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http://www.flyash.info/

Toxicity Mitigation and Solidification of MSW Incinerator Fly Ash Using Alkaline Activated Coal Ash

World of Coal Ash, Denver, CO, May 9-12

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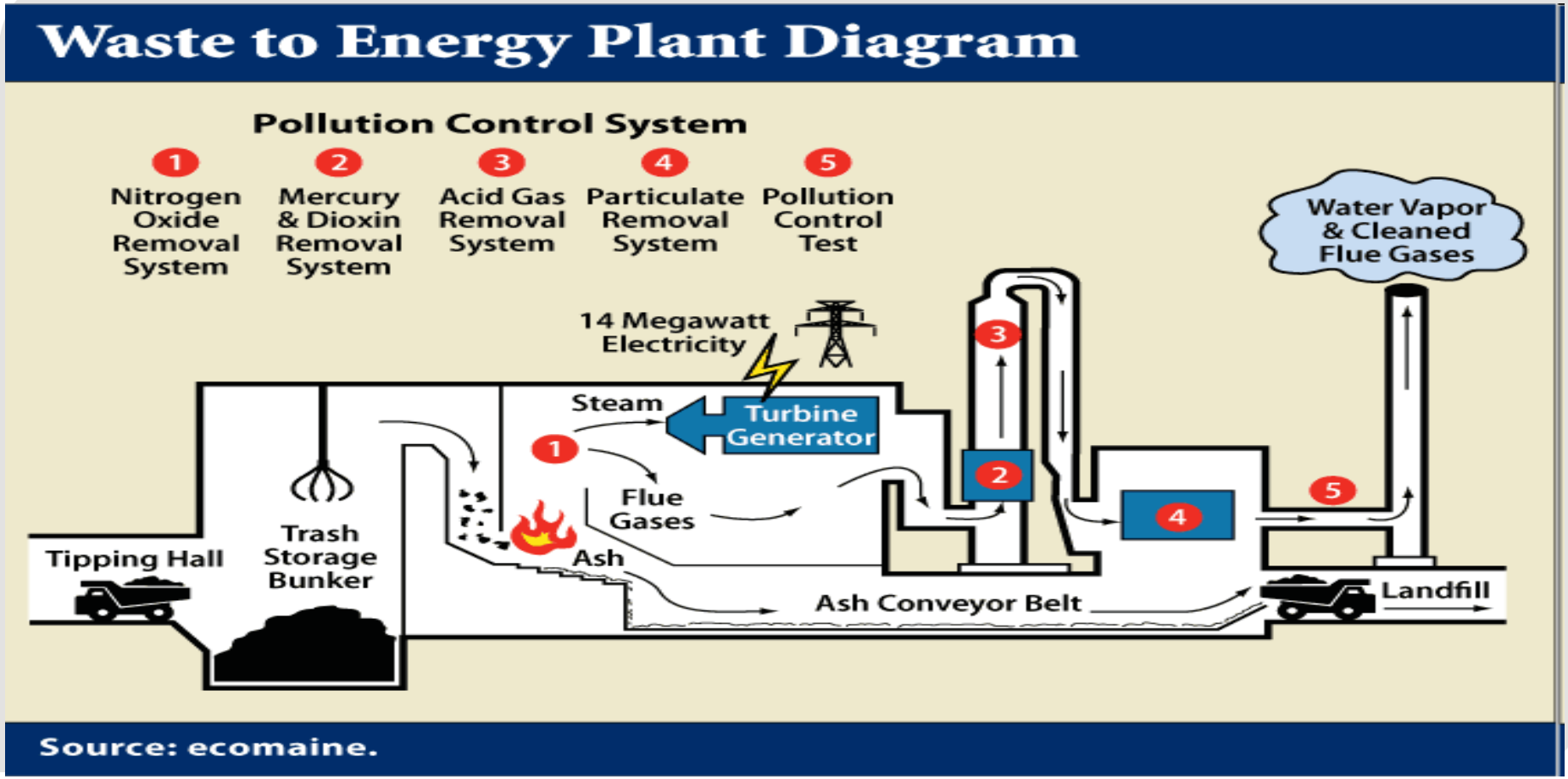
Outline

- MSW Incineration
- Mechanism of Stabilization/Solidification in GPC
- Experimental Plan
- Results
- Conclusion

