International Hybrid Session

Short Oral Presentation

FA: 3R/ Waste management

FA-1

Incineration of Municipal Solid Waste (MSW): Accounting on CO_2 emissions contribution

Jang Yuna, Amin Kalantarifard, Jang Jihoon, Byeon Eunsong, Jo Gwanggon, Yang Gosu

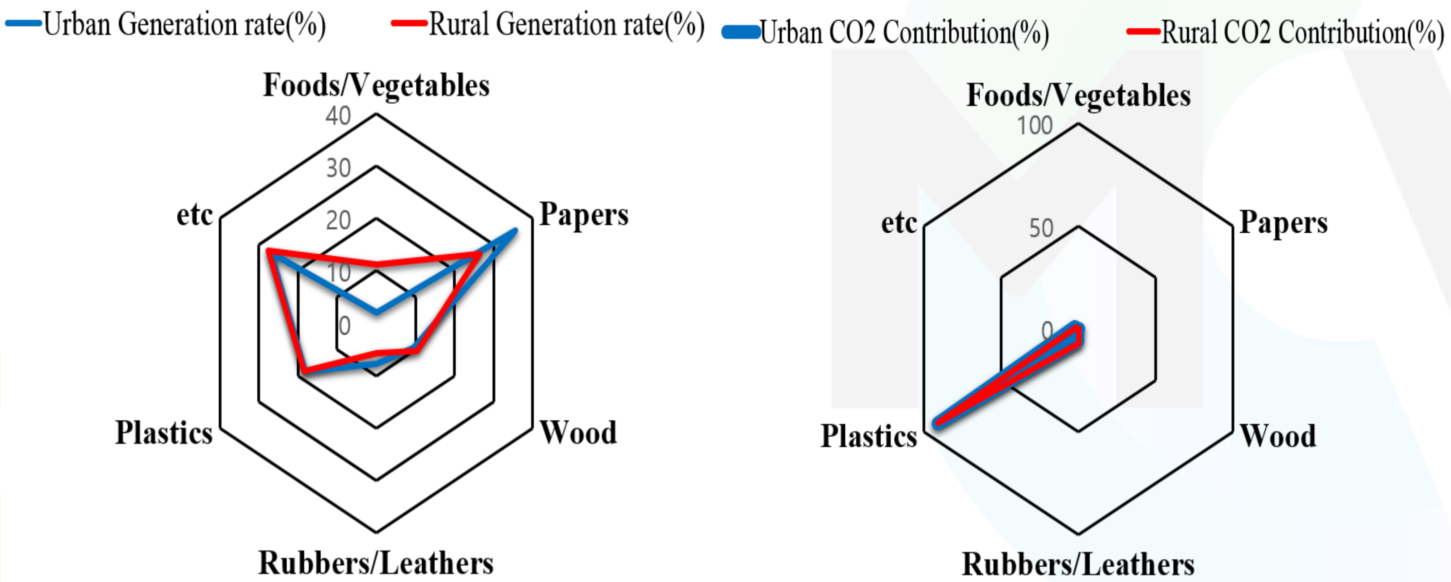
INTRODUCTION

Population growth, industries development, change lifestyle, caused increase the generation municipal solid waste. CO_2 emission from municipal solid waste is one of the main cause of global warming in developing countries. In this study, CO_2 emissions from the incineration of municipal waste in Jeollabuk-do regions calculated based on each type of solid waste. These dates can be used to estimate the total CO_2 emission based on reported equation which help to determine the suitable waste management option.

METHODOLOGY

$$CO_2\ Emissions = MSW \times \sum (WF_j \cdot dm_j \cdot CF_j \cdot FCF_j \cdot OF_j) \times \frac{44}{12}$$

MSW = municipal solid waste, Gg/yr
WF_j = ingredient J of waste type of MSW / proportion of material ($\sum WF_j = 1$)
Dm_j = dry matter content in the waste (wet weight)
CF_j = fraction of carbon in the dry matter (total carbon content), (fraction)
FCF_j = fraction of fossil carbon in the total carbon, (fraction)
OF_j = oxidation factor, (fraction)
44/12 = conversion factor from C to CO_2
j = type of waste incinerated specified as follows: paper /cardboard, textiles, food waste, wood, garden and park waste, disposable diapers, rubber, leather, plastic, metal, glass and other waste



RESULTS AND DISCUSSION

As a result, the contribution of collected municipal solid waste from rural and urban areas in Jeollabuk-do showed that plastic with more than 90% has a highest contribution in CO2 emission. Although the ratio of plastics accounted waste emissions are small, contribution of CO2 emissions has been identified to be very large compared to other waste. in order to reduce CO2 emissions during incineration, removal of plastics before incineration should be considered by sorting and recycling process.

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FA-2

The Effects of Malodorous Substances from Municipal Solid Waste (MSW)

Jo Gwanggon, Amin Kalantarifard, Byeon Eunsong, Jang yuna, Yang Gosu

1. Instruction

In countries that implemented the 'Emissions Trading', the rate of greenhouse-gas emissions as ‘energy’ is much larger than other parts. Among ‘energy’ parts, ‘incineration power station’ is known to a lots of CO_2 emissions because characteristic of fossils fuel. This study aimed to research Municipal Solid Waste (MSW)’s capacity of main incinerator at Jeollabuk-do, calculate to GWP of H_2S as malodorous substances that didn’t calculated by IPCC 5th guideline and finally convert to H_2S-greenhouse effect by using equation of its physical and chemical characteristic functions.

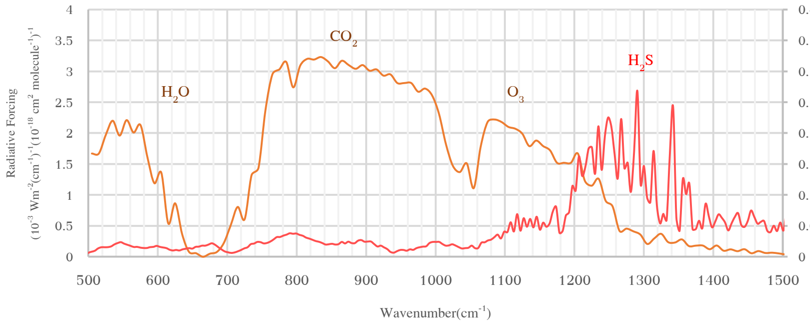
2. Material and Method

To calculate total greenhouse effect of emitted H_2S as CO_2 during MSW treatment, we need total treatment capacity of MSW, H_2S emissions factor and GWP. This function consist with following equations,

$$TGE_{H_2S} = GWP_{H_2S} \times \frac{[TW \times (E_{Ip} + E_{Sf} + E_{St})]}{10^3}$$

- E_{Ip}, $E_{Sf,}$ E_{St} indicate H_2S emission factor emitted from waste input, storage facility, stack(kg/activity-ton)
- TW is MSW’s total capacity (ton/year) to import into incinerator

GWP, calculated by Elrod’s spread sheet on his paper, is parameterized in 10 cm^{-1} intervals for a ppbv and adjusted that 100 sections (500~1500 cm^{-1}) compared divided H_2S’s substance spectrum from experimented FT-IR.



We got a RF data 3.77E-05 Wm^{-2} of H_2S from FT-IR, also realized final H_2S GWP is each 22.8, 5.8 with used basic gas characteristic of H_2S(Time Horizon 20, 100, Lifetime 0.12, adjust temperature, concentration by using Ideal Gas Equation, number density 9.70E+15 n/cm^{-3}).

3. Result and Conclusion

We illustrated import volume of MSW to incineration, H_2S Emission factor (Waste input, Storage facility, Stack), except to ‘landfill’, ‘recycle’ at Jeollabuk-do from government report research on next Table

Area	Incinerated MSW in mixed emitted (ton/year)	H_2S Emissions(kg/year)		
		Waste input	Storage facility	Stack
Jeonju	49530.50	3.46	1.59	64.39
Iksan	32923.00	2.30	1.05	42.80
Jeongup	12191.00	0.85	0.39	15.85
Namwon	36.50	0.00	0.00	0.05
Gimje	7300.00	0.51	0.23	9.49
Wanju	5365.50	0.38	0.17	6.98

Finally we got a result from equation(TGE_{H_2S})

Area	Total Emissions of H_2S (kg/year)	Converted H_2S-CO_2 Emissions from incinerator (ton/year)
Jeonju	69.448	1.583
Iksan	46.156	1.052
Jeongup	17.091	0.390
Namwon	0.051	0.001
Gimje	10.234	0.233
Wanju	7.522	0.172

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FA-3

FA-4

FA-4 Status and Challenges on the Application of Disposer in S. Korea

○Munsol Ju, Jae Young Kim, Seoul National University

	The late 1990s	2005	2013
Landfill		Ban on direct landfill	
Incineration	Strong resistance of local people due to dioxin concern		Ban on ocean dumping of organic wastewater
Material recycling		Less demand of compost or animal feeds Wastewater treatment problem	
Biogas recovery		Difficulty in operation when using only food waste Few successful cases	

Innovative way is necessary!

- Disposer performance
- Plumbing design
- Disposer wastewater treatment
- Link to the organic waste recycling
- Authority's management: Individual level or Building level

We aims to discuss considerations for the application of food waste disposer in S. Korea as one of the alternative way to present food waste management system.

FA-5

The University of Seoul

FA5

A feasibility study on the pre-treatment for the recycling bottom ash of incineration in S city

Hyeong-Wook Kim[1)], Hoon-Sang Lee[1)], Seung-Jin Oh[1)], Minah Oh[1)], Joon-Ha Kim[1)], Jai-Young Lee[1)], Myungho Lee[2)]

1) Dept, Environmental Engineering, University of Seoul

2) Dept Department of civil & Environmental Engineering, University of Induk

Introduction

Due to rapid industrialization and population growth, the amount of municipal solid waste increase.

The landfill reduces the efficiency of land use, such as the lack of landfill.

Promoting measures to increase the ratio of municipal solid waste incineration and recycling.

The amount of incineration bottom ash increases because the amount of incineration increases

√ Reduction of the landfill through recycling of the incineration Bottom ash.

√ Based building data for Bottom ash recycling in "S" city

√ Economical and effective provision of pre-treatment methods for recycling of bottom ash in the cement industry

Material & method

Resource recovery facilities in four(A, B, C, D)

Bottom ash samples collected

Sieving

Three of Pre-treatment (Weathering, CO_2 Aging, Washing)

Analysis of pH, chloride, leaching test were perform

Pre-treatment measures

√ Weathering

	Condition
Weathering place	Where the rainfall can be prevented in a well-ventilated
Weathering period	120 days (Four month)
Analysis of sample	After weathering completed 30, 60, 90, 120 days

√ CO_2 Aging

	Condition
Flow rate of injection	Where the rainfall can be prevented in a well-ventilated
Period of injection	30 days (one month)
Analysis of sample	After weathering completed 1,3, 6, 10, 15, 20, 30 days

√ Washing

	Condition
Stirring rate	200 rpm
Solid-liquid ratio	1 : 5, 1 : 10, 1 : 15
Stirring time	10, 20, 30, 60, 120 minute

FA-6

Measurement of the Potential Heat and Ash content of the Residue from Mechanical Biological Treatment in Thailand

Satoru Ochiai, Tomonori Ishigaki, Komsilp Wangyao, Masato Yamada

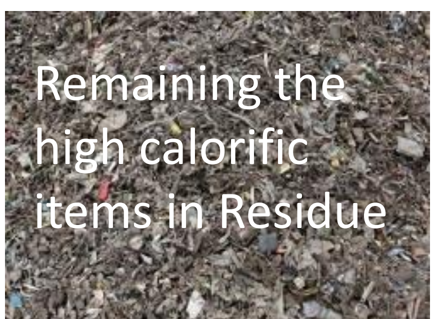
MBT process

House waste → Shredding → Biodrying → Separation

Separation → ∮ > 40mm → **RDF product** → Cement kiln

Separation → ∮ <40mm → **MBT Residue** → Landfill

Further treatment of MBT residue must be necessary to reduce the amount of the waste to be landfilled



MBT process + Additional sieving

<Objective>

✓ To clarify the feature of **potential heat, ash content** and **components** of **MBT Residue**

✓ To estimate the possibility of the reduction of the amount of the waste to be landfilled by additional sieving

House waste → Shredding → Biodrying → Separation

Separation → **RDF product** → **Mixed RDF** → Cement kiln

Separation → ∮ <40mm → **MBT Residue** → **Additional sieving**

Additional sieving →
- **High potential heat** fraction
- **Low ash content** fraction

→ **Mixed RDF** → Cement kiln

Additional sieving → Non-recyclable fraction → Landfill

FA-7

Substance Flow Analysis of Mercury in Fluorescent Lamps in Korea

Jonghyun Choi, Yeonjung Hwang, Yong-Chul Jang*
Chungnam National University

❖ Main Focus

1. With Minamata Convention agreed in 2013, mercury is gaining global concerns owing to its persistence in the environment and its significant negative effects on human health and the environment.

2. In Korea, the collection rate of mercury containing fluor escent lamps is about 25% of the total amount of the lamp manufactured. It is difficult to determine the distribution channels and disposal pathways of used fluorescent lamps in Korea.

3. Therefore, this study focused on the mass flow of mercury in fluorescent lamps in the extended producer responsibility (EPR) system in Korea by using substanc e flow analysis (SFA).

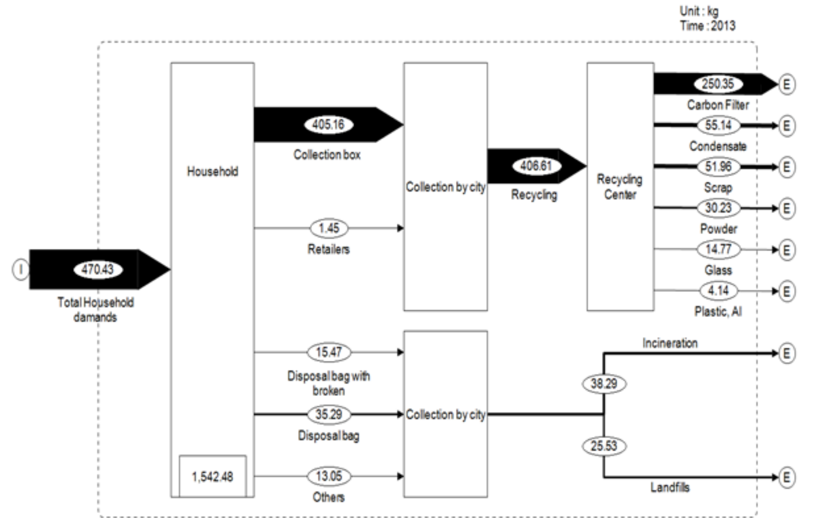
4. The system boundary for this study was defined in hous ehold sector from product manufacturing to waste recyc ling. And time boundary was limited to 1 year in 2013.

Linear shape (LFL)	Round shape (FCL)	U-tube shape (FPL)	Contains inverter (CFL)

<Fig 1. Recycling targets of fluorescent lmaps in Korea EPR system>

❖ Main Results

1. Fig 2. shows mass flow of mercury in fluorescent lamps in Korea based on result of MFA of fluorescent lamps (25mg Hg/tube).



<Fig 2. Substance flow of mercury in fluorescent lamps in Korea>

2. Total household demands of mercury(FL) : 470 kg
   Stock of mercury(FL) in household : 11,542 kg
   Collected mercury(FL) by municipalities : 406 kg
   - Recovered by carbon filter : 250 kg
   - Remaining in condensate : 55 kg
   - Remaining in scrap : 52 kg
   - Remaining in powder : 30 kg

   Incinerated mercury(FL) : 38 kg
   Landfilled mercury(FL) : 26 kg

FA-8

Unwillingness we feel when we complete serial recycle-friendly actions for PET bottle disposal

Q. H. Jiang*,T. Izumi*,S. Suzuki**, F. takahashi*
*Department of Environmental Science and Technology,Tokyo Institute of Technology
**Department of Civil Engineering, Fukuoka University

Background

Encourage way of PET bottles disposal (Yamato city)

Collected PET bottles from municipal waste collection sites

Main reason

Unwillingness

Objective

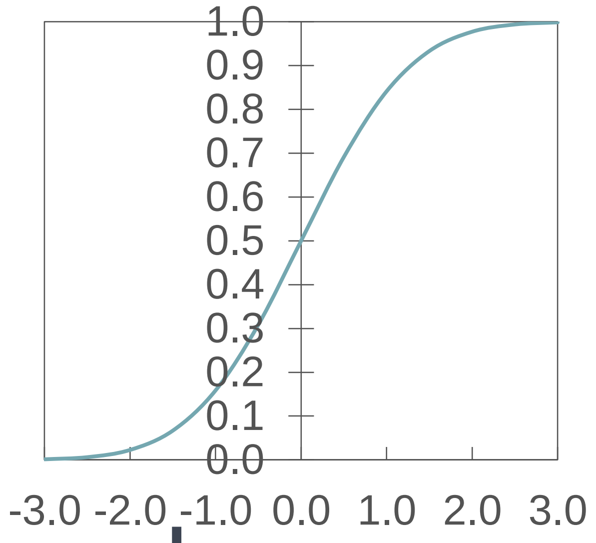
Evaluate how much people feel unwillingness to dispose of PET bottles correctly.

