



UNIVERSITEIT•STELLENBOSCH•UNIVERSITY  
jou kennisvenoot • your knowledge partner

# **Influence of thermal treatment processes of printed circuit board waste on hydrometallurgical metal recovery process**

11 November 2019

HA van Zyl

Supervisor C. Dorfling

Co-Supervisor Prof. G. Akdogan



---

Fakulteit Ingenieurswese  
•  
Faculty of Engineering





- Electronic waste one of the fastest growing solid municipal wastes
- PCBs one of the highest value components for recycling
- Most recycling focuses on the metal fractions
- Contains  $\pm 90\%$  of the value
- 70% NMF left untreated



## Advantages of Heat treatment

---



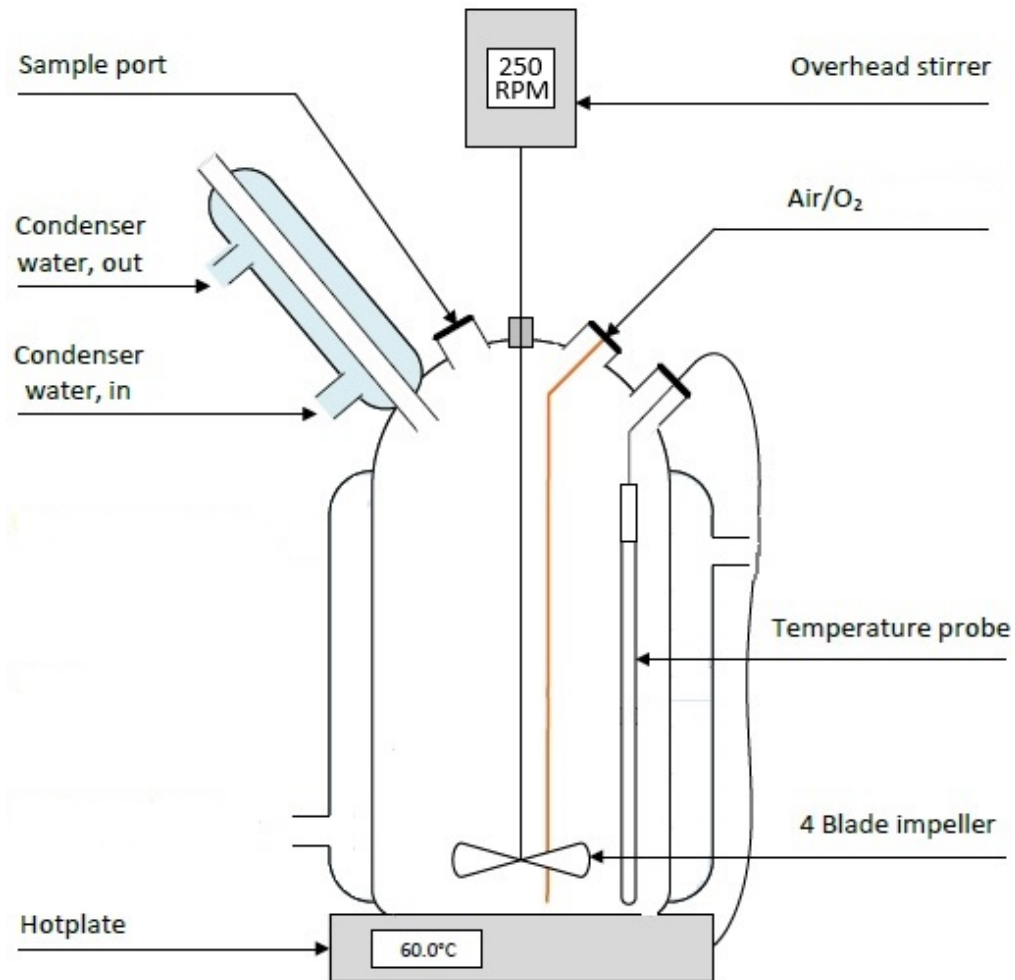
- Provides a wholistic recycling method for PCBs
- Provides additional income form recycling of non metallic fraction
- Reduce size reduction energy requirements after heat treatment
- Liberation of metals from resin



- **Combustion**
  - Used in informal recycling
  - Dioxins and furans can form
  - Large volumes of gas to treat
  - Electricity
- **Pyrolysis**
  - Requires additional fuel gas
  - Small volumes of gas to treat
  - Electricity and possible chemical recovery
- **Gasification**
  - Extreme temperature and pressure requirement
  - Slag formation
  - Electricity and syngas recovery