Municipal Solid Waste Incineration



Municipal Solid Waste Incineration

ADVANTAGES

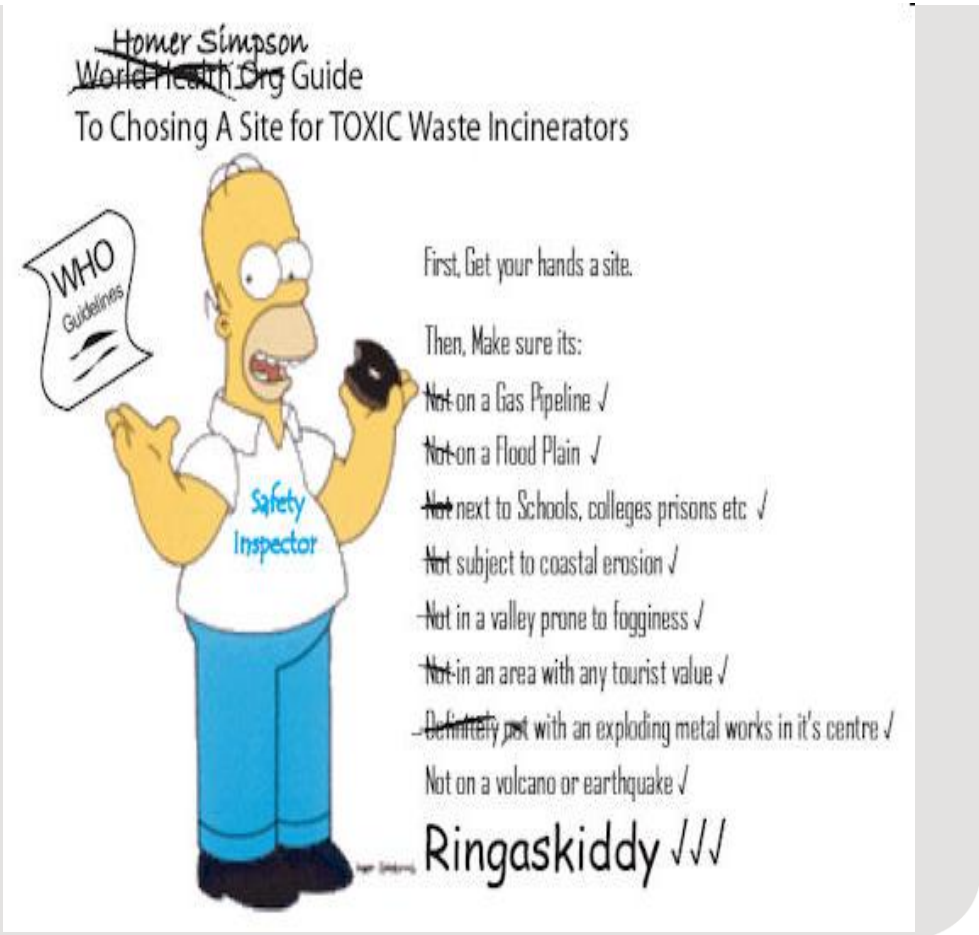
- Solid waste reduction of up to 90% by volume
- Energy recovery (in some cases)
- Sustainable solid waste management

DISADVANTAGES

- Dioxins and Furans
- CO2,NOx & SOx emissions
- Heavy metals and salts
- Cost

Those in Favor…

Those Against…



Current treatment Methods of IFA

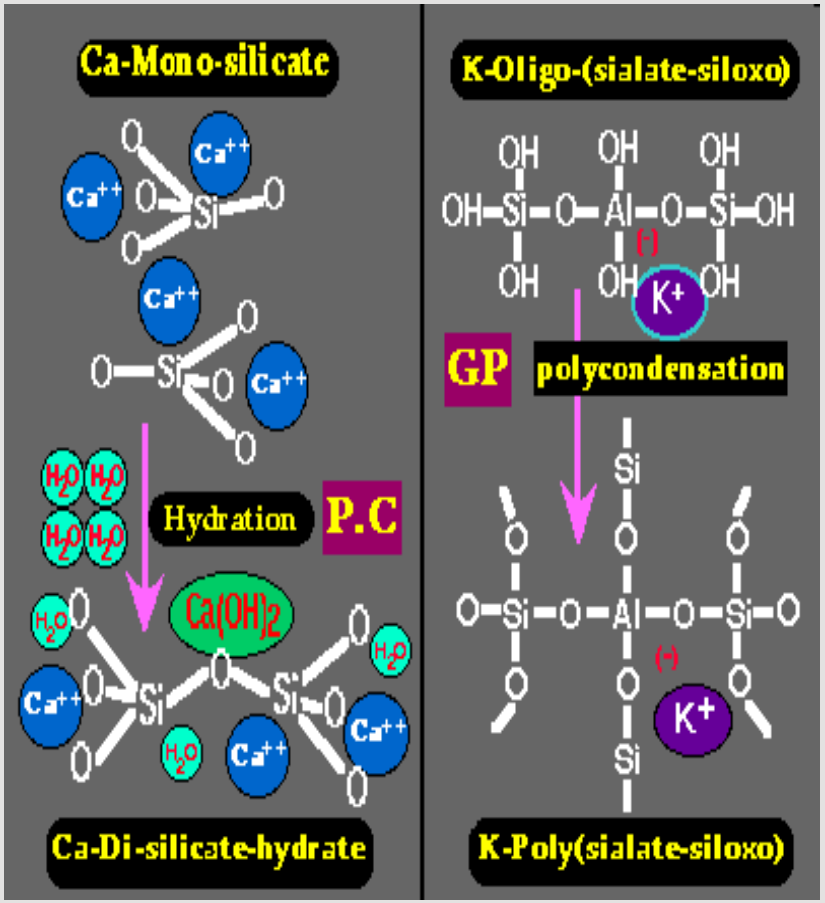
- Chemical washing
- Extraction and chloride evaporation
- Vitrification
- Soliroc

Disadvantages

- Expensive
- Energy consumption
- Generate other waste
- Product not to be used due to its toxicity

Immobilization/Stabilization Mechanism in a Geopolymer Network

1. Metal ions are taken into the geopolymer network
2. They assume charge balancing roles
3. Remaining metal iones are physically encapsulated in the geopolymer matrix



