U-MATE INTERNATIONAL, INC.

PROCESS POTENTIAL STUDY

To: Mike Panyard
Dennis Yellowhorse Jones

From: Mike Levine

The Effect of Liquid New Mex Humate Treatment on Heavy Metal Reduction in Wastewater

AIM:

Humates are a natural mined product from U-Mate International Inc. of Scottsdale Arizona with the ability to absorb and remove certain objectionable materials from water-based solutions. Our purpose, here, is to measure the ability of liquid humates to remove heavy metal ions from treated wastewater. Additionally, we would like to compare these results to the solid humates, in the report dated 6/8/04.

We will pay particular attention to the most toxic materials and to the metals that are traditionally the most difficult to remove. Cobalt, nickel, tin and zinc continue to be our most problematic elements.

DEFINITION:

Liquid humates are herein defined as the product resulting from the combination of water and solid humates mixed at high speed and high shear conditions. It is a viscous, slow pouring, nearly odorless material with the appearance of a dark brown mud.

SCOPE:

An untreated waste product was spiked with all of the elements of interest and then analyzed. Serving as a baseline, this material was then treated with increasing additions of liquid humate. The resulting mixtures were analyzed for heavy metal content. The percent reductions in each element were calculated, reported and compared to those from the solid humate data.

SAMPLE PREPARATION:

A grab sample from Tank 5 was placed in a 55 gallon drum and labeled “Drum Sample”. The sample was then spiked with all thirteen regulated elements. This material was mixed, suspended and rapidly separated into four subsamples. 70 ml of each of these subsamples were spiked with sufficient quantities of liquid humate to make 0.1%, 0.5%, 1% or 2% additions. The mixtures were stirred briefly, by hand, and then allowed to react and settle.

To better approximate production conditions, the contact time, in this case, was limited to only 15 minutes. The top 50 ml of each subsample were centrifuged. The clarified liquids were analyzed for the thirteen key elements plus iron

Identification	**Treatment**	**Description**	
Sample #1:	None	70 ml spiked Drum Sample	Centrifuged
Sample #2:	Liquid Humate 0.1%	70 ml spiked Drum Sample + 0.07g Liq Humate	Centrifuged
Sample #3:	Liquid Humate 0.5%	70ml spiked Drum Sample + 0.35g Liq Humate	Centrifuged
Sample #4:	Liquid Humate 1%	70ml spiked Drum Sample + 0.70g Liq Humate	Centrifuged
Sample #5:	Liquid Humate 2%	70ml spiked Drum Sample + 1.40g Liq Humate	Centrifuged

These samples were prepared for analysis by taking a 50 ml aliquot of each of the centrifuged samples and adding 2 ml of 1:1 nitric acid and 1 ml of 1:1 hydrochloric acid. These samples were heated to a gentle boil, digested, cooled and then diluted back to their original volume.

ANALYTICAL RESULTS:

All samples were analyzed for the thirteen key elements and iron on a Leeman Labs, Model Profile Plus ICP Spectrometer. All results are given in units of part per million (ppm).

Element / Symbol		**Spiked Drum Sample + 0.0% Liq Hum**	**Spiked Drum Sample + 0.1% Liq Hum**	**Spiked Drum Sample + 0.5% Liq Hum**	**Spiked Drum Sample + 1.0% Liq Hum**	**Spiked Drum Sample + 2.0% Liq Hum**
Antimony	**Sb**	0.300	0.288	0.266	0.265	0.243
Arsenic	**As**	0.247	0.244	0.239	0.238	0.235
Cadmium	**Cd**	0.166	0.158	0.157	0.149	0.138
Chromium	**Cr**	0.183	0.170	0.167	0.154	0.135
Cobalt	**Co**	0.267	0.263	0.266	0.263	0.261
Copper	**Cu**	0.299	0.284	0.266	0.231	0.192
Lead	**Pb**	0.172	0.142	0.099	0.066	0.046
Nickel	**Ni**	2.74	2.69	2.66	2.65	2.52
Silver	**Ag**	0.146	0.119	0.105	0.097	0.107
Tin	**Sn**	0.206	0.201	0.173	0.134	0.111
Titanium	**Ti**	0.178	0.174	0.158	0.132	0.103
Vanadium	**V**	0.188	0.181	0.187	0.183	0.175
Zinc	**Zn**	26.5	25.2	24.7	23.6	22.7
Iron	**Fe**	5.36	4.64	4.66	4.16	3.59

ND = Not Detected

PERCENT HEAVY METAL REDUCTION:

Element	Liquid Humates 2% Addition 15 Minute Contact Time		Element	Solid Humates 10% Addition 60 Minute Contact Time	
Lead	73%	Superior	**Silver**	100%	Superior
Tin	46%	Effective	**Iron**	81%	Superior
Titanium	42%	Effective	**Tin**	79%	Superior
Copper	36%	Effective	**Cadmium**	79%	Superior
Iron	33%	Effective	**Titanium**	71%	Superior
Silver	27%	Effective	**Vanadium**	69%	Effective
Chromium	26%	Effective	**Copper**	63%	Effective
Antimony	19%	Moderate	**Lead**	56%	Effective
Cadmium	17%	Moderate	**Antimony**	52%	Effective
Zinc	14%	Moderate	**Chromium**	45%	Effective
Nickel	8%	Minimal	**Arsenic**	44%	Effective
Vanadium	7%	Minimal	**Zinc**	30%	Effective
Arsenic	5%	Minimal	**Cobalt**	19%	Moderate
Cobalt	2%	Minimal	**Nickel**	12%	Moderate

CONCLUSIONS:

- Both liquid and solid humates display an ability to absorb and remove measurable amounts of objectionable heavy metal ions from wastewater.

- Heavy metal reductions, in general, tend to improve with increasing doses of humates.

- Heavy metal reductions, in general, tend to improve by increasing the contact time with humates.

- Increasing either the dosage or the contact time does not guarantee complete removal of the heavy metals. The graphs suggest a case of diminishing returns.

- Problem elements like arsenic, zinc, cobalt and nickel reach this region of diminishing returns very quickly. This applies to both the liquid and solid humates.

- The list of elements most easily removed by liquid humates does not match the list of elements easily removed by solid humates.

- Lead is preferentially removed by the liquid humate.

- Silver, cadmium and vanadium are more effectively removed by solid humates.

- Iron, tin, silver, copper and titanium appear to be easily removed by either medium.

- Antimony, chromium and zinc performed similarly on both lists.