Investigation of Thermochemical Conversion of Construction and Demolition Waste using Chemical Equilibrium

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Overview

- **Introduction**
- **Objectives**
- **Selected results**
- **Concluding Remarks**

Introduction

- Construction and demolition waste (C&DW) is generated during the construction, renovation, and demolition of buildings or houses

Composition

- Concrete
- Wood*
- Plastics
- Asphalt
- Gypsum
- Metals
- Bricks
- Glass
- Fiber

Fate

- Landfill
- Recycle
- Energy conversion

* May include chromated copper arsenate treated material

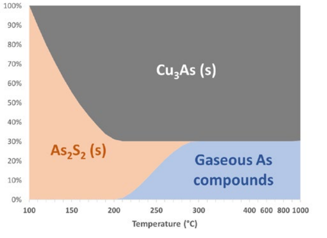
Objective

Feedstock collection & characterization

FactSage™

Gasification conditions

- Oxygen gasification ER=0.3
- Steam gasification S/B=1.0
- Oxygen + Steam gasification



Phase and concentration of inorganic species.

Special attention to Arsenic

Feedstock Collection

C&D Waste **mined from landfill** or truck intake

Material Processing

~50 kg of nominal <150 mm feedstock

Non combustible fraction: 0.19 ± 0.1

Mill to <6 mm

Riffle to 200 g

Ball mill to 0.2 mm

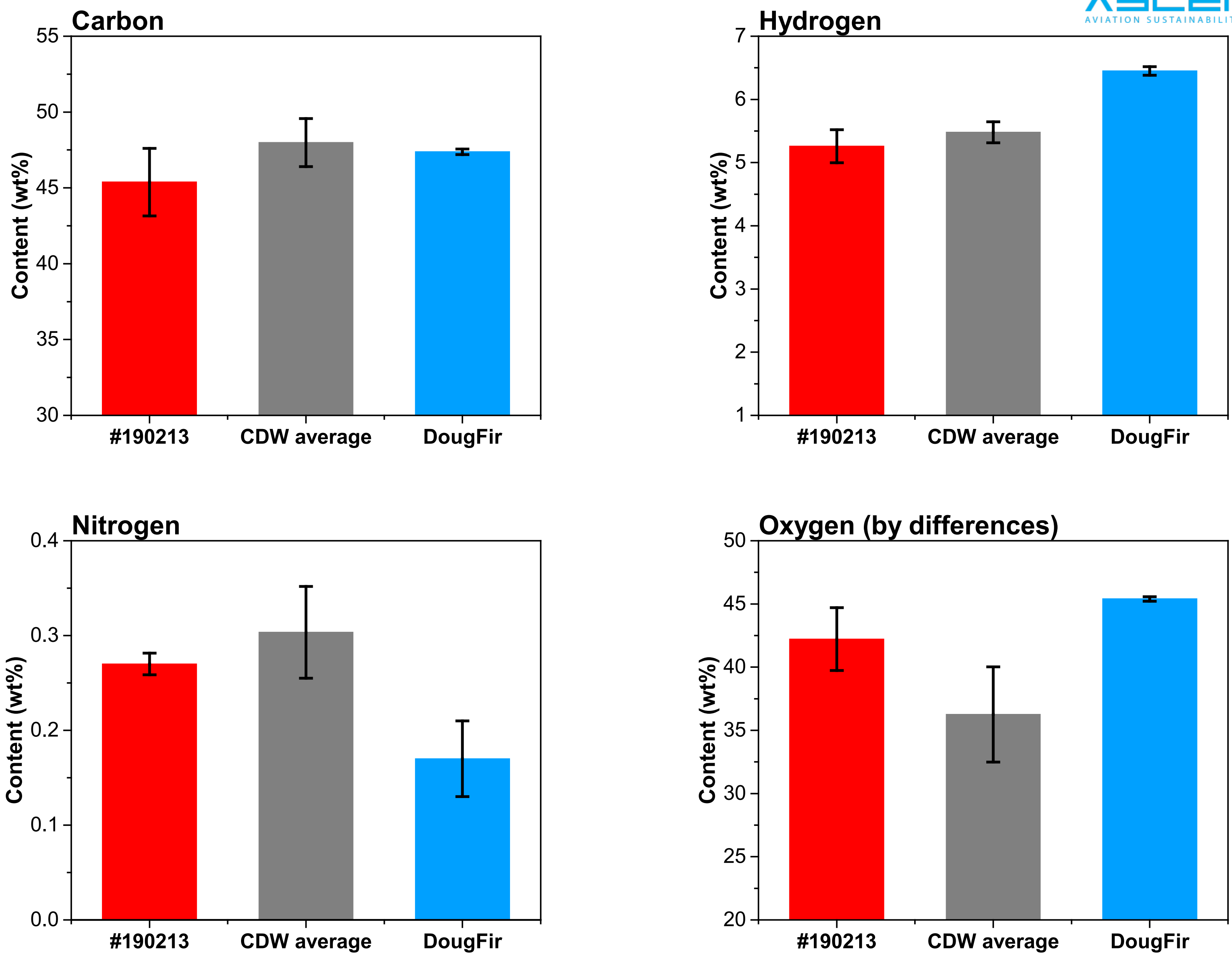
Analytical Requirement

Feedstock Characterization

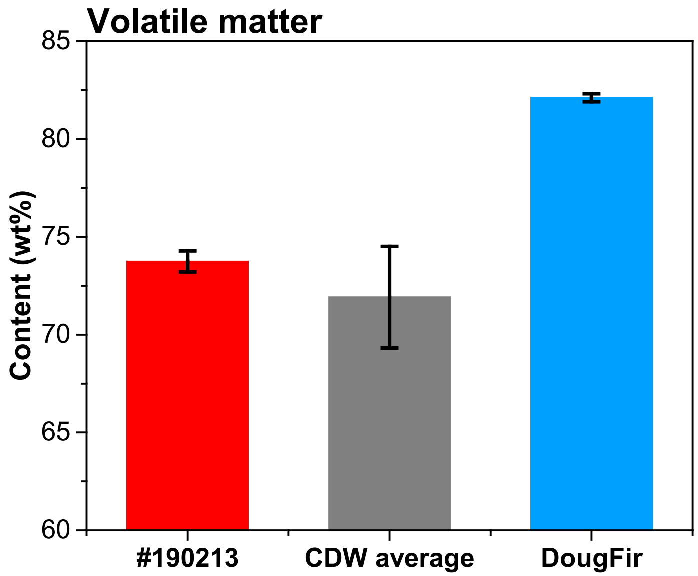
- **6 sampling events, 5 of those include 4 replicates**
- **Moisture content**
- **Proximate analysis**: volatile matter, fixed carbon and ash
- **Ultimate analysis**: C, H, O, N, and S
- **Major ash species**: Ca, Si, Fe, Al, Cl, Na, K, Mg, and Ti
- **Minor ash species**: Zn, Cr, Cu, Pb, Mn, P, As and Sr
- **Energy content** reported as higher heating value