- 90% of recycling value of PCBs in metal recovery
- Hydrometallurgical recovery with glycine
- Influence of pyrolysis and oxidation of residue on metal recovery
- Parameters
  - Type of residue
  - Initial copper complex concentration (Autocatalysis)
  - Type of oxidation medium (Air/Oxygen)
  - Glycine concentration





## Experimental conditions

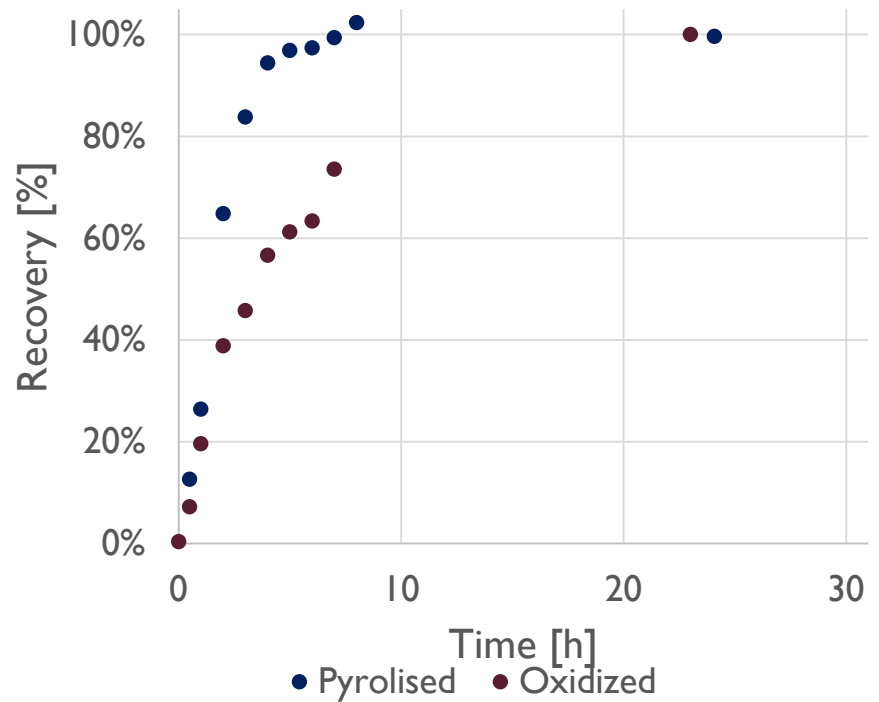
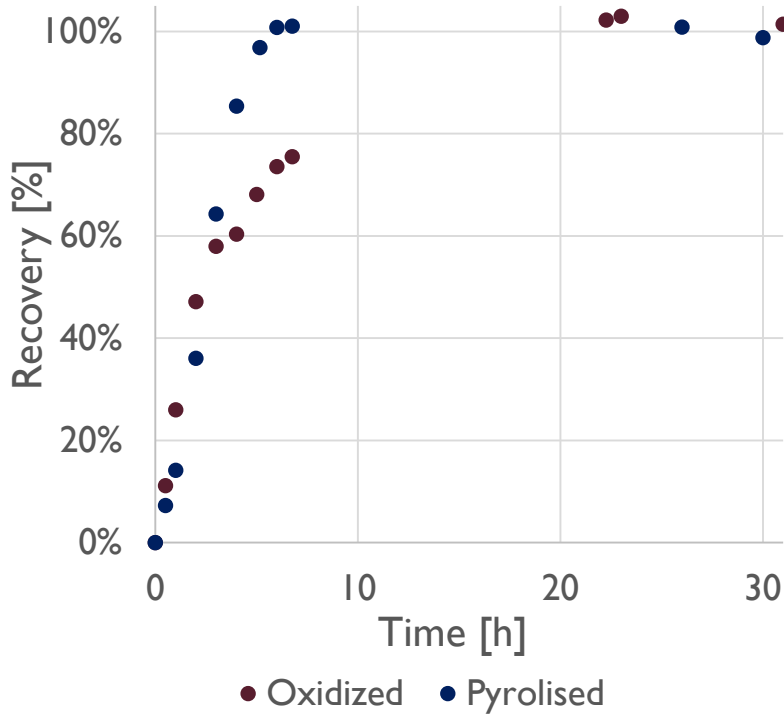
---