Experimental Plan

- Gradually substitute Coal-derived fly ash (CFA) with Incinerator fly ash (IFA) in a geopolymer matrix
  1. Control sample of CFA designated as 00-100
  2. 20% of CFA was substituted by IFA, this mixture was labeled as 20-80
  3. 40, 60, 80 and finally a control sample of IFA labeled as mixtures 40-60, 60-40, 80-20 and 100-00, respectively

Tests

Fly Ash

- Chemical analysis (XRF)
- Crystallographic characteristics (XRD)
- Particle size distribution (Laser based)
- Particle Morphology (SEM)
- Leaching Tests (EPA's TCLP)

Concrete

- Compressive strength
- Flexural strength
- Elastic modulus
- Poisson's ratio
- Setting time
- Leaching Tests

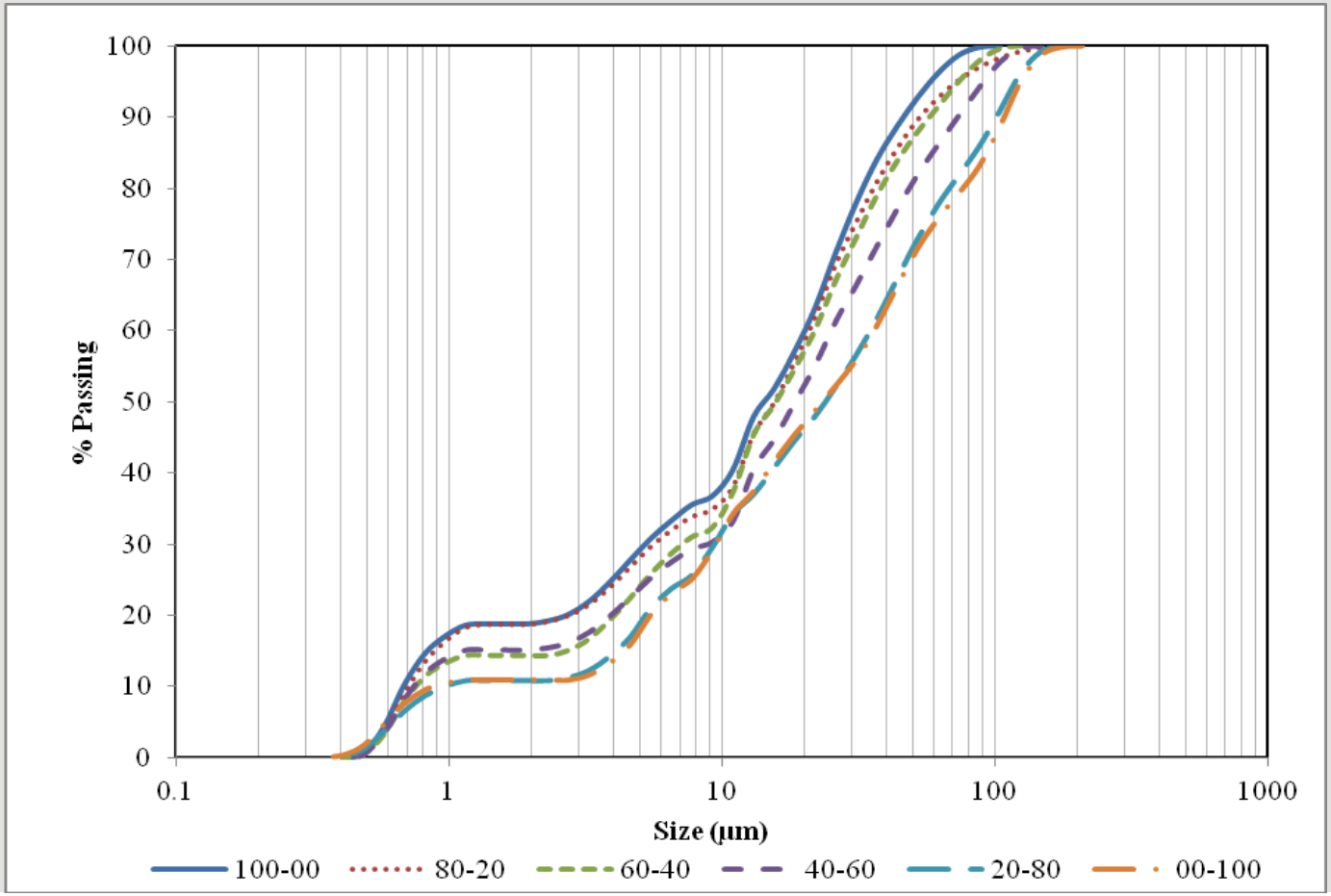
Chemical Analysis

IFA-CFA Oxide.	00-100	20-80	40-60	60-40	80-20	100-00
SiO2	62.12	50.37	38.62	26.87	15.12	3.37
Al2O3	19.59	16.01	12.43	8.85	5.27	1.69
CaO	5.01	11.89	18.78	25.66	32.55	39.43
Fe2O3	6.88	5.71	4.54	3.37	2.21	1.04
MgO	2.18	1.95	1.72	1.48	1.25	1.02
SO3	0.21	0.76	1.30	1.85	2.39	2.94
Na2O	0.88	1.28	1.68	2.08	2.48	2.88
K2O	1.37	1.63	1.88	2.14	2.40	2.65
TiO2	1.01	0.92	0.83	0.75	0.66	0.57
MnO2	0.16	0.14	0.12	0.09	0.07	0.05
P2O5	0.09	1.97	3.84	5.72	7.60	9.47
SrO	0.20	0.18	0.15	0.13	0.11	0.08
BaO	0.20	0.17	0.14	0.11	0.08	0.05
Cl		3.26	6.53	9.79	13.06	16.32
Moisture content	0.17	0.14	0.10	0.07	0.03	0.00
Loss On Ignition	0.10	3.23	6.35	9.48	12.60	15.73