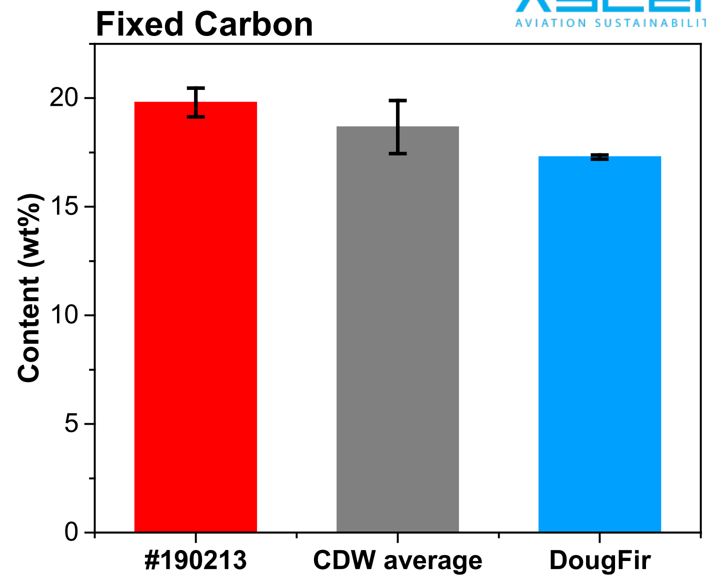
- Sample #190213 was used due to adequate Arsenic content
- Reference untreated construction wood: Douglas Fir lumber

