M, Yu Q, Jonoobi M (2019) Amine functionalization of microcrystalline cellulose assisted by (3-chloropropyl) triethoxysilane. Int J Biol Macromol 130: 280–287.
56. Eskander SB, Saleh HM (2012) Cement mortar-degraded spinney waste composite as a matrix for immobilizing some low and intermediate level radioactive wastes: Consistency under frost attack. J Nucl Mater 420: 491–496.
57. Saleh HM, Eskander SB (2012) Characterizations of mortar-degraded spinney waste composite nominated as solidifying agent for radwastes due to immersion processes. J Nucl Mater 430: 106–113.
58. Saleh HM, Eskander SB, Fahmy HM (2014) Mortar composite based on wet oxidative degraded cellulosic spinney waste fibers. Int J Environ Sci Technol 11: 1297–1304.
59. Yu X, Shengrui T, Maofa G, Lingyan W, Junchao Z, Changyan C, et al. (2013) Adsorption of heavy metal ions from aqueous solution by carboxylated cellulose nanocrystals. J Environ Sci 25: 933–943.
60. Cao J, Dongtao F, Xiaoling T, Yuejun Z, Shanshan W, et al. (2017) Novel modified microcrystalline cellulose-based porous material for fast and effective heavy-metal removal from aqueous solution. Cellulose 24: 5565–5577.
61. Liu S, Cheng G, Xiong Y, Ding Y, Luo X (2020) Adsorption of low concentrations of bromide ions from water by cellulose-based beads modified with TEMPO-mediated oxidation and Fe(III) complexation. J Hazard Mater 384: 121195.
62. El-Naggar ME, Emad KR, El-Wakeel ST, Hany K, Gad-Allah AT et al. (2018) Synthesis, characterization and adsorption properties of microcrystalline cellulose based nanogel for dyes and heavy metals removal. Int J Biol Macromol 113: 248–258.
63. Vijayalakshmi K, Gomathi T, Latha S, Hajeeth T, Sudha PN (2016) Removal of copper(II) from aqueous solution using nanochitosan/sodium alginate/microcrystalline cellulose beads. Int J Biol Macromol 82: 440–452.
64. Filho DSEC, Melo JCPD, Fonseca MGD, Airoldi C (2009) Cation removal using cellulose chemically modified by a Schiff base procedure applying green principles. J Colloid Interface Sci 340: 8–15.
65. Rafieian F, Simonsen J (2014) Fabrication and characterization of carboxylated cellulose nanocrystals reinforced glutenin nanocomposite. Cellulose 21: 4167–4180.
66. Li C, Ma H, Venkateswaran S, Hsiao BS (2020) Highly efficient and sustainable carboxylated cellulose filters for removal of cationic dyes/heavy metals ions. Chem Eng 389: 123458.

