

**Supporting Information Of Environmental assessment of recycling (EAoR) for safe recycling of steelmaking slag in the Republic of Korea: Applications, leaching test, toxicity**

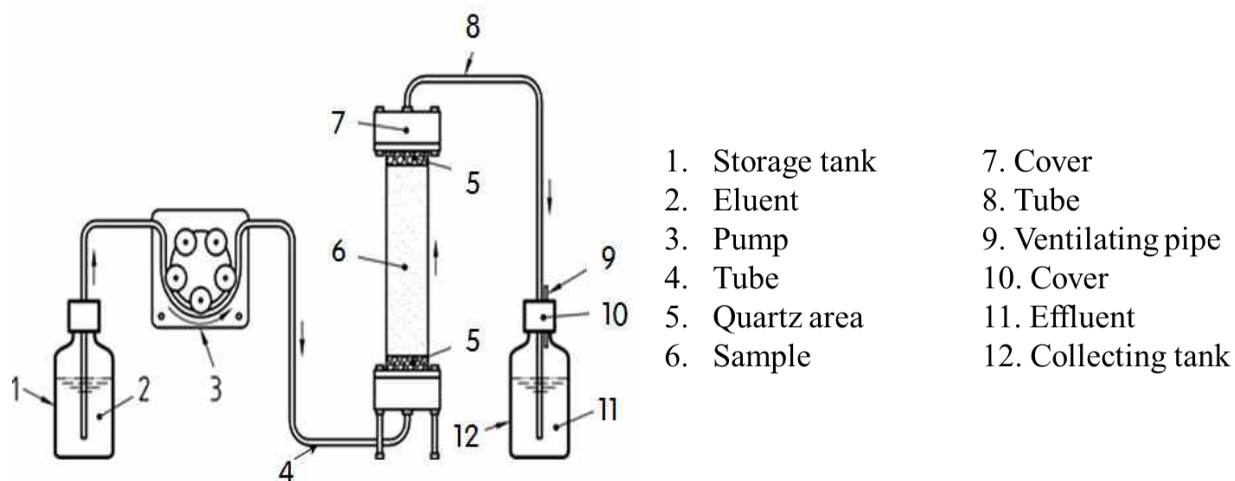


Figure S1. Schematic of percolation test

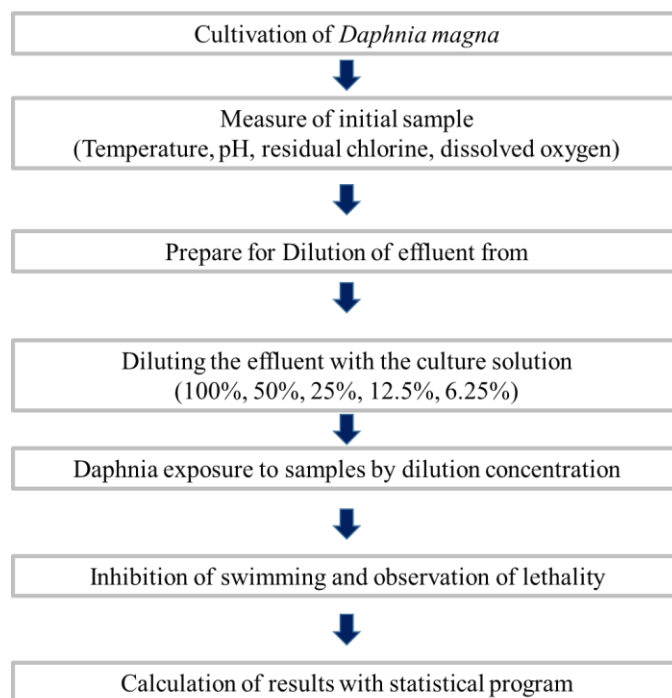
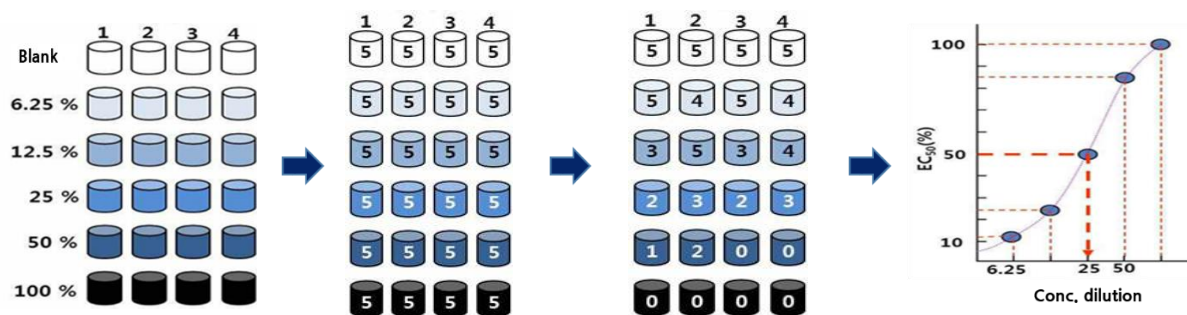