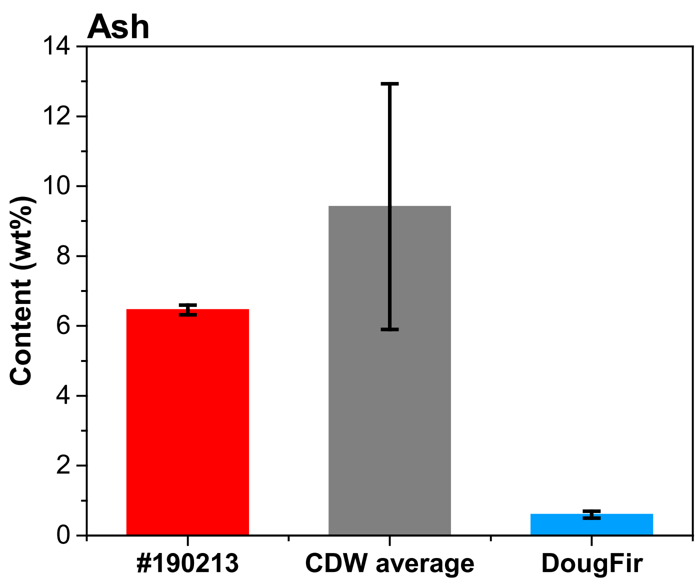
Ultimate Analysis

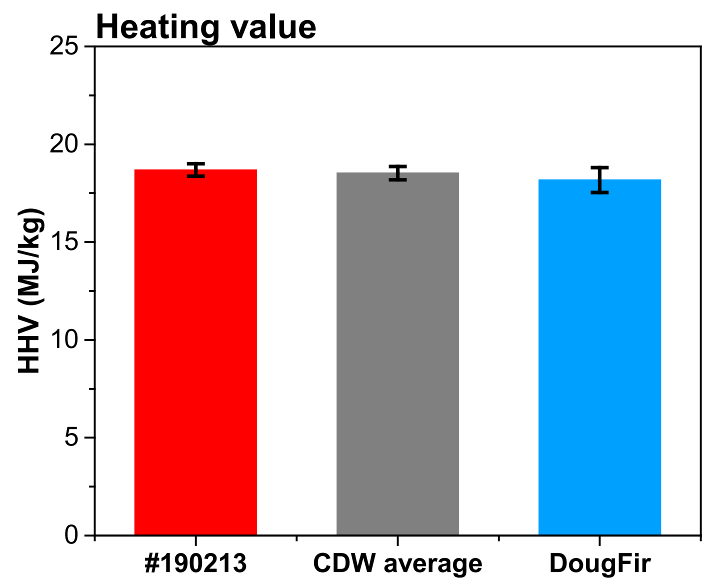


Proximate analysis