Methodology

1. Quantify the degree of unwillingness

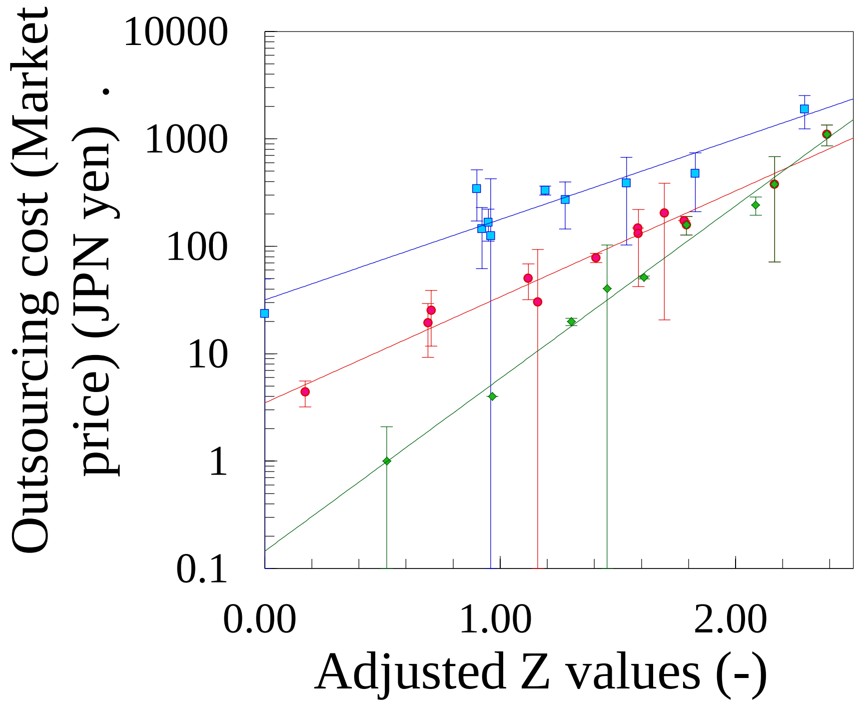
Thurston's pairwise comparison

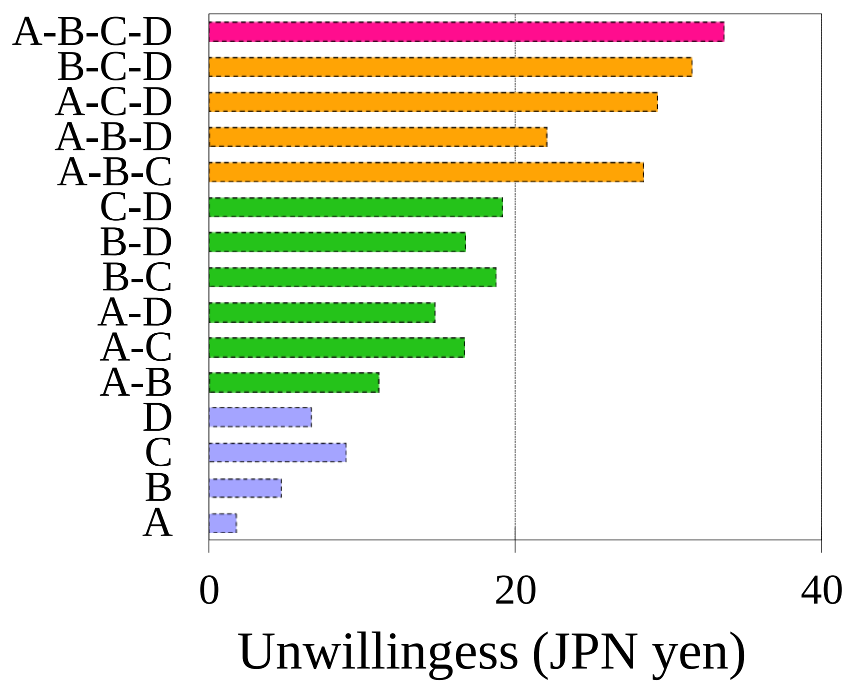
Cumulative Gaussian distribution



2. Monetary transform based on outsourcing costs

Results





FA-9

The Republic Act (RA) 9003 in the Philippines: Factors for Successful Policy Implementation

(D.G.J.Premakumara, Simon Gilby, and Kyungsun Lee)

(1) Background

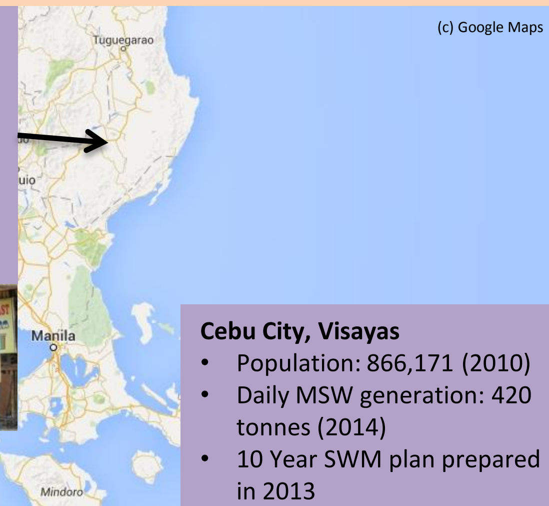
- Municipal Solid Waste Management (MSWM) is one of the serious environmental issues in the Philippines
- The Ecological Solid Waste Management Act of 2000 (the Republic Act - RA 9003) provides a national policy and legal framework to establish ISWM plans in Philippine Local Government Units (LGUs)
- However, its implementation and enforcement at LGUs is challenging with a limited number of success stories

(2) Objectives

- Identifies and discusses key challenges and factors that are required for successful national policy implementation at in LGUs.

(3) Methodology

- Reviews and discusses the current national framework and the experience of three case study cities in the Philippines
- Interviews with key stakeholders



Santiago City, Luzon
- Population: 132,804 (2010)
- Daily MSW generation: 24 tonnes (2014)
- 10 Year SWM plan prepared in 2005 (in revision)

Cebu City, Visayas
- Population: 866,171 (2010)
- Daily MSW generation: 420 tonnes (2014)
- 10 Year SWM plan prepared in 2013

San Carlos City, Visayas
- Population: 133,000 (2010)
- Daily MSW generation: 17 tonnes (2014)
- 10 Year SWM plan prepared in 2010

(4) Lessons Learned

- Establishment of national SWM policies and strategies does not guarantee their automatic implementation in LGUs
- A lack of awareness and management, financial and technical capacities of the LGUs is generally deemed responsible for the low enforcement of national policies.
- There is a need of political support and locally relevant solutions which integrate technical, social/cultural, institutional and legal aspects while building on existing actors and assets.

FA-10

FA10: Weathering mechanisms of municipal solid waste incineration air pollution control residues: A state of the art review

Angelica Naka, Hirofumi Sakanakura
National Institute for Environmental Studies

Hydrolysis:

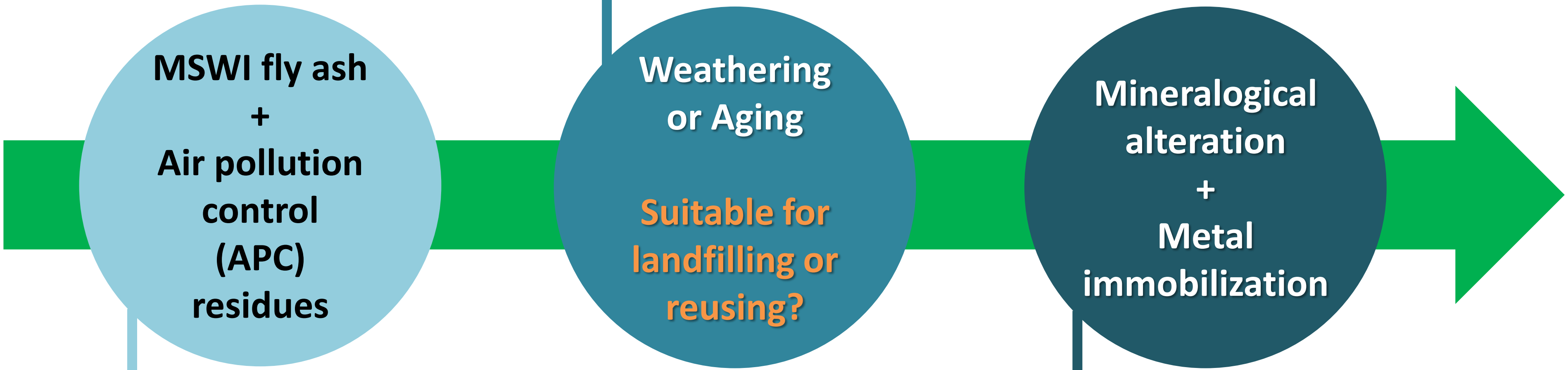
$CaO + H_2O \rightarrow Ca(OH)_2$

Secondary minerals formation (ettringite):

$6Ca^{2+} + 2Al^{3+} + 3SO_4^{2-} + 38H_2O \rightarrow 12H^+ + Ca_6Al_2(SO_4)_3(OH)_{12} \cdot 26H_2O$

Formation of calcite (carbonation):

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$



Hazardous waste:
High level of **soluble salts** (e.g. chlorides), **heavy metals** (e.g. Pb, Cd) and **persistent organic pollutants** (e.g. PHAs)

Decreasing in **pH** (e.g. due to carbonation) lead to **new mineral formation**; heavy metals can be immobilized in these minerals

FA-11

Capacity Development for Flood Waste Management in Vulnerable Asian Cities

Ishigaki T., Tajima R., Kawai K., Kubota R., Lieu P.K., Yamada M., Towprayoon, S., Chiemchaisri C.

Flood damage in Tropical Asia

Prolonged inundation (Thailand 2011)

Tsunami (earthquake of Sumatra)

Typhoon (2013)

Waste generated during Flood

Wooden furniture/ home appliance damaged by inundation

Flowout households

Disposal of daily waste by delaying of collection work

Guideline for appropriate management of flood waste for BMA

- Prediction of waste amount from flood damage
- Prevention of transfer station/ landfill damage
- Command system, Budget preparation
- Temporary storage site
- Collaboration with industries/ municipalities
- Dissemination

Capacity development workshop in Hue

Group discussion by officer/practitioner in local gov.

Resilience evaluation → Raising Preparedness Action/ Categorization → Prioriti-zation

Resources
- -Finance
- -Vehicle
- -Treatment
- -Traffic infrastructure
- -Urban discharge

industry, association, local forces

Planning
- - Flood risk zoning
- -Respond plan
- -Training
- -FW database
- - Warning system

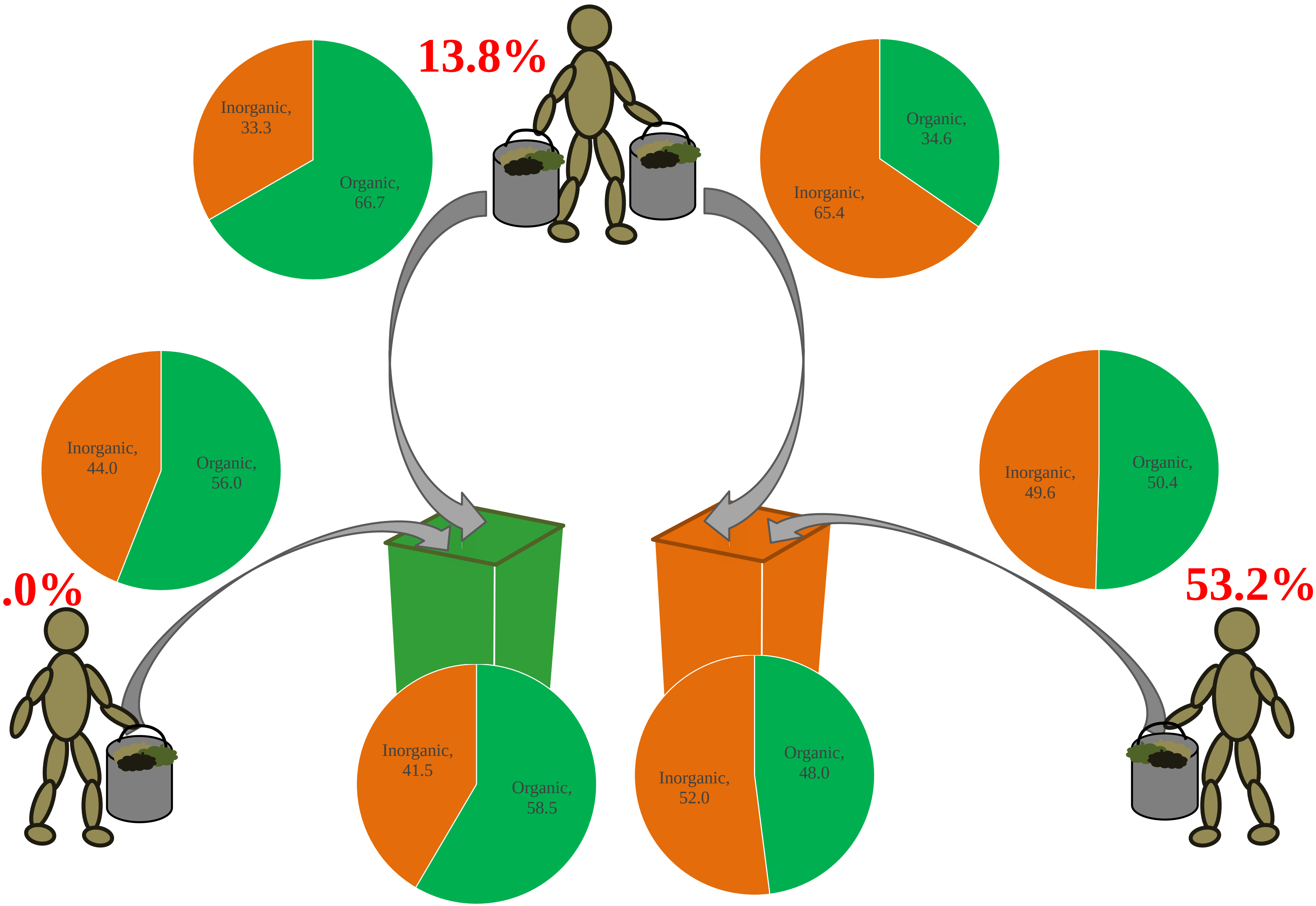
Dissemination
- - Cooperation to FWM
- -damage prevention

FA-12

FA-12 Monitoring source separation of household organic waste in Hanoi, Vietnam

○ Kosuke Kawai[1)], Luong Thi Mai Huong[2)]

[1)] National Institute for Environmental Studies, Japan [2)] Institute for Urban Environment and Industry of Vietnam



FA-13

Solid Waste Management and Public Private Partnership(PPP) in Palestine

Ziad Tawafsheh[1],正) Mitsuo Yoshida[2]

Ministry of local government[1]

Japan International Cooperation Agency[2]

The objective of this study is?

To conduct a survey of existing (PPP) practices and models at Palestinian local level (Joint service councils) in order to provide a descriptive background and real information to be used for further development of the PPP concept and framework.

Methodology

(MoLG) and (JICA), had conducted a survey for all 12 JSCs for SWM in West Bank area, Palestine; Hebron, Bethlehem, NW+N Jerusalem, NE+SE Jerusalem, Jericho, Ramallah-Albireh, Nablus, Salfeet, Qalquiliya, Tubas, Tulkarem and Jenin JSCs

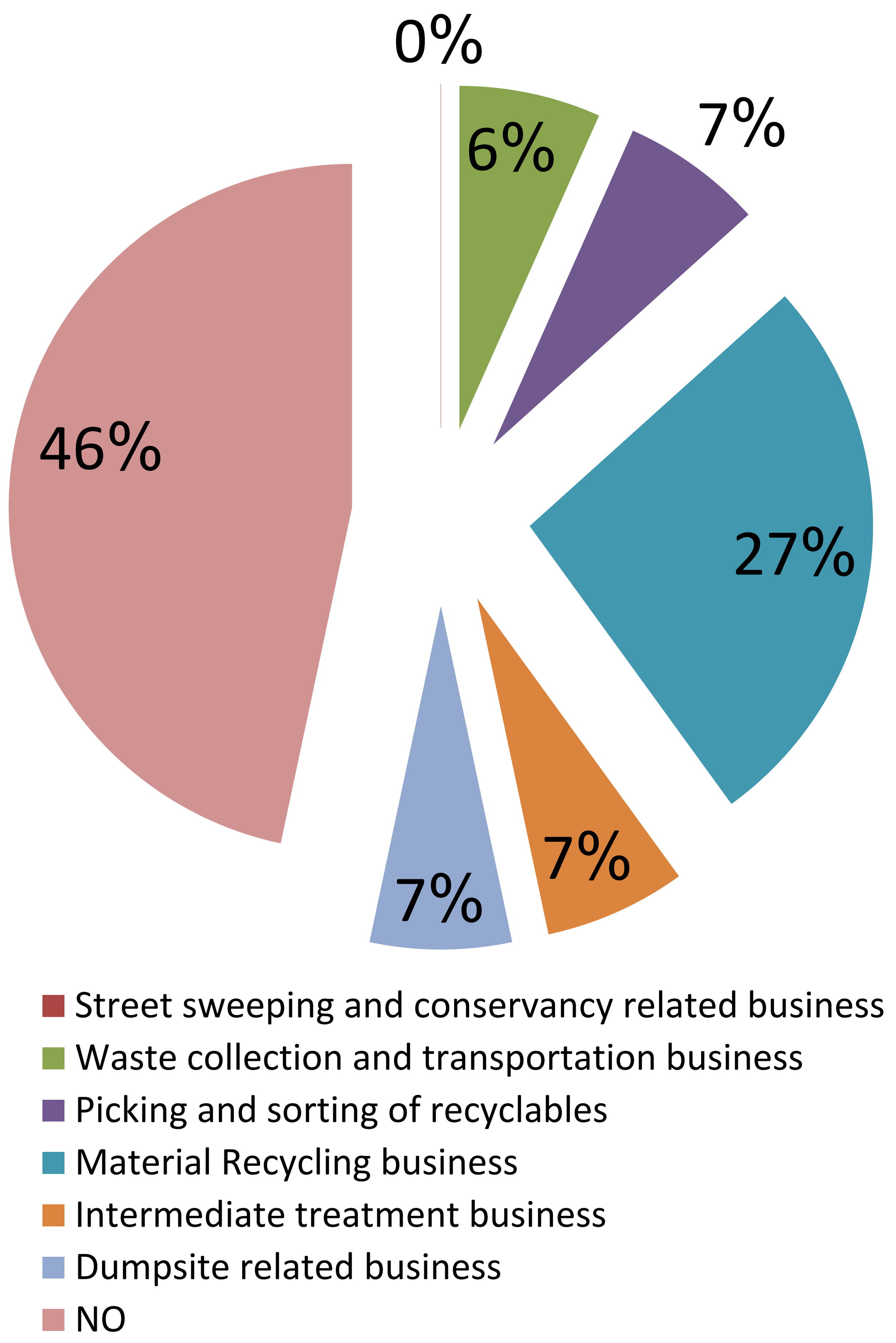
Result

1- 75% of the councils believe that the existing laws (Investment Law, Tax Law) in Palestine are discouraging any kind of investment in public service

2- 80% of local government units (LGUs) in Palestine are lacking the necessary financial capacities and resources to promote partnerships with the private sector

3- 46% of the JSCs did not have any kind of partnership agreements with the private sector

(PPP) activities in solid waste management in joint service councils



Recommendation

1- The laws should be revised or developed new laws under the consideration of PPP promotion strategy.