- Temperature 60°C
- pH 11 (10,5 – 11,4)
- Glycine 1M and 2M
- Gas flowrate 300 mL/min
- Stirrer speed 275 rpm



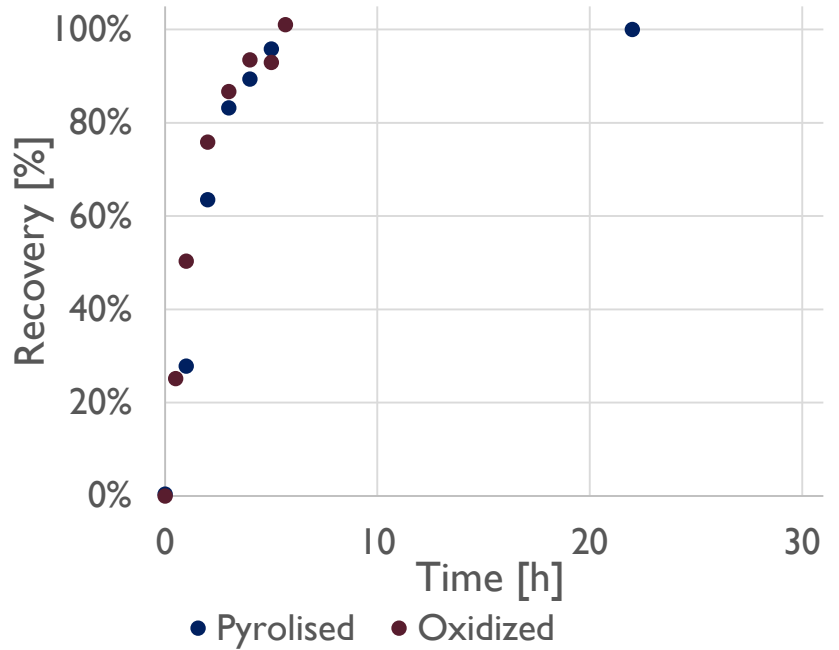
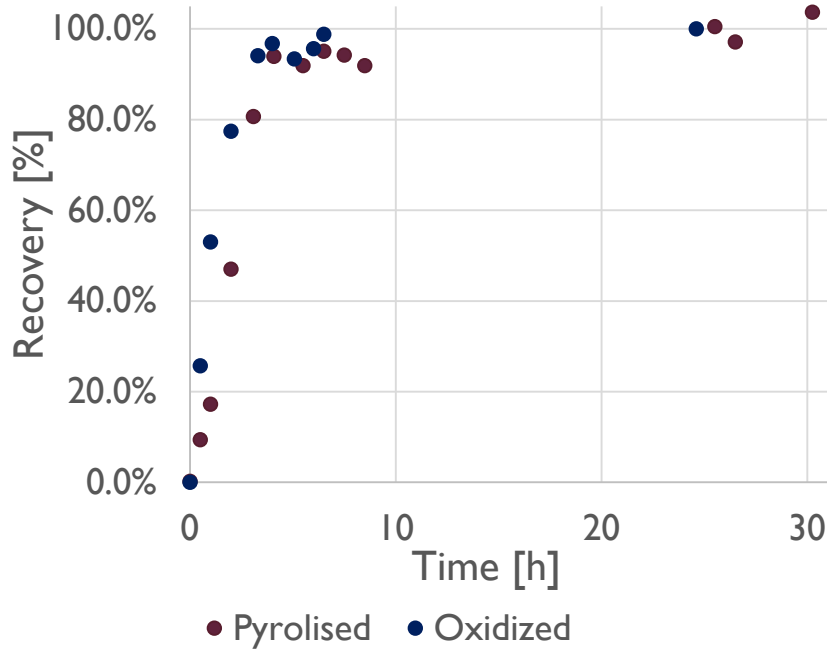
# Residue type IM Glycine