Figure S2. Procedure of toxicity test



1. Sample preparation by dilution concentration

2. Add daphnia into each beaker

3. Count Anti-swimming daphnia

4. Calculation of average impact ratio

Figure S3. Schematic of estimation toxicity using with *Daphnia magna*

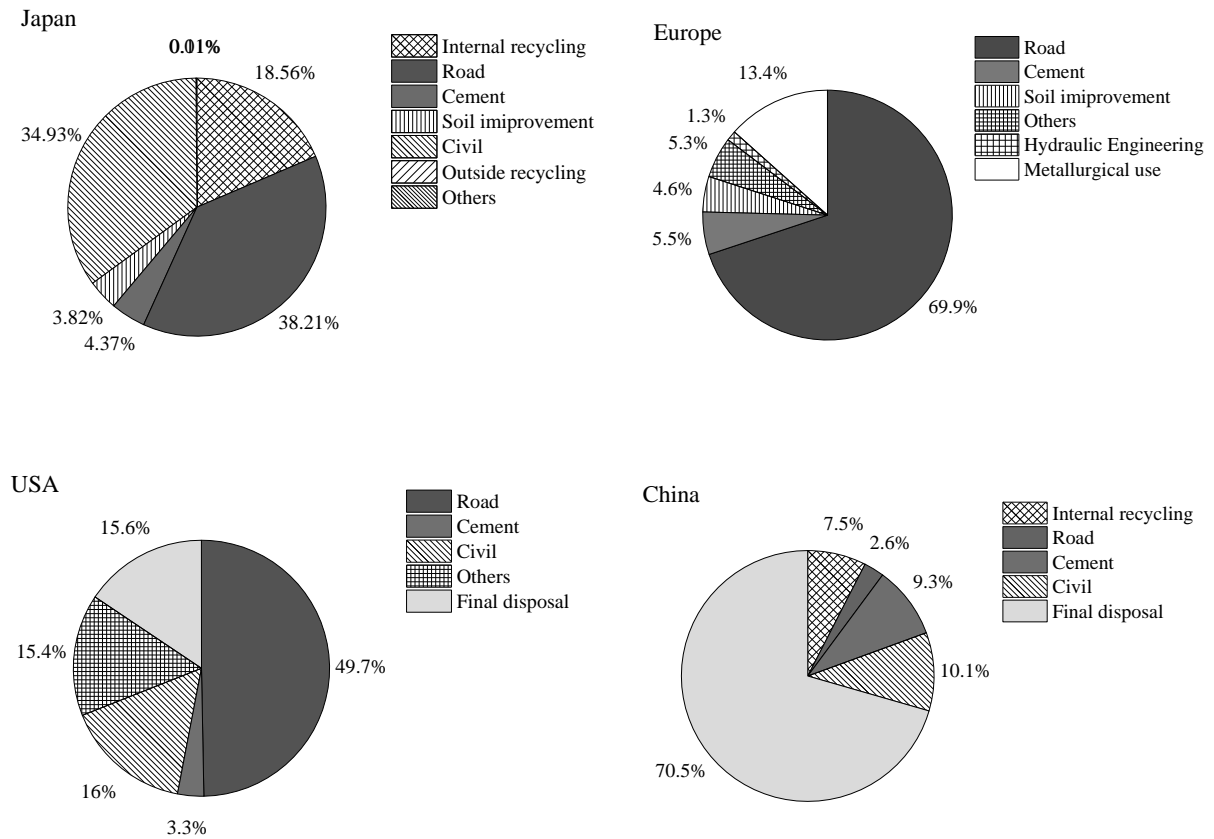


Figure S4. Steel slag utilization in Japan, Europe, the United States, and China

Table S1. Standard guidelines for recycling of slag in different countries

Country	Standard	Range	Method	pH	Standard of leaching test	Other standards
Republic of Korea	- Hazardous waste - Standard relating to soil environmental pollution	Can be used within the standard for hazardous waste	Leaching test (mg/L)	-	Hg 0.005 Cd 0.3 Pb 3 Cr <sup>6+</sup> 1.5 As 1.5 Cu 3 CN 1	Standards for soil environmental pollution ("1"/"2" area mg/kg) Cu 50/200 Cd 1.5/12 Pb 100/400 As 6/20 Hg 4/16 Cr <sup>6+</sup> 4/12 Ni 40/160 Zn 300/800 CN 2/120 Organophosphorus compound 10/30 Phenol 4/20 TCE 8/40 PCE 4/24 PCB - /12 BTEX -/80 TPH 500/2000
Japan	- Objective standard related to slag - Objective standard related to molten solidification of general waste	Recycling is possible if the environmental standards related to soil pollution are satisfied	Leaching test (mg/L)	-	T-Hg 0.0005 Cd 0.01 Pb 0.01 Cr <sup>6+</sup> 0.05 As 0.01 Se 0.01	Guidelines for promotion of the use of melted slag in Chiba Prefecture Same as the dissolution test criteria, and even if the slag criteria are not satisfied, it can be recycled if the recycled product criteria are satisfied
Germany	- DIN 38414 - Standard for recycling construction materials such as mineral by-products	Standard for waste raw materials of recycling products	Leaching test (mg/L)	5~12	Cr 0.02 Ni 0.02	