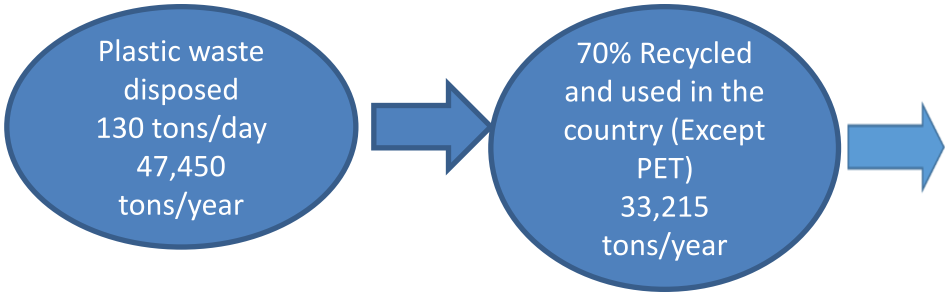
2- Improvement of financial state of LGUs and/or JSCs is key issue to promote PPP.

3-International Presses on Israel to immediately transfer to the Palestinian Authority all the value added tax and customs duties that it has collected on behalf of the Palestinians in order to payments progress to investors.

FA-14

Reduce-Reuse-Recycle: Technology and Policy as a driving force for economic development in waste management system

Business opportunity: Recycling of plastic waste in Bangladesh



- **Generating** 21,000 jobs
- **Saving expenditure** of Tk3.08 crore by avoiding plastic waste
- **Saving Foreign currency** of US $51 million/ year by avoiding import of virgin plastic.

Plastic waste recycling follows direct economic benefit

(a) Less landfilling requirement; (b) Large recycling **industry jobs and economic output; (c)Direct savings** of foreign currency

3R Developments in Asia: Informal Resource recovery and recycling

- Nearly **80 percent** of the river's pollution is the result of raw sewage. The river receives **more than three billion liters of waste per day**.
- **Highly contaminated** leachate seeps untreated into groundwater, a source of drinking water….

Need for change and attitudes to view "Waste" as "Resource"

FB: Recycling

FB-1

Study on N_2O and CO_2 emission characteristic in accordance with the incineration of wood waste

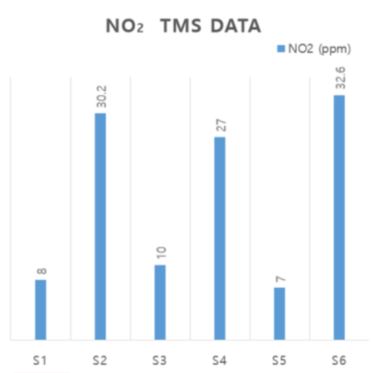
Byeon EunSong, Park BiO, Jo GwangGon, Kalantarifard Amin, Yang GoSu

- This study is focused on emission characteristic of CO_2 and N_2O that converted from NO_x as basic research for estimating the emission factors of the biomass through the analysis of wood waste from domestic power plant.

- The NO_x emission was calculated in two ways to estimate the N_2O.
  - Based on obtained NO_2 concentration using TMS data.
  - Based on the percentage of nitrogen content in the fuel and incineration temperature.

- In order to analyze the degree of oxidation of waste wood, TMS measurements used to analysis the component.
  - CO_2 generation rate and the data from the O_2 value measured by the TMS calculate the CO_2 maximum(CO_2max), which was based on degree of oxidation of CO to CO_2

- Result
  - TMS data showed the N_2O concentration with 221.5 ppm and 239.1 ppm while the theoretical analysis for these samples showed the relatively lower N_2O production with about 34.7 ppm and 51.9 ppm.
  - Oxidation of waste wood is finally determined by using the previously obtained data and calculated values were more 99.9% for all samples.



	NO_x emissions from TMS data		NO_x emissions by theoretical method	
	NO_x	N_2O	NO_x	N_2O
S1	533	58.7	331	36.4
S2	2013	221.5	315	34.7
S3	667	73.3	357	39.3
S4	1800	198.0	347	38.2
S5	467	51.3	472	51.9
S6	2173	239.1	264	29.0

(unit : ppm)

	S1	S2	S3	S4	S5	S6
C content (%)	51.53	52.08.	49.79	52.11	52.08	52.13
CO (ppm)	2.9	10.2	10.1	5.6	8.8	9.3
O_2 (%)	8.9	8.8	8.6	8.3	8.8	8.0
T (◦C)	927	891	890	923	988	830
CO_2 generation	9.59	11.11	10.66	10.37	11.32	10.19
CO_2 Max	15.45	15.15	14.56	13.73	15.15	12.92
Oxidation rate	99.99994	99.99998	99.99998	99.99995	99.99995	99.99992

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FB-2

High CO_2 Adsorption on Improved ZSM-5 Zeolite Porous Structure Modified with Ethylenediamine and Desorption Characteristics with Microwave

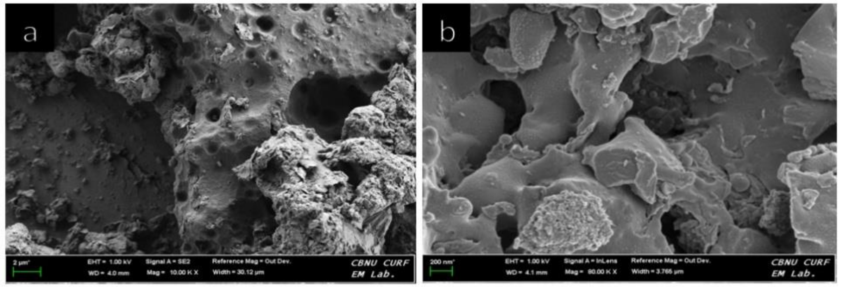
Amin Kalantarifard, Jo Gwanggon, Jang Jihoon, Byeon Eunsong, Jang yuna, Yang Go Su

Introduction:

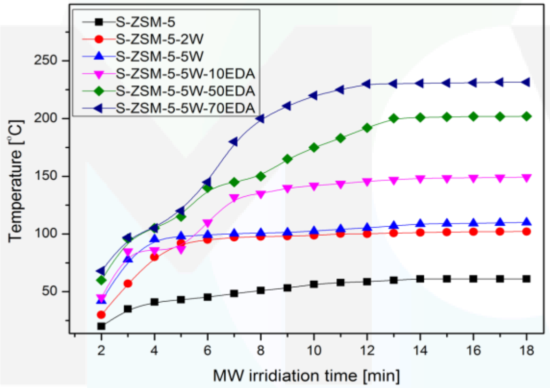
The effect of alkali earth metals, granite, bentonite and starch on the porosity and crystallinity of zeolite has been studied.
The maximum amine adsorption in synthesized zeolite obtained was 450 mg/g of zeolite.

$CO_2 + R_1NH_2 \longleftrightarrow R_1NHCOO^- + H^+$

$CO_2 + 2R_1R_2NH \longleftrightarrow R_1R_2NCOO^- + R_1R_2NH_2^+$

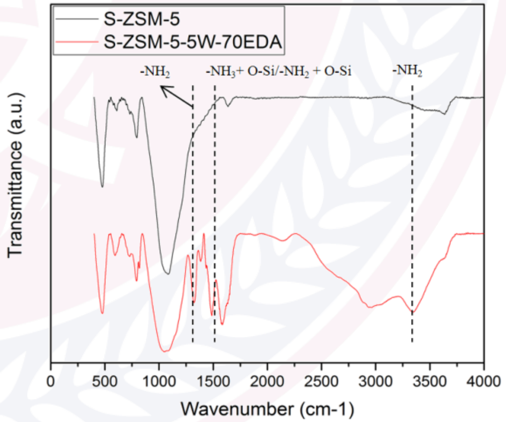


Components	S_{BET} (m^2/g)	Pore volume (cm^3/g)		
		V total	V micro	V meso
S-ZSM-5	705-762	0.662	0.378	0.26

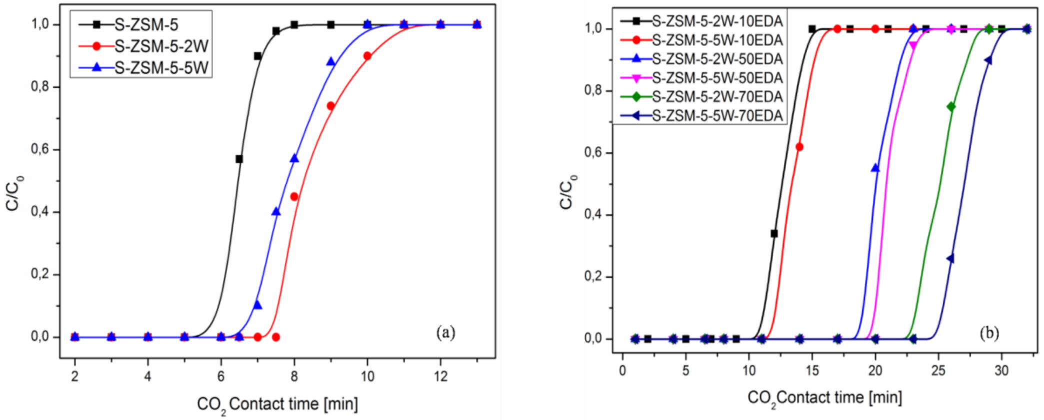


The variations of adsorbent bed temperatures curves

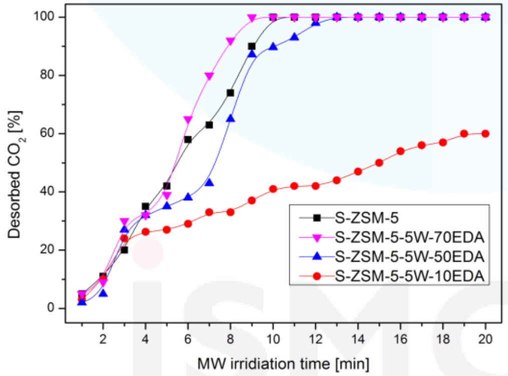
Results:



FT-IR spectra of S-ZSM-5 modified with EDA



The break through curves at 75 ºC and normal pressure



CO_2 desorption efficiency from S-ZSM-5 zeolites

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FB-3

Calcium carbonate production from MSWI fly ash by indirect carbonation

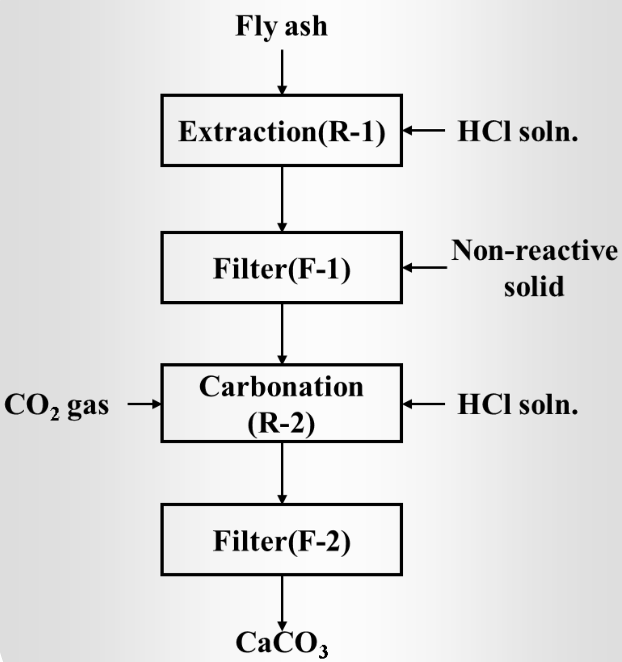
Speaker : Hoyong Jo

延世大學校 YONSEI UNIVERSITY

Introduction

- In Korea, the average output of MSWI fly ash is about 150Kton per year and it is expected to increase.
- Most of MSWI fly ash disposed in a landfill, 2nd environment problem and lack of landfill site can be occur.
- MSWI fly ash contain calcium and therefore it can be use as feedstock of mineral carbonation. vestigated.

Methodology



Results

Table 1. The composition of MSWI fly ach as oxide form(by XRF)

CaO	Cl	Na_2O	K_2O	SO_3	SiO_2	MgO	Al_2O_3	Fe_2O_3	Others
48.10	20.50	9.25	6.34	5.13	3.60	1.62	1.40	1.03	3.04

Table 2. The concentration of extracted solution from fly ash by ICP-OES

S/L	Concentration(ppm)					Dissoution Rate[a)]	Extraction Efficiency[b)]
	Ca	Fe	Al	K	Mg		
30g/L	7415.86	35.52	57.22	6131.14	266.27	0.98	0.74
50g/L	11495.24	57.16	98.27	9803.71	427.41	0.92	1.15
70g/L	12572.43	-	-	10744.49	248.12	0.71	1.26

a) amount of dissolved Ca in sample (g) / amount of Ca in fly ash

b)dissolved Ca in sample(mol) x 2 / HCl (mol)

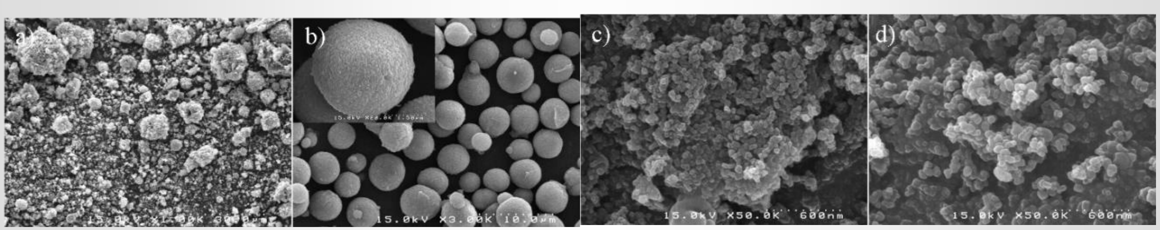


Figure 1. SEM image of fly ash and obtained $CaCO_3$. a)FA, b)30g/L, c)50g/L, c)70g/L

FB-4

YONSEI UNIVERSITY. DEPARTMENT OF CHEMICAL ENGINEERING

Production of calcium carbonate from desulfurization gypsum using MEA absorbent

Speaker : Min-Gu Lee

延世大學校 YONSEI UNIVERSITY

Introduction

CCS (Carbon Capture and Storage) is one of the best technology for carbon dioxide reduction. MEA (Monoethanolamine) is widely used absorbent in chemical absorption. We are trying to convert carbon dioxide into calcium carbonate using MEA absorbent and industrial waste which is desulfurization gypsum. The main objective of this research is to investigate possibility of calcium carbonate salts formation by converting carbon dioxide into ionic state and using metal cation extracted from desulfurization gypsum

Methodology

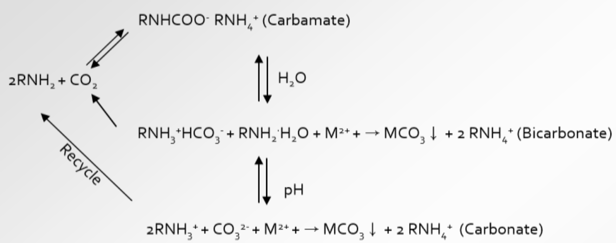


Fig 1. Mechanism of metal carbonate formation

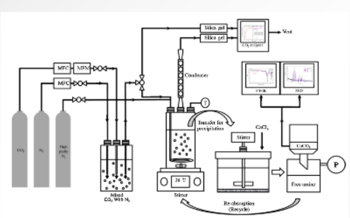


Fig 2. Schematics diagram of experiment apparatus

Result

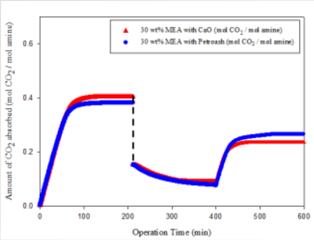


Fig 3. Carbon dioxide loading curve

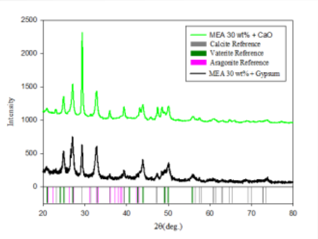


Fig 4. XRD data of generated products

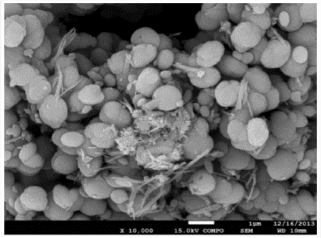


Fig 5. SEM image of produced calcium carbonate salt (CaO)

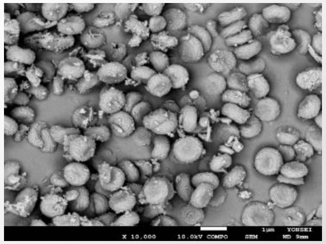


Fig 6. SEM image of produced calcium carbonate salt (Gypsum)

FB-5

Comparing the Performance of WEEE Recycling Systems in East Asia

Aya Yoshida, NIES (Japan), ayoshida@ies.go.jp

- We reviewed WEEE recycling systems in East Asian countries (China, Japan, Korea and Taiwan)
- Four systems are compared from the following aspects
  - Roles of actors: Financial, Physical responsibility
  - Performance
  - Convenience
- Although our study is still on-going, preliminary results are
  - Japanese and Taiwanese system achieve high volume of collection for large appliances, but not for smaller devices. Korean system achieves high collection rate for smaller devices.
  - Common issues (competition with informal recyclers)

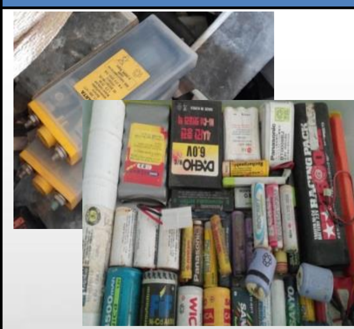
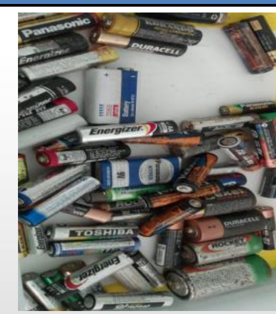
FB-6

Recycling and Current Management Practices of Used Batteries in Korea

Yeonjung Hwang, Yong-Chul Jang*
Chungnam National University

❖ Main Focus

1. In Korea, used batteries (e.g., manganese/alkaline manganese batteries, lithium battery, nickel-cadmium battery, silver oxide cell, nickel metal hydride battery) have been managed by the extended producer responsibility (EPR) policy since 2003(Manganese/Alkaline manganese batteries, Nickel metal hydride battery have been included in the EPR in 2008) to effectively collect and recycle them from consumers and to reduce of their negative effects on the environment.
2. This study presents the recycling and management practices of used batteries, especially focusing on material flow, physical and financial responsibility of used batteries in Korea.
3. The data required for this study was collected from the literature review, statistical data provided by the ministry of environment (MOE), discussion with the experts, survey and field visits to the local government office, MOE, recycling facilities.