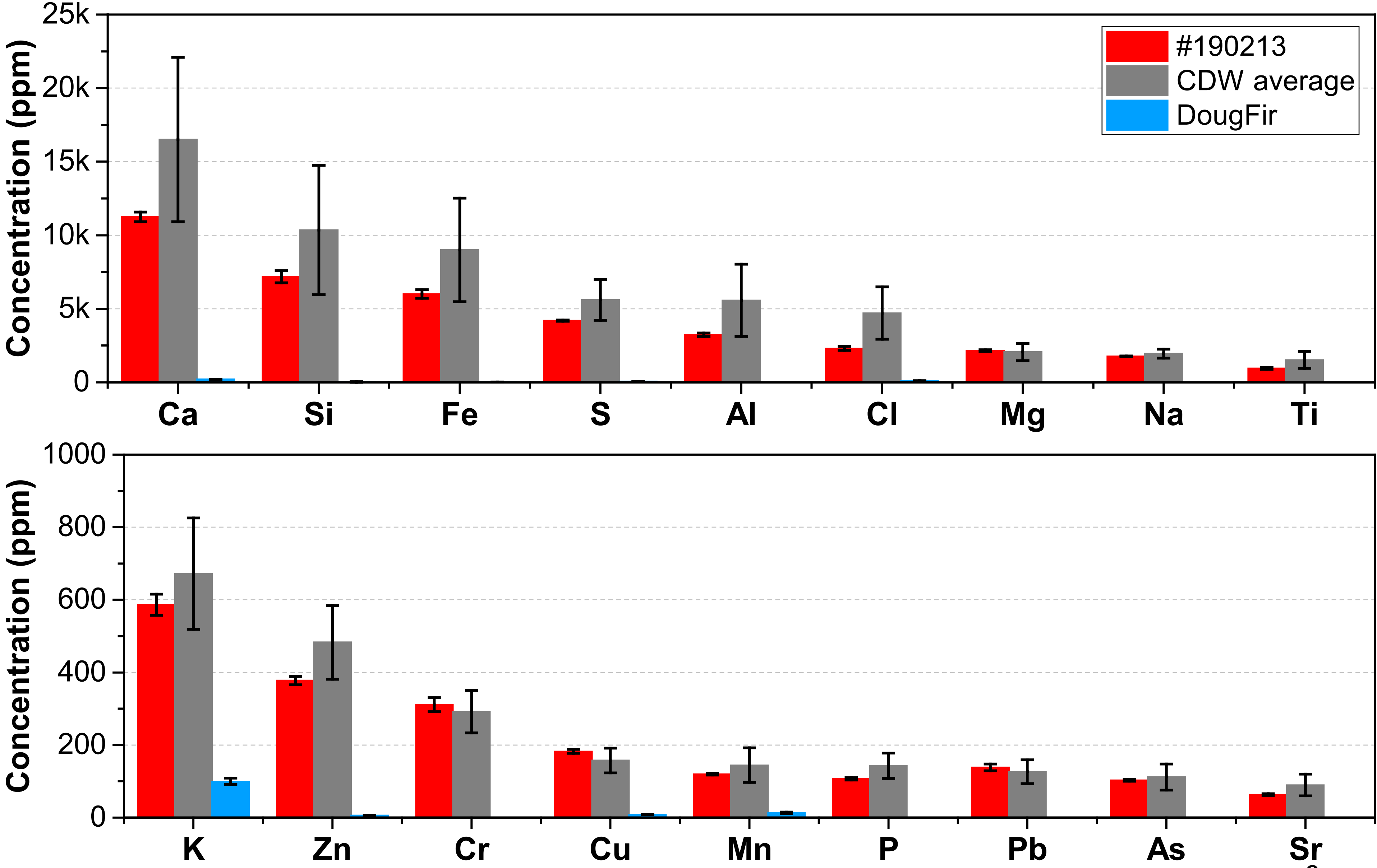








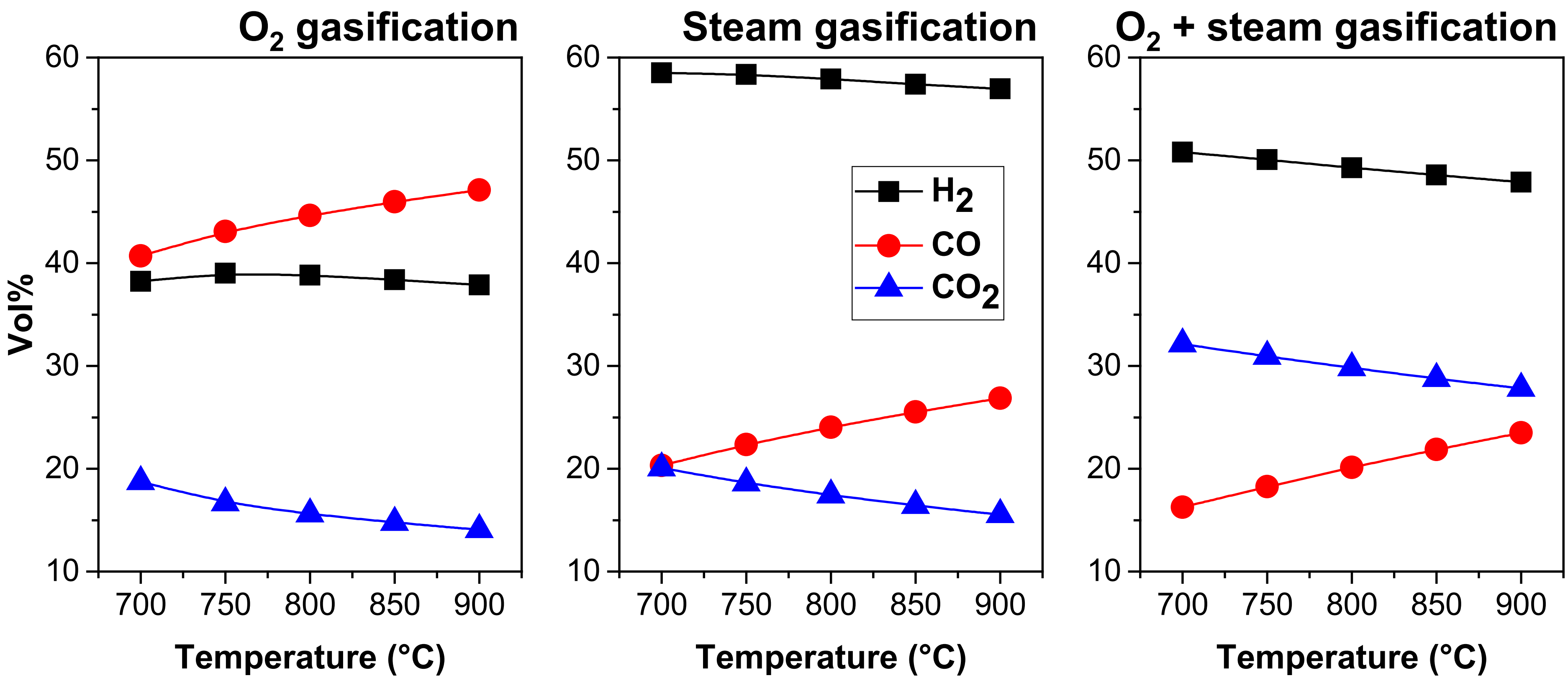
Elemental Analysis – Ash elements



Gasification conditions

