



MODULAR SYSTEMS

FOR

METAL REMOVAL & RECOVERY



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RenoCell® — THE WORLD'S MOST EFFICIENT ELECTROLYTIC CELL FOR REMOVAL OF METALS FROM PROCESS AND RINSE WATER

INTRODUCTION

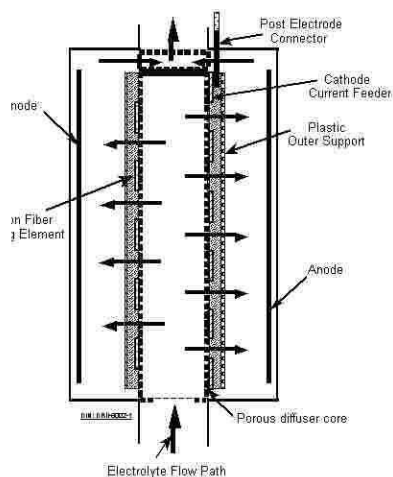
The RenoCell® is an advanced, patented electrolytic cell design that is being used today for metal recovery from process and waste water streams. The RenoCell consistently and efficiently reduces dissolved metal to the sub-mg/L (ppm) concentration levels in a wide range of applications. In effluent treatment applications, this performance level often meets or exceeds discharge compliance limits for hazardous metals without further treatment.

The revolutionary performance of the RenoCell is the result of a patented cell design that, for the first time, effectively utilizes a three-dimensional (3-D) cathode incorporating a porous carbon felt plating element. The key to performance in any electrolytic cell design is effective use of the surface area of the cathode available for electrodeposition. Since the porous carbon felt has at least a 500 times greater effective surface area than an equivalent 2D cathode, and the cell design provides effective current and flow distribution to this large surface area, RenoCell performance is greatly enhanced when compared to existing electrolytic cell designs.

The net result is that the RenoCell can achieve lower final metal ion concentrations using much less energy. This results in more metal removal in less time, and to lower concentrations than has ever been achieved by prior generations of electrolytic cell technology. In general, RenoCell is capable of a factor of 100 or lower final concentration of metal ions, and three to ten or more times higher current efficiency than other commercial cells. Higher current efficiencies translates into lower capital and operating costs to remove a given amount of metal in a given period of time.

RenoCell is being used to meet waste effluent metal discharge limits without further treatment; collect metals as solid metals ready for reuse or sale; uses removable cartridges for ease of operations and maintenance; improve cost effectiveness; and reduce life cycle costs in a broad range of applications. RenoCell's enclosed vessel design and small "foot print" allow the user substantial flexibility in placing a unit in a tight space.

The RenoCell is equally effective for valuable metal recovery or effluent treatment and is being used to either replace or enhance existing systems.



- ***Porous, high surface area cathode***
- ***Replaceable cathode cartridge for easy metal removal***
- ***Industry standard components and compact, robust design***
- ***Optional divided cell configuration***
- ***Applicable to all electroplatable metal or electroprecipitable metal hydroxides and oxides***

For chloride, fluoride or iron-rich solutions, the RenoCell is available in a divided cell configuration. In addition, RenoCell is available with an alternate anode design for enhanced cyanide destruction.

RenoCell — WHAT IT IS AND WHAT IT CAN DO FOR YOU

A RenoCell metal recovery system consists of the world's most efficient and highest performance electrolytic cell, a DC power supply and auxiliary equipment. Metal bearing rinse water or a process stream is electrolytically stripped of dissolved metal ions as it passes through the RenoCell. The metal ions are deposited as a solid metal onto a specialized high surface area, carbon cathode. When the cathode is fully loaded, it is easily removed from the cell and replaced with a fresh one. The loaded cathode may be sold for its metal value.

THE RENOCELL

The RenoCell contains a dimensionally stable anode (DSA) and porous, flow-through carbon cathode. The cathode has an active surface area approximately 500 times its geometric area and approximately 50 times the area of a reticulated cathode. This extended surface area has demonstrated unmatched current efficiency operating at high current density and low metal concentrations.

This totally enclosed cell does not require an air sparging system to promote turbulence or ventilator cover to prevent objects from falling into the cell, capture evolved gases or assure OSHA compliance.