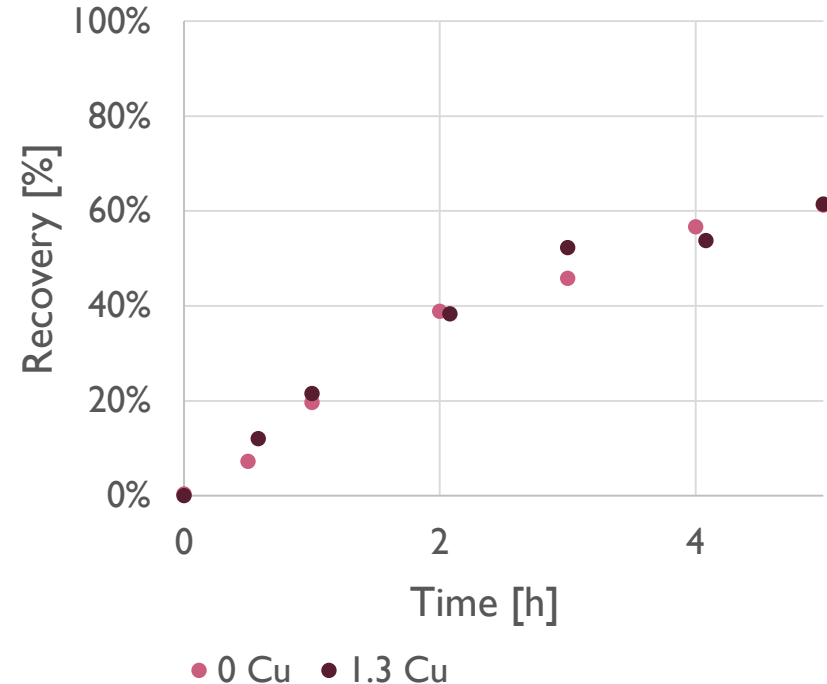
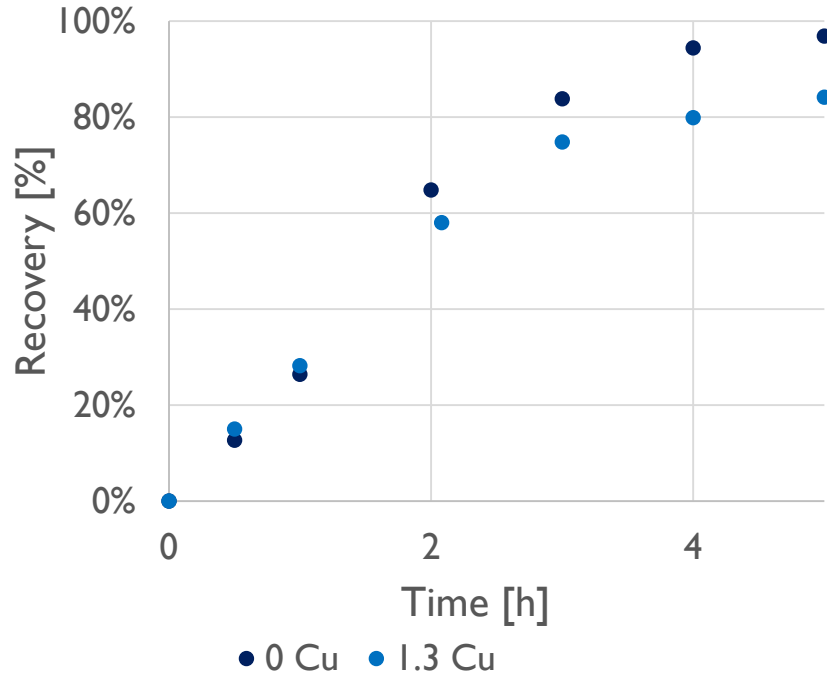


