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Application of Biochar as Filter Media for River Water Purification

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Water bodies around the world are being deteriorated due to the constant release of numerous organic and inorganic pollutants from urbanization and industrialization. Domestic wastewater is often released into the environment untreated in most developing countries, which has a negative impact on the environment overall. The availability of groundwater and surface water is steadily declining, so it is necessary to choose river water as one of the alternate sources. Some significant techniques for water purification are adsorption, biological process, coagulation, chemical precipitation, catalytic processes, membrane filtration, ionizing radiation, magnetically assisted processes, and ion-exchange. But considering the cost effectiveness, simple gravity filtration technique with different filter medium such as, gravels, sand, charcoal etc. has been studied for river water purification. Adsorption technique is most common and widely used in water purification. Low cost agricultural-wastes derived Biochar has gained the potential application in adsorption technique of filtration. In this article, different synthesis techniques of biochar, process conditions and limitations of process are properly reviewed. The physical and chemical properties of biochar and factors affecting the properties of biochar have been studied in details. Finally physical activation technique of biochar and its application in water purification has been studied.

1. Introduction

River water filtration is vital for environmental stewardship, especially where urbanization, agricultural runoff, and industrial activity negatively impact water quality. The surface and ground water, major source of drinking water are deteriorating due to pollutant disposal. Contaminants include pesticides, heavy metals, and organic chemicals present serious dangers to the environment and community health. These complicated pollutants are difficult to handle with conventional techniques like chemical and filter treatment. Recently, growing interest has been shown in sustainable and eco-friendly alternatives for water purification. Water from rivers is used for drinking, agriculture, and industrial purposes which are vital to ecosystems and human society. The purification techniques include three types of treatment: biological, chemical and physical. Biological treatment involves using microorganisms to degrade organic pollutants through biochemical reactions. Processes such as biofiltration, aerobic and anaerobic digestion, activated sludge and constructed wetlands are effective in treating organic contaminants.[1,2] Chemical treatment techniques such as, oxidation, coagulation, electron beam irradiation, radio colloid treatment and sorption to organic/inorganic substrates target certain pollutants like heavy metals, pathogens, and synthetic chemicals. Techniques for physical treatment include air-sparging and air-stripping, incineration, and membrane processes like reverse osmosis, ultra filtration, and nanofiltration.[3–5] These methods remove contaminants through physical separation, filtration, or evaporation.[6] Some new approaches such as ionising radiation, membrane processes, biotechnology, adsorption, catalysis, and magnetic assistance have also been studied for the purification of water. Adsorption is a widely studied and industrially adopted technique for water purification. Adsorbents such as activated carbon, zeolites, and biochar remove pollutants through surface interactions and chemical affinity.[7–13]

Biochar, produced from pyrolysis of biomass, is a cost-effective material with diverse applications in agriculture, industry, and environmental remediation. Its high carbon content and unique properties make it an attractive option for improving soil and groundwater quality. As there is few evidence of their use in groundwater and soil remediation, therefore, need more research to emphasize its application in water purification system. The properties of biochar, including its porosity, surface chemistry and nutrient content vary depending on pyrolysis condition and feedstock. Biochar's adsorption properties make it an effective material for wastewater treatment and remediation.The medium-to-high surface area of the structured carbon matrix encourages the biochar to function as an adsorbent similar to activated carbon. Biochar's large surface area, porous structures allow it to adsorb a wide range of contaminants found in river water, including heavy metals, organic pollutants and nutrients. Studies have shown that biochar-based adsorbents can effectively remove pollutants like lead, cadmium, arsenic, pesticides, pharmaceuticals and organic dyes from aqueous solutions.[14]

In this study, different water purification techniques have been discussed along with different filter media. Discussion was done on different adsorbents in terms of properties and applications. Special focus was given on biochar as the filter media.

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