Silver Oxide Cell	Lithium battery	Ni-Cd Battery	Carbon-Zinc, Alkaline MnO_2 battery	Ni-MH Battery
				

<Fig. Recycling targets of batteries in Korea EPR system>

❖ Main Results

1. Considering the present management status (physical, financial and end-of-life management) of batteries in Korea, the study proposes the need of stringent policy and awareness program for a better collection system.
2. The study also suggests the need of a better recycling methodology with highly advanced technologies to recover the various heavy metals and precious elements(e.g. Au, Ag and Li).
3. This study would further help decision makers to come up with an innovative policy for an effective management of batteries.

FB-7

Material Flow Analysis(MFA) and Actual Recycling Rate of Construction and Demolition Waste in Korea

Youngjae Ko, Yong-Chul Jang*, Jonghyun Choi

Chungnam National University

CNU CHUNGNAM NATIONAL UNIVERSITY

❖ Main Focus

1. Estimate and analyze of the mass flow of C&D waste by life cycle stages(generation-recycling-disposal).

2. Data collection from surveys of site visit to C&D waste recycling facilities, National statistics published by the Korea Ministry of Environment and available literature.

❖ Result

1. In 2011, approximately 67,000 thousand tons of C&D waste were generated and approximately 65,000 thousand tons came into the C&D recycling facilities.

2. About 88% of C&D waste materials were recycled a s aggregate; about 12% were separated as foreign materials.

3. About 74% of the foreign materials were transported to other recycling facilities, while the remaining fraction (36%) was landfilled and incinerated.

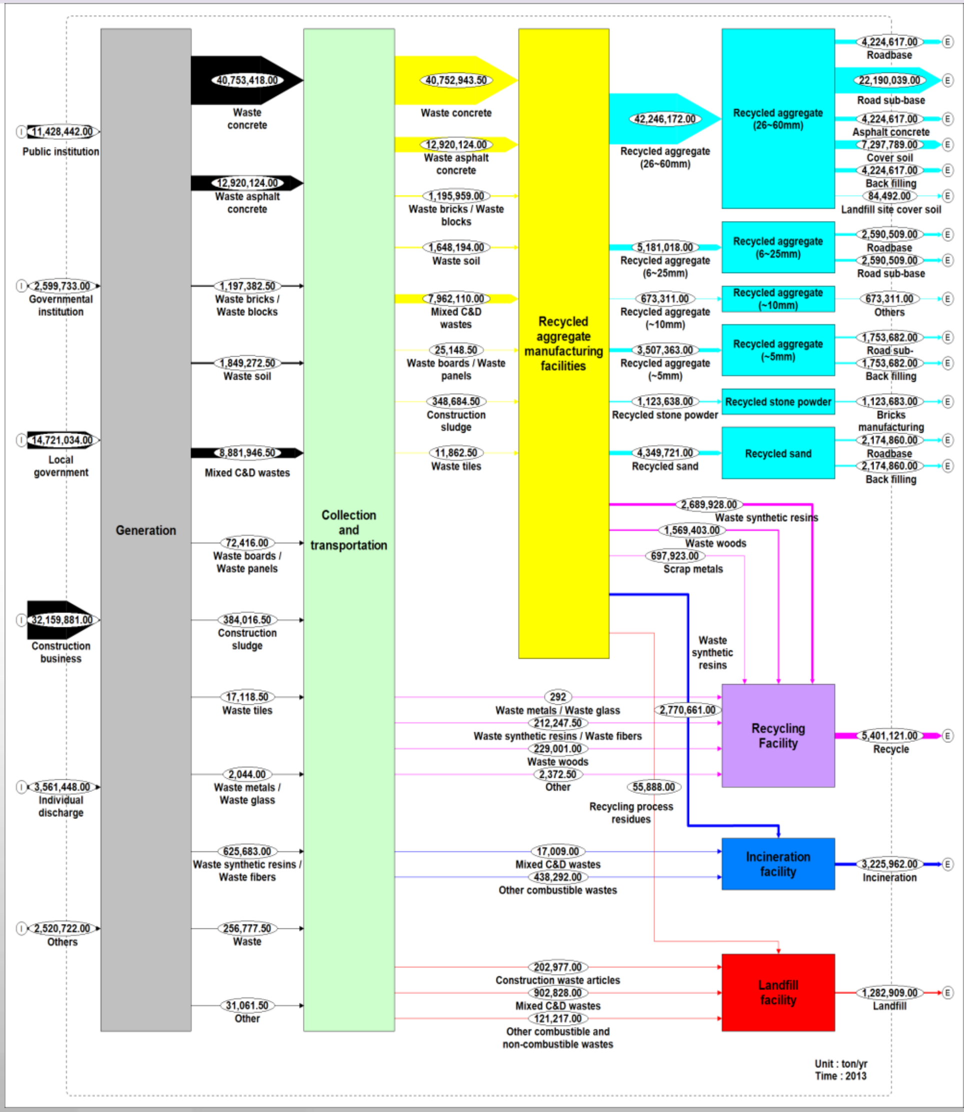


Fig.1 Material Flow of C&D waste in Korea

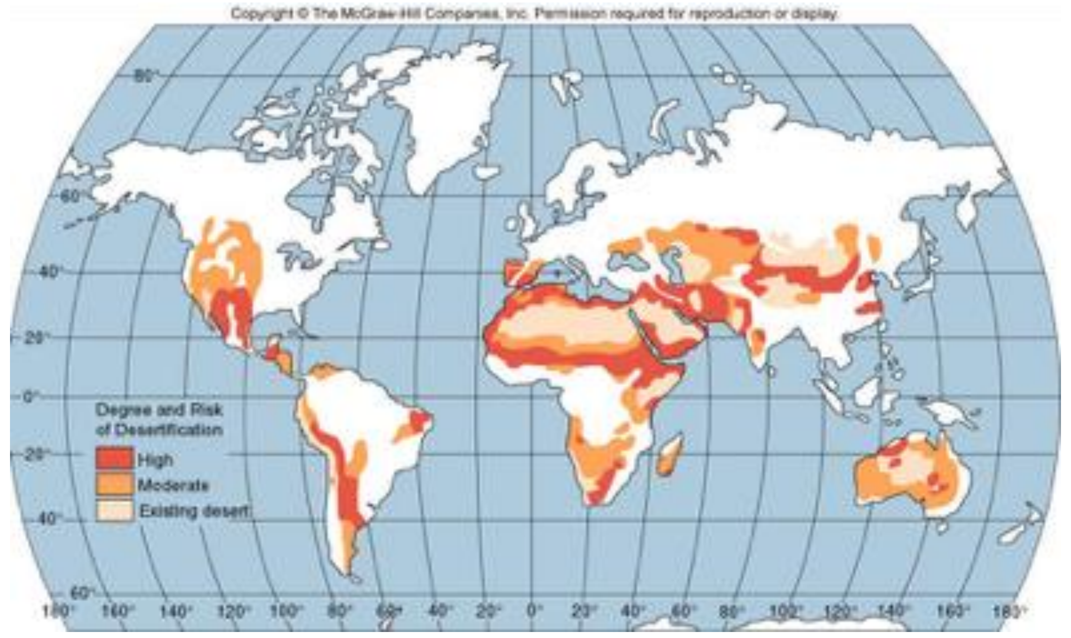
FB-8

soil particle size dependency of water holding capacity of soils amended with/without fly ash

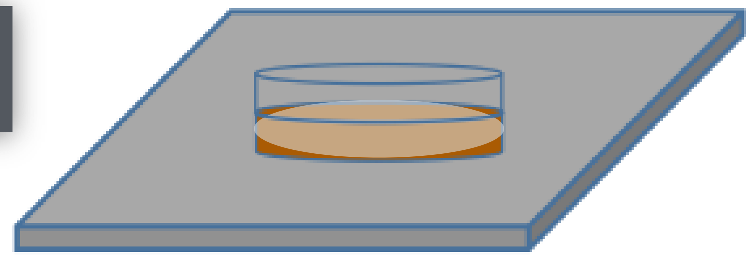
Mengzhu SONG[1] shenglei lin[2] fumitake takahashi[3] tokyo Institute of Technology

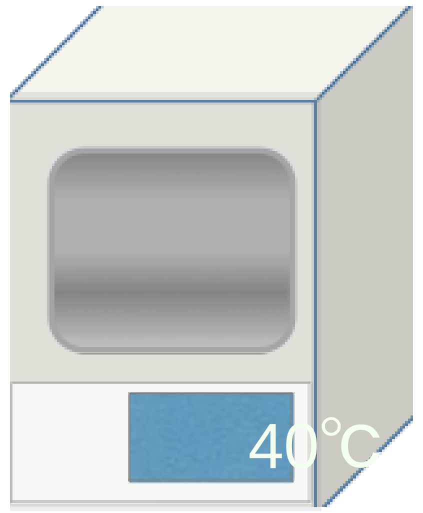
Fly ash is a major solid waste by-products from the combustion processes of coal fired power generation.

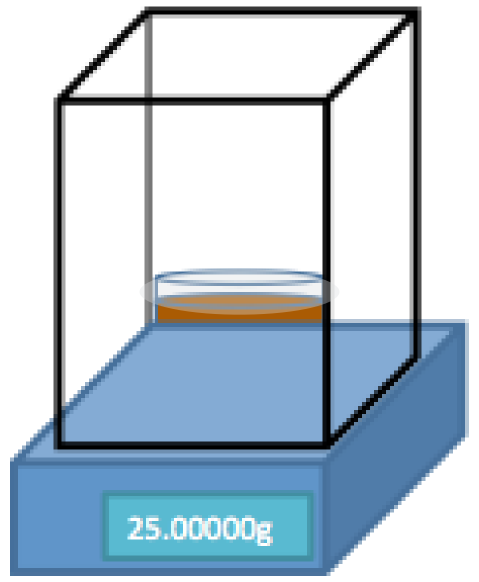
Desertification is also a severe problem in arid areas. Some ameliorants to keep soil moisture is useful to increase soil productivity.