The RenoCell offers unmatched features and benefits, including:

- *Proven world-class technology and design*

- *Effective metal ion treatment down to sub-mg/L range surpassing conventional technology by a factor of 100 or more*
- *Three to five times more cost effective than existing electrolytic cells*
- *Greatly improved electrical efficiencies and life-cycle cost savings*
- *Regulatory compliance with elimination of hazardous waste sludges or concentrates and elemental metal recovery for resale*
- *Easy metal removal and reduced operating and maintenance cost*
- *Highly reliable operations in harsh environs*
- *Compact size, robust modular design using industry-standard components*
- *Closed vessel with minimal ventilation issues*

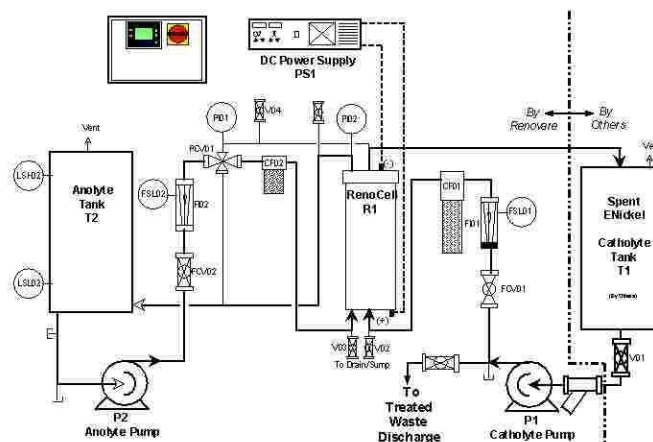
The series of RenoCell models is identical in cross-sectional area, differing only in length.

RenoCell allows the users to consider many more installation options because of its fully enclosed design and small footprint.

THE PROCESS

A RenoCell cell system is normally operated in a recirculation mode connected to and from a holding tank or static rinse tank, and in some cases may be configured in a single pass, flow-through configuration.

Designed for minimal but normal maintenance and monitoring, the cathode replacement is the only routine task required during operation.



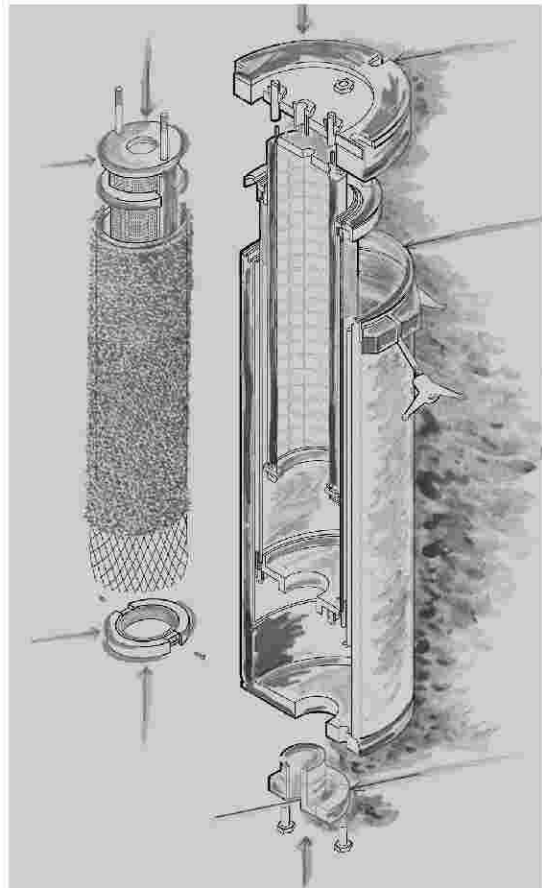
RenoCell — ADVANCED TECHNOLOGY THAT SIMPLY WORKS SUBSTANTIALLY BETTER

PERFORMANCE

The RenoCell may be used to recover metal from high concentration process streams or to strip rinse streams to below 1 mg/L metal concentrations. Depending on the application, flow volume, and time of treatment, concentration levels of 1 mg/L and lower may be achieved.

