HATLAR group

ENVIRONMENTAL PROBLEM SOLVERS

Mt Carrington Acid Mine Drainage
J-Cell Multi-Process Treatment Trial

For

REX Minerals Ltd

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MINERALS LTD
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Mt Carrington
J-Cell Trial Phase 3

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1.0 Introduction

The history of acid mine drainage (AMD) development in the Mt Carrington mine area was summarised in the first report on the J-cell process completed in March 2009. AMD generation in the Mt Carrington mine site area is substantial and is impacting significantly on stream water quality.

Recognised treatment technologies for AMD are either based on precipitation of the dissolved base metals by carbonate, adsorption onto various media such as ion exchange resins or the proprietary product Bauxsol or the use of membrane technology. These systems, while they can achieve adequate removal of dissolved base metals, and in the case of membrane technology, various levels of other anions and cations they are often expensive to operate and do not always achieve an outcome which will allow discharge to the drainage system in a cost effective manner.

Research into the treatment of AMD is ongoing as it is recognised as a serious issue in the mining industry. Most of the research is based around modifying and improving the dynamics and economics of the recognised process technologies. Occasionally, new and innovative ideas are presented which claim AMD remediation. The J-Cell is one such technology. The initial J-Cell tests on the Mt Carrington AMD showed only marginal reduction in sulphate, aluminium, cadmium and zinc. While the data did not show sufficient removal of contaminants to indicate that it is worthwhile pursuing a larger trial of the technology at this stage, the reductions observed in cadmium, zinc and sulphate suggested that the J-cell is resulting in some change in the AMD water. Discussions with the technology provider indicated that he was confident that he could achieve a better result provided he could be given more time to experiment with the cell and the AMD. To this end I supplied him with 30 litres of AMD from the waste rock dams.

Tests on the Mt Carrington AMD were conducted during April and May 2009 by the technology supplier using various sets of equipment. While the technology provider did not have the ability to complete detailed analysis, these tests indicated that a substantial reduction in conductivity was achieved suggesting a significant removal of the contained salt.

The information was thought to be sufficiently encouraging to support another sequence of more detailed testing. This report evaluates the effects of various J-Cell configurations on the treatment of AMD collected from waste rock dam 1 at the Mt Carrington Mine site.

2.0 Methodology

Mike McRae-Williams of the Hatlar Group collected 40 litres of sample from waste rock dam 1 via a siphon hose which directs No. 1 dam water to No. 4 dam where it is pumped across the drainage divide to an existing tailings dam.

The samples were then delivered to the workshop of Mr. Joe Booker. Mr. Booker ran several trials independently and then on Tuesday 24th May 2009 conducted a trial where Mike McRae-Williams observed the AMD treatment through a proprietary J-Cell.

Mike McRae-Williams observed the cell being washed with mains water and examined the cell to ensure that no extraneous matter was present prior to filling with the AMD solutions. Prior to filling, a sub-sample of the AMD was collected to provide the comparative base line data. This included 500ml for analysis of TDS, pH, and cations and a 100ml sample (with preservative added) for the measurement of base metal concentrations.

The test cell was operated and at the end of the test, sub-samples identical to those described above were collected from each sample to represent the post test water quality. The samples were then consigned to EcoWise (NATA accredited laboratory) for analysis.

3.0 Results and Discussion

The test results are attached in Appendix 1 and in Tables 1, 2 & 3 below.

The effectiveness of the various combinations of the J-Cell varied with the inline magnetic setup showing the most promise. The main outcomes of the tests are summarised below:

