

Sawdust for Wastewater Treatment

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The scarcity of water is a major problem in many countries. In addition, contaminated water sources will have to be taken into account more and more in the future. This will increase the cost of treatment. The utilization of by-products and waste materials as a raw material for water treatment chemicals has been suggested as a way to reduce costs. Lignocellulosic materials, like sawdust, are excellent raw materials since they are abundant, renewable, and cheap. The main uses of sawdust are mainly in particle-board, as an energy source, and as cattle bedding material. Sawdust has been studied as a water treatment material both as such [1] and after modification [2-6]. For the removal of anions (e.g. nitrate, vanadate), sawdust has to be chemically modified by adding cationic groups.

Previously, we have synthesized a strong anion exchanger from pine sawdust [4-6]. The raw material was reacted with epichlorohydrin, ethylenediamine, and triethylamine in the presence of N,N-dimethylformamide. High nitrate capacities (30 mg N/g) were achieved for synthetic solutions [4]. The material worked well over a wide pH range, sorption was rapid, and in column the material maintained its capacity for five ion exchange and desorption cycles [4]. In addition, modified pine sawdust worked in a wide temperature range (5-70°C) [5]. When the effect of phosphate on nitrate sorption was studied, a high uptake of phosphate was also observed [5]. Moreover, high capacities have been obtained for vanadium: 130 mg V/g for synthetic and 103 mg V/g for industrial wastewater [6]. The industrial wastewater was taken from the synthesis gas scrubber of a chemical plant and contained a large amount of vanadium as well as nickel, sulfate, and ammonium. To sum up our sawdust research so far, chemically modified sawdust has proven to be an excellent material for the removal of anions from water.

In spite of intensive research on the development of water treatment chemicals, several challenges still exist. Besides reliable raw material availability, the pretreatment and modification of the material is critical. Even though sawdust is originally a waste material, all additional stages will increase the price of the product. Simple, green, and safe modification routes must be developed. Particularly, oil-based compounds and toxic reagents (e.g. epichlorohydrin) should be avoided as much as possible.

In the case of a single-use product, the disposal of the exhausted material needs to be solved. If the aim is to retain biodegradability, chemical modification must not change the material properties too much. In the case of a multiple-use product, regeneration should be carried out using cheap solvents and the product should have a certain resistance to chemicals as well as to biodegradation. By optimizing the regeneration stage, the uptake and efficient recycling of precious components from wastewaters (e.g. nutrients and some heavy metals) can be performed. In ion exchange applications, resin fouling can occur when components are not removed by normal regeneration. For example, nickel fouling was observed in our column studies with real industrial wastewater [6,7] and acid treatment was able to solve this problem [7]. Acid treatment of ETM-modified pine sawdust is feasible according to our preliminary study on chemical resistance [6].

Modified products should be tested both for synthetic solutions and real wastewaters. Real wastewaters are typically a complex mixture of cations, anions, inorganic and organic components, all of which may

have an effect on treatment efficiency. Research on real wastewater may reveal some other benefits or drawbacks in use. Both selective products for single pollutants and general-purpose products for the simultaneous removal of several pollutants are needed on the market. In conclusion, reducing the cost of treatment to a minimum and demonstrations with real wastewater on pilot scale will enhance the commercialization of products as well as their successful and continuous use in real applications.

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