Exploring the Potential Use of Monoethanolamine-Based Lixiviants for Lead Extraction from Zinc Calcine and Zinc Leaching Residue

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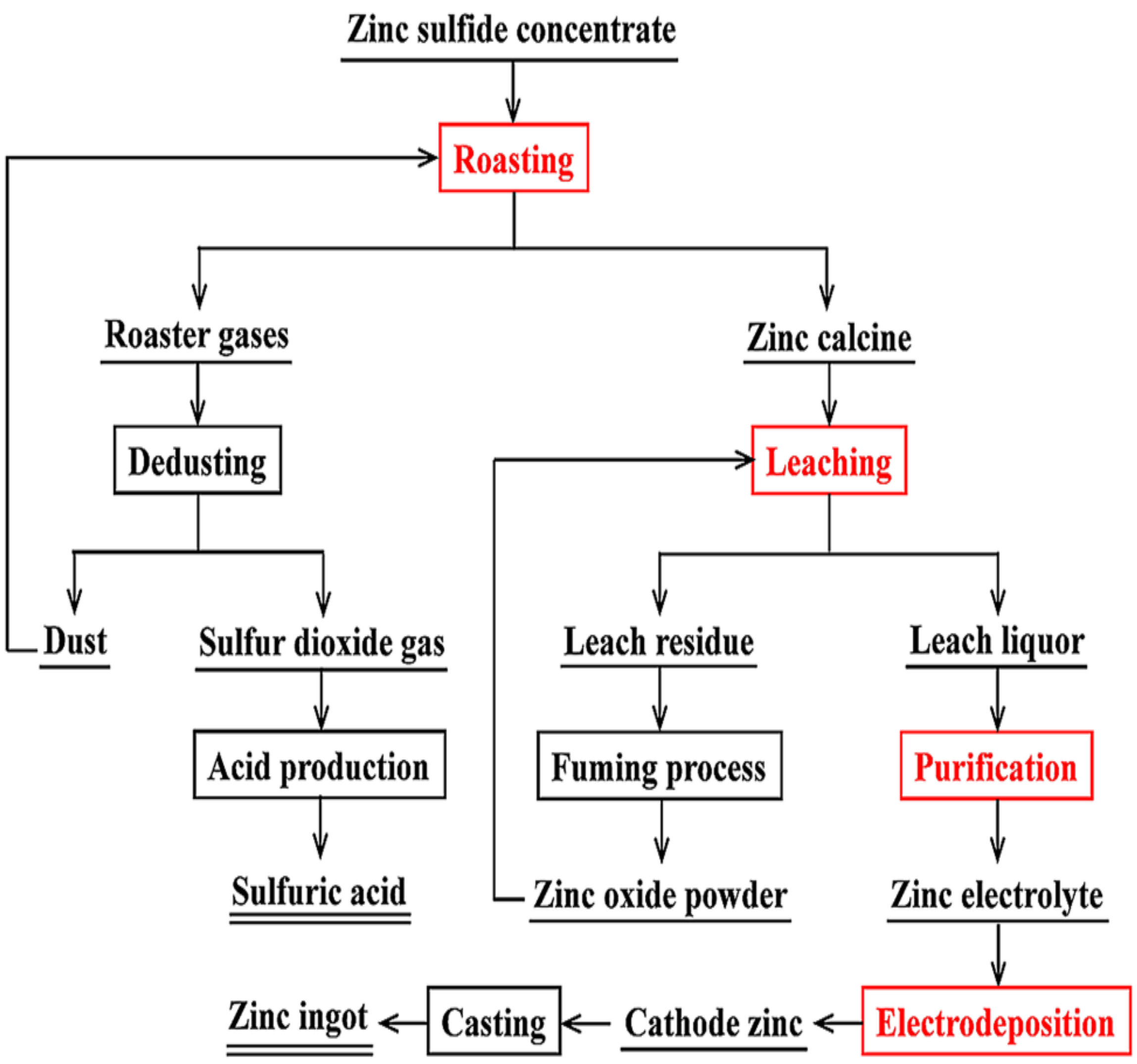
Zinc Processing



[1]

[1] S. Shao et al. (2022) “A review on the removal of magnesium and fluoride in zinc hydrometallurgy”.

