Physico-chemical evolution of geopolymers in contact with aggressive environment

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Introduction

Geopolymers are alkali aluminosilicate gels, as consisting of an amorphous network of aluminate and silicate tetrahedral sharing bridging oxygen atoms. These materials have been identified as one of the potential low CO_2 alternatives to ordinary Portland cement (OPC) towards sustainable construction materials by conversion of several wastes streams into useful products.

However, there is a lack of knowledge on understanding of **the (long-term) durability** of geopolymers under environmental conditions relevant for conditioning and disposing a (radioactive) waste stream. This research aims at performing a comprehensive study to assess the evolution of physical and chemical properties of geopolymers in contact with various aggressive environments (representative for certain waste streams).

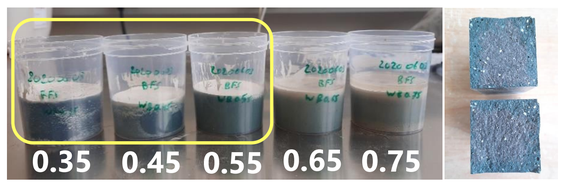
Objectives

1. Synthesis geopolymers with appropriate structure for waste immobilization
2. Investigation the interaction between geopolymers and waste stream
3. Development models for predicting the long-term durability of geopolymers in contact with aggressive environment

Methodology

Results & Discussion

Examining water to binder ratios (w/b)

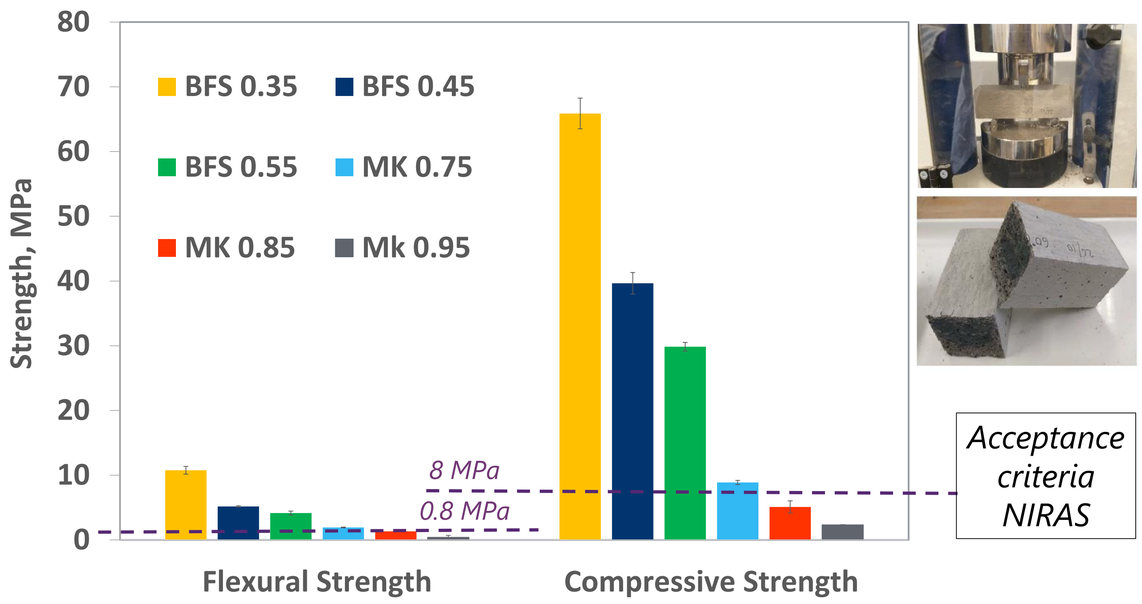


Blast furnace slag (BFS)

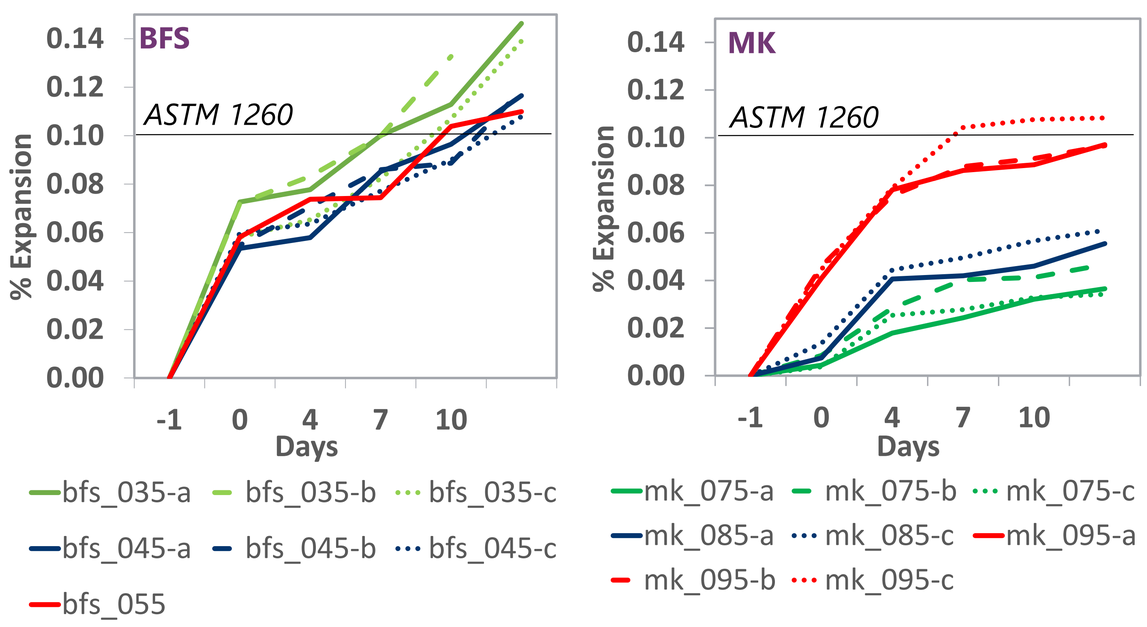
Metakaolin (MK)

