Biosorption: Application Strategies

Over the past few years, intensifying research into metal biosorption elucidated the principles of this effective metal removal phenomenon. Biosorption can be cost-effective, particularly in environmental applications where low cost of the metal removal process is most desirable. Some efficient natural biosorbents have been identified that require little modification in their preparation. It is particularly in ecological aspects where biosorption can make a difference due to its anticipated low cost. The application aspect is what makes the research and development work in this novel area exciting and worthwhile. While the biosorption process could be used even with a relatively low degree of understanding of its metal-binding mechanisms, better understanding will make for its more effective and optimized applications. If the biosorption processes were to be used as an alternative in the wastewater treatment scheme, the regeneration of the biosorbent may be crucially important for keeping the process cost down and to open the possibility of recovering the metals extracted from liquid phase. For this process it is desirable to desorb the sorbed metals and to regenerate the biosorbent material for another cycle of application.

Desorption involves the following:

- Yield of the metals in a concentrated form
- Restore the biosorbent close to the original conditions for effective reuse
- Undiminished metal uptake
- No physical change or damage

Extensive "desorption" work may be necessary for assessing whether this is possible and under what conditions. Desorption and sorbent regeneration studies might require somewhat different methodologies. While the regeneration of the biosorbent may be accomplished by washing the metal laden with an appropriate solution, the type and strength of the solution would depend on just how the deposited metal has

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been bound. Dilute solutions of mineral acids (hydrochloric acid, nitric acid, sulfuric acid, and acetic acid) can be used for metal desorption from the biomass (Holan et al. 1993; Pagnanelli et al. 2002).

Due to different affinities of metal ions for the predominant sorption site (under the solution conditions), there will be a certain degree of metal selectivity by the sorbent on the uptake. Similarly, selectivity may be achieved upon the elution–desorption operation (Kratochvil and Volesky 2000). Advantage could be taken of this selectivity on the desorption side of the operation which can contribute to the separation of metals from one another, if desirable.

The overall capacity of sorption process is to concentrate the sorbate metals. This is assessed by expressing a simple overall process parameter, the concentration ratio (CR). Obviously, the higher the CR, the better the overall performance of the sorption process, making the eventual recovery of the metal more feasible as it becomes more concentrated in the small volume of the eluant solution.

A considerable amount of research on biosorbent materials has developed solid basis of knowledge and indicated their enormous potential. The highest priority at the early stage would be the preliminary and approximate assessment of the commercial potential and practicality of application of the new technology based on the family of new biosorbent products. The preliminary assessments that should be carried out simultaneously as part of a better quantitative estimation of this technology are as follows.

Assessment of the Competing Technologies

The current costs and market share of the established conventional processes for metal removal/recovery from dilute solutions or wastewaters have to be summarized or assessed. As the emission standards tighten the conventional methods for metal detoxification are becoming progressively more inadequate or prohibitively costly for use of water treatment. Better and effective metal removal technologies are invariably more costly and often just not feasible for that purpose. The search is on for efficient and particularly cost-effective remedies. Biosorption promises to fulfill the requirements. Its overall performance and process application modes justify a comparison with the other existing techniques.

Assessment of the Market Size

While it is known that the environmental-based market for metal removal/decontamination of metal-containing (industrial) effluents is enormous, the actual figure to support this generally prevailing perception would be most convincing for commercialization. Comparison of costs between the traditional and new technology establishes the feasibility of biosorbent applications and their competitiveness in the marketplace. As the application of biosorption proves cheaper, it is anticipated that new applications, otherwise perhaps not feasible, will significantly increase the size of the current market and scope of potential clients for biosorption technology.

Assessment of Costs of New Biosorbent

Approximate costs of different types of raw biomass need to be ascertained, as well as the costs of processing the biomass into applicable biosorbent materials maintaining their high efficiency. Preliminary technical work needs to be carried out on the processing necessary for biomass formulation into a product suitable for use. Different raw biomass materials would require specific treatment for their optimal formulation into finished ready-to-use products. This part would entail specifically planned small-scale laboratory work resulting in an efficient biosorbent material. The most compelling reasons for using biosorption technology, based on renewable or waste raw materials, are that it is effective and inexpensive. The initial information gathered in preliminary economic feasibility studies leads to the following main conclusions regarding the application of bioremediation technology.

Biosorption Can Be Viewed as

- Water treatment process.
- Significant cost-saving process in comparison with existing competing techniques.
- Effective in terms of technical performance, operational qualities, and chemical properties.
- Commonly usable having low sensitivity to environmental and impurity factors.
- Additional cost reducing because of possible recovery of heavy metals.
- Cost-effective, obviously reinforced by a higher market value of recovered metal and lower cost of biomass.