

## METAPLEX 2000 – TECHNICAL DATA SHEET

---

### Heavy Metals Removal Agent for the Treatment of Industrial Wastewater

#### What is Metaplex 2000?

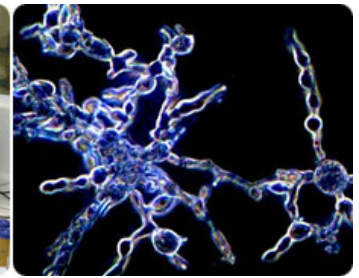
Metaplex 2000 is a fungus inoculum and a proprietary aqueous organic acid salt solution which forms a chemical matrix capable of removing virtually all traces of transition/heavy metals and their complex salts from an aqueous/liquid waste stream. The ingredients of Metaplex 2000 are neither noxious nor significantly toxic, will not corrode machinery and are registered EPA for use in the treatment of heavy metals waste waters.

#### Mechanism of Action

The organic acid salts in Metaplex 2000 remove heavy metals through a complexing reaction. In this reaction, Metaplex 2000 binds to the metallic atom to form an insoluble "metaplex sphere" around the ion. The "metaplex sphere" also exhibits a partial outer charge that attracts other metaplex-metal complexes. As these insoluble particles circulate within the waste stream, they physically bind to each other and begin to flocculate. Within 2-4 minutes, flocculation is essentially complete and a low volume, dense heavy metal laden sludge has been formed, which settles rapidly (within 30 minutes).

#### Chelation versus Complexation

Metaplex 2000 is a complexing agent. Complexing agents typically undergo an irreversible reaction with heavy metal ions to form an insoluble "floc" which can be removed from the waste stream through simple mechanical methods (e.g. settling and auger removal, filtration, etc.). During such reactions, partial charges on the complexing particles repel water but attract similar complexing particles, forcing a flocculant to develop rapidly and effectively. In contrast, chelating agents can chemically combine with heavy metals in a reversible reaction which may, or may not, form an insoluble particle. In effect, chelating agents are frequently used to keep an insoluble metal in solution. If an insoluble substrate does develop in a chelating reaction, the final reaction particles may not be attracted to each other, and if so, a flocculant will not develop. In such cases removal of insoluble chelated products requires very fine screen filters and/or further complexing with other flocculating agents.



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

### **Which metals are removed by Metaplex 2000?**

Metaplex 2000 will remove all transition metals and their respective salts. These include Iron, Copper, Nickel, Cobalt, Zinc, Mercury, Cadmium, Lead, Silver, Gold, Platinum, Chromium and Tin. Metaplex 2000 is also effective on the over 30 Lanthanide and Actinide metals. Of particular importance, Metaplex 2000 will not remove the alkaline earth metals such as Sodium, Magnesium, Potassium and Calcium. When contaminated liquid waste streams contain these elements in high concentration, no Metaplex 2000 is consumed or wasted by their presence. Only heavy metal complexing will occur.

### **How much metal can be removed by Metaplex 2000?**

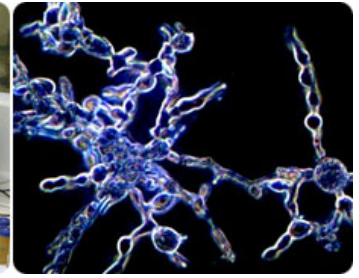
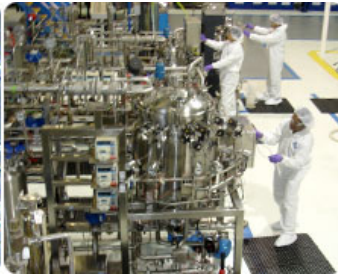
The activity of Metaplex 2000 is unaffected by high concentration of heavy metals and in fact improves with increased metallic ion concentration. Thus, it removes metals in a range of approximately 5 ppm to 50 % solutions or more without loss of performance. In general, one gallon of Metaplex 2000 will complex with and remove between 0.4 to 0.5 pounds of total metals, in direct proportion to the concentration of any given heavy metal in the waste stream.

### **What is the metal removing efficiency of Metaplex 2000?**

When applied in proper dosage, Metaplex 2000 can remove up to 99.95 % of the heavy metals in solution. To meet industry discharge quality effluent requirements, most removal rates are adequate in the range of 99.5 – 99.9 %. When an application does not require this high removal rate, the dosage of Metaplex 2000 can be scaled back to meet the requirement.