<i>Application</i>	<i>Metal</i>	<i>Initial (PPM)</i>	<i>Final (PPM)</i>	<i>Removal Efficiency (%)</i>
Acid sulfate rinse	Cu	910	0.02	99.99+
	Cu	98.2	0.22	99.78
Cyanide plating rinse	Cu	105	0.34	99.68
Fluoroborate plating rinse	Cu	115	0.3	99.74
Electroless Cu rinse	Cu	82	0.8	99.02
Micro etch bath rinse	Cu	44	0.11	99.75
Cyanide plating rinse	Ag	740	0.34	99.95
Cyanide static dragout	Cd	107	0.34	99.68
Acid sulfate rinse	Cd	978	0.37	99.96

<i>Application</i>	<i>Metal</i>	<i>Initial (PPM)</i>	<i>Final (PPM)</i>	<i>Removal Efficiency %</i>
Acid sulfate rinse	Zn	77.5	0.23	99.70
Acid sulfate rinse	Sn	93.2	0.5	99.46
Fluoroborate plating rinse	Pb	85	0.32	99.62
Watt's bath rinse	Ni	105	0.5	99.52
Acid sulfate rinse	Cr(III)	124	1	99.19
Cyanide liquor	Au	380	<0.1	99.97
Acidic liquors	Pt	24	1	95.83
	Pd	110	0.01	99.99
	Pt	2000	0.5	99.98
	Pd	500	<0.5	99.90
Groundwater (acidic)	Hg	6.3	0.036	99.43



Hundreds of test applications have proven that more than 20 metals are efficiently recoverable by RenoCell and, as application experience continues, the number of metals is expanding.

RenoCell — HELPING THE METAL PROCESSING INDUSTRIES MINIMIZE WASTE, REDUCE WATER AND CHEMICAL USE, AND RECOVER AND RECYCLE VALUABLE MATERIALS

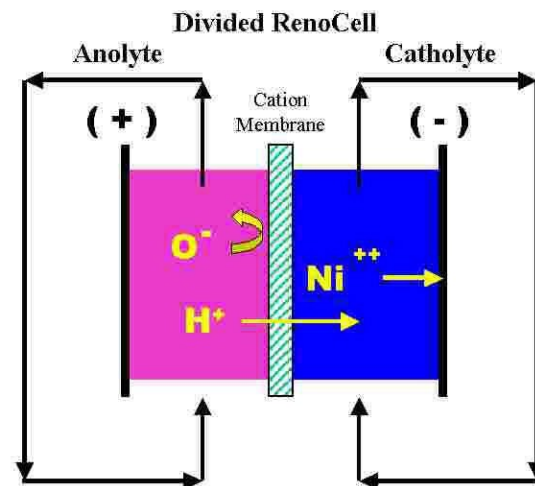
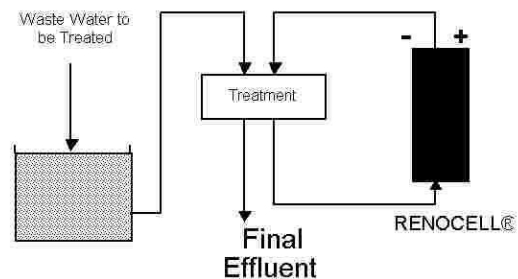
ELIMINATE METAL BEARING SLUDGE GENERATION

As hazardous waste disposal costs increase, more and more firms in the Metal Finishing Industry are looking to methods that will allow recovery of metals for refinement or resale. With this approach, liability issues are avoided and, frequently, disposal costs can also be reduced. U.S. environmental regulations governing heavy metal-bearing waste streams, administered through the Resource Conservation and Recovery Act (RCRA), are quite specific on one matter—a spent material that is recycled or reclaimed is considered differently if disposed of by land-filling (40 CFR 261.1 (c)). This regulation has far-reaching impact on disposal of the spent material. Under the RCRA system of waste handling and disposal, the generator has permanent liability for all disposed hazardous wastes. Permanent liability is avoided if the waste material is recovered for reuse or resale. The RenoCell's ability to recover metal as metal offers unsurpassed performance and reduced business risks by avoiding the potential future liability associated with the disposal of metal bearing hazardous sludge. Electrolytic recovery is also a key component of any waste minimization or recycle system.