# Residue type 2M Glycine



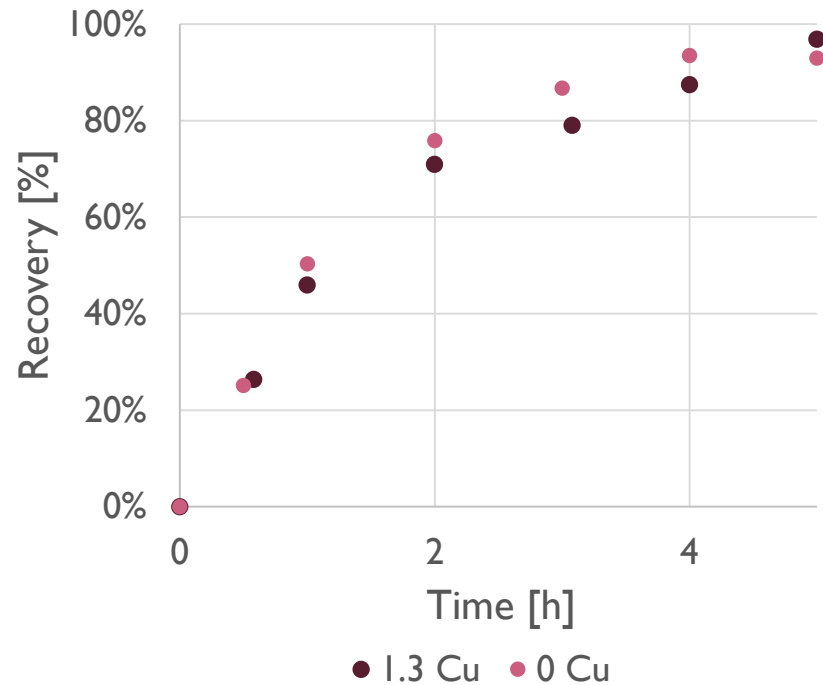
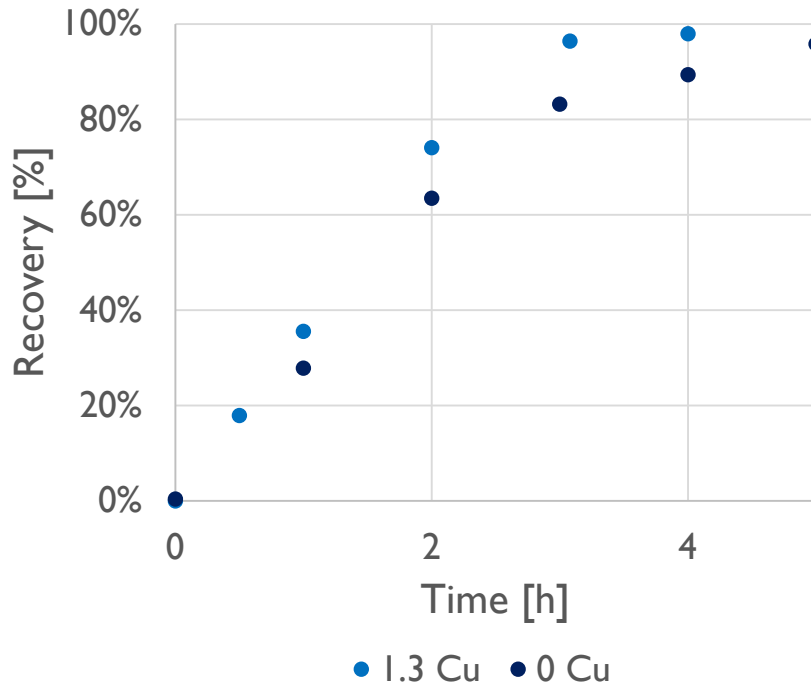