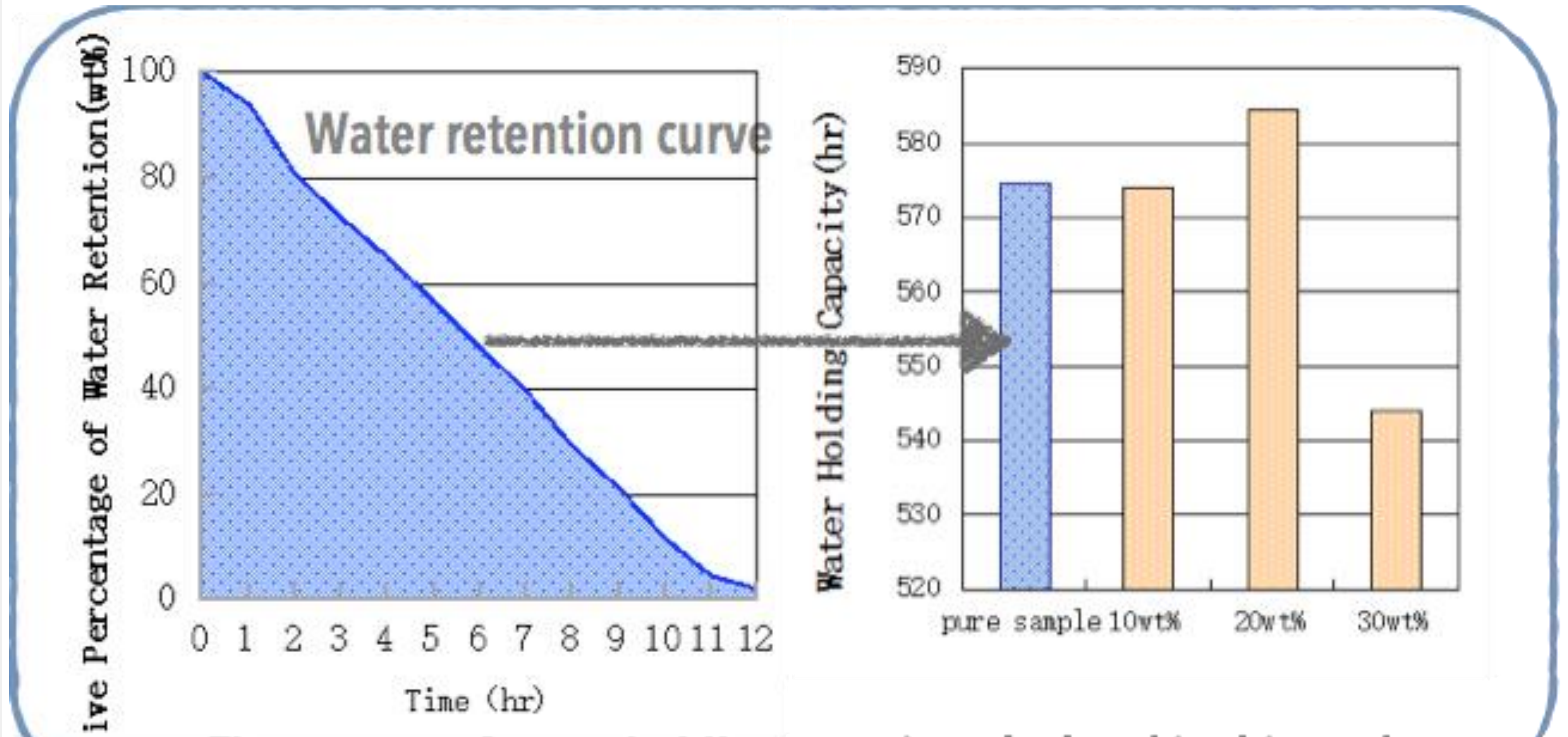


DRY EXPERIMENT





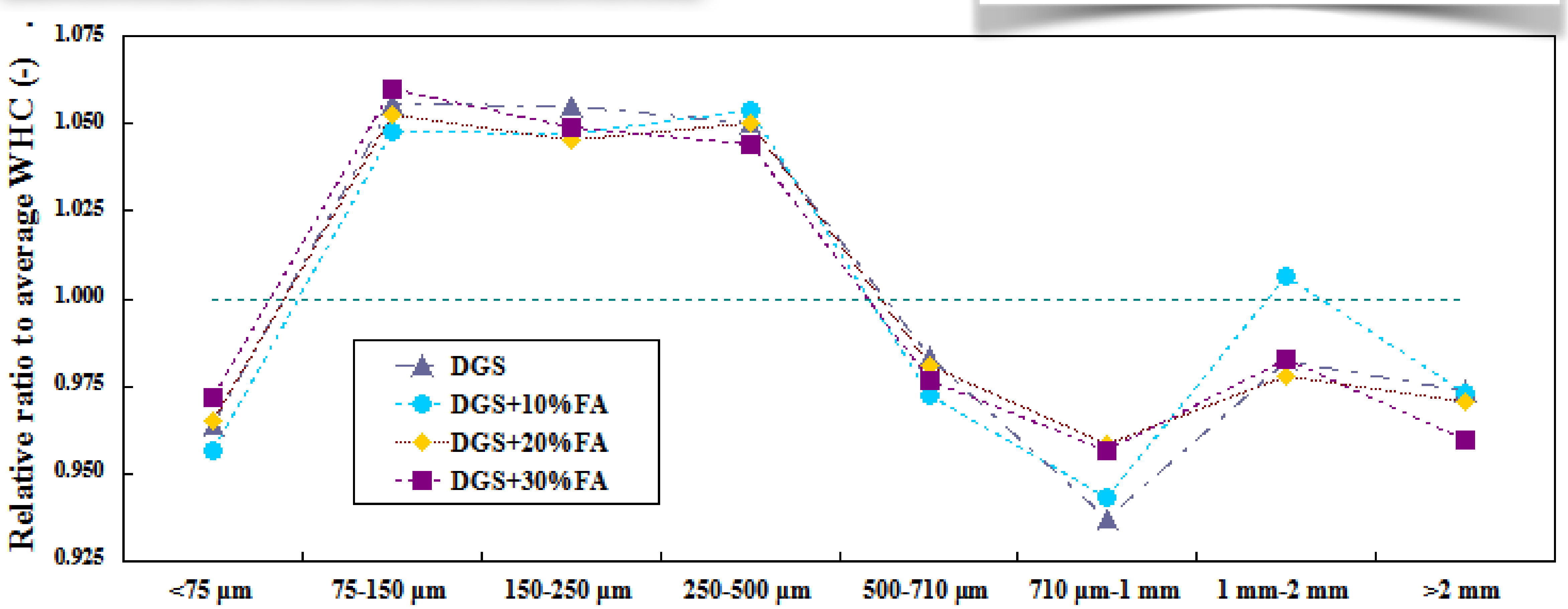


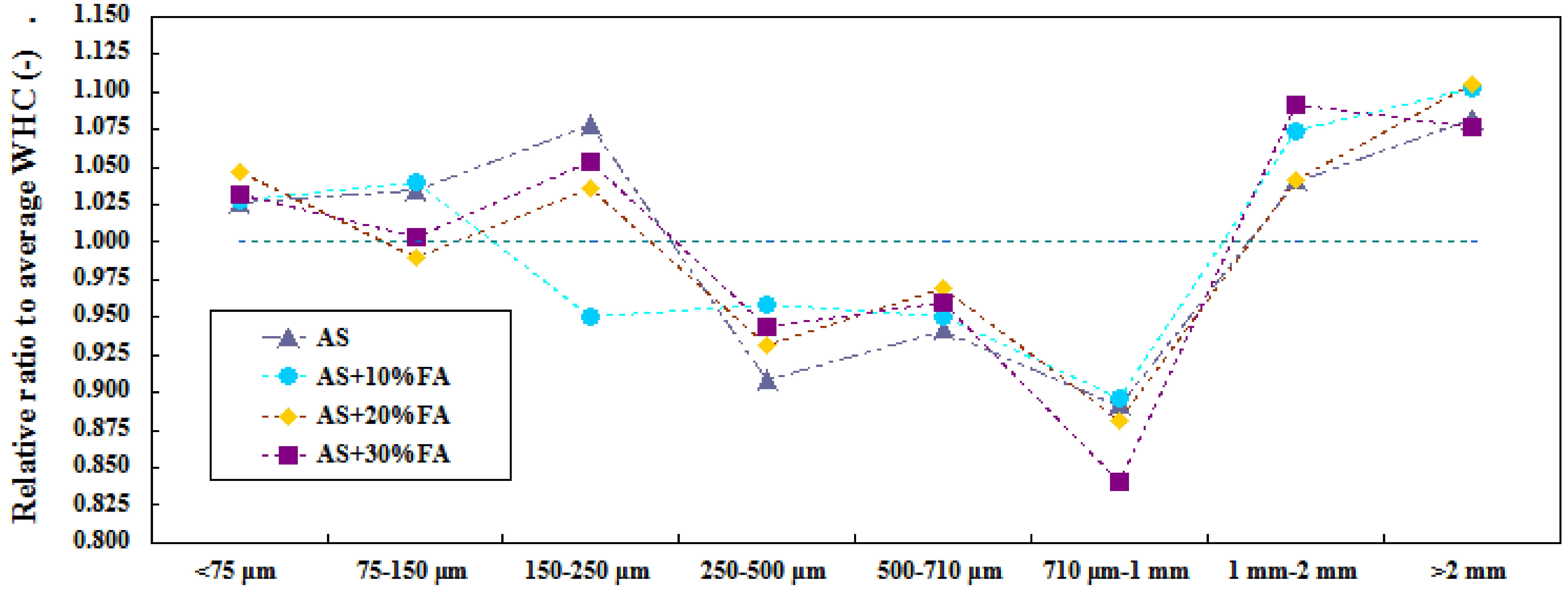


The concept of water holding capacity calculated in this study

Result and Discussion

Size dependency





WHC of samples with different FA ratio have the same variation as the function of the same particle size range.

The Welch's t-test with 5 % significance level suggests that the difference of WHC between different particle size ranges is regarded as significant.

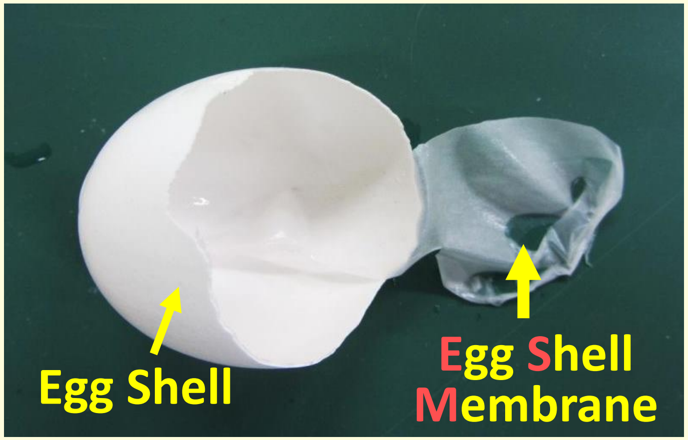
FB-9

Effect of Eggshell Membrane on Limiting Food Discoloration

FB-9

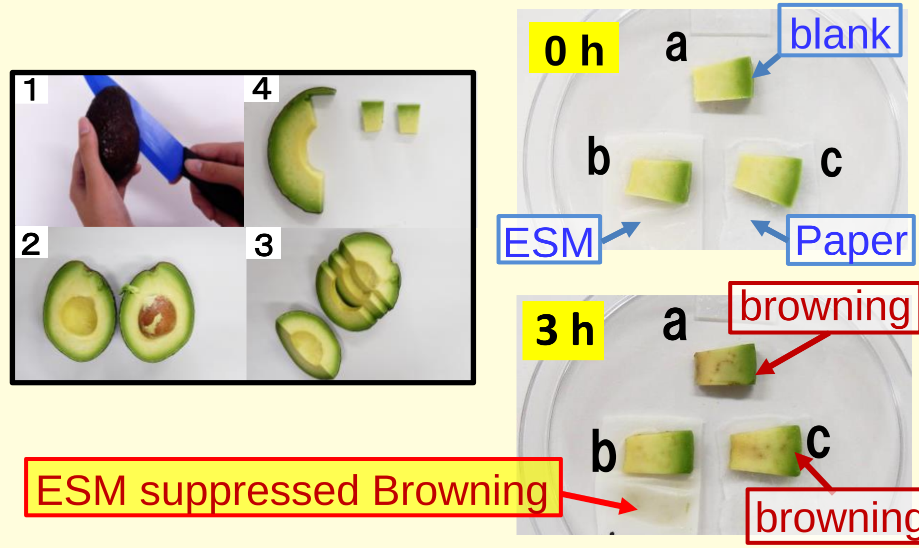
Nana KONISHI (小西那奈) N.I.T., Yonago College

Our Study: Food Waste-Recycling



ESM has several functions

Exp.1: Suppression of Food Deterioration



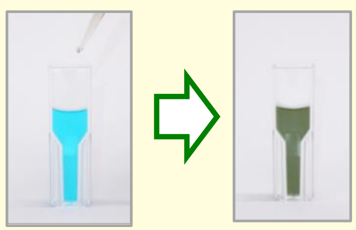
Exp.2: Enzyme Activity Inhibition

① Sample Solution

(i) 0.1M phosphate buffer
(ii) 2.5mM L-DOPA
(iii) DMSO
(iv) Sample solution

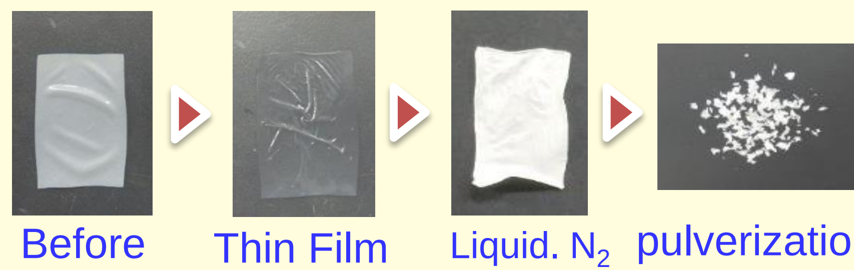
After setting introduced it into a cell whose light optical pass has 1cm (25 ºC) to leave it at rest for 15 minute.

②Tyrosinase Activity

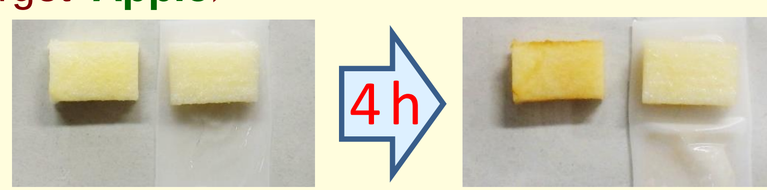


③Data Collection

Exp.3: Application



<Target：Apple>



FB-10

Fabrication of Nano-sized Copper Powders in Liquid Media Via High-Energy Electrical Explosion Method: Use of High Purity Copper Recovered from Waste Jelly-filled Cable as a Raw Material

Sungkyu Lee*, Dukhee Lee, Soo-Young Lee, Sung-Su Cho, Sunghyun Uhm

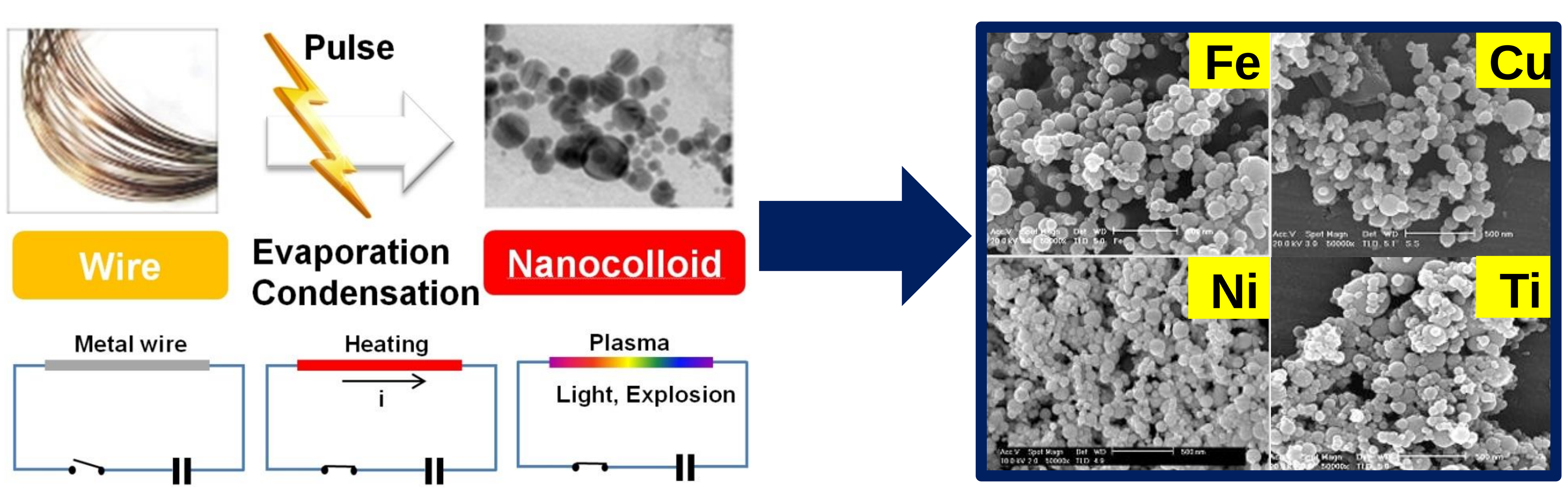
Plant Engineering & Advanced materials & Processing center, Institute for Advanced Engineering (IAE), Yongin 449-863, Korea

TEL : + 82-31-330-7318 E-mail : sklee@iae.re.kr

IAE 고등기술연구원 Institute for Advanced Engineering

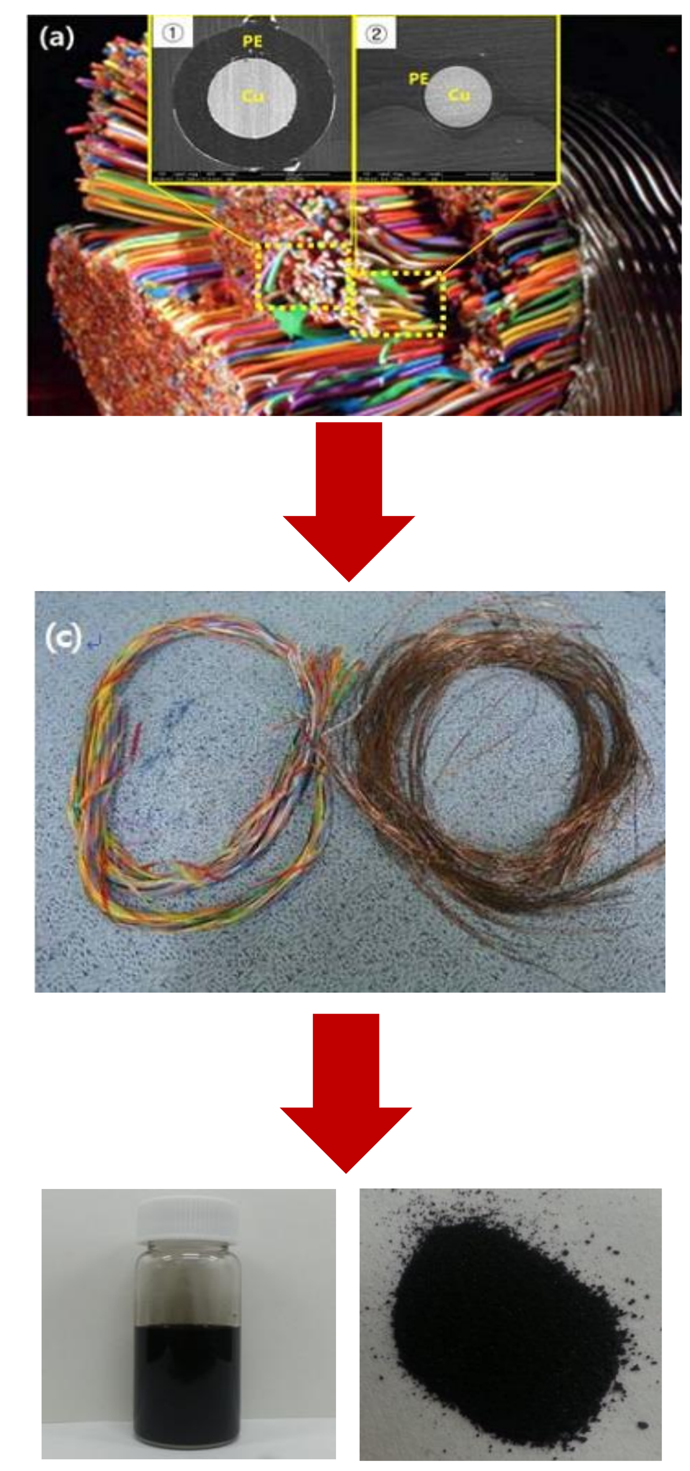
Outline

- Estimate of Korean Domestic Waste Jelly-filled Cable Wastes Accumulated to 6,500 Tons in 2008 → 4,000 Tons of High Purity Copper Resources.

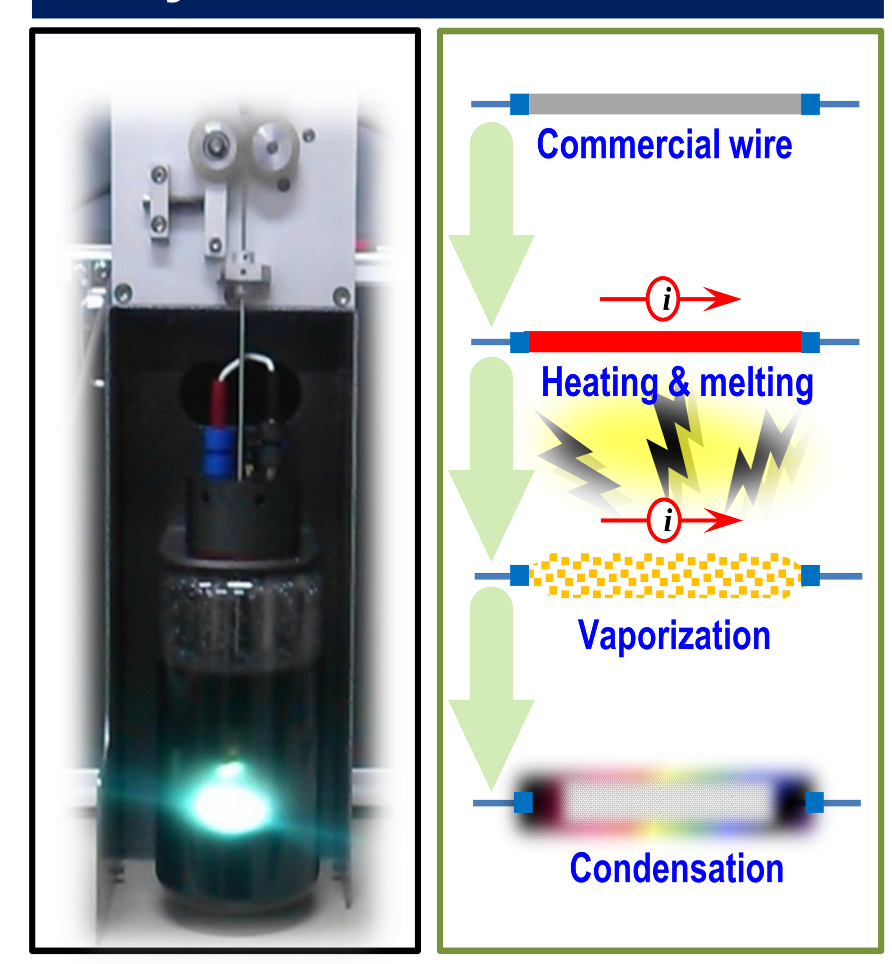


- Copper nano-powders are highly promising form of recycling copper-based jelly-filled communication cables via novel wire explosion in liquid media.