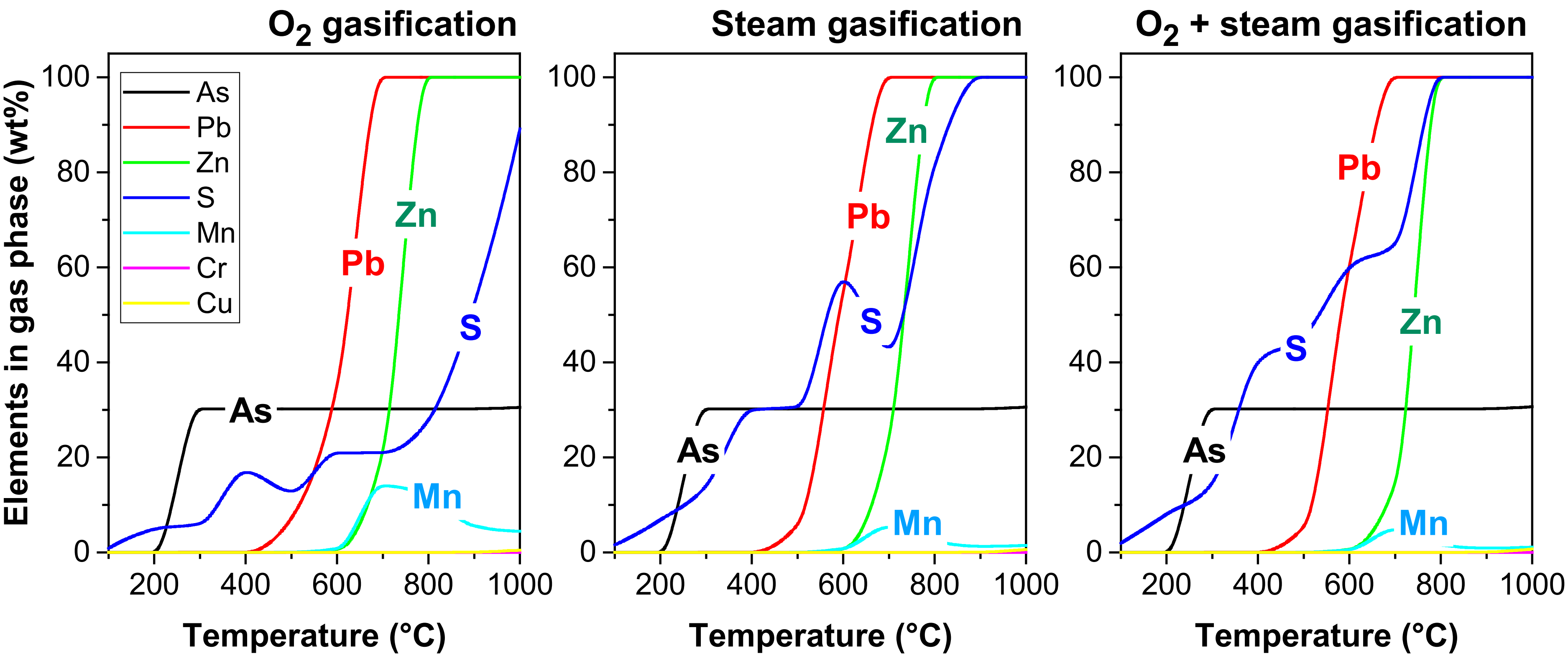
- Oxygen gasification ER=0.3
- Steam gasification S/B=1.0
- Oxygen + Steam gasification

