Biogeochemical Analysis of Spent Media From a Vertical Flow Treatment Pond

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Site History


Problem Statement
& Methods
Bobcat
T300

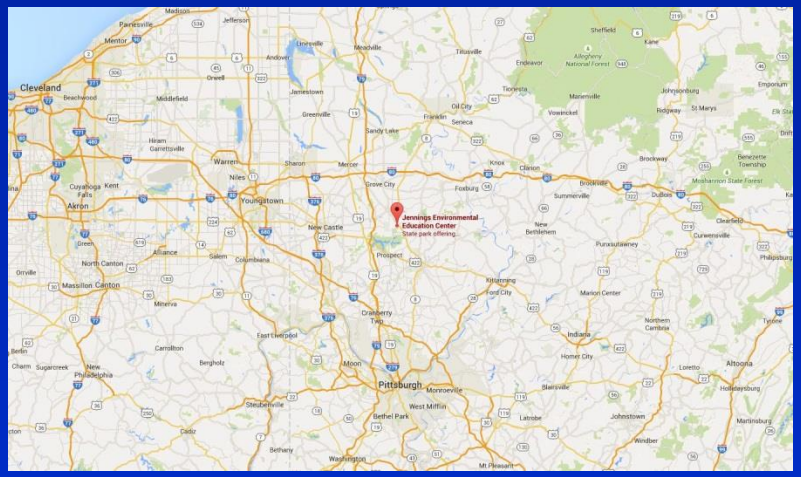

Data
Thermo


Conclusions

Site History

Jennings Passive treatment System

- Butler County, Pennsylvania
  - Slippery Rock Creek Watershed
  - Jennings Environmental Education Center
- Constructed 1997
  - Net acidic
  - Elevated Al, Fe, Mn, Pb, Zn
  - Maximum expected life of 14 years
- Vertical flow pond (VFP)
  - 272 metric tons mushroom compost
    - 40-60% Organic Matter
  - 345 metric tons of limestone



Water Quality Through VFP

Parameter		Inflow	Outflow
pH		4.13	6.75
Al	(mg/L)	13.6	1.7
Fe	(mg/L)	33.1	12.7
Mg	(mg/L)	13.7	13.5
SO_4^{-2}	(mg/L)	720.8	729.1
Flow	(L/min)	75.5	74.5

Water quality averaged over fifteen year period

Vertical Flow Pond Media

- Stirred 2004, 2007, 2011
  - Agitation of the spent media in order to increase the permeability (pictured below)
- Removed in Summer 2012
  - Due to decreased permeability

Problem Statement & Methods

Problem Statement

- Determine if spent media qualifies as hazardous waste
  - Resource Conservation and Recovery Act (RCRA)
- Find approximate metals concentrations in media
  - Via ICP-OES and XRF
- Determine the approximate organic matter
  - Via Loss on Ignition

Methods

- Toxicity Characteristic Leaching Procedure (TCLP)
  - RCRA hazardous waste determination
- Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)
  - Determine total metals concentrations (g/kg)
- X-Ray Fluorescence Spectrometry (XRF)
  - Determine total metals concentrations (g/kg)

Methods Continued

- Loss on Ignition (LOI)
  - Estimate organic matter
- Calculate decomposition and metal accumulation rates for spent media
- Triplicates completed for all analytical methods from six different media samples

Data

TCLP Results

Metal	Sample Mean	Sample Standard Deviation
Al	3.261	1.276
As	BDL	BDL
Cd	0.006	0.0006
Co	2.773	0.2140
Cr	0.002	0.0013
Cu	0.014	0.0029
Fe	0.272	0.0452
K	4.867	1.0264
Mg	37.210	1.1916
Mn	9.497	0.3778
Na	6.116	1.9056
Ni	3.744	0.3888
Pb	0.029	0.0031
Zn	7.113	1.0767

TCLP Results vs RCRA Criteria

Metal	Concentration (mg/L)	RCRA Standards (mg/L)
Arsenic	BDL	5.0
Cadmium	0.006 ± 0.0007	1.0
Chromium	0.002 ± 0.0012	5.0
Lead	0.029 ± 0.0031	5.0

