U-MATE INTERNATIONAL, INC.

PROCESS POTENTIAL STUDY

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Effect of pH on New Mex Humate Treatment

AIM:

Our purpose is to investigate the effect pH has on the ability of solid New Mex Humate provided by U-Mate International Inc. of Scottsdale, Arizona to remove heavy metals from processed industrial waste. We are attempting to find the conditions under which humates can most effectively absorb heavy metals.

SCOPE:

This study examines the effect of a humate treatment on one raw wastewater sample, at three different pH levels. Each sample is treated with humates, for an extended period, and then filtered to remove the maximum amount of heavy metal contamination. In order to separate out the effect of the humates from the effect of the filtering process, we analyzed the both raw sample and a filtered version, at the same pH. These results were then compared to an analysis of the humate treated filtered sample.

SAMPLE PREPARATION:

Several portions of wastewater, taken in April 2004, were combined into one sample and dubbed "April Composite". The sample was then split into three subsamples. The first of these were adjusted to a pH of 2 with sulfuric acid. The second subsample was left at its original pH of 6. The third subsample was adjusted to a pH of 10 with caustic.

50 ml aliquots of each of these unfiltered, pH adjusted samples were spiked with 2 ml of 1:1 nitric acid and 1 ml of 1:1 hydrochloric acid. The samples were heated to a gentle boil, digested, cooled and then diluted back to their original volume. A second set of aliquots were filtered first to remove any particulate matter and then subjected to same acid digestion as described above.

A third set of 50 ml aliquots were combined with 5 grams of dry hand-ground humate. These mixtures were stirred briefly, by hand, and then allowed to sit for

approximately 20 hours. These mixtures were then filtered and acid digested, in the same manner as described above. These prepared samples were analyzed for the 13 key elements and iron.

ANALYTICAL RESULTS:

All samples were analyzed for trace metal content on a Leeman Labs, Model Profile Plus ICP Spectrometer. All results are given in units of part per million (ppm).

Element / Symbol		**April Composite pH 2 Unfiltered**	**April Composite pH 2 Filtered**	**April Composite pH 2 Humate Treated**
Antimony	**Sb**	0.028	0.018	0.054
Arsenic	**As**	0.008	0.023	0.215
Cadmium	**Cd**	ND	ND	ND
Chromium	**Cr**	0.111	0.101	0.111
Cobalt	**Co**	0.296	0.306	0.355
Copper	**Cu**	0.041	2.23	0.082
Lead	**Pb**	0.054	0.058	0.080
Nickel	**Ni**	4.84	4.83	4.54
Silver	**Ag**	ND	ND	ND
Tin	**Sn**	0.468	0.286	0.157
Titanium	**Ti**	ND	ND	0.024
Vanadium	**V**	0.017	0.021	0.060
Zinc	**Zn**	2.57	2.56	2.90
Iron	**Fe**	4.19	3.01	0.455

ND = Not Detected

Element / Symbol		April Composite pH 6 Unfiltered	April Composite pH 6 Filtered	April Composite pH 6 Humate Treated
Antimony	**Sb**	0.020	0.002	0.009
Arsenic	**As**	ND	ND	ND
Cadmium	**Cd**	ND	ND	ND
Chromium	**Cr**	0.062	0.056	0.049
Cobalt	**Co**	0.304	0.275	0.268
Copper	**Cu**	0.024	0.038	0.030
Lead	**Pb**	0.031	ND	ND
Nickel	**Ni**	4.99	4.59	4.89
Silver	**Ag**	ND	ND	ND
Tin	**Sn**	0.482	0.071	0.014
Titanium	**Ti**	ND	ND	ND
Vanadium	**V**	0.005	0.007	0.017
Zinc	**Zn**	2.55	1.06	0.765
Iron	**Fe**	3.21	1.66	ND

ND = Not Detected

Element / Symbol		April Composite pH 10 Unfiltered	April Composite pH 10 Filtered	April Composite pH 10 Humate Treated
Antimony	**Sb**	0.016	0.005	0.036
Arsenic	**As**	ND	ND	ND
Cadmium	**Cd**	ND	ND	ND
Chromium	**Cr**	0.064	0.024	0.043
Cobalt	**Co**	0.304	0.253	0.278
Copper	**Cu**	0.044	ND	0.020
Lead	**Pb**	0.051	ND	0.073
Nickel	**Ni**	4.86	4.69	6.18
Silver	**Ag**	ND	ND	ND
Tin	**Sn**	0.469	0.057	0.009
Titanium	**Ti**	ND	ND	0.001
Vanadium	**V**	0.018	0.004	0.015
Zinc	**Zn**	2.63	ND	0.274
Iron	**Fe**	3.52	ND	ND

ND = Not Detected

OBSERVATION:

A spike occurred, in the concentration of copper, on the pH 2 - Filtered sample. The solution was retested and the high copper level has been confirmed. The root cause

of this spike is not known, but a contamination of the beaker, the funnel or the sample vial is suspected.

CONCLUSIONS:

- Overall, the dry humic substances appear to absorb the most heavy metal contaminants under alkaline conditions.
- Acidic conditions proved to be the least effective for removing heavy metal contamination. The concentration of elements like arsenic and vanadium increased significantly after exposure to humates in an acidic environment.
- The levels of cadmium, silver and titanium were not high enough to provide a fair test for the retention capacity of the humates.
- The response of the elements antimony, copper and lead were mixed and highly variable. The humate treatment was not beneficial, in this case.
- The cobalt and nickel concentrations remained virtually unchanged after the humate treatment and regardless of the pH level. .
- The levels of chromium were slightly reduced, by humates, in an alkaline environment.
- The most effective reductions occurred with tin, zinc and iron. The alkaline mixes removed nearly 100 % of all three metals. The neutral mixes were almost as effective. The acidic mixes generally gave disappointing results

RECOMMENDATIONS:

- Investigate the use of liquid humates.
- Repeat the humate treatment on a sample spiked with additional heavy metals.
- Consider varying the dosage of humate in the treatment step.