Main components in dry product gas



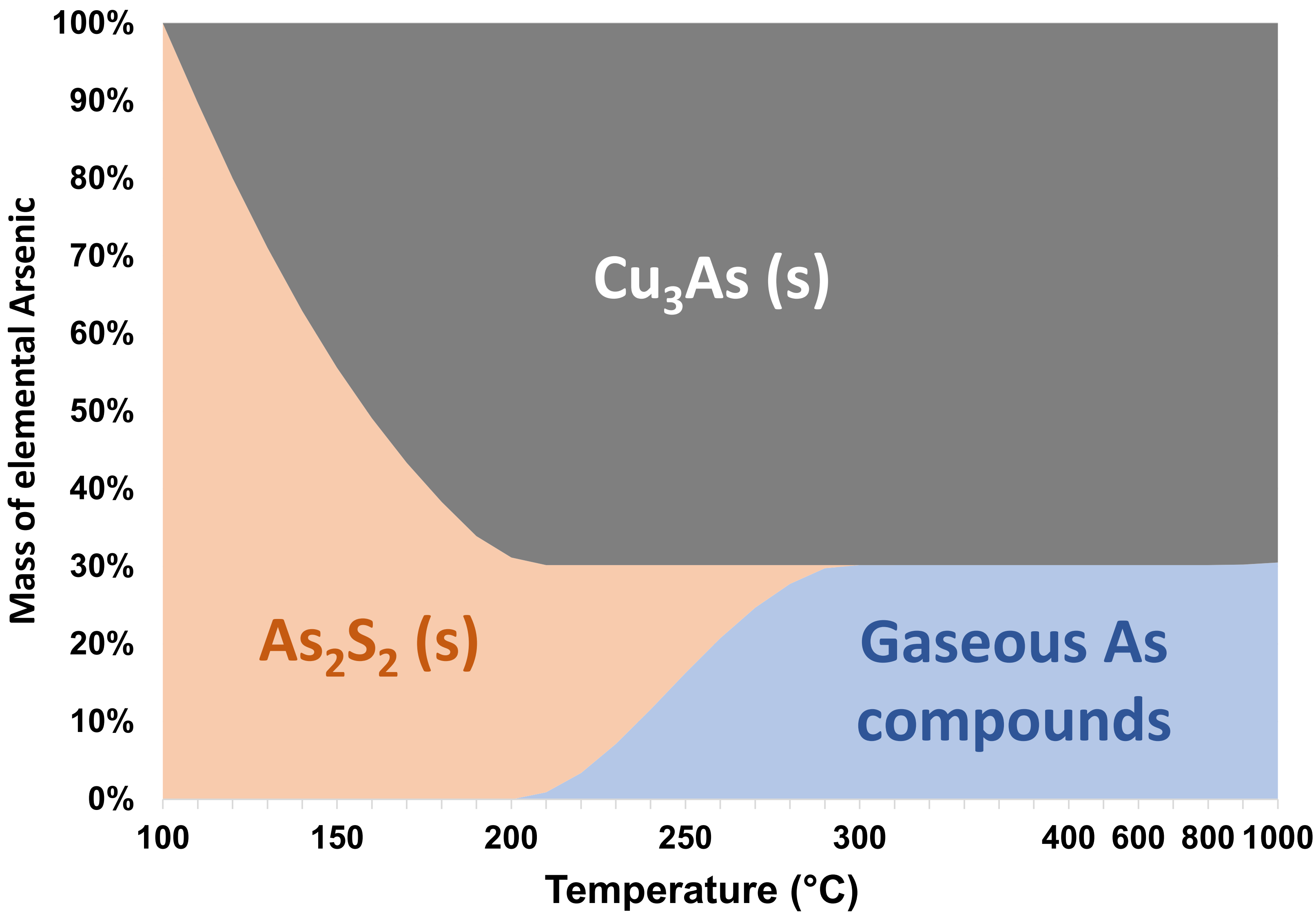
- Trends for gas yields vs temperature are similar
- Product gas from steam gasification offers highest H_2 fraction, while that from O_2 gasification yields highest CO fraction.