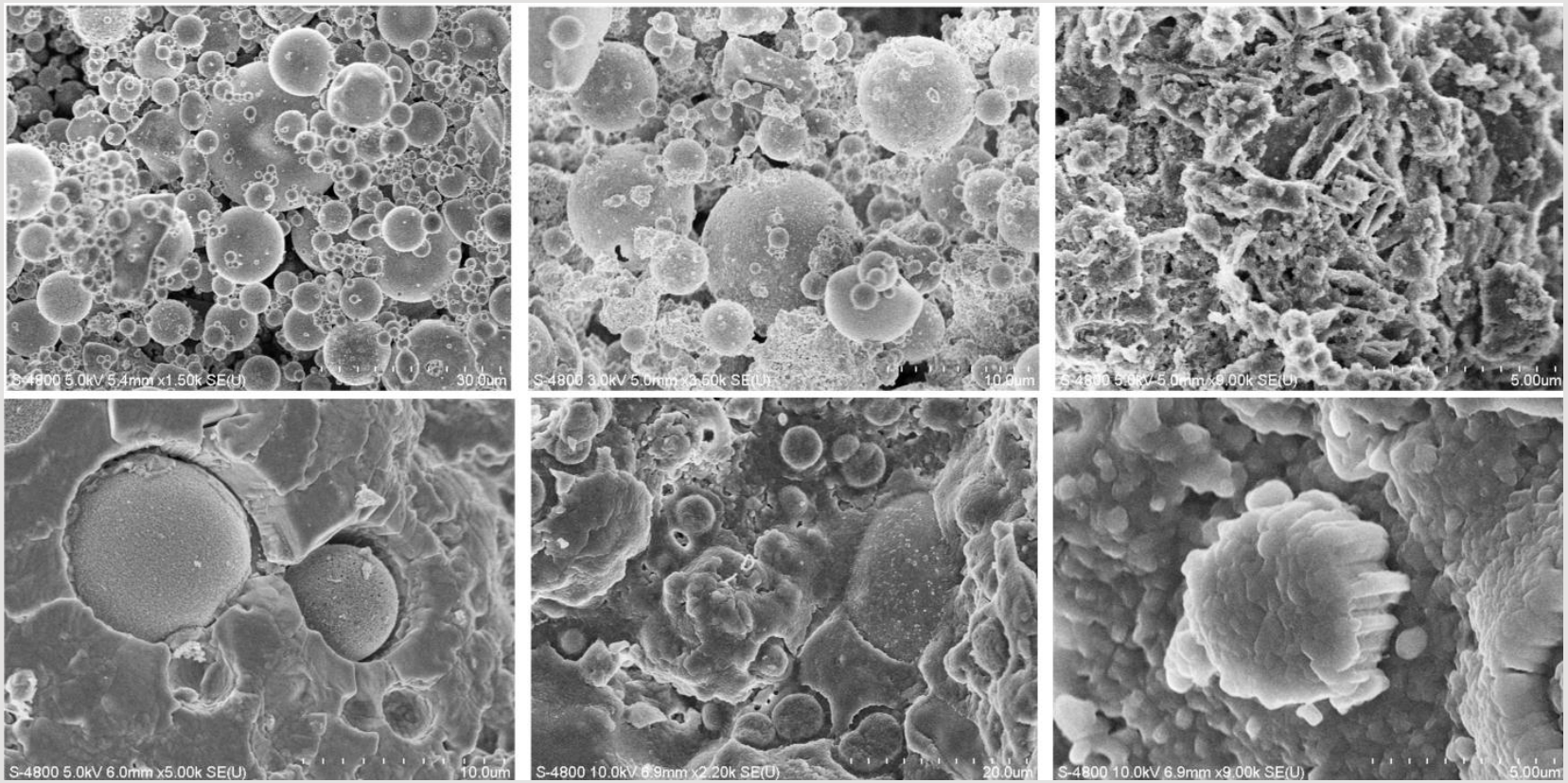
Crystallographic Characteristics

Component ID Code	00-100		20-80		40-60		60-40		80-20		100-00	
	FA	GP	FA	GP	FA	GP	FA	GP	FA	GP	FA	GP
Anhydrite $CaSO_4$			0.08		0.38		0.96		1.60		2.00	
Anorthite $CaAl_2Si_2O_8$			0.12		0.58		1.44		2.40		3.00	
Calcite ($CaCO_3$)			0.12	0.28	0.58	1.40	1.44	3.50	2.40	5.84	3.00	7.30
Gehlenite $Ca_2Al_2SiO_7$			0.15		0.77		1.92		3.20		4.00	
Hematite (Fe_2O3)		0.20		0.16		0.10		0.04		0.01		
Ellestadite $Ca_5(SiO_4, PO_4, SO_4)(F,OH,Cl)$)			1.20	1.38	2.40	2.76	3.60	4.14	4.80	5.52	6.00	6.90
Halite (NaCl)			0.60	1.50	1.20	3.00	1.80	4.50	2.40	6.00	3.00	7.50
Magnetite (Fe3O4)	1.00	0.80	0.80	0.64	0.60	0.48	0.40	0.32	0.20	0.16		
Mullite ($Al_{4.5}Si_{1.5}O_{9.75}$)	5.20	4.80	4.16	3.84	3.12	2.88	2.08	1.92	1.04	0.96		
Quartz (SiO_2)	20.70	12.20	16.66	9.82	12.62	7.44	8.58	5.06	4.54	2.68	0.50	0.30
Sylvite (KCl)			0.04		0.08		0.12		0.16		0.20	
Na_2CO_3			0.20		0.40		0.60		0.80		1.00	
Amorphous	73.10	82.00	73.94	81.20	74.78	80.40	75.62	79.60	76.46	78.80	77.30	78.00