# Influence of initial copper(II) concentration IM Glycine



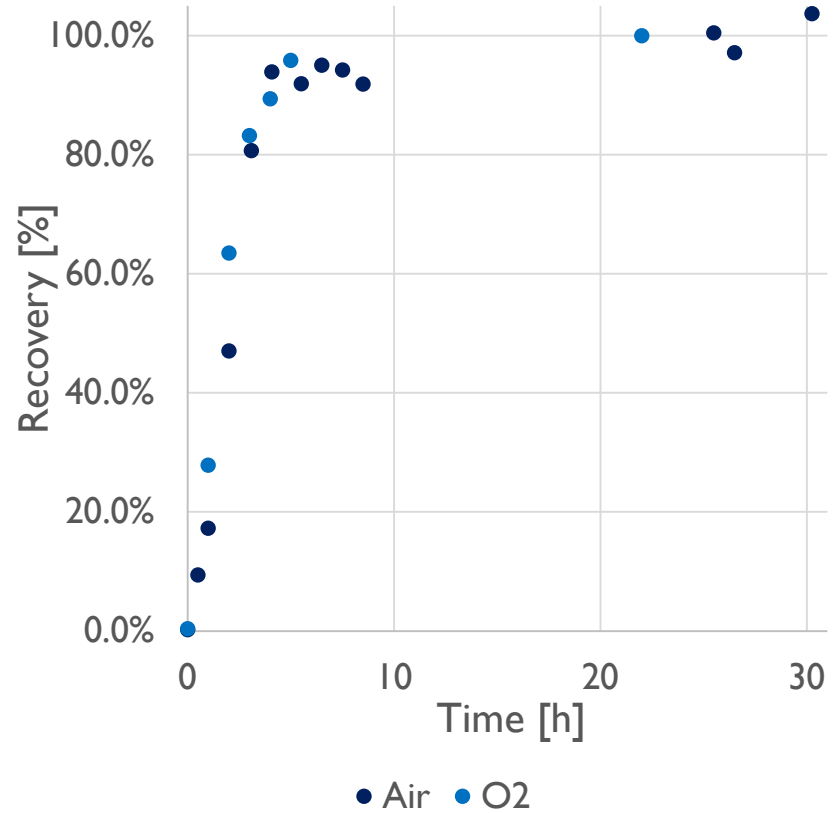
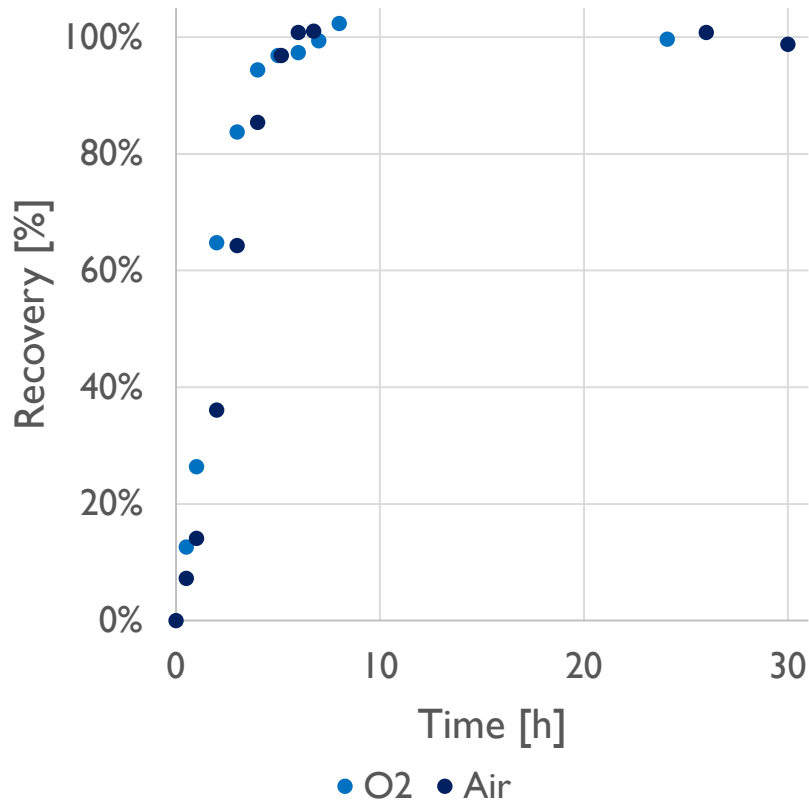