Fabrication process

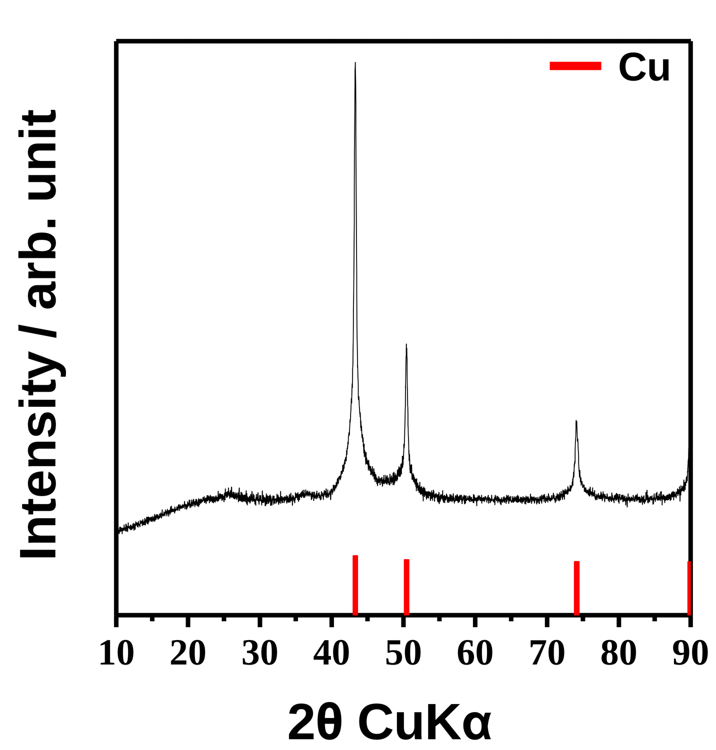


Synthesis mechanism

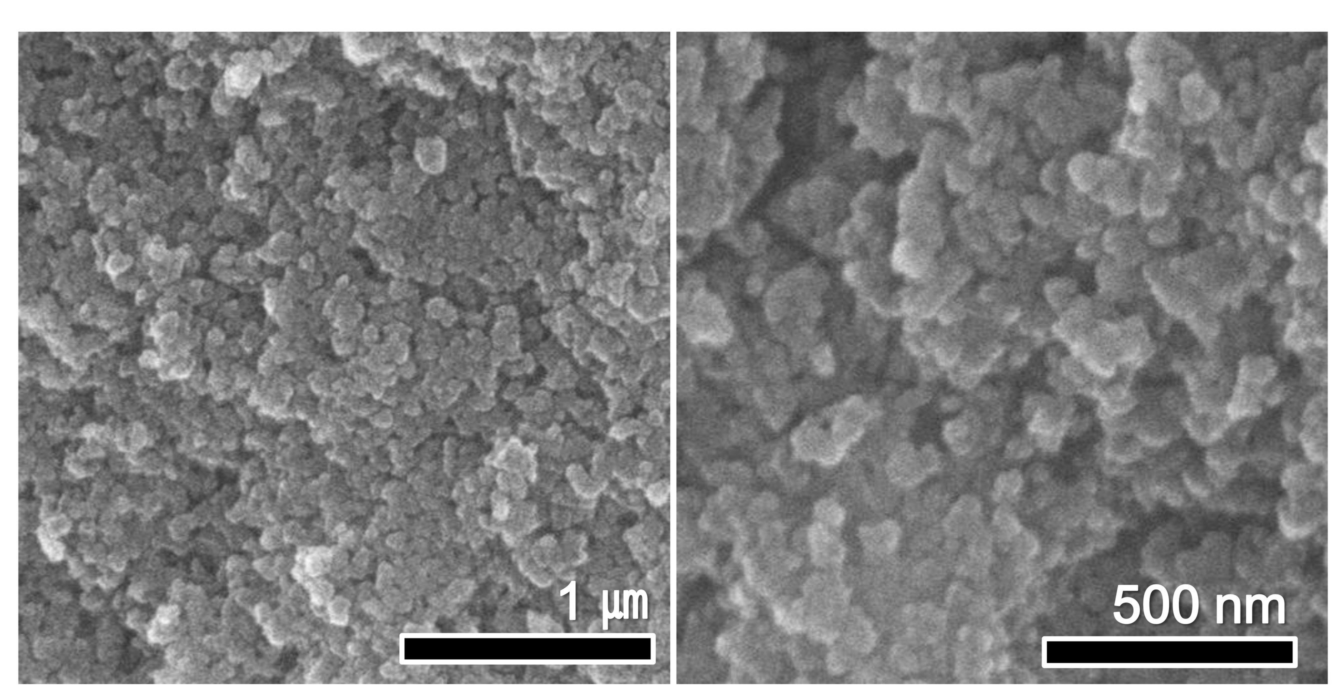


Synthesis conditions	
Wire diameter	0.8 mm
Solution	Oleic acid
Feeding distance	40 mm
Voltage	320 V

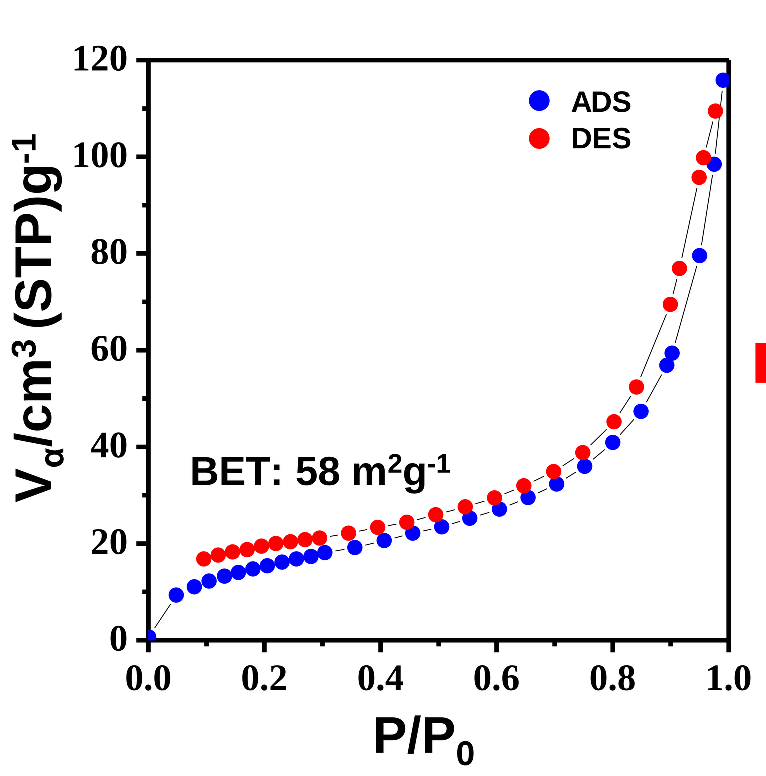
Results



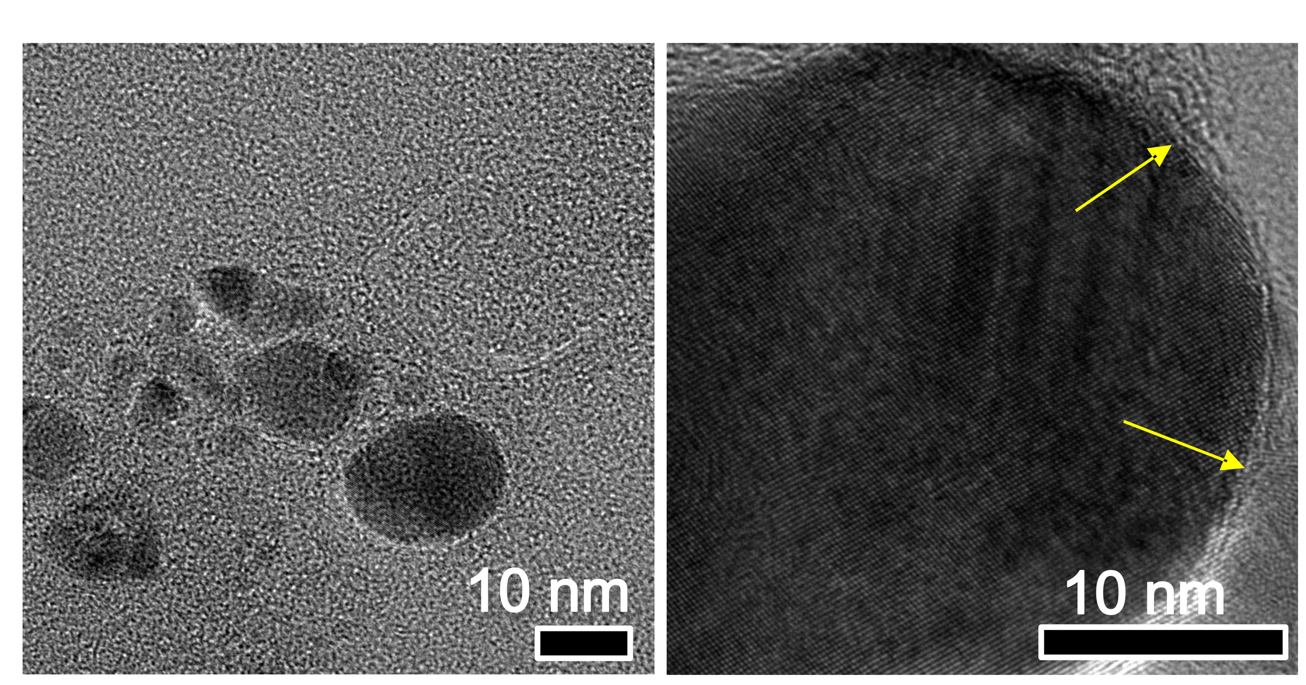
High purity cubic structured copper with no secondary (oxide) phases were fabricated.



50 nm-sized copper powders were fabricated without agglomeration



Highly porous (58m^2/g of BET porosity) copper nano-sized powders were synthesized.



Colloidal suspension of copper nano-powders were well dispersed and of spherical contour.

Conclusions

- Electrical explosion in oleic acid medium was optimized to synthesize nano-sized copper powders of less than 50 nm particle size.
- Spherical particles of nano-sized copper powders were not agglomerated and the X-ray diffraction revealed peaks peculiar to cubic copper structure without any oxide phases.
- The BET porosity of 58m^2/g was regarded as superior to similarly synthesized copper powders in deionized water or ethyl alcohol medium.

FC: Thermal Treatment

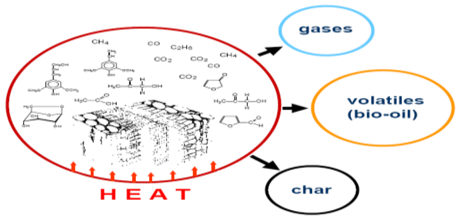
FC1: Cancelled

FC-2

CONDENSATION PERFORMANCE OF TWO DIFFERENT HEAT EXCHANGERS FOR COLLECTING PYROLYZED OIL

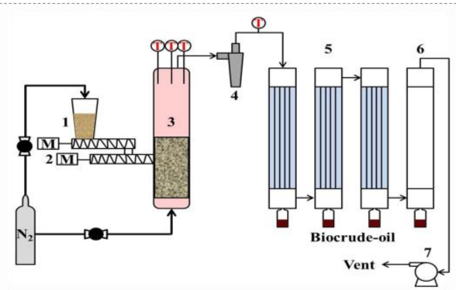
○ Jae Gyu Hwang, Hang Seok Choi*, Hoon Chae Park

Fast Pyrolysis Process



- Biomass can be converted to more valuable forms via thermo-chemical conversion process
- During fast pyrolysis, biomass is rapidly heated in anaerobic condition and is decomposed into biocrude-oil, char and gas.

Experimental apparatus



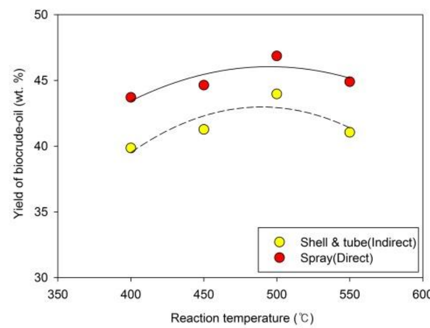
1. Silo 2. Screw feeder 3. Bubbling fluidized bed reactor
4. Cyclone 5. Heat exchanger (Shell & Tube, Spray)
6. Electrostatic precipitator 7. Blower

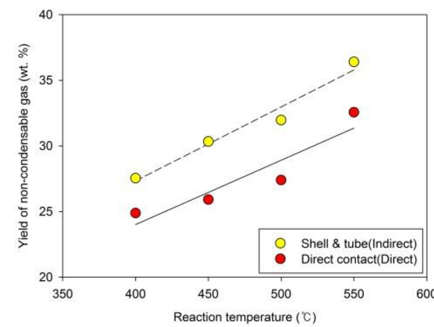
Heat exchangers

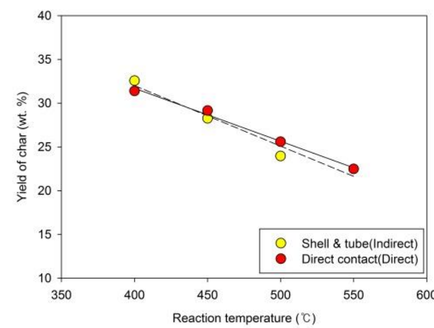
Shell & Tube (Indirect contact) Spray (Direct Contact)

- Experimental apparatus consist of silo, screw feeder, bubbling fluidized bed reactor, cyclone, heat exchanger and electrostatic precipitator.
- Fast pyrolysis temperature was changed from 400 ℃ to 550 ℃.

Yield of products with reaction temperature







Conclusions

- The yield of products and properties of biocrude-oil were affected by the type of heat exchanger.
- The biocrude-oil yield of direct contact heat exchanger was higher than those of indirect type over all reaction temperatures. (about 3-4 wt. %)
- Compared to indirect contact condenser, direct contact condenser shown high quantity of biocrude-oil yield, and it shown high quality of biocrude-oil such as higher HHV, carbon content and viscosity.

FC-3

YONSEI UNIVERSITY . DEPARTMENT OF CHEMICAL ENGINEERING

Characteristics of bio-oil, bio-char production from lignocellulosic biomass under slow pyrolysis

Speaker : Dongwoo Kang

延世大學校 YONSEI UNIVERSITY

Introduction

Pyrolysis is a thermochemical conversion technology to produce bio-char, bio-oil and bio-gas through the thermal decomposition of biomass under anoxic conditions. The aim of this study is investigated producing the bio-oil, bio-char, and non-condensable gas from lignocellulosic biomass via slow pyrolysis at different temperatures. Chemical composition of bio-oil is analyzed using gas chromatography-mass spectrometry (GC/MS).

Methodology

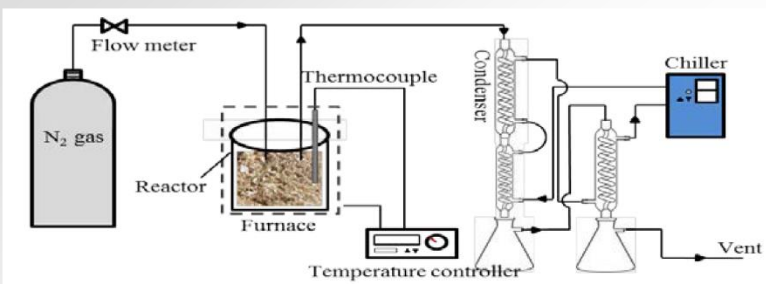


Fig 1. Mechanism of metal carbonate formation

Sample	Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulfur (%)	Oxygen[a] (%)	HHV[b] (MJ/kg)
Pine	50.80	6.33	0.21	0.53	42.13	18.77
Larch	47.17	6.92	0.31	0.66	44.94	17.90

[a] by different
[b] HHV(MJ/kg)= 0.3383(C of wt%)+1.443[(H of wt%) - (O of wt%)/8]+0.0942 (S of wt%)

Table 1. Mechanism of metal carbonate formation

Result

		C (%)	H (%)	N (%)	S (%)	O[a] (%)	HHV[b](MJ/kg)
Pine	350℃	76.63	4.2	0.34	0.25	18.58	28.66
	400℃	82.95	3.77	0.33	0.23	12.72	31.23
	450℃	84.2	3.43	0.49	0.31	11.57	31.38
Larch	350℃	76.69	5.46	0.5	0.44	16.91	30.81
	400℃	80.31	4.31	0.26	0.32	14.8	30.75
	450℃	84.87	4.01	0.19	0.31	10.62	32.61

[a] by different
[b] HHV(MJ/kg)= 0.3383(C of wt%)+1.443[(H of wt%) - (O of wt%)/8]+0.0942 (S of wt%)

Table 2. Ultimate analysis of bio-char.

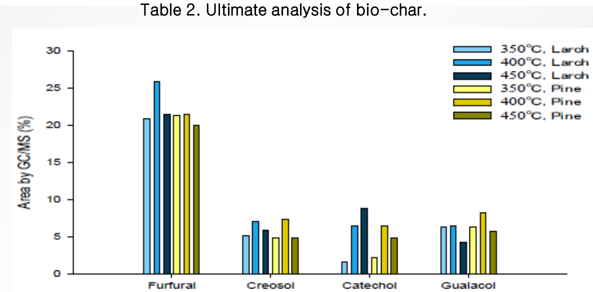


Fig 2. Main compound identified in bio0oil analyzed by GC/MS

FC-4

FC4

The Characteristics of Bio-char by grinding of the food waste

WonDuck Chung[1)] , Woo Ri Jo[1)] , Minah Oh[1)] , Sung-Yeol Yun[1)] ,Seong-Kyu Park[2)] , Jai-Young Lee[1)]
[1)] Dept. of Environmental Engineering, The University of Seoul, Korea
[2)] KofirstR&D center, KF E&E Co.Ltd, Korea

Introduction

The amount of food waste in Korea is increasing every year. Despite food waste contain a large amount of valuable organic resources, its recycling is low because of high moisture contents and sodium.