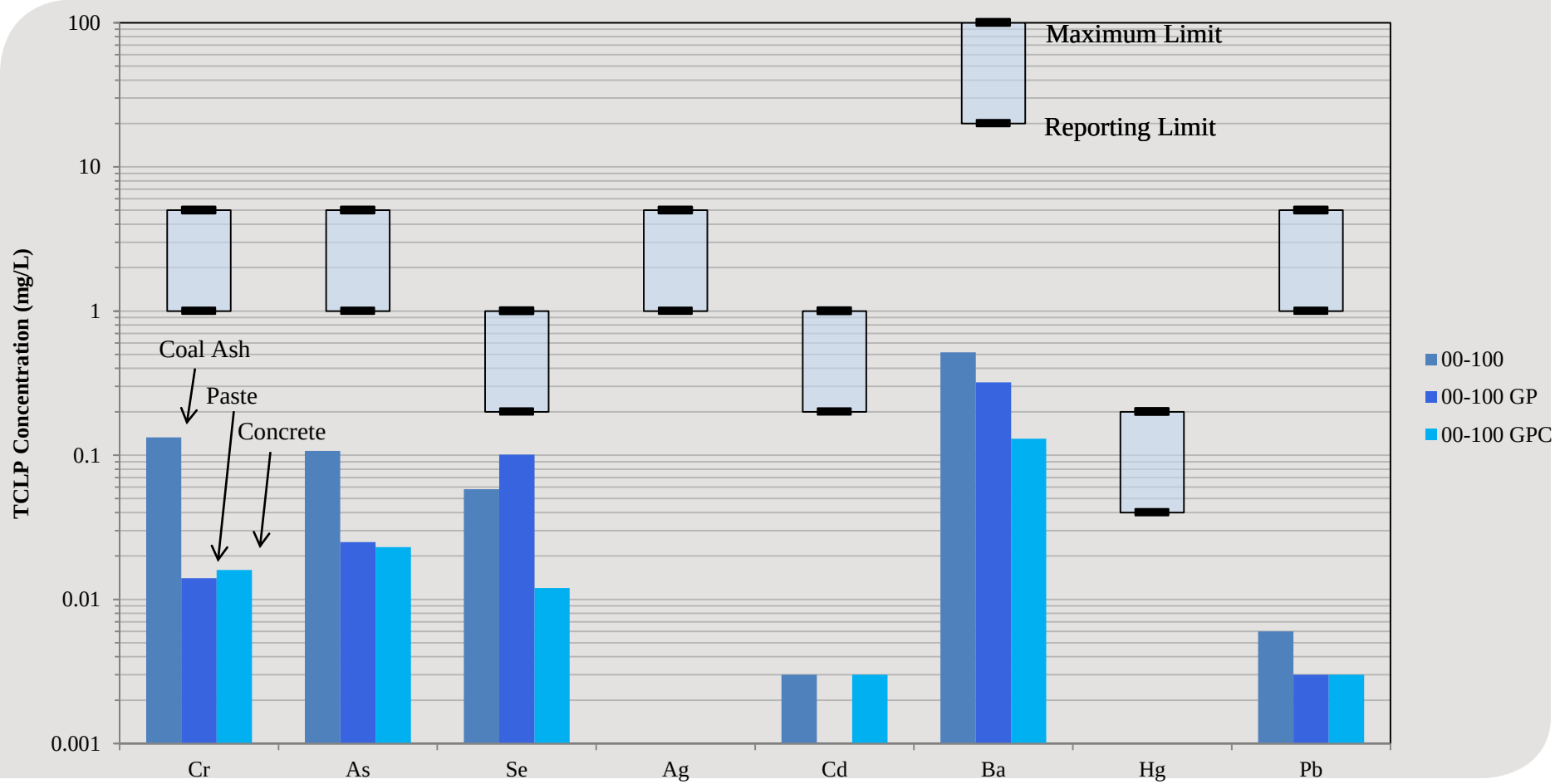
Particle Size Distribution



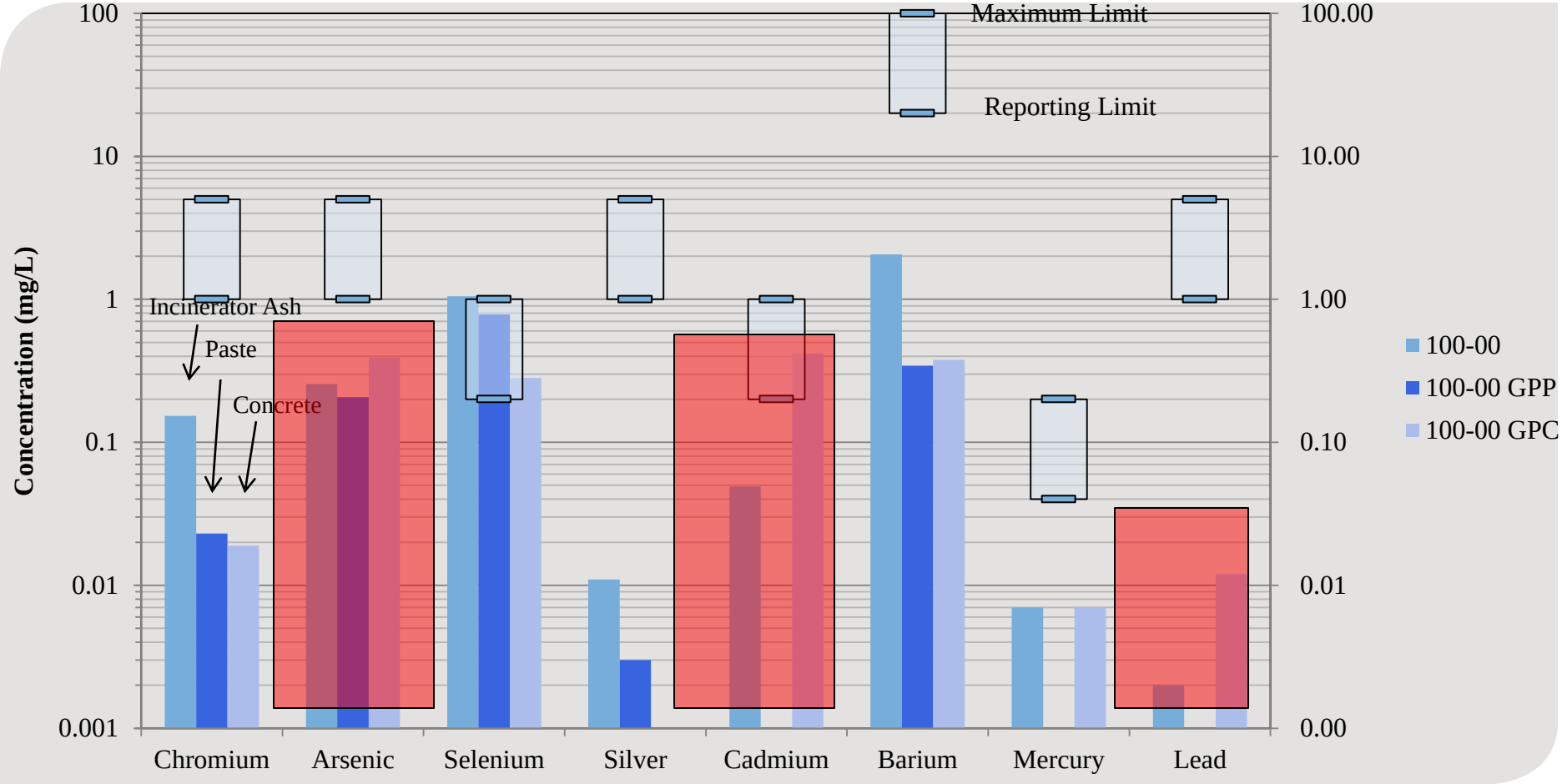
Scanning Electron Microscopy



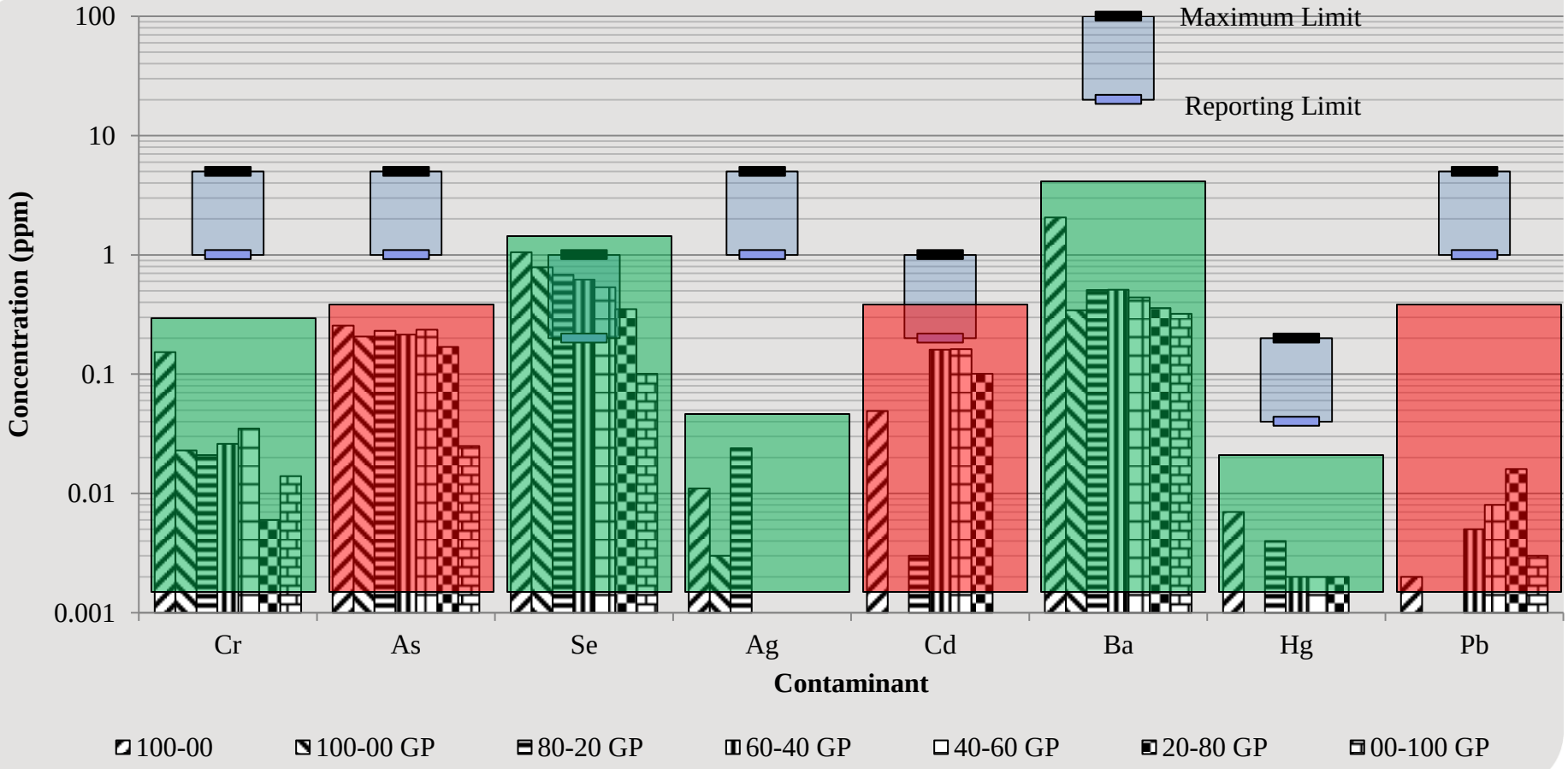
Leaching of Coal Fly Ash



