Experimental Leaching Testing of Air Cooled Blast Furnace Slag Materials

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Introduction

- **Air-cooled blast furnace slags (ACBFSs) are steelmaking co-products** valued in construction for their favorable physical and mechanical properties.
- Different cooling methods of molten slag produce distinct forms of steel slags**; ACBFS is formed by slow air cooling.**
- Due to their durability and high performance, ACBFSs are widely used in roadway and geotechnical applications, **providing environmental and economic benefits by reducing reliance on natural aggregates.**

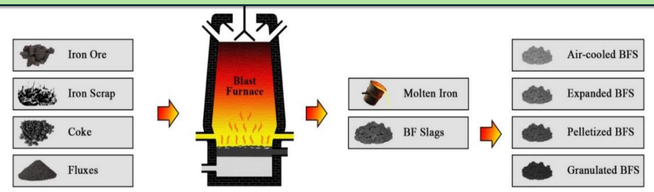


Figure 1. Blast furnace slag production process.(Pasetto et al., 2023)

16 million tons produced annually. 54% Blast furnace slag (USGS, 2024)

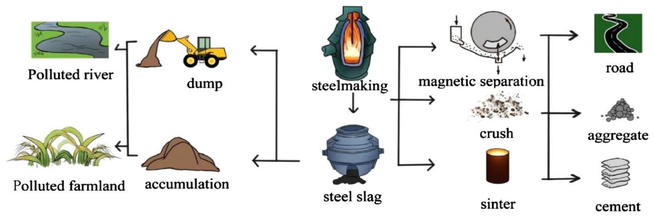


Figure 2. Steel slag production and disposal routes (Song et al., 2021)

Research Problem and Objectives

- **Conventional testing protocols (e.g., ITM-212) may not fully capture the unique leaching behavior of ACBFS under field representative conditions.**

- **Evaluate the applicability and limitations of existing test methods for ACBFS.**
- **Perform laboratory leaching studies (batch, column, and stockpile tests) to better simulate field conditions.**
- **Compare results from conventional and alternative approaches.**
- **Propose more representative testing protocols to assess the environmental performance of ACBFS.**

Materials and Methods

Figure 3. Air-Cooled Blast Furnace Slag Samples

Figure 4. Subgrade Samples

Leaching Tests

Batch Tests

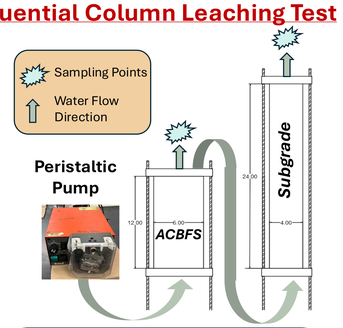
ITM-212 Protocol

- L/S of 0.4 mL/g-dry
- 1, 3, 7 and 15 days
- Only ACBFS

Sequential Batch Test

- L/S of 10 mL/g-dry
- 1, 7, 30, 90 and180 days
- ACBFS + Subgrade

Sequential Column Leaching Test



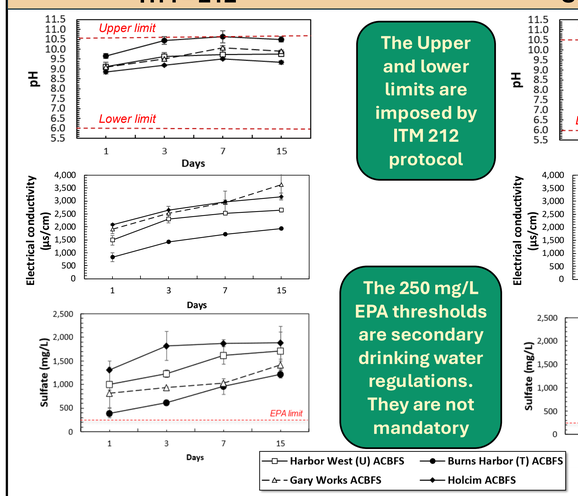
Stockpiles

Parameters

- ❑ Ph
- ❑ Electrical Conductivity (EC)
- ❑ Oxidation Reduction Potential
- ❑ Alkalinity
- ❑ Sulfate Content
- ❑ Color and Odor
- ❑ Metals Concentration

Results

ITM – 212



The Upper and lower limits are imposed by ITM 212 protocol

The 250 mg/L EPA thresholds are secondary drinking water regulations. They are not mandatory

(U : Untreated, T : Treated)

