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Editorial

Special Issue "Applications of Biosorption in Wastewater Treatment"

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The interest in the use of biosorption for the elimination of pollutants is because this technique is an efficient and environmentally friendly process, constituting an alternative to the so-called conventional treatment processes. Low-cost or disposable materials of biological origin (biomass) are used, which allows these materials to be useful. For these reasons, the current contributions in the field of biosorption continue to be numerous and very attractive. An example is this Special Issue on the "Applications of Biosorption in Wastewater Treatment" in the journal *Processes*, which is available online at: https://www.mdpi.com/journal/processes/special_issues/biosorption_wastement_treatment (accessed on 25 November 2021).

In this Special Issue, several articles are published that demonstrate the high efficiency of this process, its versatility to develop different applications, and show the recent advances. Thus, the review by Torres [1] shows the recent contributions made in the field of pollutant removal using biosorption. The general aspects of, and the usefulness of this process are included in this review. The process can be applied to most pollutants, regardless of their nature, which demonstrates its operability. This article shows numerous examples of this process as a solution to the elimination of pollutants, which demonstrates the scientific interest in developing applications using biosorption. This variety of examples is due to the fact that the sorbent material of biological origin has a varied nature, which allows the evaluation of a large number of materials, in order to find the most suitable for a certain application. The use of living biomass is a possible option in this field when biological material is applied, preserving its activity. It is an excellent alternative that can be used in different situations, and offers a great efficiency, as shown in this article.

One of the great advantages of the biosorption process is that the sorbent material can be very varied; thus, it is possible to use waste materials that lack an apparent utility. As an example of this, we have the article by Mahato et al. [2] in this Special Issue. This review shows the application of biomass from citrus waste for the elimination of a great diversity of pollutants. This waste, produced in large quantities around the world, can be transformed into an excellent biosorbent. The article analyzes its synthesis and sorption capacity in detail, and also provides information on its biotransformation for the production of biofuel and other valuable compounds.

In biosorption studies, it is common to consider the effect of different parameters on the performance of the process. Thus, there are several parameters that influence the performance of the biosorption process, such as pH, temperature, type of biomass, and nature of the sorbent, to name some of the most studied. However, there are other lesser-known factors that also influence the process, such as ionic strength. An interesting study by Aranda-García et al. [3], published in this Special Issue, shows the inversely proportional effect of ionic strength on nickel biosorption capacity. In addition, the effect of this capacity of different background electrolytes, and how these can alter the performance of the process, is also studied. This is interesting because pollutants from real solutions are not dissolved in distilled water, which means that these solutions may contain other components that influence the performance of the pollutant biosorption process. These authors used acorn shell from the oak *Quercus crassipes* as biomass, and demonstrated that this biomass was

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suitable for removing nickel ions from solutions containing impurities at different concentrations. Few studies have included the effect of ionic strength; however, in this Special Issue, this parameter was also considered in the article by Villen-Guzman et al. [4]. This article studies the ability of biomass from *Spirulina* to remove lead ions. This is not only a typical biosorption article: it also includes a study with this biomass immobilized in alginate. The immobilization of biomass is another step in the improvement of biosorption processes, since it provides mechanical strength, rigidity, ideal size, and porous characteristics. The promising results obtained in this study for immobilized *Spirulina* on alginate beads, could be the first step towards the valorization of this biomass for the treatment of industrial wastewater polluted by toxic metals, such as lead.

Immobilization is not the only tool to improve the biosorption process. The combination of biomass with modern materials to form composites is another very useful tool for this purpose. This combination allows a greater stability of the biomass, which increases the performance of the process. An example is found in the article by Wan et al. [5] in this Special Issue, in which a composite consisting of Mxene (transition metal carbide, nitride, or boride) and chitosan that was used to remove chromium ions, is successfully obtained. This novel Mxene–chitosan composite can be considered as an alternative for the adsorption of heavy metals from wastewater.

The application of biomass for the removal of pollutants from wastewater goes beyond biosorption, since biomass can also act as a substrate to promote the biodegradation of organics in wastewater. Banch et al. [6] used palm oil mill effluent to treat stabilized leachate from old landfill. The biological treatment of this mixture with an aeration process was able to remove the organics effectively.

To conclude, this Special Issue shows that biosorption constitutes a very useful tool for the removal of pollutants from wastewater. The variety of articles published, where different modalities of biosorption are exposed, demonstrates the enormous versatility of this technique, and allows us to continue advancing in a promising future in the field of biosorption. The state-of-the-art applications of biosorption presented in this Special Issue may serve as valuable references for future research in this ever-evolving field.

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