Conversions of elements into gas phase

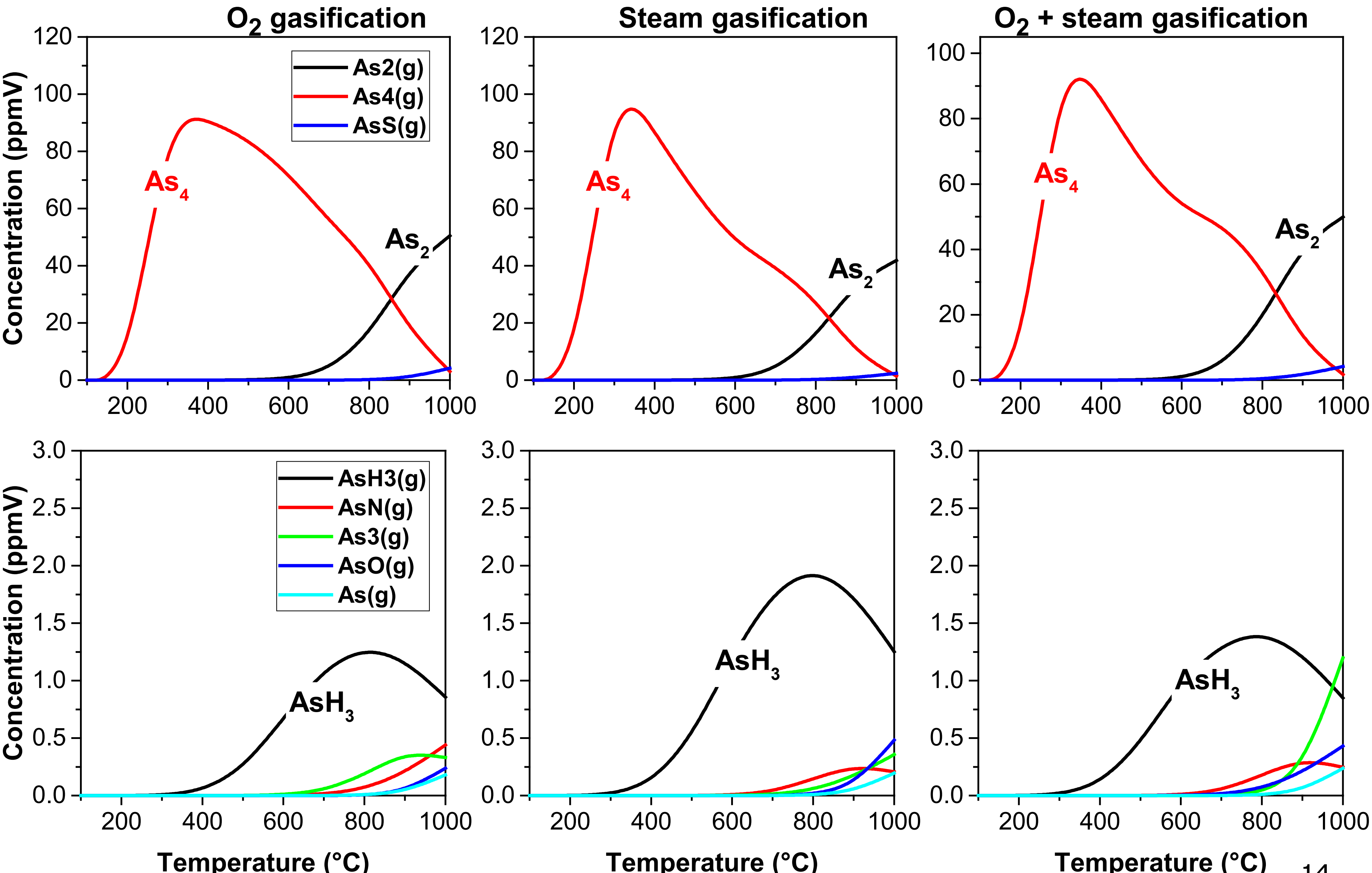


- 100% Pb and Zn present in gas phase at 700°C and 800°C, respectively. 30% As found in gas phase.
- Conversion of S and Mn into gas phase affected by both gasification temperature and environment

Transformation of Arsenic



Concentration of Arsenic compounds in dry product gas



Concluding Remarks

- Fuel properties of C&D waste mined from landfill are characterized
- C&D waste can be utilized as feedstock for gasification in different environments
- ~30% As (element) is found in gas phase due to the formation of stable solid Cu_3As
- Gas phase concentrations of As, Pb and Zn are controlled by temperature, whereas S and Mn have gasification environment dependence
- Conversion system design will need comprehensive contaminant management plan
- Additional sampling and analysis required to improve insights into variability of feedstock properties

University of Hawaii Participants

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Questions?