URBAN SOLUTIONS AND SUSTAINABILITY

R&D CONGRESS 2023

BUILDING SUSTAINABLE, RESILIENT, AND LIVEABLE CITIES OF TOMORROW

4TH – 5TH OCTOBER 2023

PRODUCING SLAG FROM SLUDGE AND EXPLORING ITS USE IN STRUCTURAL APPLICATIONS

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A feasibility study and long-term technical evaluation for the use of sludge-derived slag as NEWSand for structural applications and enhanced resource recovery from sludge through high temperature slagging gasification process

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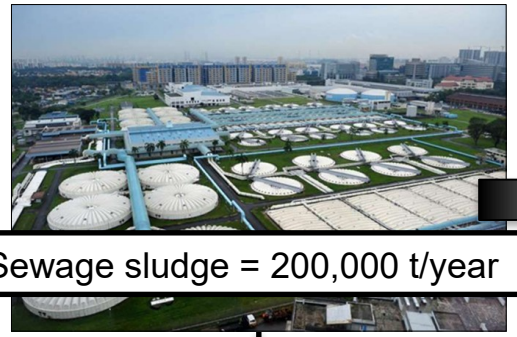
Nanyang Environment & Water Research Institute (NEWRI), Nanyang Technological University

5th October 2023

Problem definition – Sustainable waste management

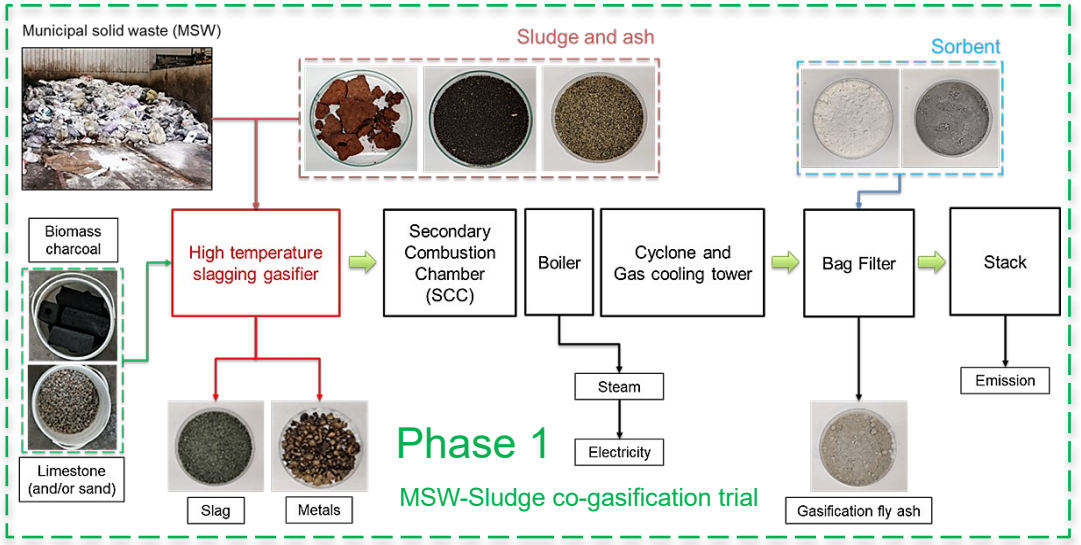


Sewage sludge = 200,000 t/year

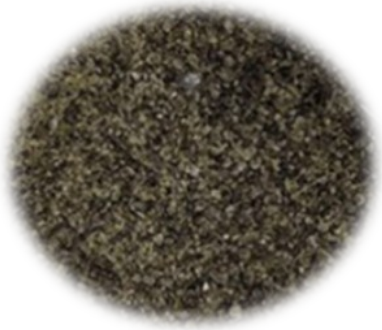
Sludge incineration ashes = 35,000 t/year