Netherlands	- Availability Test, Columntest, and Serial Batch Extraction in NVN 2508 - Monolith Tank Leaching in NVN 5432	Controlled by the amount of mixing per 100 years in the soil and surface water around construction materials	Tank leaching test (mg/m <sup>3</sup> )	5<pH<7.5	Hg 4.5 Cd 12 Pb 1275 Cr 1500 As 435 Se 15 Cu 540 Zn 2100 Ni 525	

					Ba 6300 Sn 300 Sb 39 Co 300 Mo 150 V 2400 Cl 30000 SO <sub>4</sub> 45000 Br 300 F 14000 CN(free) 15	
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Table S2. Comparison of leaching methods in different countries

Country	Method name	Particle size	Solvent	pH	Volume of sample (g)	Sample/ Solvent (g/mL)	Stir type	Time (hrs)	Filter (μm)
Republic of Korea	Waste process test	0.5~5	Distilled water	5.8~6.3	100	10	Shake	6	1
	Soil pollution process test	2	0.1N/1N HCl	-	10	5	Shake	1/0.5	4
		0.15	Aqua regia	-	3	33	Shake	2 hrs at room temp. and elevate temp, respectively	8
Japan	MOE Japan article 13 (leaching of waste)	0.5~5	Distilled water+ HCl	5.8~6.3	>50	10	Shake	6	1
	MOE Japan article 19 (Standard of soil environment)	<2	Distilled water+ HCl	5.8~6.3	>50	10	Shake	6	0.45
Germany	DIN38413S4	<10	Deionized water	-	100	10	Up and down motion of shaker	6/24	0.45
Netherlands	Serial Batch	<3	Deionized water	4	40	20	Shake	24 × 5 step	0.45
	Column test	<3	Deionized water	4	-	0.1~10	Upflow	-	0.45
	Availability Test	<125 μm	Deionized water+HNO <sub>3</sub>	7.4 (keep)	16	100	Shake	3 × 2 step	0.45
France	AFNOR x 31-210	<4	Deionized water	-	150	10	Shake 60 rpm	16	0.45
Switzerland	TVA (Technische Verordnung Abfaelle)	-	saturated CO <sub>2</sub> solution	5.6	100~200	10	CO <sub>2</sub> 100 mL/min	24	0.45

USA	TCLP	<9.5	Acetic acid or acetic acid buffer solution	2.88/4.93	100	20	Shake 30±2 rpm	18	0.6~0.8
Canada	TCLP	<9.5	Acetic acid or acetic acid buffer solution	2.88/4.93	100	20	Shake 30±2 rpm	18	0.6~0.8