The w/b values of **0.35, 0.45, 0.55** for BFS and **0.75, 0.85, 0.95** for MK-based geopolymer could be the most suitable. → MK is more potential for waste immobilization.

Strength at 28 days



Alkali silica reaction (ASR)

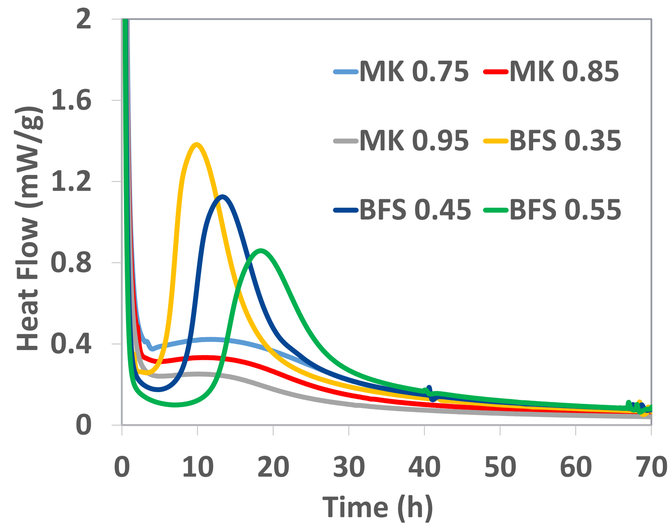


Geopolymers produced from BFS are more vulnerable to ASR than from MK.

Early age properties

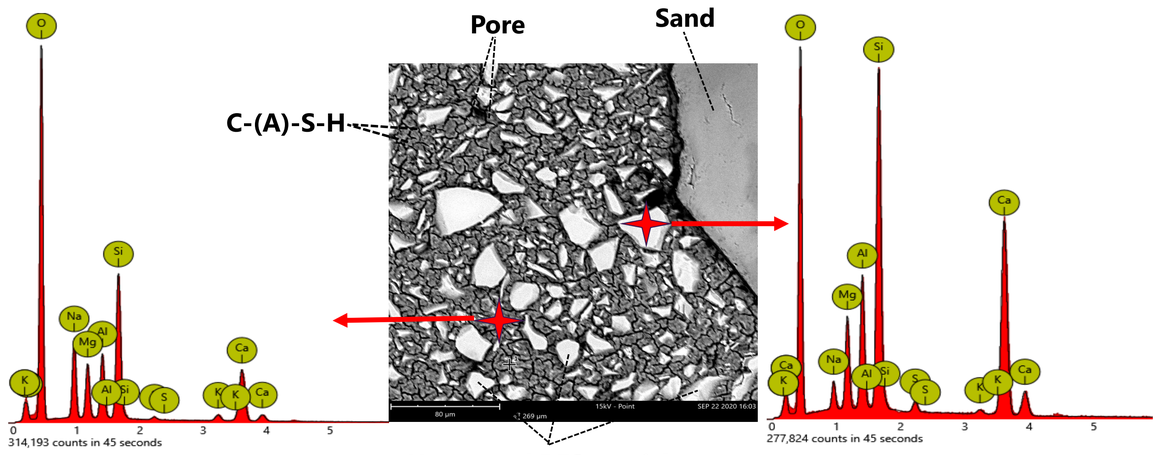
The higher w/b is, the higher heat releases on both BFS and MK.

→ **BFS based geopolymers are much reactive than MK based ones due to low w/b ratios.**



SEM/EDX

SEM image of BFS-based mortar with w/b=0.35



Aluminosilicate gel (C-(A)-S-H) or geopolymer was already formed.

Conclusion

- The w/b 0.35, 0.45, 0.55 for BFS –based gepolymers are suitable due to high mechanical strength and acceptable ASR expansion. The w/b for MK still need to be further investigated.
- MK can produce geopolymers with higher potential for liquid waste immobilization thanks to the capacity to contain higher water content of matrixes.
- MK-based geoplymers are good at ASR resistance.

Future plans

- Re-design recipes for MK-based geopolymers
- Investigate the transport properties of geopolymers: permeability, diffusivity, sorptivity
- Examine the leaching behavior

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