In this study, bio-char was produced by Hydrothermal Carbonization (HTC) that is one of the thermal decomposition methods. HTC is a method of carbonization with water-containing of biomass in a completely sealed reactor. So, It is advantageous process for treatment of food waste in Korea. At this moment, the bio-char produced in the hydrothermal carbonization reactor of pilot scale, was studied whether or not in the grinding of the food waste.

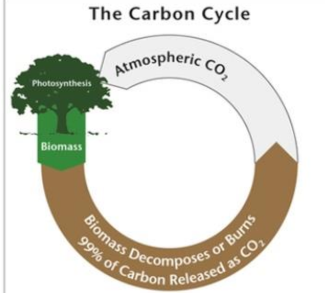
【Food waste】

Generation amount of food waste in Korea (2012)
: 4.3 million ton/year

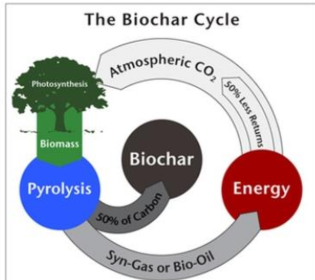
Treatment of food waste
(unit : ton/year)

① Recycling : 881,000
② Landfilling : 469,000
③ Incineration : 756,000
④ 4Ocean dumping : 1,823,000

- Prohibition of ocean dumping in Korea by **London Dumping Convention** (after 2012)
- Need the alternative treatment of ocean dumping → **Biochar**



Almost all of the carbon returns to the air



Up to half of the carbon is sequestered

Material & method

– Method

Collecting food wastes at K company cafeteria

Food waste was grinded about 10mm and non-grinded food wastes used without any pre-treatment

Food wastes Reacting with conditions of 220 ℃ heating temperature, 4hr reacting time, 2.2Mpa Inner pressure

Analysis each samples with [Official waste test method, 2015] and [Solid fuel product quality testing and analysis methods,2013]

[Research procedure]

– Material

[The HTC reactor condition]

	Condition
Food waste Amount	40~80 kg
Reactor Volume	100 L
Reacting Pressure	2.2 Mpa
Reacting Degree	220 ℃

[The weight of samples #]

The weight of feed stock (Kg)	Samples #
40	1
60	2
80	3

[The comparison of standards for SRF]

Classification		Unit	Before change state					After change state			
			RDF		RPF	TDF	WCF	SRF		BIO-SRF	
Form & size	diameter	mm less	30	-	50	-	-	50	-	50	-
	length		100	50×50 (120×120)	100	120	120	100	50×50	100	120×120
Moisture content		wt% less	10	25	10	10	10	10	25	10	25
Low calorific value		kcal/kg more than	3500		6000	6000	3500	3500		3000	
Ash		wt% less	20		20	4.0	8.0	20		15	
Chloride		wt% less	2.0		2.0	2.0	0.3	2.0		0.5	
Sulfur		wt% less	0.6		0.6	2.0	1.2	0.6 (waste tire 2.0 less)		0.6	
Heavy metals	Hg	mg/kg less	1.2		1.2	1.2	1.0	1.0		0.6	
	Cd		9.0		9.0	9.0	2.0	5.0		5.0	
	Pb		200		200	200	30	130		100	
	As		13		13	13	2.0	13		5.0	
	Cr		-		-	-	30	-		70	
Biomass		wt% less	-		-	-	-	-		95	

UNIVERSITY OF SEOUL

FC-5

The University of Seoul

A study on the characteristics of the bio-coal using agricultural by-products

Jin Gwan Kim[1], Min-Jung Kim[1,3], Kyoung-Joo Park[1], Jong Bin Kim[1], Seong-Kyu Park[2], Jai-Young Lee[1]

[1]Dept. of Environmental Engineering, The University of Seoul
[2]Kofirst R&D center, KF E&E Co.Ltd
[3]Resource Recirculation Research Division, National Institute of Environmental Research

Introduction

The rapid industrial development is facing problems due to the **energy depletion**

Bio-fuels can be produced using waste fuels, so it **eco-friendly**

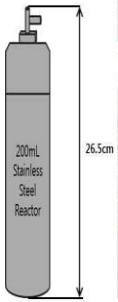
Contribute to the development of **alternative energy**

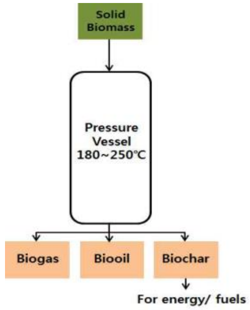
We **chose agricultural by-products** into bio-fuels

The method used in this study was **HTC(Hydrothermal carbonization)**

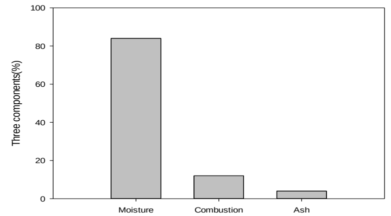
The purpose of this study was the **energy assessment of bio-coal**

Material and Method

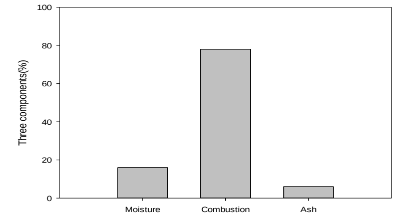




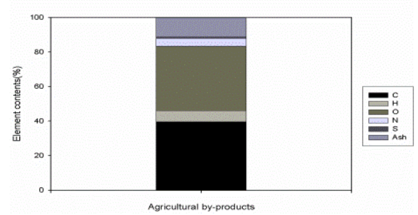
Result



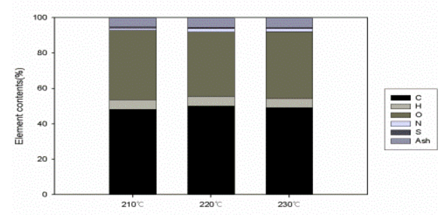
Three components of agricultural by-product



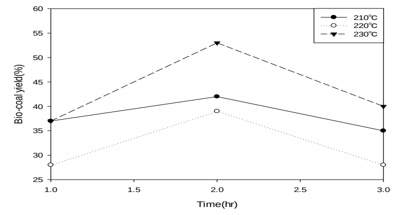
Three components of agricultural of bio-coal



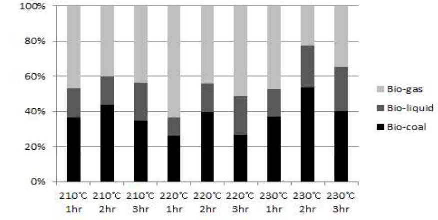
Results of element analysis of agricultural by-product



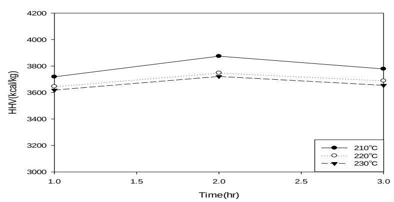
Results of element analysis of bio-coal



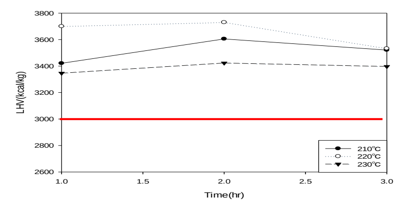
The yield of bio-coal in this study



The yield of bio-coal, bio-liquid, bio-gas



The results of HHV of bio-coal



The results of LHV of bio-coal

FC-6

Study on a Fixed Bed Gasification of Polyurethane SRF from Electronic Waste

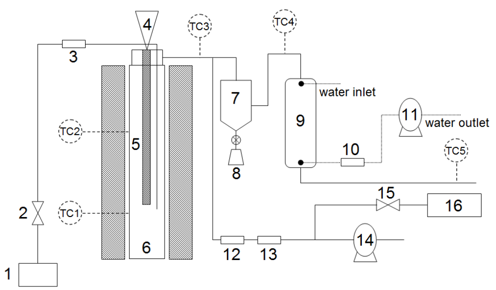
Jae-Jun Kang Yong-Chil Seo*, Jang-Soo Lee, Won-Seok Yang, Se-Won Park, Md. Tanvir Alam

Feedstock

Elemental analysis(wt. %)	
C	63.88
H	6.34
O	15.21
N	6.59
S	ND
Cl(ppm)	1350

Proximate analysis(wt. %)	
Moisture	1.86
Volatile	82.91
Fixed-C(carbon)	10.18
Ash	5.05
Higher heating value(kcal/kg)	6,128 – 7,542

Schematic diagram



[1. air supply, 2. air controller, 3. MFC(Mass flow controller, 4. feeder, 5. feeding pipe, 6. furnace, 7. cyclone, 8. residue collector, 9. scrubber, 10. fabric filter, 11. water pump, 12. filtering system (1), 13. filtering system (2), 14. gas vacuum pump, 15. syngas controller, 16. micro GC, 17. peristaltic pump, 18. steam generator, TC-thermocouple]

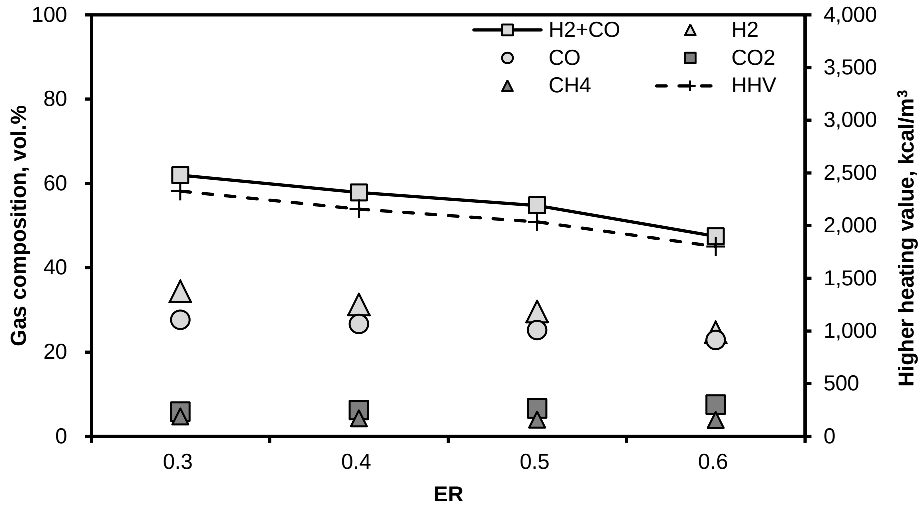
Operating condition

Feedstock	Polyurethane SRF
Temperature	1000 °C
ER(Equivalent Ratio)*	0.3, 0.4, 0.5, 0.6
Feeding rate	10 g/min
Particle size of feedstock	< 1 mm
Gasification agent	Air

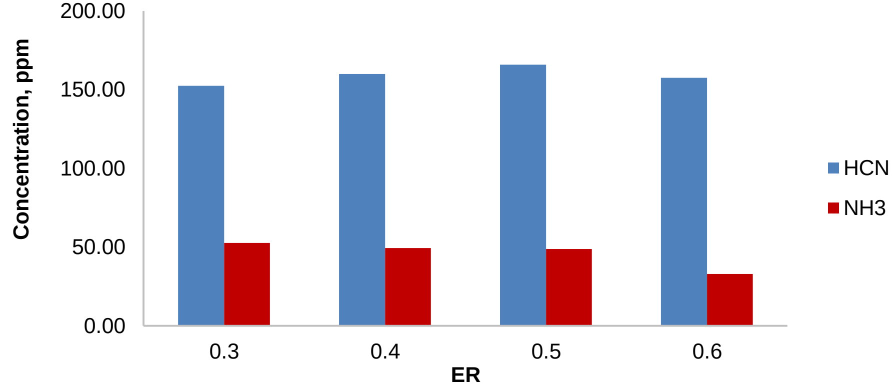
* Equivalent ratio was calculated as the ratio of air supplied to air required for complete stoichiometric combustion of feedstock

Results

✓ Dry gas composition and HHV with ER



✓ Gaseous pollutant(N) with ER



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FC-7

Environmental Assessment of Polyurethane Gasification Residue

Md. Tanvir Alam, Jang-Soo Lee, Won-Seok Yang, Se-Won Park, Jae-Jun Kang, Yong-Chil Seo*

Sample (bottom ash)

ER 0.3

ER 0.4

ER 0.5

ER 0.6

Experimental Method

✓ Leaching Test

1. Weight the sample accurately (g)
2. Add solution of D.W. + HCl (pH range 5.8~6.3)
3. Weight : Volume ratio = 1 : 10 (total volume above 500ml)
4. Mixing & Shaking for 6 hours (stroke 4~5cm, 200rpm, normal temperature & pressure)
5. Filtering (glass fiber 1.0㎛) or centrifuging (3000rpm, 20min)
6. Weight : Volume ratio = 1 : 10 (total volume above 500ml)
7. Sample (leachate)

✓ Loss on iginition

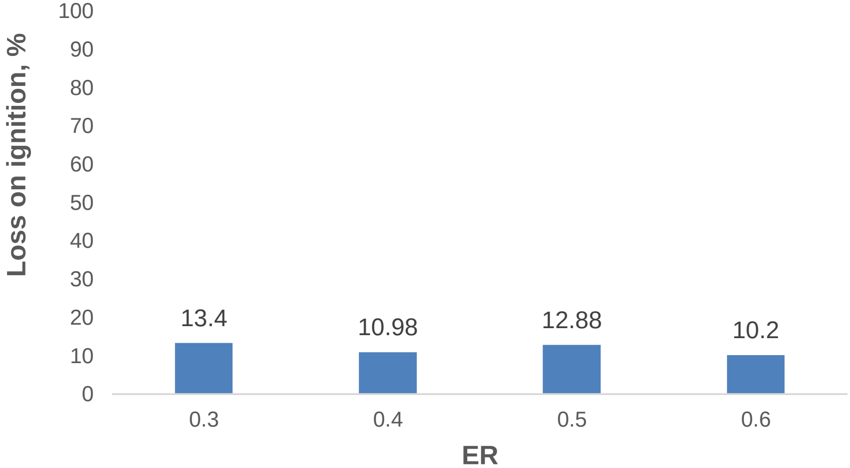
Parameter	Unit	Value
Heating rate	℃ / min	10
Temperature	℃	600
Initial mass	g	About 1
Samples	-	Bottom ash
Atmosphere	-	Air

Results

✓ Result of Leaching Test

Heavy Metal	Standard	ER 0.3	ER 0.4	ER 0.5	ER 0.6
As	< 1.5	0.1	0.2	0.2	0.1
Cd	< 0.3	ND	ND	ND	ND
Cr	< 1.5	ND	ND	ND	ND
Cu	< 3	ND	ND	ND	ND
Hg	< 0.005	ND	ND	ND	ND
Pb	< 3	ND	ND	ND	ND

✓ Result of loss on ignition



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Air & Waste Engineering Laboratory

FC-8

A study on pyrolysis characteristics of torrefied biomass

○ Ho Seong Yoo, Hang Seok Choi*, Byeong Kyu Lee
Department of Environmental Engineering, Yonsei University

Biomass Torrefaction and Pyrolysis

- Biomass is eco-friendly and carbon neutral fuel, but it has high moisture and volatile matter.
- Torrefaction is pre-treatment process of pyrolysis or gasification. It can moisture and volatile matter of biomass.
- Torrefaction were perfromed with changing temperature range 220~300 ℃. After torrefaction, torrefied biomass was pyrolyzed.

Dry biomass

Torrefaction 200-300℃

Torrefied biomass

Pyrolysis 400~600℃

Experiments

Pyrolysis condition	
Temperature	500℃
Inner gas	Nitrogen
Time	2 sec
Material	Raw Sawdust, Torrefied sawdust
Feeding rate	1kg/hr

Results

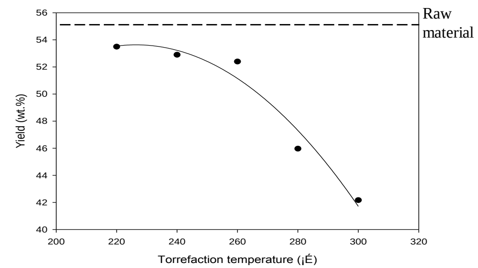


Fig. 1 Yield of bio-oil

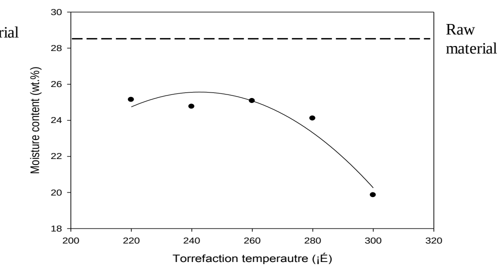


Fig. 2 Moisture content of bio-oil

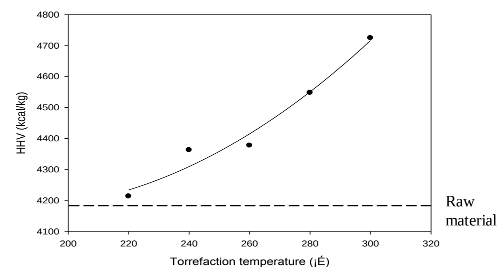


Fig. 3 HHV of bio-oil

Conclusion

- Torrefaction decreases yield of bio-oil.
- Torrefaction increases HHV and decreases moisture content of bio-oil
- The fuel quality of pyrolyzed bio-oil is remarkably improved by torrefaction.