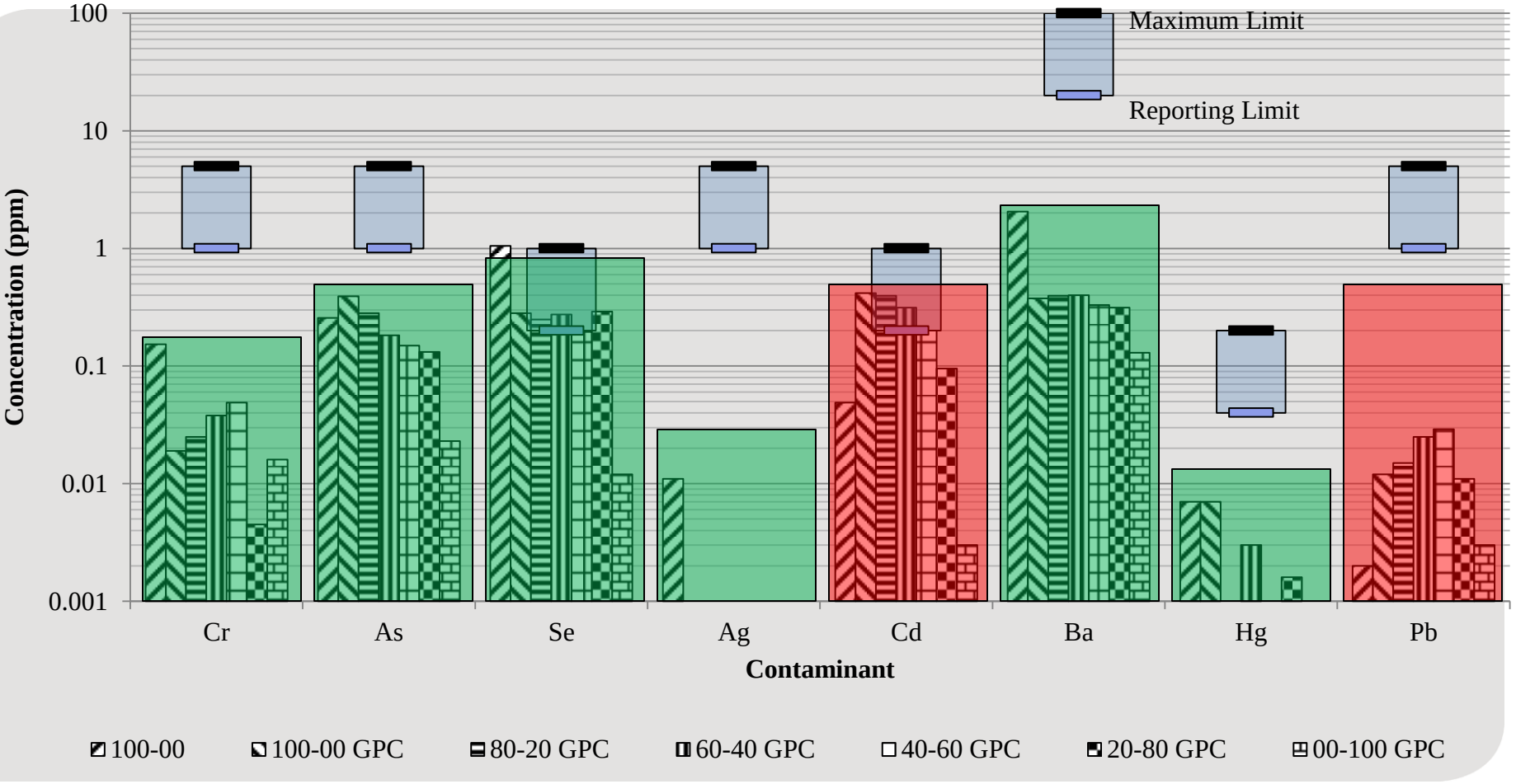
Leaching of Incinerator Fly Ash



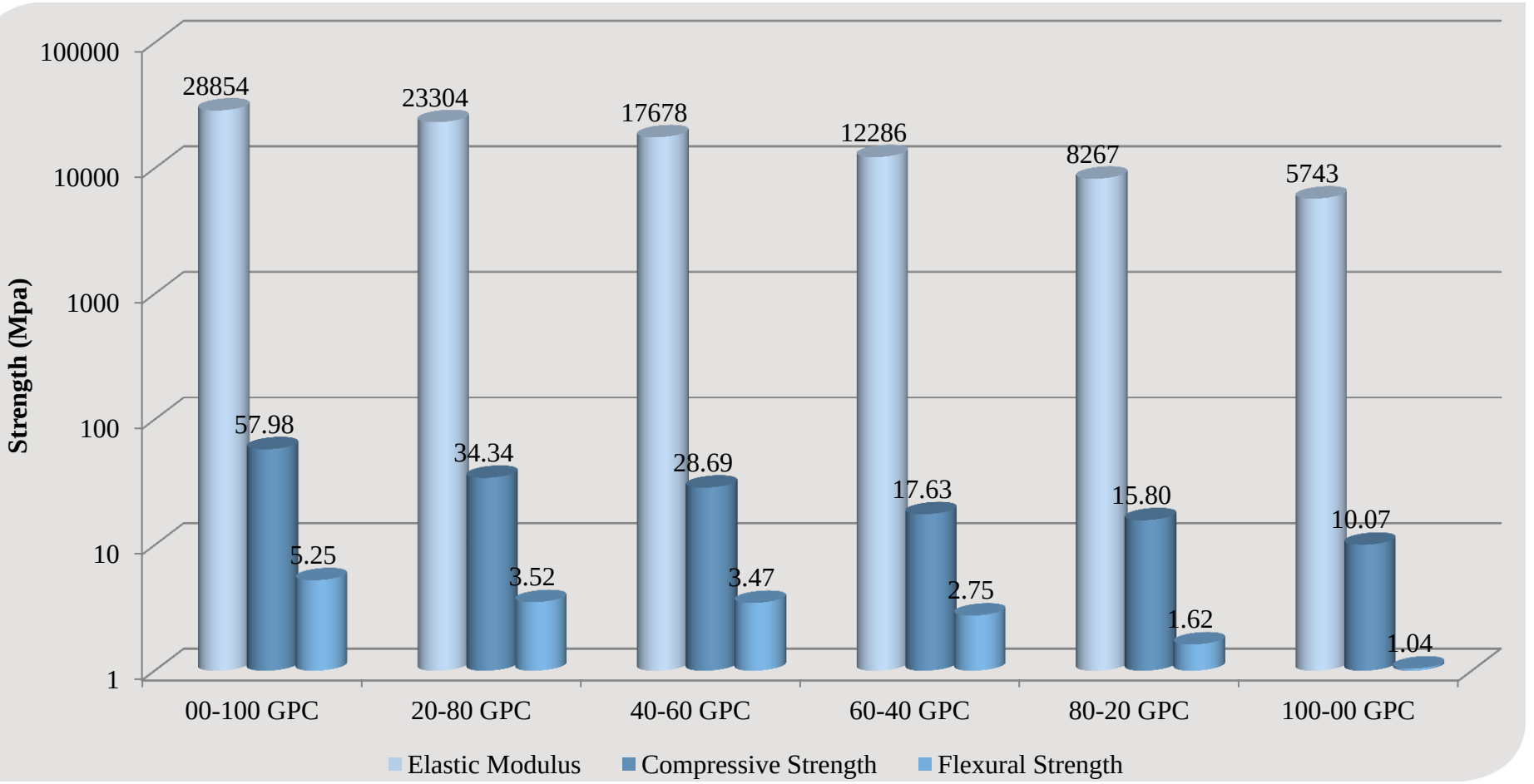
Toxicity Reduction in GPP



Toxicity Reduction in GPC



Mechanical Characterization of Concrete Samples



Conclusions

- The leachability of Cr, As, Se, Ag, Ba and Hg contained in IFA can be effectively reduced in a geopolymer concrete network
- No reduction in the leachability levels of Cd and Pb
- TCLP results and mechanical tests suggest that the concrete product could be used in construction applications

Thank you!

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