BV SORBEX

TECHNOLOGY DESCRIPTION

BV SORBEX technology is based on extensive research work of the recent two decades that resulted in the discovery of especially potent and durable metal-binding biomass types that bind and immobilize heay metals. This technology is capable of effectively and economically remove heavy metals from industrial aqueous solutions and wastewaters. The metals of sufficiently high market value can subsequently be recovered and re-sold. US Patents No. 4,769,223 and No. 4,320,093 and a Canadian patent No. 1,143,077 issued to protect the process technology relevant to some metals, more patents may be filed.

The core of this technology is a family of biosorbent materials (BV-SORBEX™) which can selectively bind and immobilize dissolved toxic heavy metals. These unique biosorbent materials are derived from specific types of biomass through simple procedures. An extremely cost–effective biosorption process is easily applicable on a large-scale. Granulated biosorbents are regenerative and can be reused in multiple adsorption/desorption cycles in standard equipment.

BV-SORBEX™ Family of Biosorbents

General Characteristics

SORBEX-type biosorbent materials normally exist either as powders or granules of classified size ranges between 0.1 and 3 mm with a density slightly greater than that of water. They can also be as unclassified varied size particulates.

SORBEX granules are capable of extracting heavy metals from aqueous solutions (wastewater) or process streams. This special property is particularly useful for eliminating the need for costly and cumbersome chemical pre-treatment of toxic metal-bearing effluents. Sludge, an undesirable yet unavoidable byproduct of chemical pretreatment, is not produced in the application of SORBEX materials, and so the costs of sludge disposal are avoided.

This novel technology provides an economical alternative to the expensive ion exchange applications and particularly to landfilling of hazardous sludge wastes. In most cases the metals can be recovered and recycled.

The technology employed in forming the SORBEX granules distributes metal-binding sites not only on the surface of sorption particles but throughout the granule itself, so that the area of metal uptake is significantly increased. The characteristics of proprietary and unique new SORBEX biosorbents make them an ideal media for treatment of metal-bearing industrial wastewaters enabling also an economical metal recovery.

Metal Selectivity

Being derived from different natural raw materials, SORBEX family of biosorbent products represents a wide variety of possibilities due to their individual metal-sequestering properties. The broad-spectrum SORBEX materials are not selective in the heavy metals they sorb. They tend to simultaneously remove several different hazardous metals from the solution regardless of their differing concentrations. This makes biosorbents vastly superior to numerous conventionally used and costly ion exchange resins. In addition, these SORBEX materials remove only those metals which are considered hazardous, and allow non-toxic alkaline earth metals (Ca, Na, K, Mg) to pass, reserving all possible sorptive sites for hazardous heavy metal species.

Metal-selective SORBEX materials are formulated to be very specific in their choice of metal they bind. Good selectivities have been achieved for instance for Cd, Cr, Cu, Zn, Pb, U, and Hg, all highly toxic. Even gold can be recovered.

No Concentration Dependence

SORBEX biosorbents load single or mixed metals independent of influent concentrations; therefore they function as effectively in solutions containing concentrated (100's of ppm) metals as they do in relatively dilute streams (less than 10 ppm). This

property is especially valuable in industrial situations that produce wastewater streams with varying metal concentrations. These biosorbents are extremely efficient in scavenge and concentrate metals present even in very minute quantities they making their recovery feasible.

High Efficiency

SORBEX biosorbents load single or mixed metals in excess of 10% of the sorbent dry weight. They have metal-removal efficiencies of >99.7%, yielding effluents with total metal concentrations of less than 10-50 ppb. This is more effective than with other metal removal methods.

High Versatility

Many SORBEX biosorbents function generally over a wide range of pH values (pH 4-10) as well as temperatures (5-75^{o}C) with no change in efficiency. Those formulated for a metal-specific function may require, in some cases, better specified process conditions in order to operate most effectively. The process equipment required for the application of these biosorbents is of a standard sorption contacting type. Most often it would be a sorption (trickle) column simple to operate, maintain and modify. The process can operate outdoors, and may be used in industrial or remedial action applications. In the latter case, the ability to treat lagoon or groundwater without pretreatment makes SORBEX biosorbents extremely easy to apply even in mobile treatment unit operations.

Tolerance to Organic Contaminants

SORBEX biosorbents are not affected by low level (<5000 ppm) organic contamination. Although SORBEX materials do not treat or significantly sorb the organic fraction, they can be used in conjunction with other technologies in order to detoxify mixed aqueous flows. The physical properties of SORBEX biosorbents make it possible to use them in fluidized bed systems, which allow suspended particulate matter to pass through the SORBEX process bed and thus prevent fouling.

Regeneration

After they are fully loaded with metals, SORBEX biosorbents can be regenerated and then reused. This eliminates the need for constant biosorbent replenishment resulting in an improved economy of the process. In some applications, the regeneration of cheap biosorbents may even not be practiced as they may be used on a once-through basis and when they become saturated, they could just be simply incinerated. The metal becomes then concentrated in the small volume of ashes that can be either easily disposed of or processed for metal recovery.