### **Will Metaplex 2000 remove Hexavalent Chromium?**

As a consequence of the ionic reactions involved, the reaction between Metaplex 2000 and transition metals is highly dependent on the charge balance of the solution. Metaplex 2000 is designed to complex with typical transition metallic ions carrying either a +2 or +3 charge when in solution. Under such conditions, the charge balance is adequately maintained and Metaplex 2000 is uninhibited. However, hexavalent chromium carries a +6 charge. In concentrations below 10% of total heavy metals present, hexavalent chromium will be removed as charge balance naturally reverts to a +3 state. When present in concentrations above 10% of total metals, however, chromium removal will decrease. Above 50% concentrations, no hexavalent chromium will be removed.



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

### **Will Metaplex 2000 remove cyanides and complex cyanogens?**

Metaplex 2000 will not remove cyanide compounds directly. However, cyanogens are reactive with certain metals such as iron and copper. If present, or intentionally added to the waste stream, iron and copper can combine with the cyanide or cyanogen to form a metallic substrate which will react with Metaplex 2000. A pilot scale treatability study is recommended to optimize the ratio of iron/copper/cyanide and Metaplex 2000.

### **Is Metaplex 2000 effective on chelated metals in solution?**

In general, complexing agents have a greater affinity for metals than chelating agents and in many cases, Metaplex 2000 can break a chelated bond and free the metal for complexing and flocculation. However, we recommend that a simple pilot scale treatability study using Metaplex 2000 should be undertaken when considering treatment of a waste treatment containing chelated metals.

### **Will Metaplex 2000 remove radioactive metals?**

KAM Biotechnology research has demonstrated that Metaplex 2000 will react with radioactive transition, lanthanide and actinide metal isotopes at the same efficiency as stated above. However, the ionic charge state must be compatible with Metaplex chemistry (i.e. a +2 or +3 charge). Metaplex 2000 has been shown unaffected by ionizing radiation exposure up to  $10^6$  rads. Levels above that exposure have not been evaluated.

### **Can Metaplex 2000 remove heavy metals from contaminated soil?**

Because of the potential interference of the flocculation reaction by solid particles, Metaplex 2000 cannot be added directly to contaminated soils. However, if heavy metals can be extracted from the soil by soil washing, the solvent can be collected, filtered and fully treated with Metaplex 2000. Use of Metaplex 2000 for this application offers a very cost effective alternative to direct disposal of heavy metal contaminated soil in a hazardous waste disposal site.

### **How is Metaplex 2000 supplied and fed into a treatment system?**

Metaplex 2000 is supplied as an aqueous solution in 55 gallon (205 litres) plastic drums. Because it is in liquid form, it can be introduced into a treatment system by simple manual or automated metered pumping. The liquid form also enhances dispersion in the mixing/reaction tank for faster flocculation rates.



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

### **What type of chemical conditions is required?**

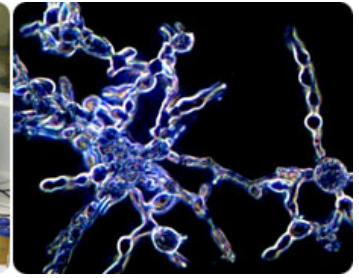
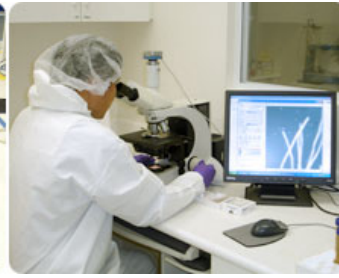
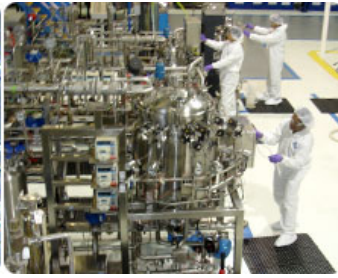
Although Metaplex 2000 will be reactive within a pH range of 3.0 to 9.0, a narrower range of 4.0 to 5.5 is optimal. Many metallic solutions to be treated already have acidic pH, and the pH of the influent will, however, affect the size of the flocs formed. As the pH becomes increasingly alkaline, flocculation particle size decreases. At pH levels above 7.0, floc particle size will be small, settling rates will decrease and removal of floc from the waste stream by settling and filtration will be hampered. Consequently, we recommend pH adjustments to the optimum range before Metaplex 2000 treatment.