67. Güçlü G, Gürdağ G, Özgümüş S (2003) Competitive removal of heavy metal ions by cellulose graft copolymers. J Appl Polym Sci 90: 2034–2039.
68. Rafieian F, Hosseini M, Jonoobi M, Yu Q (2018) Development of hydrophobic nanocellulose-based aerogel via chemical vapor deposition for oil separation for water treatment. Cellulose 25: 4695–4710.
69. El-zawawy WK, Ju Y, Heinze T (2013) Cellulose and microcrystalline cellulose from rice straw and banana plant waste : preparation and characterization. cellulose 20: 2403–2416.
70. El-sakhawy M, Hassan ML (2007) Physical and mechanical properties of microcrystalline cellulose prepared from agricultural residues. Carbohydr Polym 67: 1–10.
71. Collazo-bigliardi S, Ortega-toro R, Boix AC (2018) Isolation and characterisation of microcrystalline cellulose and cellulose nanocrystals from coffee husk and comparative study with rice husk. Carbohydr Polym 191: 205-215.
72. Ohwoavworhua FA, Adelakun TA (2005) Some physical characteristics of microcrystalline cellulose obtained from raw cotton of cochlospermum planchonii. Trop j pharm res 4: 501–507.
73. Xiong R, Zhang X, Tian D, Zhou Z, Lu C (2012) Comparing microcrystalline with spherical nanocrystalline cellulose from waste cotton fabrics. Cellulose 19: 1189–1198.
74. Zhao T, Chen Z, Lin X, Ren Z, Li B, Zhang Y (2017) Preparation and characterization of microcrystalline cellulose ((MCC)) from tea waste. Carbohydr Polym 184: 164–170.
75. Shao X, Wang J, Liu Z, Hu N, Liu M, et al. (2020) Preparation and characterization of porous microcrystalline cellulose from corncob. Ind Crops Prod 151: 112457.
76. Taye M, Chaudhary BU, Kale RD (2019) Extraction and analysis of microcrystalline cellulose from delignified serte leaf fiber wastes. J Nat Fibers 1–13.
77. Kian LK, Saba N, Jawaid M, Fouad H (2020) Characterization of microcrystalline cellulose extracted from olive fiber. Int J Biol Macromol 156: 347–353.
78. Jahan MS, Saeed A, He Z, Ni Y (2011) Jute as raw material for the preparation of microcrystalline cellulose. Cellulose 18: 451–459.
79. Abdul Khalil HPS, Tze KL, Ying YT, Paridah MT, Nurul FMR, et al. (2018) Preparation and characterization of microcrystalline cellulose from sacred bali bamboo as reinforcing filler in seaweed-based composite film. Fibers Polym 19: 423–434.
80. Suchaiya V, Aht-Ong D (2011) Effect of microcrystalline cellulose from banana stem fiber on mechanical properties and cystallinity of PLA composite films. Mater Sci Forum 695: 170–173.
81. Wang Z, Sun XX, Lian ZX, Wang XX, Zhou J et al. (2013) The effects of ultrasonic/microwave assisted treatment on the properties of soy protein isolate/microcrystalline wheat-bran cellulose film. J Food Eng 114: 183–191.
82. Akhabue CE, Osubor NT (2017) Optimization of extraction of microcrystalline cellulose from orange peel waste using response surface methodology. Ife J Sci 19: 227.
83. Uesu NY, Pineda EAG, Hechenleitner AAW (2016) Microcrystalline cellulose from soybean husk: effects of solvent treatments on its properties as acetylsalicylic acid carrier. Int J Pharm 206: 85–96.
84. Katakojwala R, Mohan SV (2020) Microcrystalline cellulose production from sugarcane bagasse: Sustainable process development and life cycle assessment. J Clean Prod 249: 119342.
85. Nguyen XT (2006) Process for preparing microcrystalline cellulose. Google Patents.
86. Boock JT (2015) Expanding the capabilities of a bacterial quality control mechanism for engineering enzymes. Cornell University.
87. Chen H (2014) Chemical composition and structure of natural lignocellulose. in:Biotechnology of lignocellulose 25–71.
88. Nghiem NP, Kleff S, Schwegmann S (2017) Succinic acid: technology development and commercialization. Fermentation 3: 1-14.
89. Heath S (2019) Methods, products, and systems relating to making, providing, and using nanocrystalline cellulose superlattice solar cells to produce electricity. Google Patents.
90. Battista OA, Smith PA (1962) Microcrystalline cellulose. Ind Eng Chem 54: 20–29.
91. Debiagi F, Faria-Tischer PCS, Mali S (2020) Nanofibrillated cellulose obtained from soybean hull using simple and eco-friendly processes based on reactive extrusion. Cellulose 27: 1975–1988.
92. Thirumavalavan M, Lai YL, Lin LC, Lee JF (2010) Cellulose-based native and surface modified fruit peels for the adsorption of heavy metal ions from aqueous solution: Langmuir adsorption isotherms. J Chem Eng Data 55: 1186–1192.
93. Zhang N, Chen S, Hu J, Shi J, Guo Y et al. (2020) Robust and recyclable sodium carboxymethyl cellulose-ammonium phosphomolybdate composites for cesium removal from wastewater. RSC Adv 10: 6139–6146.
94. Wang J, Zhuang S (2019) Removal of cesium ions from aqueous solutions using various separation technologies 18 :231-269.
95. Yamauchi S, Yamagishi T, Kirikoshi K, Yatagai M (2014) Cesium adsorption from aqueous solutions onto Japanese oak charcoal I: effects of the presence of group 1 and 2 metal ions. J Wood Sci 60: 473–479.
96. Wang H, Luo P (2020) Preparation, kinetics, and adsorption mechanism study of microcrystalline cellulose-modified bone char as an efficient pb (ii) adsorbent. Water Air Soil Pollut 231.
97. Hashem A, Fletcher AJ, Younis H, Mauof H, Abou Okeil A (2020) Adsorption of Pb (II) ions from contaminated water by 1, 2, 3, 4-butanetetracarboxylic acid-modified microcrystalline cellulose: Isotherms, kinetics, and thermodynamic studies. Int J Biol Macromol 164: 3193-3203.
98. Nhung HL, Thanh ND (2019) Cellulose modified with citric acid and its absorption of pb2+ and Cd2+ IONS.
99. Filho ECS, Santos LS, Silva MMF, Fonseca MG, Santana SAA et al. (2013) Surface cellulose modification with 2-Aminomethylpyridine for copper, cobalt, nickel and zinc removal from aqueous solution. Mater Res 16: 79–87.
100. Sun C, Jiadong N, Chunyan Z, Jinmei D, Change Z, et al. (2017) Preparation of a cellulosic adsorbent by functionalization with pyridone diacid for removal of Pb(II) and Co(II) from aqueous solutions. Cellulose 24: 5615–5624.
101. Najar PAM, Gondane SR, Jeurkar JU, Nimje MT (2013) Adsorption studies of heavy metal cations on silica flat bed induced with microcrystalline cellulose gels: quantitative

determination of cobalt and nickel by optical scanning densitometry. Sep Sci Technol 48: 1810–1819.

102. Wu Y, Jiang Y, Li Y, Wang R (2019) Optimum synthesis of an amino functionalized microcrystalline cellulose from corn stalk for removal of aqueous Cu 2+. Cellulose 26: 805–821.
103. Dong F, Xu X, Hiba S, Jiawen G, Lizhen G, et al. (2020) Factors influencing the morphology and adsorption performance of cellulose nanocrystal/iron oxide nanorod composites for the removal of arsenic during water treatment. Int J Biol Macromol 156: 1418–1424.
104. Yasmeen S, Kabiraz M, Saha B, Qadir M Gafur M et al. (2016) Chromium (VI) Ions removal from tannery effluent using chitosan-microcrystalline cellulose composite as adsorbent. Int Res J Pure Appl Chem 10: 1–14.
105. Li B, Li M, Zhang J, Pan Y, Huang Z, et al. (2019) Adsorption of Hg (II) ions from aqueous solution by diethylenetriaminepentaacetic acid-modified cellulose. Int J Biol Macromol 155: 149–156.
106. Sun J, Xu L, Ge M, Zhai M (2013) Radiation degradation of microcrystalline cellulose in solid status. J Appl Polym Sci 127: 1630–1636.