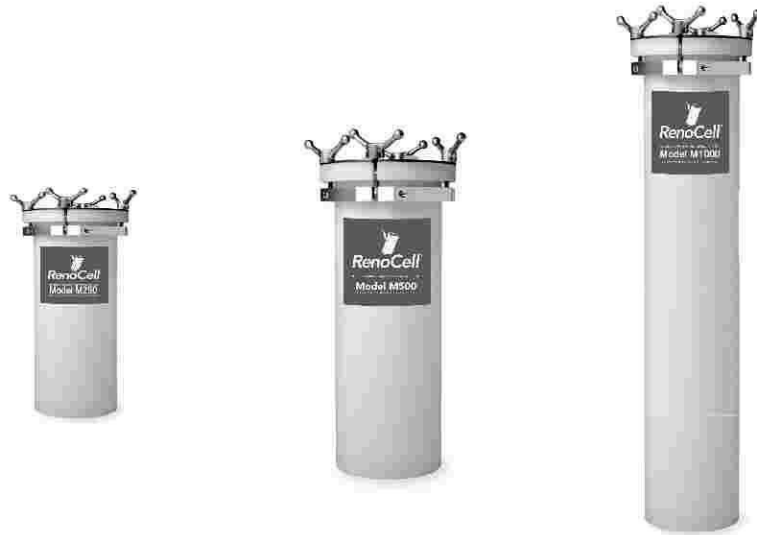
RenoCell electrolytic cell technologies integrate readily into virtually any operation. And, through your RenoCell provider and service supplier, RenoCell can be easily integrated with other technologies such as membrane microfiltration, ion exchange, reverse osmosis and evaporation systems. RenoCell may often be used to polish your precipitation systems effluent or enhance your ion exchange systems performance.

RECOVER METALS AND REUSE WATER AND CHEMICALS

The RenoCell Metal Recovery Systems are specially designed to help metal finishers recover heavy metals such as copper, nickel, tin, lead, cadmium and precious metals. RenoCell in conjunction with ion exchange can also allow reuse of chromic, sulfuric, phosphoric and other acids.



RenoCell — METAL RECOVERY IS A KEY PART OF A RECYCLE OR WASTE MINIMIZATION SYSTEM



Specifications

	Model 250	Model 500	Model 1000
Standard Material	Polypropylene	Polypropylene	Polypropylene
Dimension			
– Length	435 mm	645 mm	1065 mm
– Width	200 mm	200 mm	200 mm
Anode	DSA	DSA	DSA
Cathode	Carbon	Carbon	Carbon
Metal Loading	1-3 kg	3-5 kg	6-10 kg
Flow Rate	15 to 45 l/m	30 to 90 l/m	60 to 180 l/m

Applications

The RenoCell cell is used commercially in metal finishing in various applications including:

- Copper Sulfate
- Electroless Copper
- Cadmium Cyanide/Sulfate
- Gold Cyanide
- Cyanide Destruction (during metal removal)
- Copper Cyanide
- Tin - Lead
- Precious Metals
- Nickel Sulfate
- In combination with ion exchange

RenoCell — ADVANCED ELECTRODEPOSITION TECHNOLOGY INCORPORATED IN A COMPACT, ROBUST, MODULAR SYSTEM DESIGN

DESIGN FLEXIBILITY

RenoCell Modular Systems are available in range of sizes and capacities, and are fully integrated. These skid-mounted systems come complete with cells, DC rectifier, pump, valves, piping, sensors, and AC electrical power and controls.



Modular System Model Number [1]	Electrical		Water Recirc. Rate [2]	Piping Interface	System Dimensions (Nominal) [3]			
	DC Amps [4]	AC			LPM/GPM	Length mm/in.	Width mm/in.	Height mm/in.
MX0251	25A	10A@110, 5A@220V, 1Ø, 50/60Hz	15/4	[6]	762/30 [5]	610/24	1778/72	114/250
MX0252	50A	15A@110, 8A@220V, 1Ø, 50/60Hz	30/8	[7]	1372/54	610/24	1778/72	170/375
MX0501	50A	15A@110, 8A@220V, 1Ø, 50/60Hz	30/8	[6]	762/30 [5]	610/24	1778/72	120/265
MX0502	100A	20A@110, 10A@220V, 1Ø, 50/60Hz	60/16	[7]	1372/54	610/24	1778/72	182/400
MX0503	150A	12A@220, 7A@480V, 3Ø, 50/60Hz	90/24	[7]	1372/54	610/24	1778/72	202/445
MX0504	200A	15A@220, 8A@480V, 3Ø, 50/60Hz	120/32	[7]	1372/54	610/24	1778/72	216/475
MX1001	100A	10A@220, 5A@480V, 3Ø, 50/60Hz	60/16	[7]	1372/54	610/24	1778/72	189/415
MX1002	200A	15A@220, 8A@480V, 3Ø, 50/60Hz	120/32	[7]	1372/54	610/24	1778/72	207/455
MX1003	300A	25A@220, 12A@480V, 3Ø, 50/60Hz	180/48	[7]	1372/54	610/24	1778/72	225/495
MX1004	400A	30A@220, 15A@480V, 3Ø, 50/60Hz	240/64	[7]	1372/54	610/24	1778/72	243/535

Specifications subject to change without notice.