Waterworks sludge = 15,000 t/year

High temperature slagging gasification



Sludge-derived slag

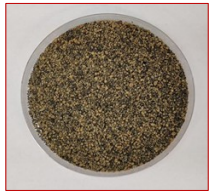


For reutilization as a NEWSand

Proposed solution – From Sludge to Slag

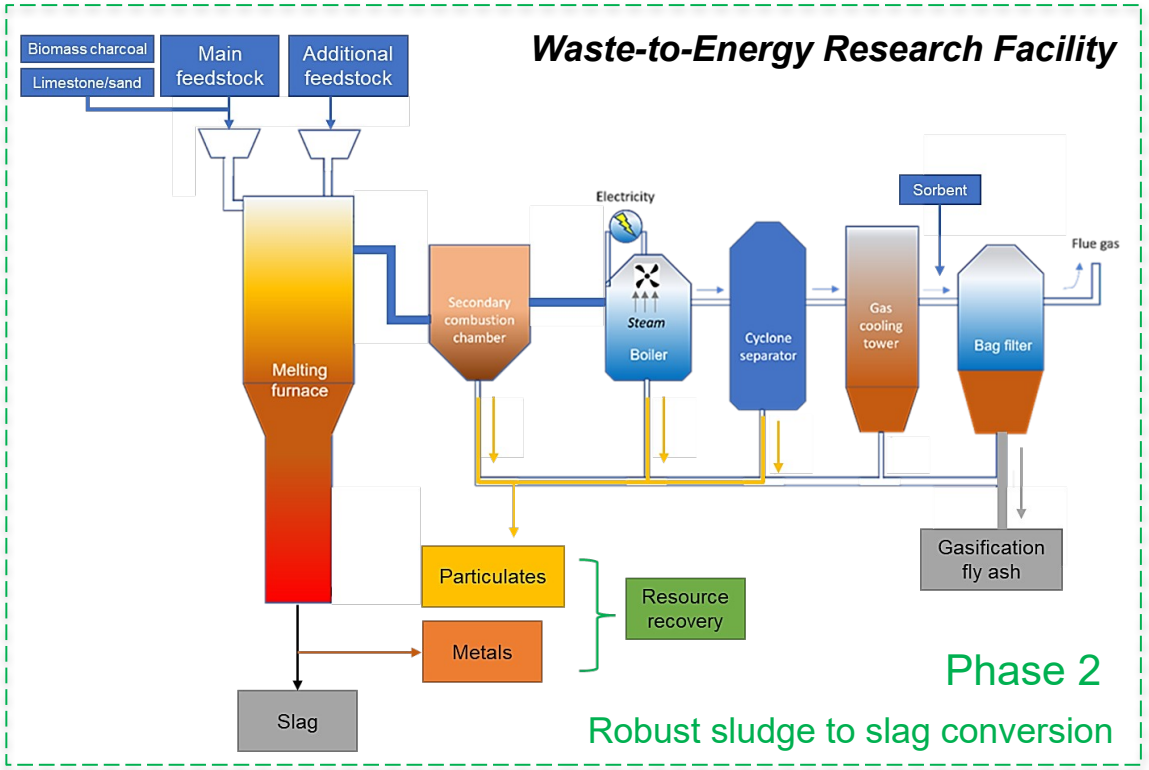
Dried sewage sludge

Sewage sludge ashes

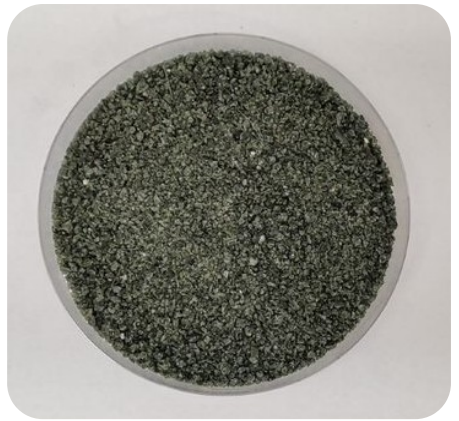


Waterworks sludge

Sludge-based gasification



Sludge-derived slag for reutilization



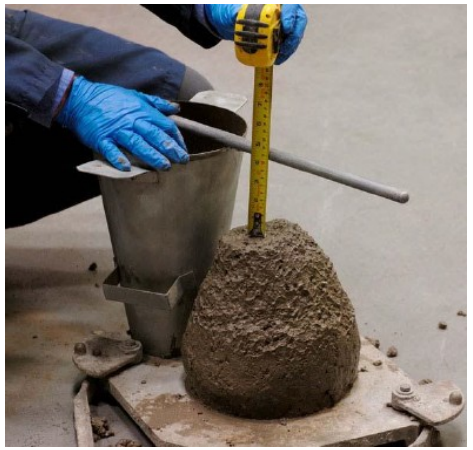
Resource recovery from by-products

Metals | Particulates | Fly ash

- A long-term feasibility study and technical evaluation at demonstration scale
- Increase the co-gasification ratio of sludge from 50% and up to 100% with modification and operation at WTERF
- Explore optimum sludge-based gasification mix with sewage sludge, sludge ash and waterworks sludge
- Produce up to 100 tonnes of sludge-derived slag with consistent properties based on the optimum mix
- Resource recovery (P and valuable metals) from the by-products and concurrently generate cleaner residues
- Structural application of sludge slag concrete with sand replacement for future application in PUB's facilities
- Techno-economic analysis (TEA) and life cycle assessment (LCA) to support the decision making
- Contributing towards the circularity of economy and closing the waste loop for Singapore

Structural application of Sludge-derived Slag

Fresh concrete properties

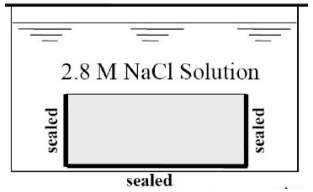


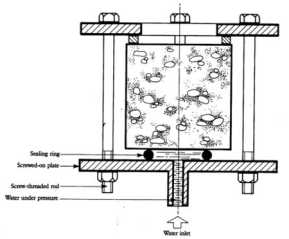
- Slump
- Bleeding
- Setting time

Mechanical properties

- Compressive strength
- Tensile strength
- Modulus of elasticity
- σ-ε relationship
- Shrinkage and creep

Durability





- Water absorption
- Chloride diffusivity
- Water permeability
- Carbonation
- Sulfate content

Objective: To determine the properties and specifications of the slag-derived concrete developed in this project.