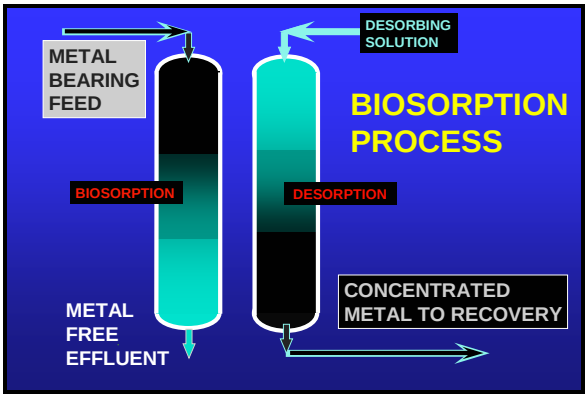
Regeneration of loaded SORBEX biosorbents is normally accomplished through a two-step process. In the first step, the loaded metals are stripped from the biosorbent by the application of either alkaline or acidic solution, or by an appropriate chemical solution of a proprietary nature. The reactivated sorbent is washed in the second step. Some SORBEX biosorbent materials can be regenerated/reused by the customer up to 50 times.

Regeneration of the biosorbent takes place either *in situ*, in the same process equipment, or separately from where the active metal uptake originally took place. Metals stripped from the loaded biosorbent become concentrated in the regenerating solution and may be recycled and reused by the producer or be recovered from the solution by an electrowinning process to yield cathodic metal. This is often done by a specialized metal recycling plant.

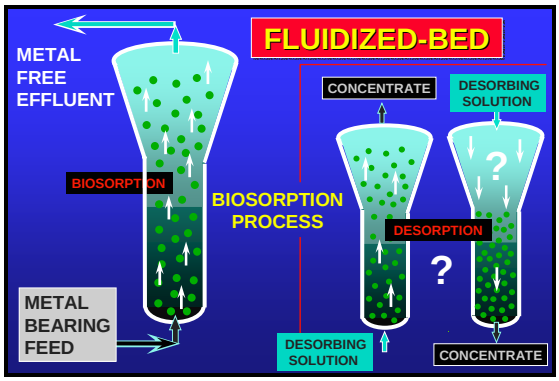
Process Application Equipment

The utilization of biomass, combined with the proprietary processes of SORBEX formulation and granulation, produce biosorbents with characteristics that allow great flexibility in engineering process design and applications. This versatility, plus the significantly faster sorption kinetics of SORBEX biosorbents, is unequaled by traditional ion exchange media. These properties, in addition to those cited above, allow to engineer highly effective yet simple industrial metal-removal systems. These systems are of three basic types:

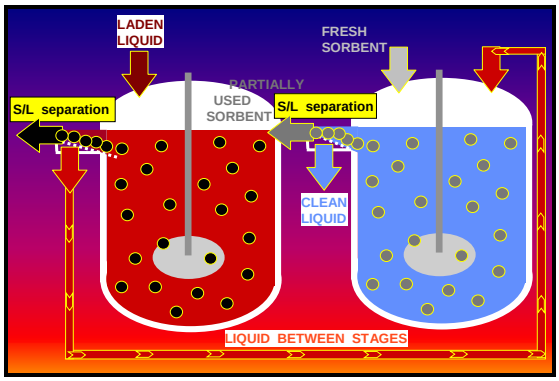
1) Sorption column(s) (or the fixed-bed system):



2) fluid bed system (also in columns):

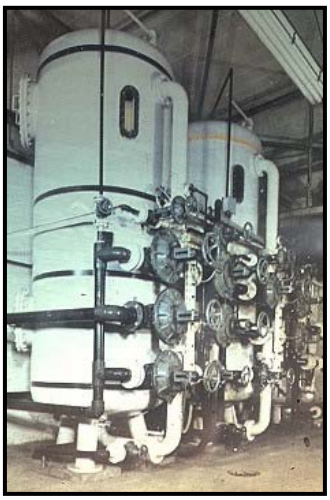


3) Completely mixed tanks (counter-current):



The Sorption Column System

The system utilizes the SORBEX granules as a packed bed of extremely high surface area. Wastewater stream is fed from its source to an equalization tank where it is held until it is ready for treatment. It is then pumped, at a predetermined rate, from the tank into the first of usually two SORBEX-packed columns.

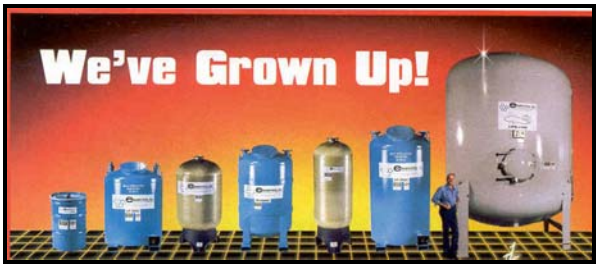


There is a great inherent advantage in using columns for sorption – they can come in a range of sizes. From very small "cannisters" (even portable) to the largest size as seen in the picture. For high flow-rates, columns can be multiplied into sets of many (paralell) for unlimited process scale-up.

