

Study on Risk Management for Reuse of Biosolids

バイオソリッドの再利用におけるリスクマネジメント

Masaaki Ozaki, Public Works Research Institute, Japan

土木研究所 尾崎正明

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Public Works Research Institute

Back ground

PRTR(Pollutant Release and Transfer Register) Law was enforced in 2001. Manager of wastewater treatment plant (WWT) has also to report the behavior about chemical materials.

Object

Heavy metals are known to be concentrated into sludge.

The object of this study is to

- clarify behavior of heavy metals in WWT
- and its transportation to the products,
- estimate its behavior in environment.

Contents

1. Reuse of biosolids in Japan
2. Behavior of heavy metals in WWT process
3. Behavior of heavy metals in environment

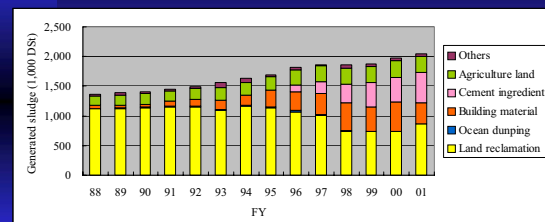
1.1 Reuse of biosolids in Japan

About 2,000,000 DSt of bosolid is generated every year in Japan.

Approximately 60% is beneficially used,

- 15% for agriculture land
- and 45% for building material, especially 25% for cement ingredient.

1.2 Generated sewage sludge



1.3 Standards for agriculture land

item	maximum amount included	
	(%)	(mg/kg)
As	0.005	50
Cd	0.0005	5
T-Hg	0.0002	2
Ni	0.03	300
Cr	0.05	500
Pb	0.01	100

1.4 Standards for building materials

item	maximum amount eluted by leaching test (data < mg/L)
Cd	0.01
Pb	0.01
Cr(+6)	0.05
As	0.01
T-Hg	0.0005
Se	0.01
B	1
F	0.8

1.5 Effective reuse

- Develop the methods for beneficial usage
- Supply stabilized products
- Research the market of products
- Quality control to meet the standards

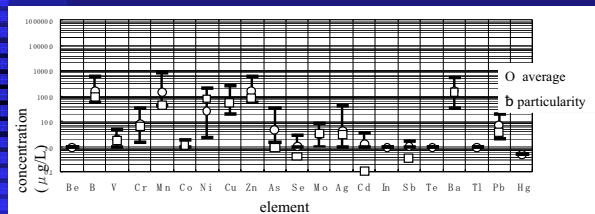
2.1 Behavior of heavy metals

- First specified by PRTR
Zn, Cd, Cr, Cr(+6), Hg, Se, Cu, Pb, As, B, Mn 10 kinds of heavy metals
- Second specified by PRTR
Sb, Ag, V, Co, Ni, Ba, Be, Mo, In, Tl, Te, Sn 12 kinds of heavy metals

2.2 Analytical method of heavy metals

- Sewage sludge (0.2g) could be decomposed with HNO_3/HF (5ml/1ml) microwave for the analysis by ICP-MS.
- In the analysis of solid standard sample, 80-120% recovery rate was obtained.
- For liquid samples (50ml), only HNO_3 (5ml) was sufficient.

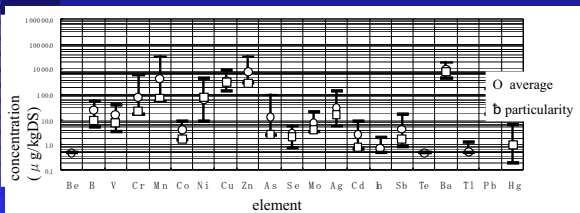
2.3 Concentration in wastewater



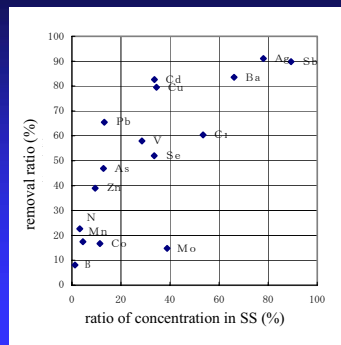
average: Average of 22 WWTs

particularity: WWT particularly investigated in detail.

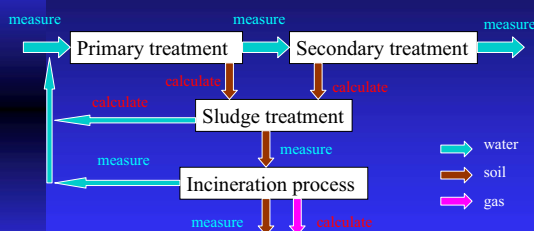
2.4 Concentration in de-watered sludge



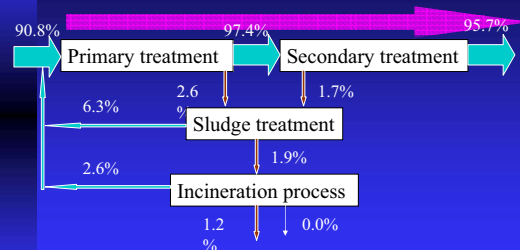
2.5 Effect of SS to removal ratio



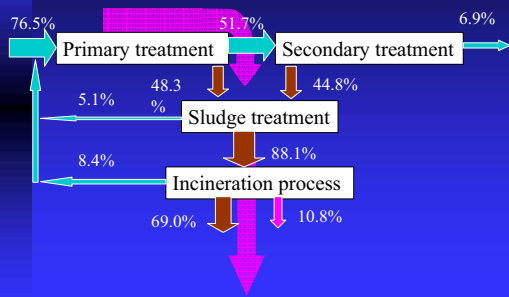
2.6 Balance of heavy metal



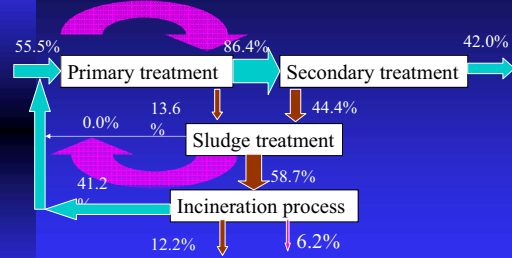
2.7 Balance of heavy metal "B"