- The inline magnetic J-Cell tests (tests 4, 5, 8 & 9) all showed significant reductions in the parameters of importance that were tested. Substantial precipitate was observed in the treated sample after allowing 20 minutes for settling.
- Electric enhanced J-Cell tests were generally not as successful as the magnetic systems. Only one electric enhanced J-Cell setup (test 7) showed removal of contaminants comparable to those achieved in the magnetic J-Cell trials.
- The electric enhanced J-Cell again showed increases in chromium, iron and nickel suggesting that some "bleeding" of these materials is occurring from the stainless steel electrodes. However, no obvious pitting was discernable on the electrodes.
- The magnetic J-Cell configurations showed around 90% or higher removals in all the parameters of importance (TDS, Al, Cd, Cu, Mn, Ni, Zn, Ca and Mg). Slightly lower reductions in potassium were indicated (67%) and no reduction in sodium levels was observed.
- The levels of removal achieved in the magnetic J-Cell resulted in treated water which either exceeded or were close to the ANZECC Guidelines for drinking water except for the parameters, cadmium and manganese.
- The levels of removal achieved in the magnetic J-Cell resulted in treated water which was of significantly higher quality for all parameters when compared to the receiving waters of Sawpit Creek (Table 3). The only exception to this was cadmium where the levels of the treated water were similar to those measured in Sawpit Creek.
- Test 7 with the electric enhanced J-Cell showed equivalent removal of contaminants with the added benefit of a 50% reduction in sodium levels.

These tests indicate that on a bench scale the magnetic J-Cell technology and the Test 7 electric J-Cell configuration have the potential to treat the AMD occurring on the Mt Carrington mine site to a level which would meet the discharge criteria detailed in the Mine Operations Plan (MOP) and the Mine Closure Plan (MCP). These plans indicate that the specific objective of the

rehabilitation in this catchment is to improve Sawpit Creek water quality to a degree that ensures that the beneficial uses (drinking water, stock water, ecological protection) of Plumbago Creek into which it flows are not compromised. Due to the amount of derelict mine sites in the area, the water quality of Sawpit Creek may always be relatively poor but with a reduction of 50% relative to existing water quality the impact on the beneficial uses of the Plumbago system will be minimal. Treatment through the magnetic J-Cell, based on the data available at this stage may well meet this requirement and would certainly meet the preservation of beneficial use criteria for Plumbago Creek.

4.0 Recommendations

The test data from this trial shows that, the magnetic J-Cell and one configuration of the electric enhanced J-Cell, achieved significant reduction is salt and dissolved metal loads. The reduction was sufficient to ensure that the discharge criteria detailed in the MOP and MCP could be met. The tests to this stage have been small volume (5 litre trials) and before a definitive evaluation can be made a longer and continuous trial is necessary. Moreover, if such new technology was to receive acceptance from DPI and DECC a continuous trial spanning at least 6 months would be required.

Discussions with Joe Booker, the inventor of the technology, have indicated that a commercial scale processing plant has been constructed and could be made available for the trial. He is however, somewhat reticent to allow the equipment to leave his control because of the potential for the loss of intellectual property. However, provided we can supply adequate security and the equipment can be camouflaged in some way then it may be possible to negotiate for the plant to be installed on the Waste Rock Dam discharge pipe at the mine site.

It is therefore recommended that Mike McRae-Williams negotiate with Mr. Booker to provide the equipment to set up a trial to substantiate the viability of the magnetic J-Cell process operated on a continuous basis over a 6 month period.

Table 1: Analysis Data for the Various J-Cell Trials on Mt Carrington AMD

Description Number	pH Units	TDS 180 mg/L	Aluminium mg/L	Cadmium mg/L	Chromium mg/L	Cobalt mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	K mg/L	Na mg/L
1	4.3	3500	8.9	2.9	<0.01	0.6	8.4	0.3	0.08	42	0.25	160	32	500	3	29
2	2.8	3500	7.5	2.6	4.4	0.56	7.2	12	0.02	31	2.7	150	31	450	3	27
3	4.4	3600	6.3	3	5.2	0.63	8.8	0.9	<0.01	33	3.7	180	32	510	3	28
4	6.6	460	0.1	0.29	<0.01	0.06	0.12	<0.2	<0.01	4.3	0.03	19	5	51	1	29
5	6.7	490	0.1	0.29	<0.01	0.06	0.1	<0.2	<0.01	4.4	0.03	19	5	55	1	31
6	7	3400	0.2	1.9	1.4	0.31	0.04	<0.2	<0.01	16	0.39	25	29	540	3.2	26
7	6.9	400	0.4	0.16	0.86	0.06	0.09	<0.2	<0.01	2.3	0.15	10	3	47	<1	15
8	7.2	460	0.8	0.2	<0.01	0.02	0.03	<0.2	<0.01	4.2	<0.01	10	6	56	1	31
9	7.2	440	0.4	0.24	<0.01	0.03	0.03	<0.2	<0.01	4	<0.01	13	6	56	1	32
10	7	3500	0.3	1.7	2.1	0.4	0.05	<0.2	<0.01	13	0.76	43	29	550	3	26
11	7.1	3400	<0.1	1.7	1.5	0.27	0.05	<0.2	<0.01	14	0.36	22	31	580	3	28