Total Metals Results

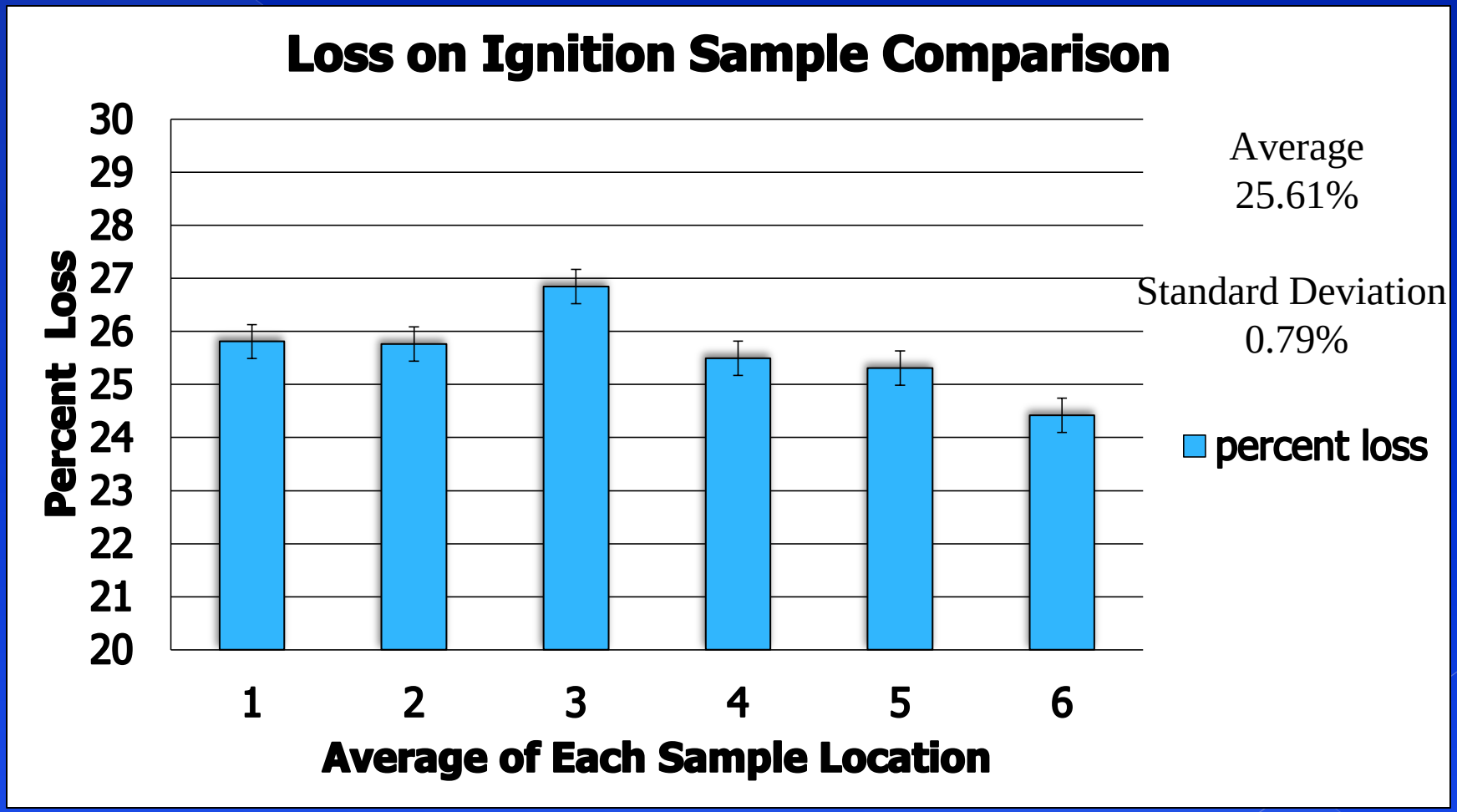
ICP-OES Vs. XRF Analysis (g/kg)

	Al	As	Ca	Cd	Co	Cr	Cu
ICP-OES	37.001	BDL	40.689	0.01	0.279	0.025	0.067
XRF	N/A	0.02	50.67	<LOD	0.45	0.21	0.09
Difference			24.52%		61.29%	740%	34.33%

ICP-OES Vs. XRF Analysis (g/kg)

	Fe	Mg	Mn	Na	Ni	Pb	Zn
ICP-OES	72.073	1.684	0.647	0.212	0.646	0.043	1.199
XRF	84.14	N/A	0.88	N/A	0.69	0.018	1.49
Difference	16.74%		36.01%		6.81%	58%	24.27%

Loss on Ignition




Conclusions

Conclusions

- Spent media not classified as RCRA hazardous waste
- XRF analysis significantly faster and simpler than ICP-OES
  - XRF lacked accuracy and repeatability for trace metals
- Loss on ignition suggests about half of the organic matter has decomposed

Future Work

- Leachability of spent media in various wetland environments
- Determination of the decomposition rate of media
- Masses of accumulated metals in spent media
- Potential extraction and reuse of accumulated metals
- Determine whether spent media meets fill regulations

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Questions ?