Column systems, available in a variety of sizes, can accommodate a wide spectrum of flow requirements and process performances. Columns are cylindrical of variable sizes from 3cm (1.5 inch) to the maximum size not exceeding ~1m diameter and 4m height. They are filled up to about 3/4 with active biosorbent. A single column can accommodate flows from about 500 gal/d to 10, 000 gal/d.

Flow of the waste stream is directed downward through the column. The biosorbent in the column actively removes toxic heavy metals from the solution as it passes through the bed. The stream then may even flow into a second column, that would remove any traces of metal not sorbed by the first. Effluent leaving the second column has metal concentrations reduced to the 10-50 ppb range..

When the biosorbent in the first column becomes fully loaded, this column is removed and the second column, with its still unexhausted biosorbent, is moved to the first position. The fully loaded column no. 1 is then regenerated, and replaced in the process as a second one to carry out the polishing job. In this way there is always sufficient highly active biosorbent present in the system to remove metals from the incoming metal-laden solution to meet the effluent specifications. The figure below shows typical column systems.



Development of New Biosorbents

The process of biosorption has an exceptional commercial potential. Continued R&D activity that BV SORBEX is always close to assures its leading technological and know-how edge.
All the key new discoveries are subject to patent applications assuring a strong proprietary position in the area of the new biosorbent technology.

Technology Description

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economically removing heavy metals from industrial aqueous solutions and wastewaters. The metals of sufficiently high values can be recovered and resold.
US Patents No. 4,769,223 and No. 4,320,093 and a Canadian Patent No. 1,143,077 issued to protect process technology relevant to some metals, more patents are currently pending. The core of this technology is a family of biosorbent materials (SORBEX) which can sequester metals either selectively or as a broad spectrum of metallic species. These unique biosorbent materials are derived from specific types of microbial biomass by a simple process which makes them applicable in large-scale sorption processes.
The granulated biosorbents can be regenerated and can be reused in multiple adsorption/desorption cycles.

Commercial Potential

Biosorption technology is a very effective method for removing metals from solutions featuring either high or low metal concentrations, even well below 100 mg/L. The cost-effective nature of biosorption guarantees an excellent bcompetitive edge of this alternative metal-removal/detoxification process.
Due to the low-cost nature of biosorption, it is forseen as to be able open new and undoubtedly large environmental application markets that have not been tapped so far due to high costs of conventional metal-removal processes briefly described in the following section.

Conventional technologies
for handling heavy metals-containing effluents

The most widely utilized practise of "avoiding" environmental hazards connected with spreading toxicity of heavy metals has been simple containment of effluents in *tailing ponds.* These have been widely utilized mainly by mining industries generatig by far the largest volumes of metal-bearing wastes. This practise, however, has serious side-effects and devastates large tracts of land. It has led to numerous and well publicized disasters.

Precipitation

of heavy metals often precedes tailing pond containment. It usually does not meet the current environmental standards and generates concentrated sludges that pose a serious environmental hazard and final disposal problems.
More current competing technologies for removal of toxic metals from wastewater streams are few. The main established competing technologies are ion exchange systems and reverse osmosis. A detailed competitive analysis report was already performed by independent consultants, conclusions of which are that:
Reverse osmosis, although performing well in most applications, it is commercially more expensive than ion exchange systems as it uses membranes and high pressure process.
Ion exchange systems are established and they are effective for removing low concentrations of heavy metals. However, the relatively high cost of synthetic ion exchange resins seriously limits their use, particularly in environmental applications. These man-made resins are derived from hydrocarbon raw material extremely susceptible to crude oil price fluctuations with an uncontrollable and mainly upward trend.

Opportunity and Clients for Biosorption

The cost-effective nature of the biosorption process in removing heavy metals places this novel technology in a interesting position of being able to open and successfully penetrate the pent-up potentially huge environmental clean-up markets. That is in addition to existing applications of ion exchange resins in this area. Their current market niche can be penetrated by cheaper biosorbents.

The industrial sectors which are being hard pressed for cleaning their toxic metal-containing effluents include:
- mining operations
- all metal/ore processing
- electroplating
- leather tanning
- battery/accumulator manufacture
- coal-fired power generation
- nuclear power generation

A special case pressing for immediate action is the (natural) ***arsenic*** contamination of drinking water in many regions of the world – acutely poisoning large population segments particularly in Bangladesh (**70 million affected people !**), China and India, but also in South America and even in the USA.

All of these sectors represent an excellent world-wide market opportunity for cost-effective clean-up technologies needed to satisfy the progressive regulatory effluent discharge demands that are more and more strictly enforced.