No Substantial Change Substantial Decrease Substantial Increase

Legend

1 = MT Carrington Feed Water
2 = MT Carrington Electric cell, (positive charge 2), minerals separated from top water underneath
3 = MT Carrington Electric cell, (Reverse Charge, positive charge), 1 minute
4 = MT Carrington Inline magnetic cell 2min run (2)
5 = MT Carrington Inline magnetic cell 2min run negative charge
6 = MT Carrington Electric Cell, sludge to top then fell to bottom, (negative charge)
7 = MT Carrington Electric cell, 20min after separation (negative charge)
8 = MT Carrington Inline magnetic cell, from bottom of beer keg next morning (2)
9 = MT Carrington Inline magnetic cell, Bottom of cell, next morning
10 = MT Carrington Electric cell, minerals to bottom, 2 minutes, negative charge
11 = MT Carrington Electric cell, Minerals to surface, 2 minutes, negative charge

Table 2: Analysis Data on those Trials where a Significant Reduction in Parameters was obtained

Description Number	pH Units	TDS 180 mg/L	Aluminium mg/L	Cadmium mg/L	Chromium mg/L	Cobalt mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	K mg/L	Na mg/L
1	4.3	3500	8.9	2.9	<0.01	0.6	8.4	0.3	0.08	42	0.25	160	32	500	3	29
4	6.6	460	0.1	0.29	<0.01	0.06	0.12	<0.2	<0.01	4.3	0.03	19	5	51	1	29
5	6.7	490	0.1	0.29	<0.01	0.06	0.1	<0.2	<0.01	4.4	0.03	19	5	55	1	31
8	7.2	460	0.8	0.2	<0.01	0.02	0.03	<0.2	<0.01	4.2	<0.01	10	6	56	1	31
9	7.2	440	0.4	0.24	<0.01	0.03	0.03	<0.2	<0.01	4	<0.01	13	6	56	1	32
7	6.9	400	0.4	0.16	0.86	0.06	0.09	<0.2	<0.01	2.3	0.15	10	3	47	<1	15

Legend

1 = MT Carrington Feed Water
4 = MT Carrington Inline magnetic cell 2min run (2)
5 = MT Carrington Inline magnetic cell 2min run negative charge
7 = MT Carrington Electric cell, 20min after separation (negative charge)
8 = MT Carrington Inline magnetic cell, from bottom of beer keg next morning (2)
9 = MT Carrington Inline magnetic cell, Bottom of cell, next morning

Table 3: Data Showing the Percentage of Removal of the Various Parameters

Description Number	TDS 180 mg/L	% Reduction	Aluminium mg/L	% Reduction	Cadmium mg/L	% Reduction	Copper mg/L	% Reduction	Manganese mg/L	% Reduction	Nickel mg/L	% Reduction	Zinc mg/L	% Reduction	Ca mg/L	% Reduction	Mg mg/L	% Reduction	K mg/L	% Reduction
1	3500		8.9		2.9		8.4		42		0.25		160		32		500		3	
4	460	87	0.1	99	0.29	90	0.12	99	4.3	90	0.03	88	19	88	5	84	51	90	1	67
5	490	86	0.1	99	0.29	90	0.1	99	4.4	90	0.03	88	19	88	5	84	55	89	1	67
8	460	87	0.8	91	0.2	93	0.03	100	4.2	90	0.01	96	10	94	6	81	56	89	1	67
9	440	87	0.4	96	0.24	92	0.03	100	4	90	0.01	96	13	92	6	81	56	89	1	67
7	400	89	0.4	96	0.16	94	0.09	99	2.3	95	0.15	40	10	94	3	91	47	91	1	67
ANZECC	500	86	0.2	98	0.002	100	2	76	0.1	100	0.02	92	3	98						
Sawpit Ck.	950		1.1		0.22		2.75						24-52							