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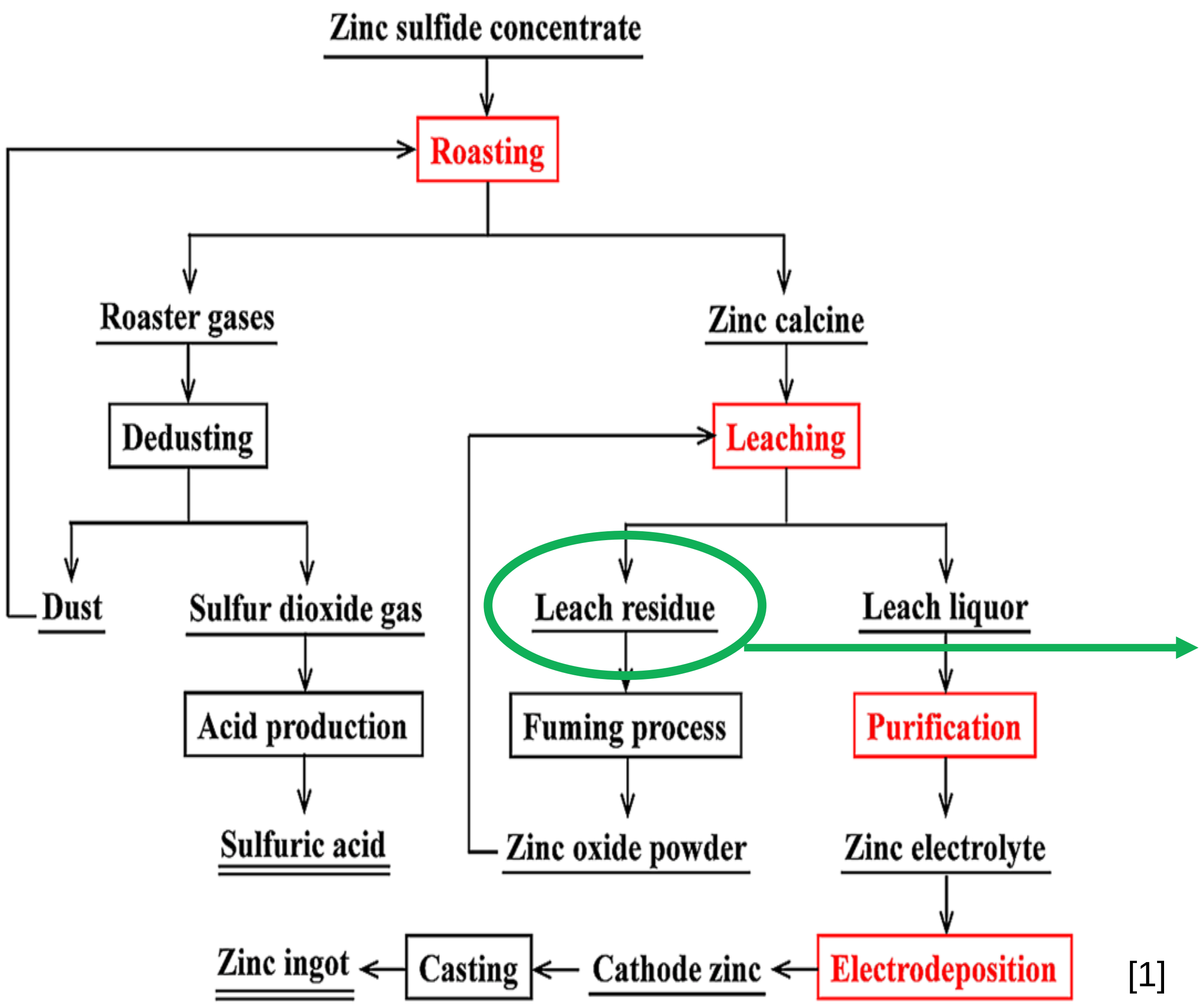

[1]

- For 1 ton of Zn produced → 0.5-0.9 ton of zinc leach residue (ZLR) generated
- ZLR is generally landfilled
- ZLR still contains valuable metals, e.g. Zn, Cu, Ag, Pb

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Alternative Extraction Method for Pb

- Pb used: batteries, ammunition, radiation protection material.
- Produced as a by-product of Zn processing → Pb as insoluble anglesite ($PbSO_4$).