# Influence of initial copper(II) concentration 2M Glycine



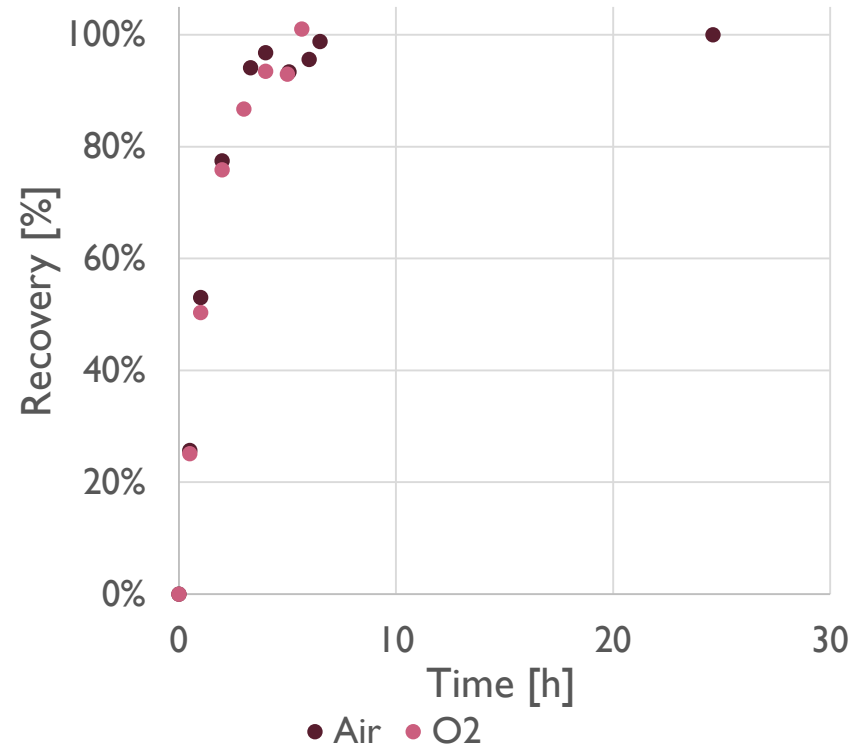
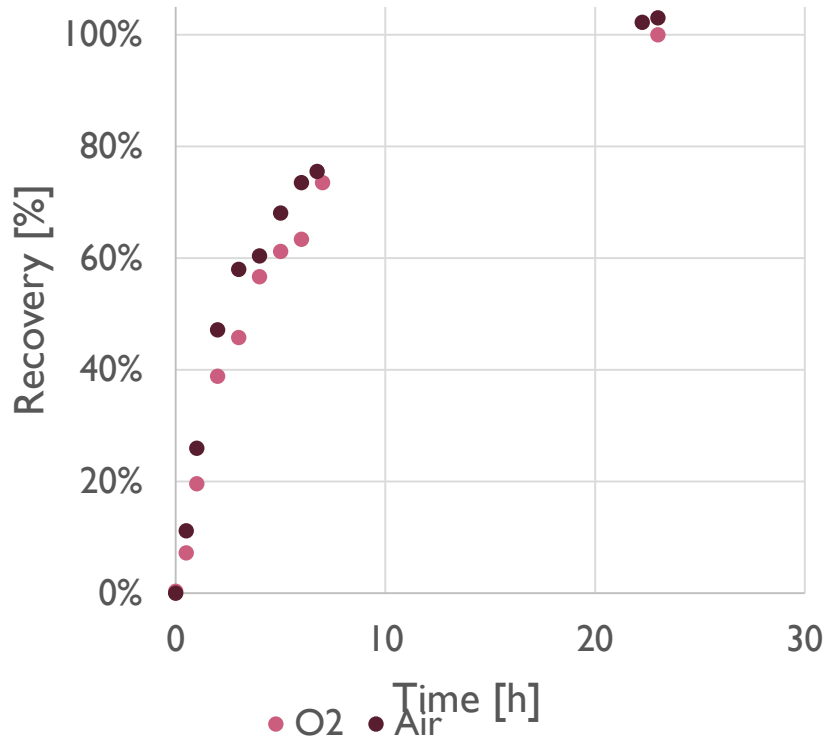