Metaplex 2000 is generally unaffected by the usual temperature ranges of industrial heavy metal contaminated waste streams. For optimum effect, however, we recommend that waste streams below 40°F or above 140°F, be adjusted for temperature, or evaluated by a treatability study before Metaplex 2000 use.

### **What type of treatment equipment is needed?**

Because Metaplex 2000 is a non-corrosive chemical, special fabrications are not necessary. In most applications, a Metaplex 2000 treatment "system" will consist of:

- a pH/flow equalization tank
- a metering pump to introduce Metaplex 2000 into the waste stream
- a reaction vessel, where the complexing reaction can take place
- a settling and clarification tank (for continuous flow systems)
- a final finishing filter and/or flocculent removal system
- a sludge de-watering apparatus



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

### **What is the volume of sludge generated?**

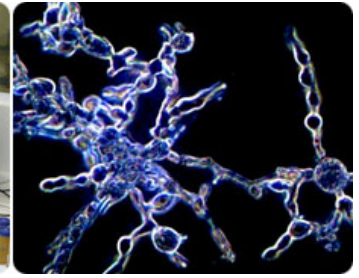
One of the greatest economic benefits of using Metaplex 2000 in the removal of heavy metals is the low volume of hazardous waste sludge that the reaction produces. Because of the particles formed by the reaction are direct metal/Metaplex 2000 complexes and not bulky hydroxide sludges, the volume of contaminated sludge produced by Metaplex 2000 is far lower than other metal removing agents. For example, one gallon of liquid waste containing 75 ppm total metals will react with Metaplex 2000 to form approximately 98 ml or 0.026 gallons of a 30 minute settled sludge (not de-watered). For a 25,000 gpd waste stream flow at that metal concentration total daily sludge yield is below 650 gallons prior to thickening and/or dewatering. Waste streams with lower or higher metals concentrations produce correspondingly lower or higher sludge volumes respectively.

### **What % solids can be achieved through de-watering?**

The metal flocculant produced with Metaplex 2000 is hydrophobic and repels water. This fosters extensive compaction of the sludge and enables routine de-watering techniques to produce sludge solids concentrations approaching 80%. In the above example, the 650 gallon initial sludge can be de-watered to a volume of only 130 gallons. The costs associated with disposing of such low volume sludges in hazardous waste landfills are therefore greatly reduced.

### **How is Metaplex 2000 produced metal sludge classified?**

Depending upon the heavy metals removed from the waste stream, Metaplex 2000's metal sludge may be classified as hazardous waste and must be disposed of in accordance with federal/state regulations governing these wastes. However, preliminary research by KAM Biotechnology has indicated that Metaplex 2000 produced metal sludge is non-leaching under normal environmental storage conditions. Thus, on a site by site basis, it may be possible to de-list the sludge for non-hazardous waste disposal.



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

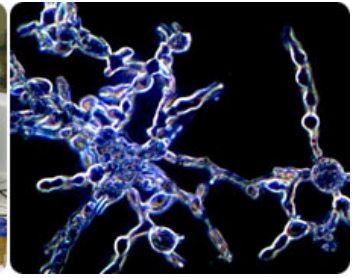
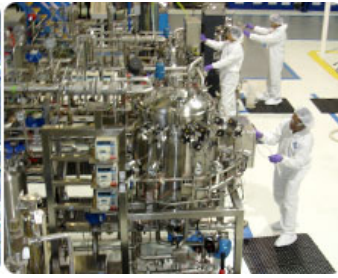
### **Comparison to Other Heavy Metal Removal Technologies**

Use of Metaplex 2000 for heavy metal removal offers several cost and logistical advantages over other metal removal methods.

For example:

**Capital Equipment:** Metaplex 2000 is non-corrosive and functions at relatively mild pH ranges with no energy input required. The Metaplex 2000 treatment system is a simple combination of a few meters, pumps and tanks. Consequently, purchase of expensive corrosion resistant equipment, complex piping systems, bulk solids handling equipment, resin beds, mixers and other equipment typically found in lime, caustic, electrochemical and ion-exchange heavy metal removal systems, is not required.

