Perspective

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Wastewater Treatment System with Phytoremediation of Nitrogen

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Perspective

Although various traditional methods are used to treat ammoniacal nitrogen pollution in wastewater, they are not long-term or cost-effective. Ammoniacal nitrogen, for example, can be found in a variety of sources and has negative environmental consequences. As a result, the current work also discusses nitrogen phytoremediation and its green chemistry features. Based on the reviews, it can be stated that the green chemistry features of nitrogen phytoremediation have demonstrated that it is both sustainable and cost-effective when compared to alternative ammoniacal nitrogen remediation approaches.

As a result, it can be inferred that using phytoremediation in wastewater treatment can result in a more cost-effective and environmentally friendly ammoniacal nitrogen technology. Ammoniacal nitrogen is a wastewater pollutant that may be present in a wide range of wastewater types. Excess ammoniacal nitrogen in a water body can produce eutrophication, which causes excessive plant and algae development and decomposition, resulting in water quality degradation. Aside from the traditional air stripping tower, break-point chlorination can also be used to remove ammoniacal nitrogen. Phytoremediation is one of the most economically feasible, long-term, and cost-effective methods. This is owing to the fact that phytoremediation uses plant-based systems and microbiological activities to decrease pollution in nature.

Sources and environmental impact of ammoniacal nitrogen

At room temperature and pressure, ammonia is a colourless gas with a strong odour. Domestic wastewater concentrations are primarily made up of it. It is very soluble in water and occurs in a state of equilibrium with both ionised ammonia (NH_3) and ionised ammonia (NH_4^+). A number of investigations have found that the impact of unionised NH_3 causes total ammonia toxicity. The sum of ammonia and ammonium concentrations is generally referred to as total ammonia. Ammonium ions are a crucial ingredient that plants require for development. Ammonia is released into the environment primarily by municipal, agricultural, industrial, and natural processes. The presence of ammoniacal nitrogen in water causes environmental issues such as surface water eutrophication, ecological alterations, and acidification. Ammoniacal nitrogen serves as a source of nitrogen in aquatic eutrophication, as it is required for the formation of nitrates. Because of the nitrification process, excessive concentrations of nitrates and ammonia in water bodies can create a hazardous environment as well as oxygen shortage. Severe eutrophication can cause hypoxia, which is a dead zone in which no aquatic life can live.

Ammoniacal nitrogen phytoremediation

Uptake, assimilation, and translocation are all phases in the nitrogen consumption process in plants. Ammonia is integrated into proteins and other organic combinations via a biochemical process once it is present in the plant cell. By way of an enzymatic mechanism, only the ammonium ion is absorbed into organic molecules in plant tissues. The main sources of nitrogen for plant development are ammonium and nitrate ions, which are required in greater quantities than the other mineral nutrients. Ammonium is readily taken by plants when compared to nitrate. This is because the absorption and assimilation of ammonium ions requires less energy than the uptake and assimilation of nitrate ions. It should be emphasised that ammonium ions can be directly absorbed by plant roots, or they can be digested into the amide amino group of glutamine by glutamine synthetase and then into glutamic acid by glutamate synthase as a result of nitrate ion reduction. The majority of the ammonium ions were absorbed by these two enzymes. The ammonium ions are poisonous and cannot be stored in plants. As a result, the ammonium ions are transformed to amides, oxidised nitrates, or assimilated to create amino acids.

Phytoremediation characteristics in green chemistry

Chemical goods and methods that reduce or eliminate the generation of harmful chemicals are referred to as green chemistry. Green chemistry not only improves the environment, but it also leads to increased innovation and economic growth. In comparison to traditional ammoniacal nitrogen remediation technology, phytoremediation of ammoniacal nitrogen process has green chemistry properties such as no chemical use, energy efficiency, and a safer reaction condition.

No chemical use: The phytoremediation technique uses no chemicals in compared to traditional ammoniacal nitrogen remediation technologies. Chemicals used for traditional ammoniacal cleanup may result in an increase in operational costs. This expense is a loss since it does not contribute to the company's earnings. Notably, the phytoremediation method does not necessitate the use of any chemicals. To encourage their growth, the plants naturally take up ammonium ions from the wastewater. Furthermore, the plants employed in phytoremediation are renewable feedstock that assists in climate change mitigation via carbon dioxide fixation.

Energy consumption reduction: Energy usage in a wastewater treatment facility is frequently linked to the amount, type, and load of the pollutant. Nutrient removal technology has greater energy intensity on average. Notably, phytoremediation is a solar-driven technique, which means that all of the energy necessary for the phytoremediation process comes from the sun. It's worth noting that phytoremediation uses less energy than the other ammoniacal nitrogen remediation methods on the market.

Safer process intrinsically: Phytoremediation offers safer responses and lesser hazards than certain standard ammoniacal nitrogen clean-up methods. Phytoremediation is a method of removing ammoniacal nitrogen from the environment by utilising environmentally benign biomass rather than chemicals, which can pose health concerns, chemical reaction risks, fire and explosion risks, and environmental dangers. Phytoremediation, a sustainable alternative to traditional ammoniacal nitrogen clean-up technique, is a viable choice for tertiary industrial wastewater treatment.

As a result, because it is environmentally friendly and cost-effective, there is a growing need to improve its efficiency for industrial applications. Phytoremediation, on the other hand, takes time and space since a vast surface area is required to hold the effluent. It is regarded important to conduct research into the creation of phytoremediation reactors, which may lower the surface area for greater quantities of wastewater and increase the retention period.