What we study:

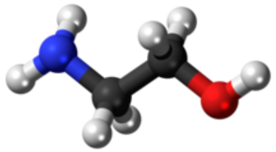
- Pb is extracted in the first step, directly from zinc calcine (ZC)
- The method is applied to extract Pb from ZLR
- Preventing the generation of strongly acidic ZLR
- Avoiding high lixiviant consumption

What we apply:

Alkaline lixiviant based on monoethanolamine (MEA)

MEA : a bifunctional solvent with amine and hydroxyl functional group

$H_2N\text{-}CH_2\text{-}CH_2\text{-}OH$

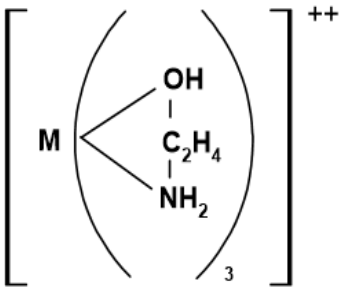


Industrial application:
CO_2 adsorber
Wood preservation
Surfactant

Application in metal extraction:

Recovery of Pb from waste battery scrap by leaching in mono-, di- and triethanolamine (MEA, DEA, TEA) in aqueous solution[2]

$PbSO_4\,(s) + TEA\,(aq) \rightarrow Pb(TEA)^{2+}\,SO_4^{2-}(aq)$



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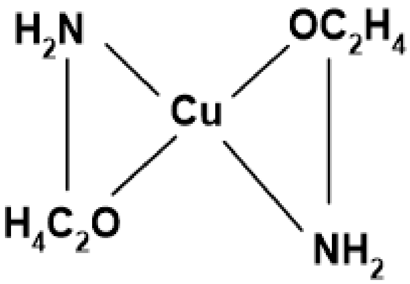


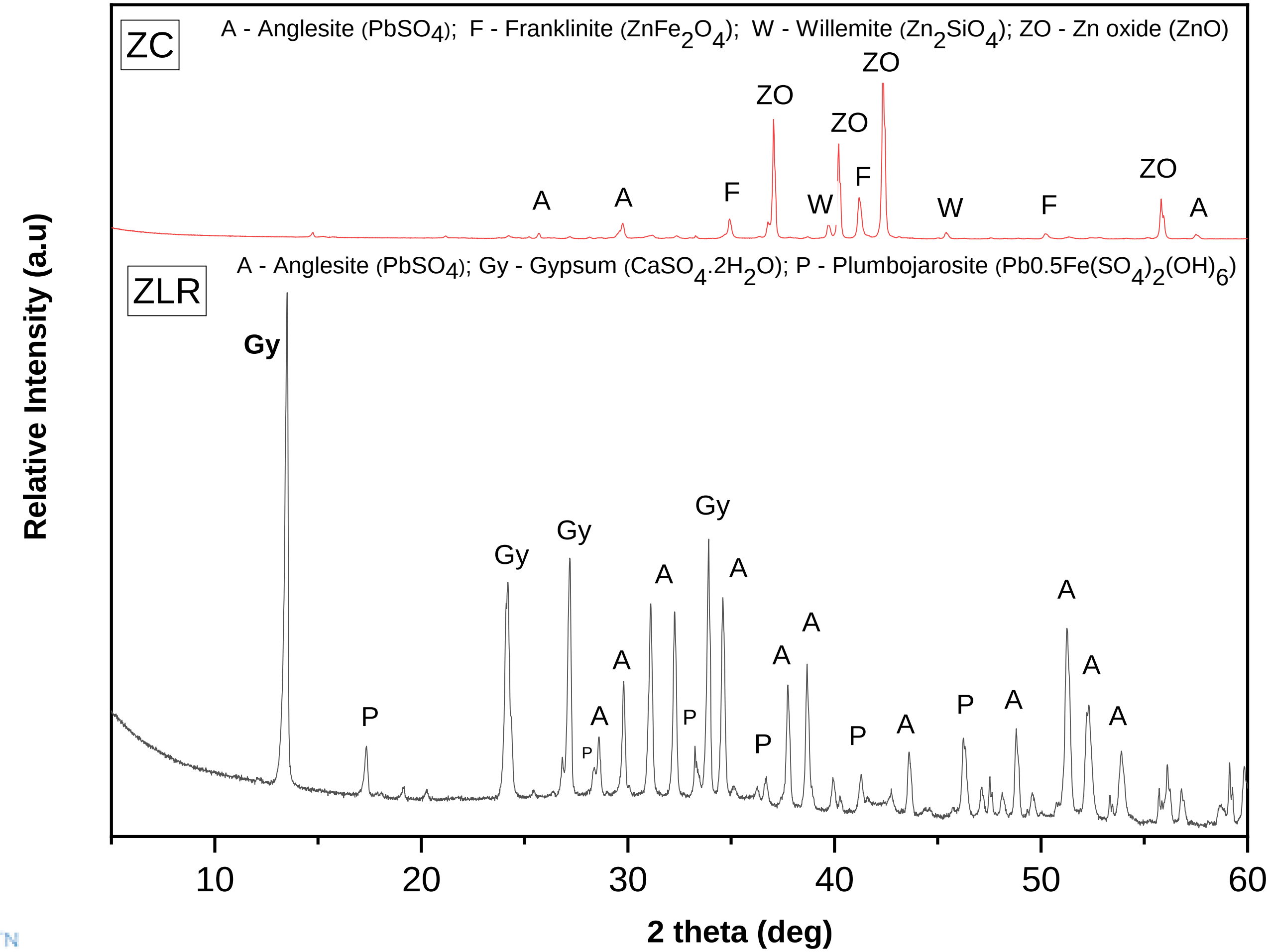
[4]