**Maintenance/DownTime:** Due to the corrosive nature of lime, caustic or electrochemical systems, frequent maintenance schedules for cleaning of lime slakers, pumps and feed systems, must be maintained. Ion-exchange resins must be periodically regenerated and replaced. In contrast, the Metaplex 2000 system does not require frequent cleaning because it does not corrode, clog or form scales on equipment. In situations where the influent also poses no corrosive problems, maintenance of a Metaplex 2000 system is confined to calibration and routine servicing of the pH monitoring and metering system, oiling of pumps and replacement or cleaning of flocculant filters/de-watering equipment. The down time for a Metaplex 2000 system should not exceed a few days per year, under normal conditions of use.



## METAPLEX 2000 – TECHNICAL DATA SHEET

---

**Secondary Chemical Costs:** Typical lime and caustic metal removal processes are alkaline reactions and force the waste stream to a high pH of 9.5 – 10.0. After the lime/hydroxide sludge has been removed, the effluent will still have a high pH and must be neutralized with additional chemicals. Ion-exchange treatment uses significant amounts of regenerating solution which also becomes a non-reducing hazardous waste which must be discarded. Electrochemical systems use consumable electrodes which must be replaced as often as once a month and require power consumption to drive the electrodes. In contrast, Metaplex 2000 treatment requires a substantially lower initial pH adjustment and results in an effluent with a moderate pH which may not have to be neutralized at all. With the exception of initial pH adjustment chemicals and Metaplex 2000 itself, there are no other consumable supplies in a Metaplex 2000 system.

**Personnel Time:** The Metaplex 2000 system is simple to operate. It also affords far less hazard to plant workers from exposure to toxic caustics and offers less time devoted to handling of heavy metal contaminated solids, due to lower sludge volumes.

**Disposal Costs:** Metaplex 2000 treatment offers great cost savings in this area. Lime, hydroxide and caustic sludges are voluminous, often gelatinous materials that can be difficult to de-water. Electrochemical processing also generates hydroxide sludges. Ion-exchange generates significant quantities of contaminated regenerating solutions and resin. These wastes are all laced with heavy metals and must be disposed of in very expensive hazardous waste landfills.

Metaplex 2000 generates a compact, easily de-watered sludge of up to 80% solids by volume. The volume differential between a Metaplex 2000 sludge and a hydroxide sludge can approach a factor of 500. Metaplex 2000 sludge is non-leaching and non-hazardous to handle by workers. Specially fabricated drums are not required for shipping to a disposal site.



## METAPLEX 2000 – TECHNICAL DATA SHEET

**Personnel Safety:** Metaplex 2000 is an aqueous solution with a pH of 10.0. Normal safety precautions should be taken when handling and shipping. A Material Safety Data Sheet is included with all Metaplex 2000 shipments.

Metaplex 2000 is one of several products manufactured by KAM Biotechnology Ltd. for the chemical/bio-treatment of municipal, industrial and commercial wastewaters, removal of heavy metals, reduction of sludge, degradation of toxic/hazardous organic water, grease buildup in sewer lines, reduction of BOD/COD and odors in ponds and lagoons and "in-situ" biodegradation of petroleum and petrochemicals.

The following table is intended as a guideline only, when estimating the quantity of Metaplex 2000 in gallons required to treat a particular volume of liquid waste containing total metals in the range of 5 to 500 ppm. To calculate Metaplex 2000 requirements for higher or lower waste volumes or metal content, the table demonstrates that it requires approximately 0.002 gallons of Metaplex 2000 (0.75 ml) to remove 10 ppm total metals from one gallon of liquid waste. Thus, if the waste stream contained 100 ppm total metals, approximately 0.002 gallons (7.6 ml) of Metaplex 2000 would be required per gallon of waste volume. Optimum dosages are best determined, however, by performing a pilot scale treatability study.

Treatment Volume in gallons	Total Metals (ppm)										
	5	10	15	20	30	40	50	100	250	500	
	In gallons										
<b>5,000</b>	0.5	1	1.5	2	3	4	5	10	25	50	
<b>10,000</b>	1	2	3	4	6	8	10	20	50	100	
<b>15,000</b>	1.5	3	4.5	6	9	12	15	30	75	150	
<b>20,000</b>	2	4	6	8	12	16	20	40	100	200	
<b>30,000</b>	3	6	9	12	18	24	30	60	150	300	
<b>40,000</b>	4	8	12	16	24	32	40	80	200	400	
<b>50,000</b>	5	10	15	20	30	40	50	100	250	500	

For optimum performance, adjust pH of waste stream to range of 4.0-5.5 prior to addition.