2.8 Balance of heavy metal "Pb"



2.9 Balance of heavy metal "Se"



2.10 Behavior of heavy metals in WWT process

- Heavy metals concentrated into de-watered sludge more than 60%.
V, Cr, Cu, Zn, Ag, Cd, Sb, Ba, Pb
- Heavy metals concentrated into incinerated ash more than 60%.
V, Cu, Ag, Cd, Sb, Ba, Pb

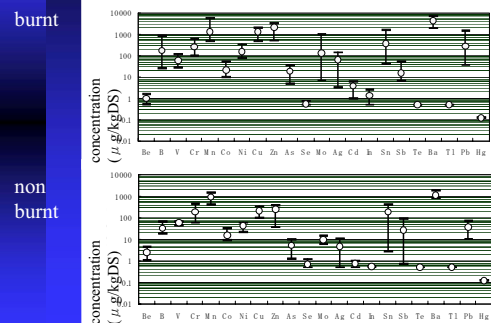
3.1 Reuse of biosolids in environment

- Agriculture land
Dried sludge: non fermentation
Composted sludge: fermentation
- Building material
Block: non burnt
Brick: burnt by high temperature

3.2 leaching test method

method	Japanese Environmental Standard	Evaluation of re-products
size	< 2mm	20mm - 50mm
elution agent	de-ionized water, pH 5.8 - 6.3	de-ionized water saturated with CO ₂ , pH = 4.0
pH- value	no control	no control
elution time	6 hours	24 hours
filter	0.45 μm MF	0.45 μm MF
liquid : solid	10 : 1	10 : 1
movement	turntable (200rpm)	stirrer (200rpm)

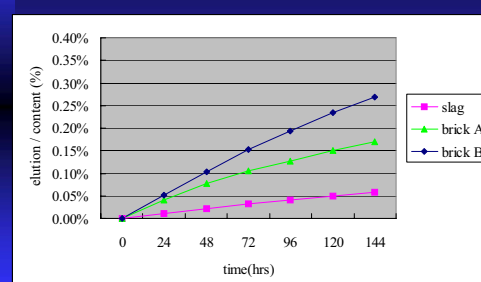
3.3 Contents of heavy metal



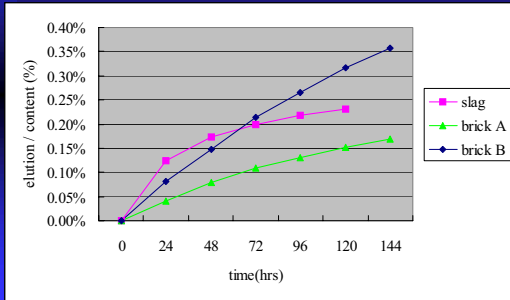
3.4 Behavior of heavy metal in environment

Estimate the behavior of heavy metals in environment.
Sequential leaching test was applied to building materials.
"Evaluation of re-products" method was applied 6 times to same sample.

3.5 Behavior of heavy metal "Mn"

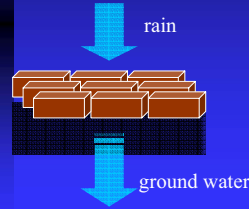


3.6 Behavior of heavy metal "As"



3.7 Risk assessment

1. Estimate the water quality, using a leaching test "Evaluation re-products" method.
2. And calculate "Rate of hazard", in the case of a man (50kg) drink the water (2L/day).



"Draft"
 Rate of hazard
 = amount of exposure / TDI

3.8 Rate of hazard

element	building material (burnt)			building material (non burnt)		
	max	min	average	max	min	average
B	1.7E-02	7.3E-04	7.6E-03	1.2E-02	9.3E-04	4.7E-03
Mn	2.8E-01	2.1E-03	4.9E-02	7.3E-03	4.2E-05	1.9E-03
Ni	6.6E-05	4.5E-06	3.0E-05	1.2E-05	2.9E-06	6.3E-06
As	6.9E-02	1.1E-03	3.4E-02	2.0E-01	1.0E-03	6.2E-02
Se	3.1E-02	5.0E-04	1.2E-02	1.2E-03	5.0E-04	6.8E-04
Ag	1.5E-09	2.0E-10	3.9E-10	2.0E-10	2.0E-10	2.0E-10
Cd	1.3E-02	2.0E-03	5.8E-03	2.0E-03	2.0E-03	2.0E-03
Sn	8.0E-04	8.0E-04	8.0E-04	1.8E-03	8.0E-04	1.1E-03
Sb	1.4E-02	3.3E-04	3.0E-03	9.9E-04	3.3E-04	5.6E-04
Pb	5.2E-02	5.7E-04	6.8E-03	3.8E-03	5.7E-04	1.4E-03

3.9 Standards for re-products

- Standards for re-products are investigated by Japanese government.
- Aggregate for road construction
- Aggregate of concrete
- Evaluation of safety is considered as one of the most important items for quality control.

3.10 Risk assessment of re-products

- Durability of re-products
- Seeking data of long-term exposure test
- Size of samples for leaching test
- Original size will be also available.
- Risk assessment method should be considered under the real condition.

Reuse of Biosolids

About heavy metal, the behavior of heavy metals in WWT and its transportation to the products was observed in this research. And its behavior in environment was estimated by using a leaching test.