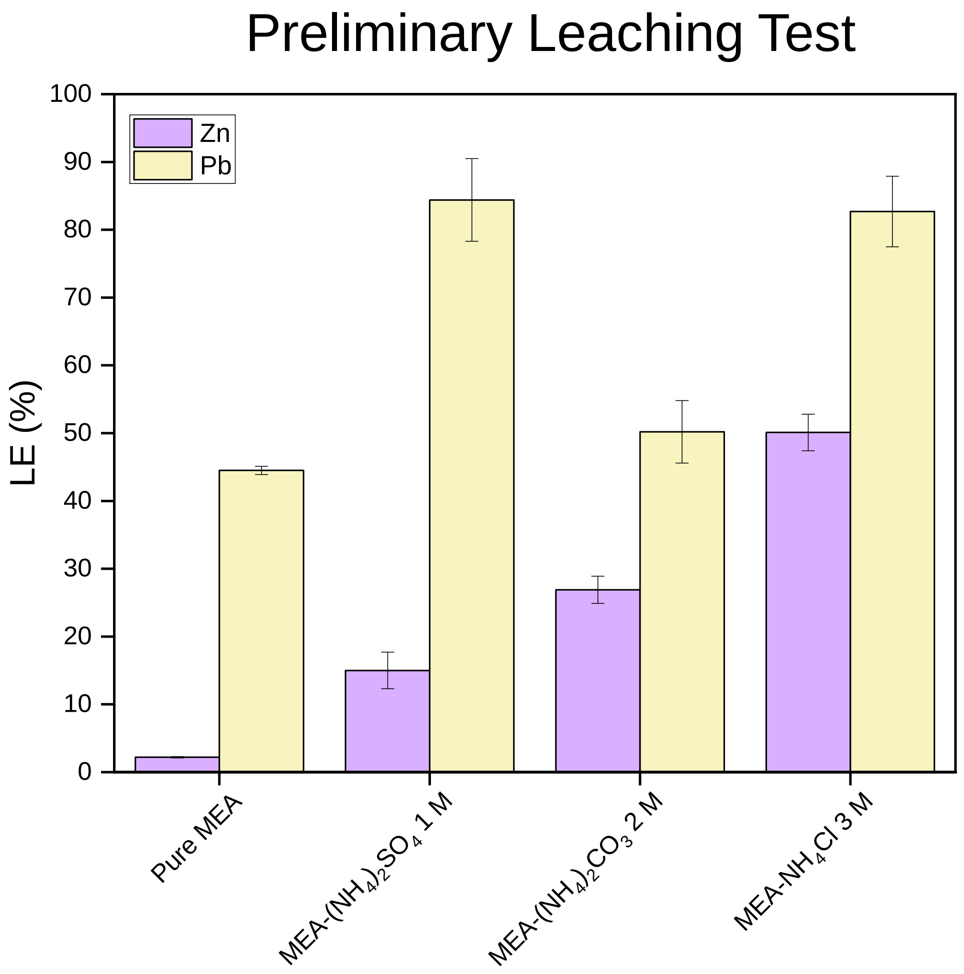
[2] D. A. Begum et al. (1988) "A study on the dissolution of lead sulphate from waste batteries in ethanolamine".
[3] R.S. Subrahmana (1956) "Polarographic behaviour of cadmium, copper, lead, nickel, cobalt, zinc and iron in ethanolamines and potasium nitrate or sulfate".
[4] C.W. Davies, B.N. Patel (1968) ''Complexes of the cupric ion with mono-, di-, and tri-ethanolamine''.