NOTES:

- [1] System Model Number indicates RenoCell Model and number of cells, e.g., MX0251 identifies that the Modular System consists of one (1) Model 250 RenoCell.
- [2] Water recirculation rate assumes cell used in recirculating mode and refers to internal pumping rate only - source/receiver tank(s) must be sized accordingly.
- [3] See MODULAR SYSTEM drawings for typical layout configurations.
- [4] DC Amps at 12Volts nominal power supply rating. Other power supplies with higher and lower DC voltage ratings are available.
- [5] Model MX0251 and MX0501 each include one RenoCell integrated on single frame with DC power supply, electrical, control, and pumping system.
- [6] Pump suction - 1-1/2" FNPT, Cell outlet - 1" FNPT.

Larger configurations, custom engineered to meet customer specific requirements, are also available from your RenoCell supplier.

RenoCell — THE NEXT GENERATION OF METAL RECOVERY AND WASTEWATER TREATMENT SYSTEMS

SELECTING THE APPROPRIATE RENOCELL SYSTEM

Using the information provided below, it's a simple two step process to select the right RenoCell Modular System(s) to meet your metal recovery or removal needs.

Required Information:

Step 1. Determine the Incoming Metal Rate as follows:

$$\begin{aligned} & [(\text{Starting Concentration} - \text{Ending Concentration, in ppm or Milligrams/Liter}) \\ & \quad (\text{divide by 1000 to get Grams/Liter})] \\ & \quad \times [\text{multiply by the Source flow rate in Liters/Hour}] \\ & \quad = \text{Incoming Metal Rate in Grams/Hour} \end{aligned}$$

Step 2. Select a RenoCell Modular System from the performance specification chart below. Choose a unit that provides enough Metal Removal Capacity to offset the Incoming Metal Rate calculated above.

Modular System Model Number	METAL																				
	Copper (Cu+2)			Cadmium (Cd+2)			Silver (Ag+1)			Gold (Au+3)			Tin (Sn+4)			Lead (Pb+2)			Nickel (Ni+2)		
	Metal Removal Capacity		Time to Treat 1m3	Metal Removal Capacity		Time to Treat 1m3	Metal Removal Capacity		Time to Treat 1m3	Metal Removal Capacity		Time to Treat 1m3	Metal Removal Capacity		Time to Treat 1m3	Metal Removal Capacity		Time to Treat 1m3			
	g/hr	g/day	hrs	g/hr	g/day	hrs	g/hr	g/day	hrs	g/hr	g/day	hrs	g/hr	g/day	hrs	g/hr	g/day	hrs			
MX0251	10	230	104	5	112	215	14	327	73	17	420	57	7	170	141	24	572	42	5	118	204
MX0252	19	460	52	9	228	107	27	654	37	35	839	28	14	340	70	48	1,143	21	10	235	102
MX0501	19	460	52	9	228	107	27	654	37	35	839	29	14	340	70	48	1,143	21	10	235	102
MX0502	38	920	26	19	447	54	55	1,309	18	70	1,678	14	28	681	35	95	2,287	10	20	470	51
MX0503	58	1,380	17	28	670	36	82	1,963	12	105	2,517	10	43	1,021	23	143	3,430	7	29	705	34
MX0504	77	1,840	13	37	893	27	109	2,618	9	140	3,357	7	57	1,361	18	191	4,574	5	38	940	26
MX1001	38	920	26	19	447	54	55	1,309	18	70	1,678	14	28	681	35	95	2,287	10	20	470	51
MX1002	77	1,840	13	37	893	27	109	2,618	9	140	3,357	7	57	1,361	18	191	4,574	5	38	940	26
MX1003	115	2,760	9	58	1,340	18	164	3,927	6	210	5,035	5	85	2,042	12	286	6,861	3	69	1,410	17
MX1004	153	3,680	7	74	1,787	13	218	5,235	5	280	6,713	4	113	2,722	9	381	9,147	3	78	1,880	13
<i>Specifications subject to change without notice.</i>																					
Starting Concentration (mg/l)	1000			1000			1000			1000			1000			1000			1000		
Ending Concentration (mg/l)	1			1			1			1			1			1			1		
Current Density (A/m ²)	300			300			300			300			300			300			300		
Average Current Efficiency	54%			15%			23%			48%			43%			41%			30%		

This sizing estimate will allow you to more easily estimate the approximate size and price of the modular system(s) needed to meet your application requirements. Please note that in some cases a standard modular system configuration may not be appropriate and other configuration options are available. Contact Renovare Sales or Technical Support for additional assistance.