FC-9

For Waste to Energy, Assessment of Fluff Type SRF (Solid Refuse Fuel) by Thermal Characteristics Analysis

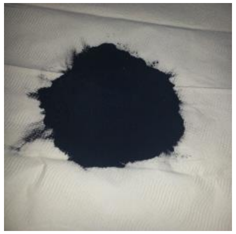
Se-Won Park [1], Yong-Chil Seo[1], Jang-Soo Lee[1], Won-SeokYang[1], Jae-Jun Kang[1] , Md. Tanvir Alam[1]

Figure of Feedstock

[1]

[3]

[2]

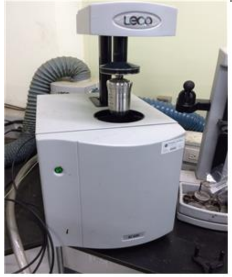


[4]

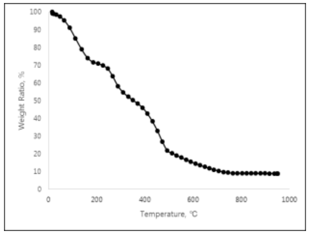
Classification	Samples
[1]	EFB
[2]	Coal
[3]	SRF
[4]	SRF (after crushing)

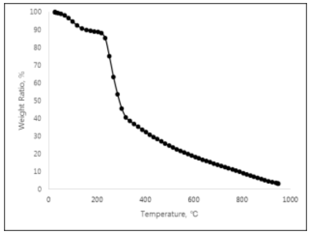
Method of analysis

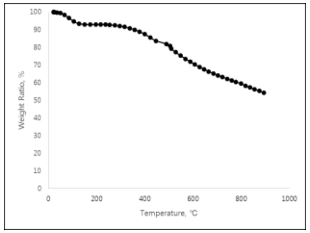
Analysis	Instrument	Method
Elemental	EA 1112/EA 1110, Thermofinnigan co.	ASTM D 5379
Heating Value	AC - 600, LECO	ASTM D 4809
Thermogravimetric	TGA – 701, LECO	ASTM E 1131
Proximate	TGA – 701, LECO	ASTM D 3172

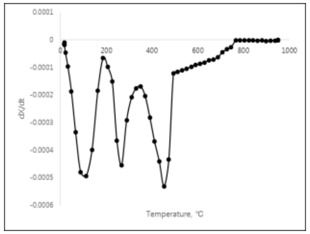


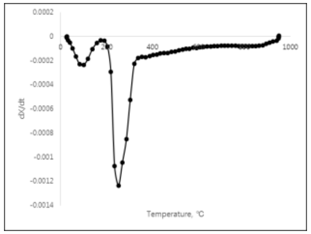
Result and Discussion

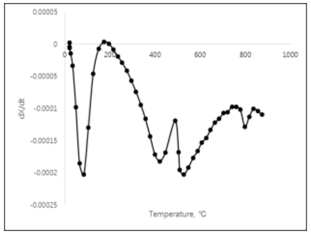












[SRF (Fluff)] [EFB] [Coal]

- In results of TG analysis, weight loss of EFB was almost completed at 950℃. But, weight loss of coal was not completed because of low reactivity.
- Comparison with biomass and coal, SRF shows various peak because of various components in SRF.
- So, SRF have limitation for fuel because of optimum condition control
- But, SRF shows possibility for auxiliary fuel in result of heating value. If we solve the problem about equalization, SRF is good fuel by main fuel and substitute for fossil fuel including coal used in this study.

Yonsei University

Air & Waste Engineering Laboratory

FD: Treatment Technology and Landfill

FD-1

Estimation of oxidation factor of methane using landfill gas concentrations from vent pipes and surfaces in the W landfill, Korea

Sangjae Jeong[1)], Anwoo Nam[2)], Tae Hoon Kim[2)] and Jae Young Kim[ǂ, 1)]

1)Seoul National University 2) Korea Environment Corporation

Purpose

Evaluating methane oxidation factor by comparison of landfill gas composition between landfill surfaces and vent pipes

Materials and Methods

- CH_4 and CO_2 fluxes are observed in the W landfill
- Spatial interpolation is conducted on surface measurement results
- OX is evaluated with Eq. (1)

$$OX = {(R_v - R_s)}/{R_v \times (1+R_s)} \qquad \text{Eq. (1)}$$

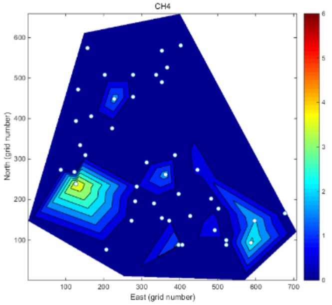
Where,

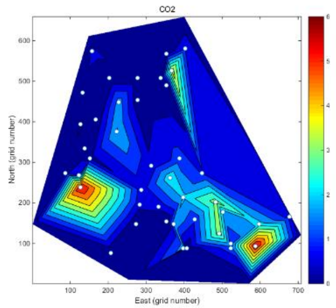
OX = Oxidation factor (fraction), $R_v = {C_{CH_4}}/{C_{CO_2}}$ *at vent pipe* (fraction),

$R_s = {C_{CH_4}}/{C_{CO_2}}$ *at surface* (fraction)

Results

- The oxidation factor was 4.8 to 7.3 times higher than the default value of IPCC guidelines
- Oxidation factor is varied depend on the statistics which we use





Laboratory of Waste Management and Resource Recirculation, Department of Civil and Environmental Engineering, College of Engineering, Seoul National University

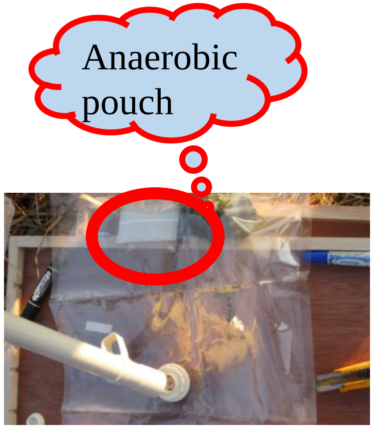
WML-SNU

FD-2

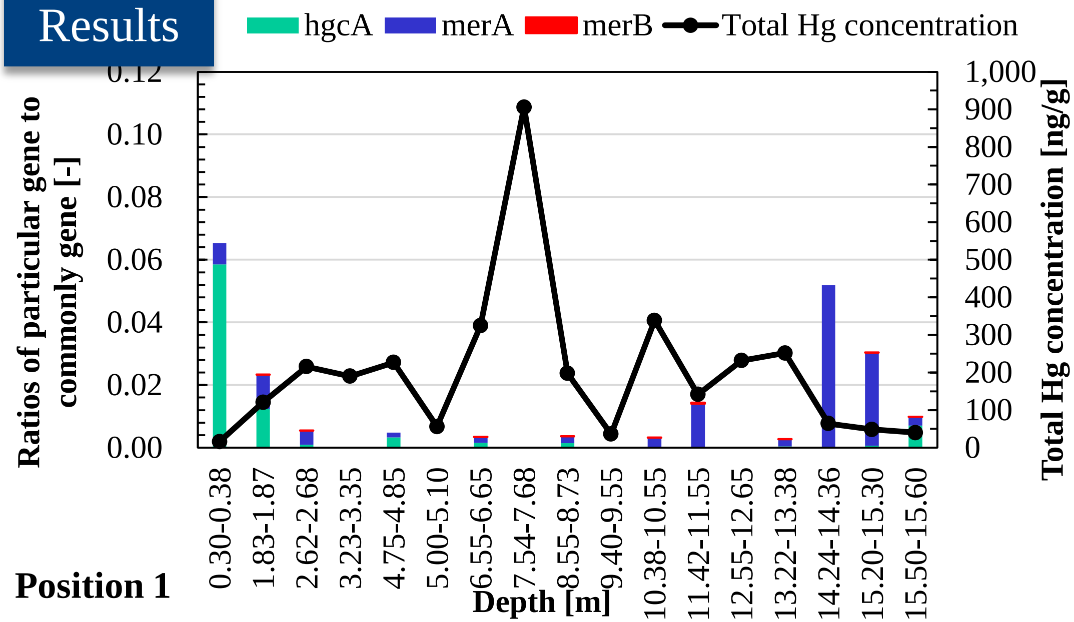
Depth characteristic of mercury in a landfill site of Japan

Mercury (Hg) is a persistent environmental pollutant of high toxicity. Hg can be transported **long distances** within the environment, and **methyl mercury** is so neurotoxic that can be bio accumulated by animals like fish via food chain.

In this study, we **sampled** in a landfill site in Japan and plan to understand what happens in old Hg containing waste inside the landfill site, which will suggest useful information on **long-term disposal** of Hg waste in the future.



Results



Summaries

In the three positions, the **total mercury** concentration is presented to be **lower** than that in deeper places approaching the ground surface, and shows a high concentration between 5-15m.

hgcA gene was detected highly at 0.30-0.38 m. This result indicates that surface layer in landfill becomes anaerobic condition. Gene of ***merB*** was not detected at all samples which indicates that demethylation is difficult to occur.

○**Jing YANG** [1)], Akira Sano[2)], Ryuji Yanase[3)], Masaki TAKAOKA[1), 2)]

1) Graduate School of Eng., Kyoto University; 2) Graduate School of Global Environmental Studies, Kyoto University; 3) Environmental Protection Center, Fukuoka University

FD-3

Development of landfill management system using 3D measurement system

Jong-Yun Kang, Jin-Kyu Park , Sung-Youn Cho, Kyung Kim , Nam-Hoon Lee

This study presents the waste volume calculation method using the point cloud of the surface of 3 dimensional objects based on 3 dimensional laser scanner.

The system has been installed a landfill facility in Ansung city in Korea.

The calculation method of the waste volume

- **At first, laser scanners collect the point clouds of landfill facility by the command of the P.C. server.**
- **Second, the laser scanners send them to the P.C. server, which aligns the coordinate of the point clouds to have the same coordinate and it merges them to be one point cloud file. The uniform grid meshing is applied to the merged point cloud and the calculation of the volume is performed referring the initial shape of the landfill facility.**
- **Finally, the calculated volume is sent to the GIS server, which records periodically the volume history of the waste.**

The proposed system periodically collects the volume of the waste from the landfill facility and sends it to the GIS in the landfill facility.

Fig. 3. The appearance of the developed laser scanner based on robot technique

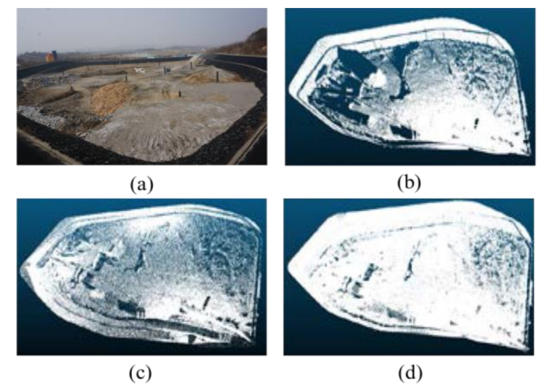


Fig. 4. The obtained results of the point cloud in the landfill facility

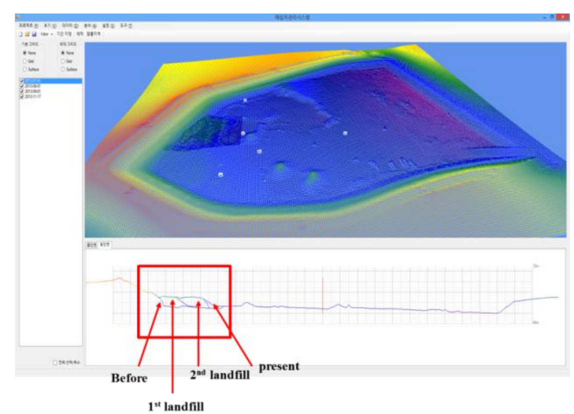


Fig. 5. Scanning data with cross section

FD-4

Park Jin-Kyu, Kang Jong-Yun, Lee Nam-Hoon

Estimation of methane emission flux at landfill surface using laser methane detector

The aim of this study : The possibility of measuring methane mission fluxes, using surface methane concentration and gauge pressure, as well as the correlation between the methane emission flux and surface methane concentrations

Method : The surface methane concentration was measured using a laser methane detector (LMD).

Results : - A positive linear relationship between the surface methane concentration and the methane emission flux (Fig. 1)

- The methane emission flux showed a positive linear relationship with the gauge pressure (Fig. 2).

- The median of the vertical permeability for cover soil : 5.54 x 10^{-10} m^2

Conclusion : When the surface methane concentration and the surface gauge pressure are measured simultaneously, the methane emission flux can be calculated using Eqs.(1) and (2).

$$F_v = \frac{K_z}{u}\left(\frac{Pg}{\Delta z}\right) \qquad (1)$$

Where, F_v: Volumetric methane emission flux ($m^3/m^2/s$)

P_g: the gauge pressure (Pa)

u: the viscosity of methane (Pa·S),

Δz: the thickness of surface coverage of landfill (m),

K_z: the vertical permeability of surface landfill (m^2).

$$F = F_V \times C_S \qquad (2)$$

Where, F: Methane emission flux ($g/m^2/d$)

Cs: Surface methane concentration (mg/m^3)

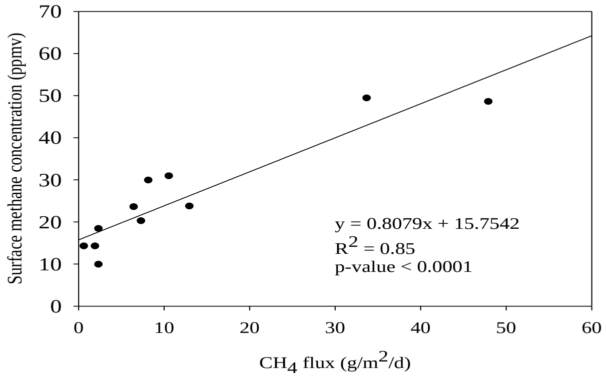


Fig. 1 Correlation between methane emission flux and surface methane concentration

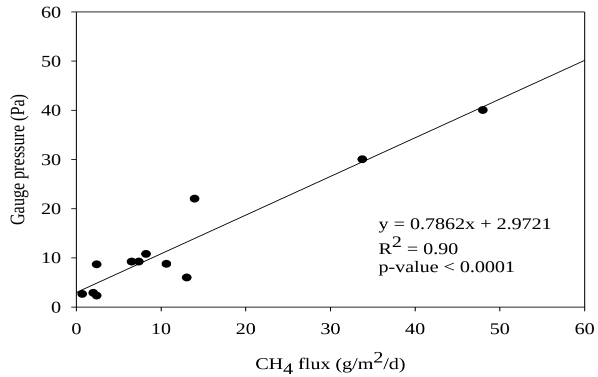


Fig. 2 Correlation between methane emission flux and gauge pressure

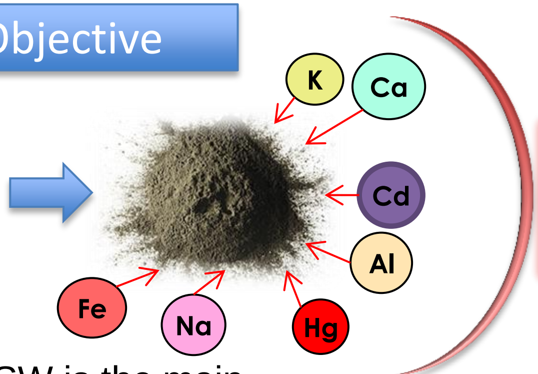
FE: Hazardous Waste

FE-1

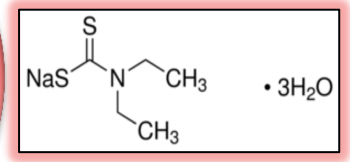
Mercury immobilization for municipal solid waste incineration (MSWI) fly ash by chelate treatment

Fong, Cheng Lip (Tokyo Institute of Technology)

Background/Objective



- incineration of MSW is the main method of disposal in Japan
- Residues in the form of ashes
- Fly ashes more toxic



Chelate

In 2011, post chelate-treated fly ash from a Nagano incinerator found to have leached Hg exceeding 0.005mg/L!

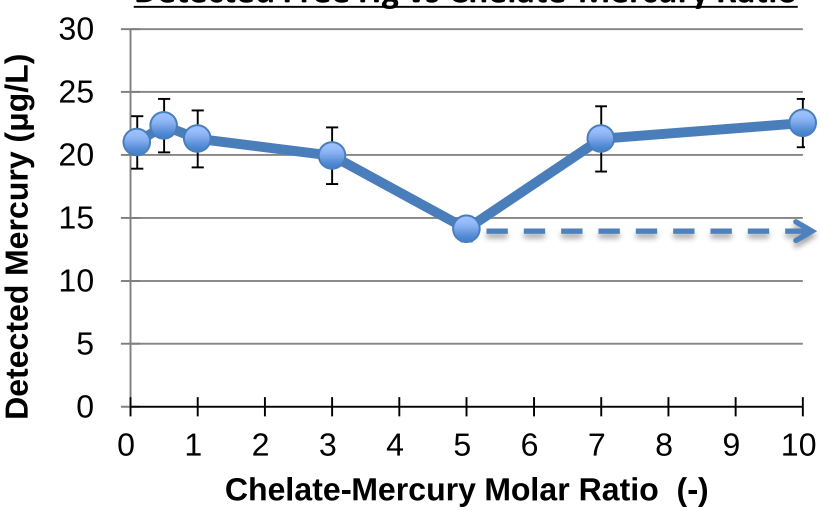
Material/Method

The Cold Vapor Atomic Absorption Spectrometry

- reduction vaporization using Tin (II) Chloride as a reducing agent
- $C_2H_5)_2NCS_2Na \cdot 3H_2O$ as chelate
- $HgCl_2$ in 0.1mol/L HNO_3

Discussion

Detected Free Hg vs Chelate-Mercury Ratio



Detected Free Hg vs Chelate Storage Time