Elemental Composition (wt%)

	Zn	Pb	Fe	Si	S
ZC	53	2	8	1	3
ZLR	2	10	3	5	12

Mineralogical Analysis

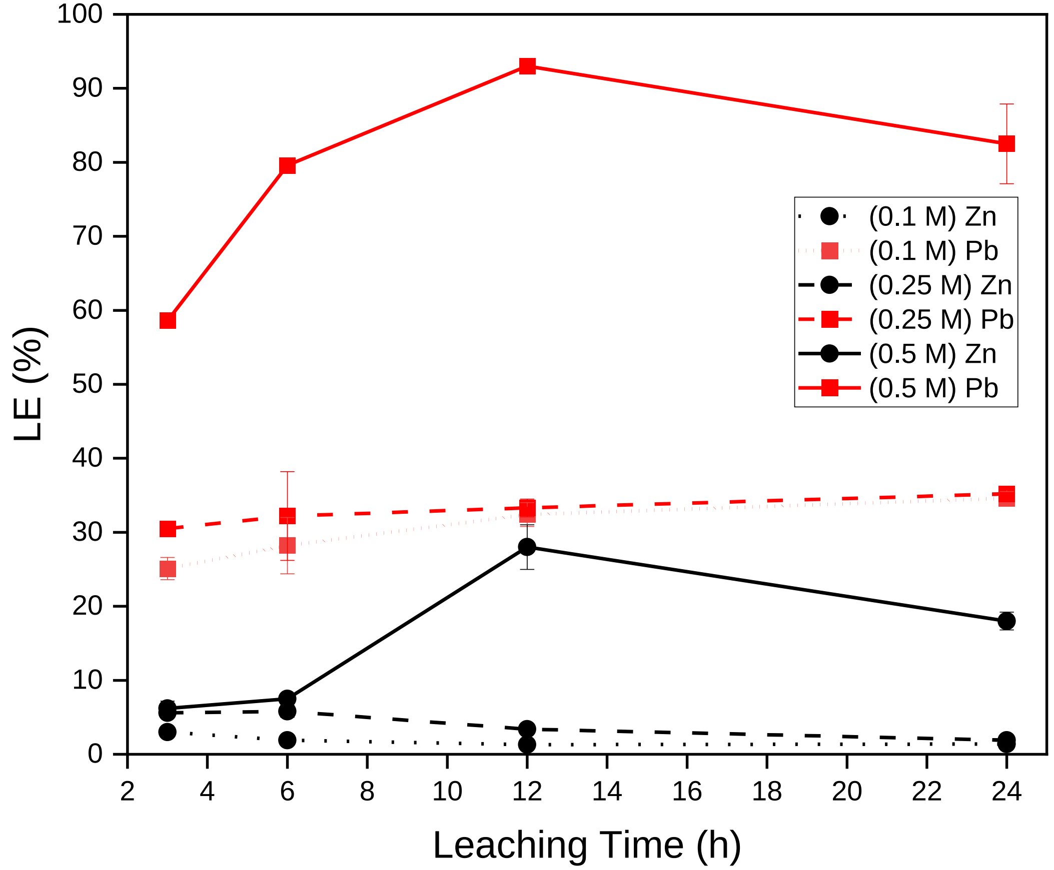




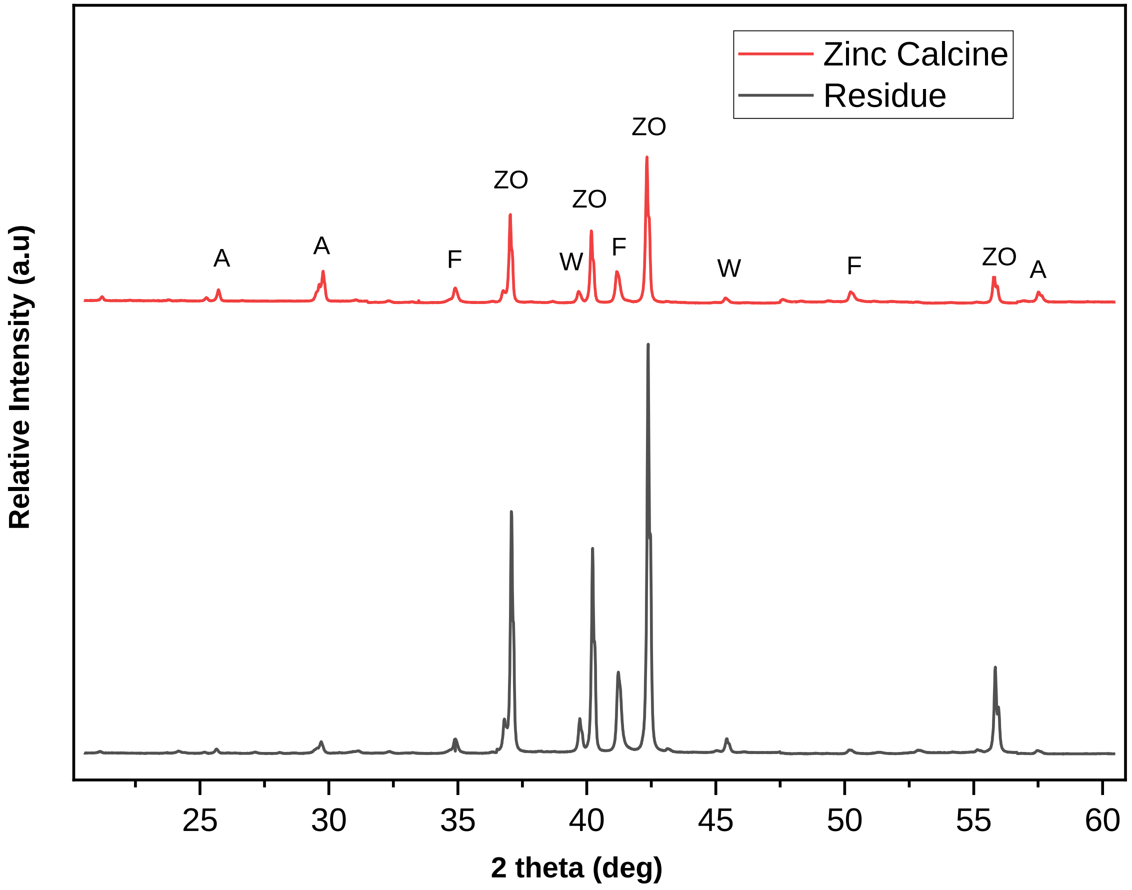
(T=25 °C; t=3 h; S/L ratio=1/10; stirring speed=500 rpm)

- Leaching in pure MEA is selective, but low LE
- The addition of ammonium salts increased the extraction of both Pb & Zn → higher LE, less selective

Leaching of ZC



((NH$_4$)$_2$SO$_4$ Concentration=0.1, 0.25, 0.5 M;
T=25 °C; S/L ratio=1/10; stirring speed=500 rpm)