Stagnant Batch Test

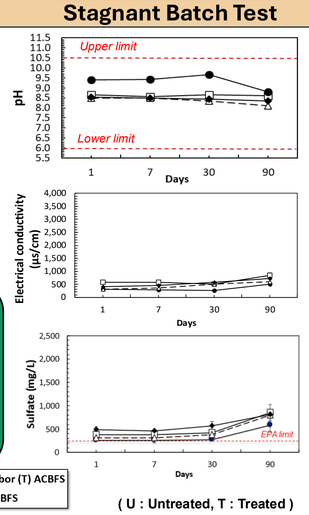


Figure 5. pH, EC and Sulfate Concentration for ITM-212 and Stagnant Batch Test

Results

ITM – 212

Color Before Filtration (PCU)	1 Day	3 Days	7 Days	15 Days
Harbor West Indiana (Untreated)	180	250	280	365
Burns Harbor Indiana (Treated)	500	500	500	500
Gary Works Indiana	500	500	500	500
Holcim Pennsylvania	500	500	500	500
Color After Filtration (PCU)	**1 Day**	**3 Days**	**7 Days**	**15 Days**
Harbor West Indiana (Untreated)	0	0	0	0
Burns Harbor Indiana (Treated)	0	0	0	0
Gary Works Indiana	0	0	175	263
Holcim Pennsylvania	0	0	50	50

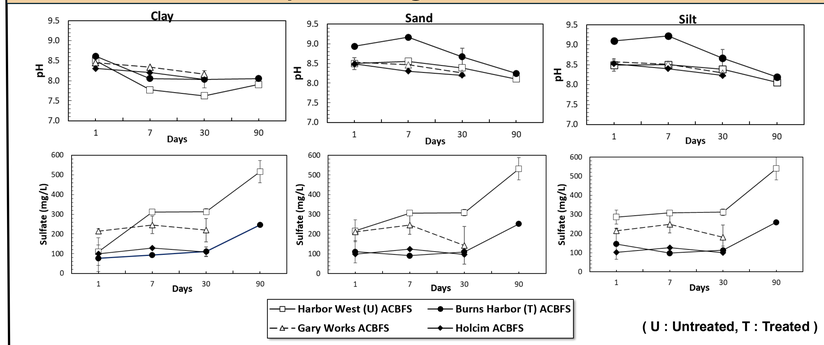
Stagnant Batch Test

Color Before Filtration (PCU)	1 Day	7 Days	1 Month	3 Months
Harbor West Indiana (Untreated)	64	145	205	172
Burns Harbor Indiana (Treated)	500	500	500	325
Gary Works Indiana	98	50	64	10
Holcim Pennsylvania	267	215	260	360
Color After Filtration (PCU)	**1 Day**	**7 Days**	**1 Month**	**3 Months**
Harbor West Indiana (Untreated)	0	0	0	0
Burns Harbor Indiana (Treated)	0	0	0	0
Gary Works Indiana	0	0	0	0
Holcim Pennsylvania	0	0	0	0

Figure 6. Color measurements for ITM-212 and Stagnant Batch Test

- **An H_2S meter was also used during the test to measure the odor. The concentrations were below detection limit.**

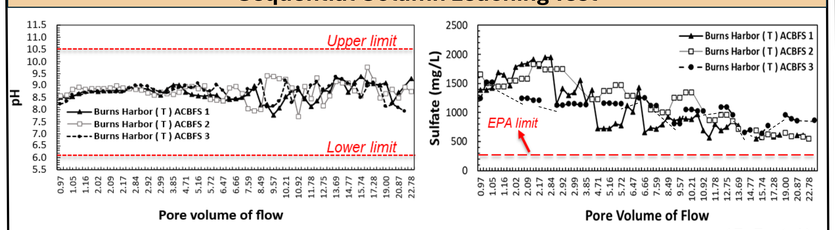
Sequential Stagnant Batch Test



(U : Untreated, T : Treated)

Figure 7. pH and Sulfate Concentration for Sequential Stagnant Batch Test

Sequential Column Leaching Test



(T : Treated)

Figure 9. pH and Sulfate Concentration for SCLT

Conclusions and Future Works

- **Results depend on methodology, and interactions with different soils may mitigate environmental impacts.**
- The treatment method provides **less electrical conductivity, lower sulfate and sulfur concentrations**
- These observations highlight the value of **developing more representative testing approach** instead of relying on a single protocol.
- **Numerical modelling needs to be carried out to link laboratory results with field conditions**, aiming to provide clearer insight into the long-term fate and environmental impacts of ACBFS leachate

References & Acknowledgements

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