Accelerated Mineralization Technology of MSW Incineration Residue for Landfill Site Renewal

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Background

In Japan, 78% of the total amount of municipal solid waste (MSW) discharged was incinerated in 1998. The main content of landfill sites is MSW incineration residue (MSWIR), and there is not enough space to landfill the huge amounts required. In addition, uncertainties about the environmental safety of sites after closure prevent the space from being used efficiently. Therefore, an urgent issue is to secure landfill sites of sufficient capacity. This study investigates methods of securing landfill space by renewing the sites. For this purpose, an accelerated mineralization technology (AMT), which is an accelerated "soilification" technology (AST), could be applied to MSWIR.
This paper proposes a new system for using MSWIR and renewing landfill space using AMT and considers the viability from technological and regulatory aspects in Japan.

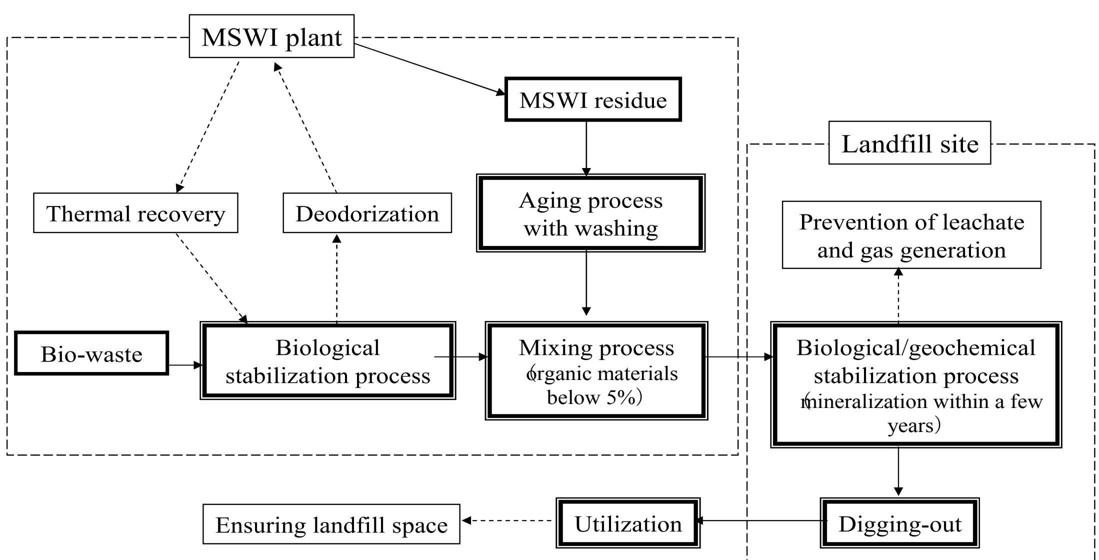

Figure 1 Outline of System Using Accelerated Mineralization Technology

Outline of AMT

Figure 1 outlines the proposed system. The residue generated at the MSWI plant after processing by an aging treatment with a washing process is mixed with organic materials, which originate from the bio-waste in MSWs and have been biologically stabilized by a composting type of method. The proportion of organic materials mixed is expected to be less than 5%. In the biological stabilization process of the organic materials, heat generated through thermal recovery at the MSWI plant could be efficiently used and the emitted odorants could be deodorized by thermal decomposition in a furnace of the MSWI plant. The mixture is landfilled and kept aging with biological and geochemical stabilization, which involves various mineralogical reactions such as carbonation, humification, clay formation and so on. These reactions could prevent the leaching of heavy metals and persistent organic pollutants, and among them humification might contribute to stabilization mainly. The mixture filled at the landfill site is expected to become fully stable within a few years, and could then be dug out and used as ordinary soil for various purposes. Thus, this system prolongs the life-span of the landfill site.

Technological and regulatory considerations

The effects of biological stabilization for organic wastes has already been clarified through a research project associated with mechanical biological treatment in Germany. However, there are not enough data on the immobilization of harmful substances in MSWIR which is mixed with the stabilized organic wastes. The elemental composition of Japanese bottom ash in MSWIR is shown In Table 1. Humic matter formed through humification has the potential to immobilize heavy metals and organic pollutants, but conversely could also increase the leachability of these harmful substances in the colloidal state under alkali conditions.

Table 1 Elemental composition of MSWI bottom ash

unit: mg/dry-kg

Items	Number	Mean	σ	σ/Mean	Median	Range
As	248 (19)	3.18	2.99	0.940	2.8	ND-15.9
Cr	207 (3)	321	238	0.741	270	ND-1250
Cr(VI)	111 (88)	142	125	0.880	<0.5	ND-395
Cd	287 (9)	11.9	15.3	1.286	4.9	ND-80
Hg	243 (50)	0.591	1.06	1.794	0.043	ND-4.9
Pb	387 (1)	908	898	0.989	521	<6-4300
Sb	30	84.9	99.7	1.174	46	5-410
Se	105 (60)	0.809	0.849	1.049	<1	ND-3.25
Sn	14	284	292	1.028	142	53-899
Zn	177	3810	2760	0.724	3280	562-16000
Al	105	68600	21600	0.315	68600	26000-121000
Ca	174	123000	43700	0.355	110000	56200-229000
Cu	167	3850	5440	1.413	1850	160-33000
Fe	146	46000	28700	0.624	41800	2590-140000
K	156	1060	4760	4.491	9900	3200-25700
Mg	102	17200	5440	0.316	17900	4100-28300
Mn	126	1080	723	0.669	880	230-3400
Mo	15	5.15	1.6	0.311	5.29	3.27-8.47
Na	158	19100	9380	0.491	16000	6900-48200
Ni	71	141	133	0.943	90.6	31-680
Si	90	165000	59400	0.360	160000	61700-290000
Cl	103	10400	10100	0.971	7400	1800-58000
CN	124 (69)	1.18	0.774	0.656	<1	ND-3.2
F	39	166	126	0.759	140	18-410
P	133 (95)	5700	3850	0.675	<0.5	ND-11400
PO4	13	18200	7420	0.408	15500	9900-34000
SO4	55	13000	7300	0.562	11000	1020-31500
total-S	38	3220	2930	0.910	2890	0.05-12000

The time scale required to complete soil formation with humification should be investigated. The endpoint to be reached by humification depends on the intended application of the processed materials.

AMT applied to MSWIR is expected to be a simple, low-cost and low-environmental-load technology in terms of life-cycle. However, regulatory issues must be taken into consideration. There are several regulation standards for the recycling and utilization of MSWIR in Japan. In order to use MSWIR on or under the surface of the ground in place of soil, especially, the mineralized residue must meet the soil environmental standard which sets target values in a newly legislated law for the control of contaminated soil. Further investigation of environmental safety is needed.