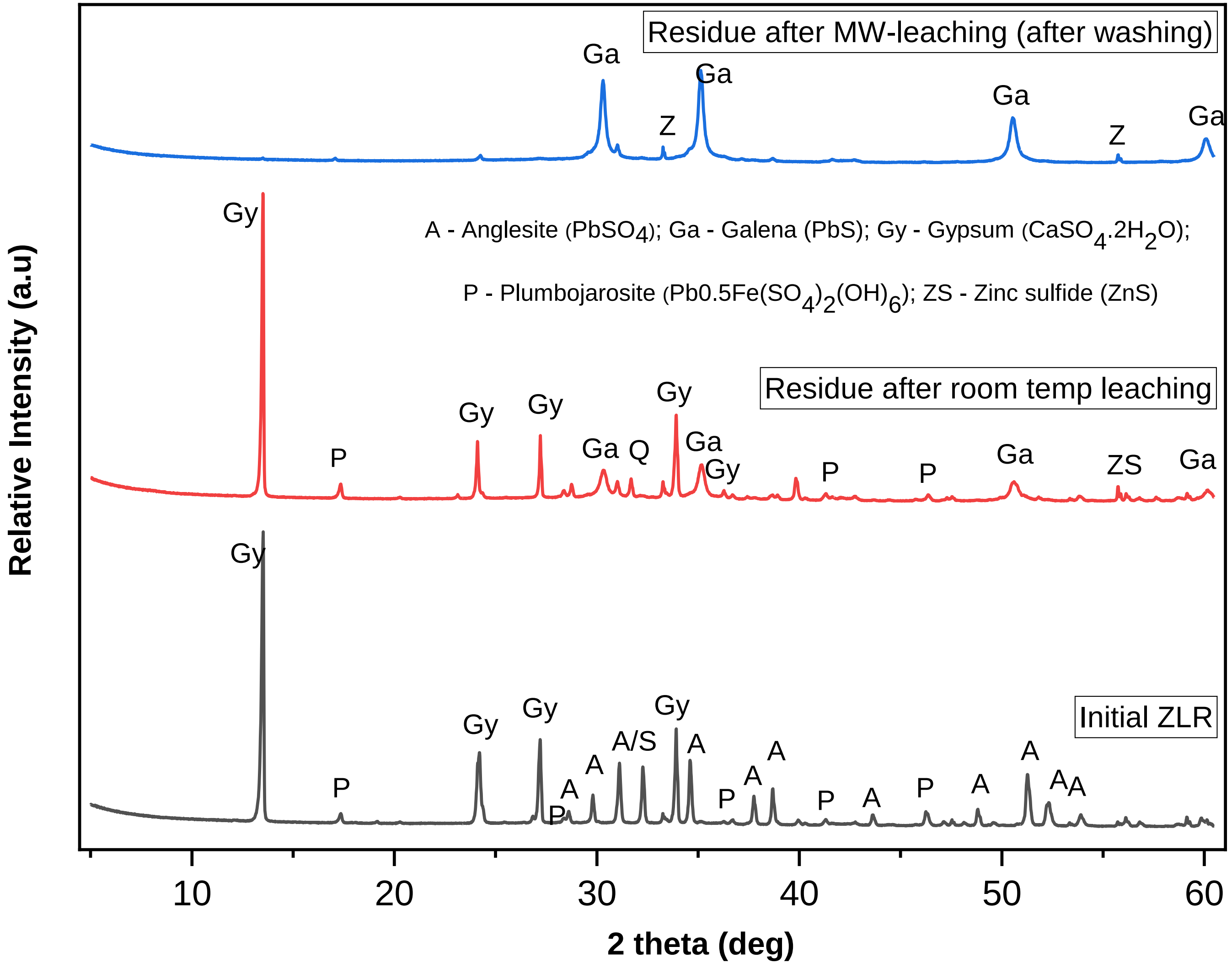
W - Zn silicate; A - Pb Sulfate; F - Zn Fe oxide; ZO - Zn oxide

- The minimum ammonium salt concentration and leaching time are required to achieve high LE
- Pure MEA & MEA-$(NH_4)_2SO_4$ dissolved anglesite; zinc phases remained insoluble

Leaching of ZLR

Leaching Treatment	Pb (%)	Zn (%)	Fe (%-
MW-Leaching			
MEA+$(NH_4)_2SO_4$; 120, 150 °C; 15, 30, 60 min	0.2 – 0.6	3.0 – 5.1	19.4 – 25.9
Water Bath Leaching			
MEA+$(NH_4)_2SO_4$; 100 °C; 4.5 h	0.1 ± 0.0	14.9 ± 0.6	21.1 ± 1.3
Room Temperature Leaching			
MEA+$(NH_4)_2SO_4$; 25 °C; 3, 6, 12, 24 h	0.1-0.3	17.4-19.5	-

Leaching of ZLR



- Negligible Pb yield due to reductive leaching → $PbSO_4$ is transformed into PbS

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Conclusions

- MEA-lixiviant can leach Pb from anglesite phases in zinc calcine
- ZLR leaching in the MW can destruct plumbojarosite phases
- MEA-lixiviant can not leach Pb from zinc leaching residue → reductive leaching to produce galena (PbS)
- On-going work: to understand reductive leaching of ZLR

Thank you

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