RenoCell — METAL RECOVERY IS A KEY PART OF ANY RECYCLE OR WASTE MINIMIZATION SYSTEM

REAL COST SAVINGS

When comparing the RenoCell system to precipitation or ion exchange and sludge disposal, the following cost factors should be considered:

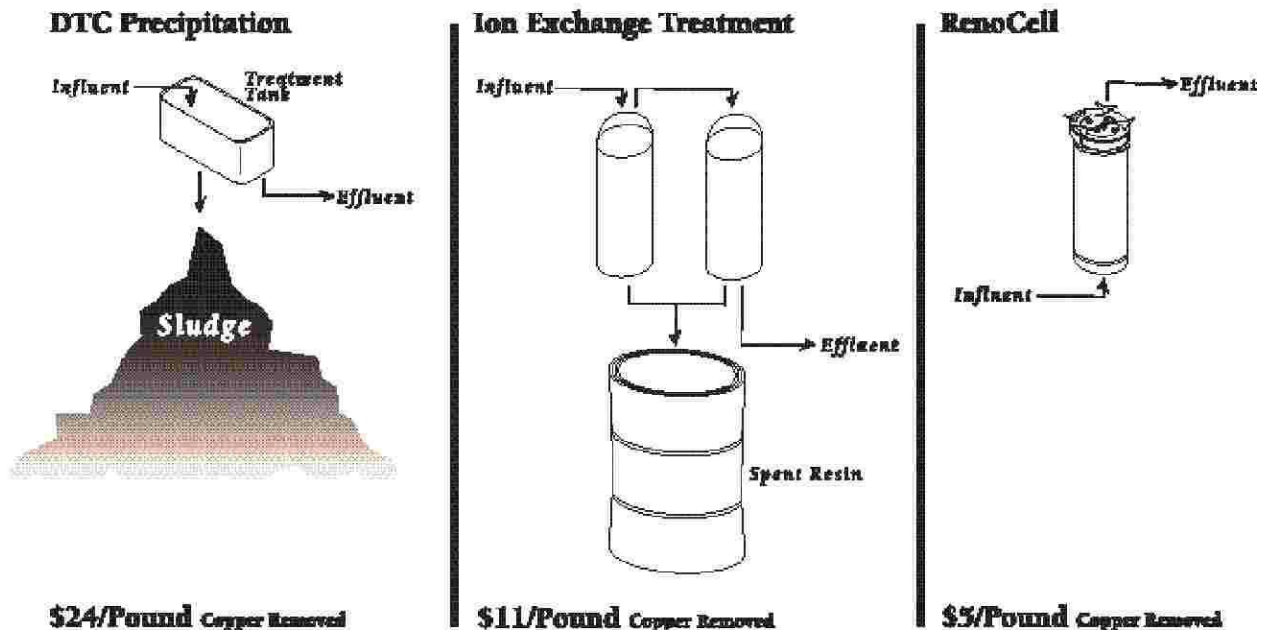
Expenses

Depreciation
Cathodes
Electricity
Sludge disposal
Water

Savings

Recovered metal
Sludge treatment
Chemicals
Labor
Electricity

TYPICAL COST COMPARISON FOR COPPER REMOVAL FROM PLATING RINSE WATERS



***RenoCell — THE NEXT GENERATION OF WASTE
WATER TREATMENT AND METAL RECOVERY
SYSTEMS BRINGS REAL-WORLD BENEFITS***

- **Virtually complete removal of all metal to allow rinse water reuse, saving more than 40% in overall treatment cost**
- **Total operational cost savings up to 70% over conventional treatment methods**
- **Lower capital cost payback (less than two years on most metals, from weeks to months for precious metals)**
- **Reduced metal and wastewater loading on existing waste treatment facilities**
- **Conformance with national and local discharge standards**
- **Elimination of long-term “hazardous” waste disposal liabilities**