# Oxidant influence on Pyrolysis residue



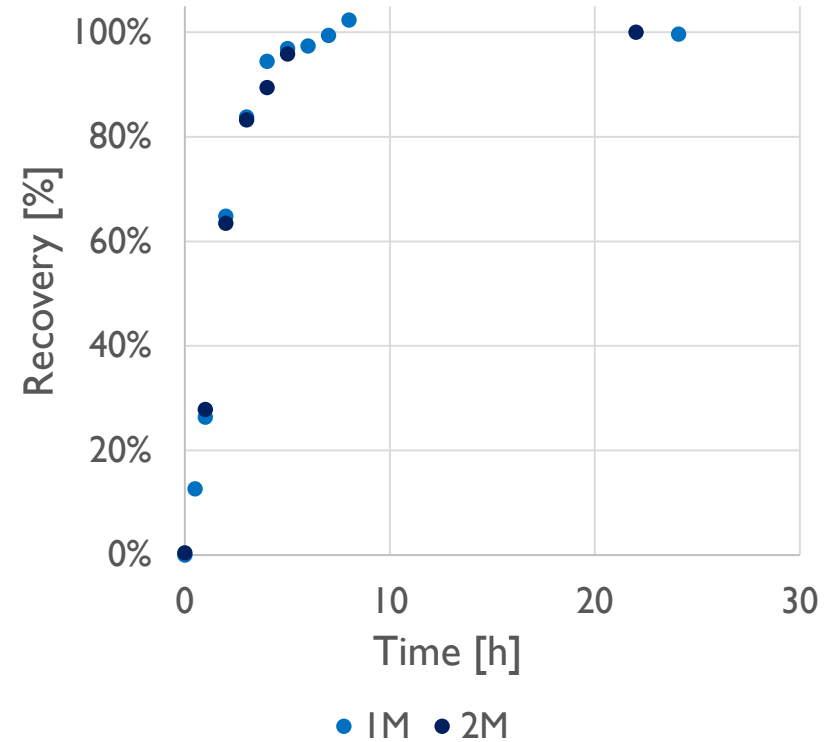
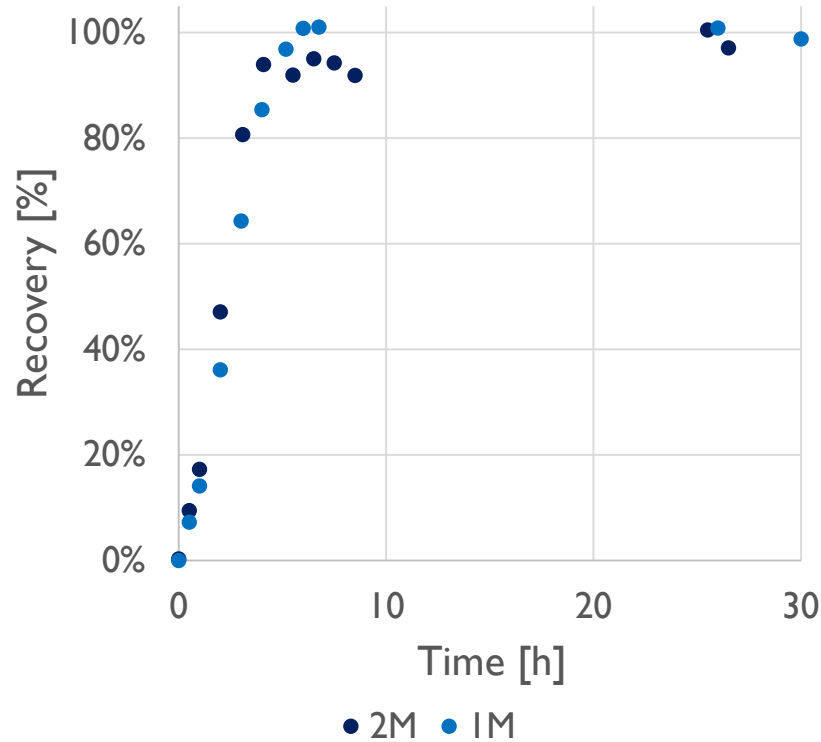


# Oxidant influence on Oxidised residue



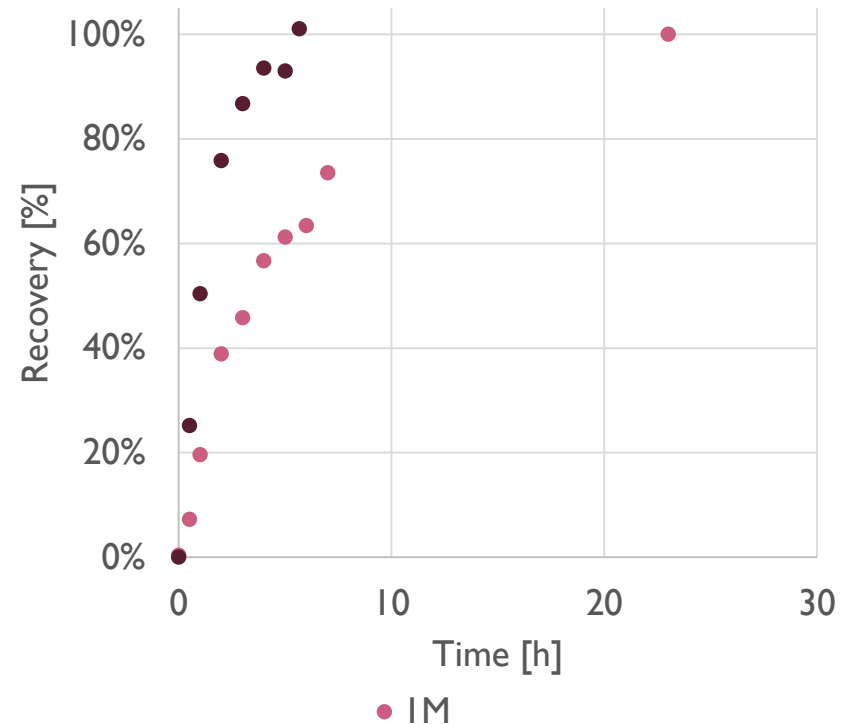
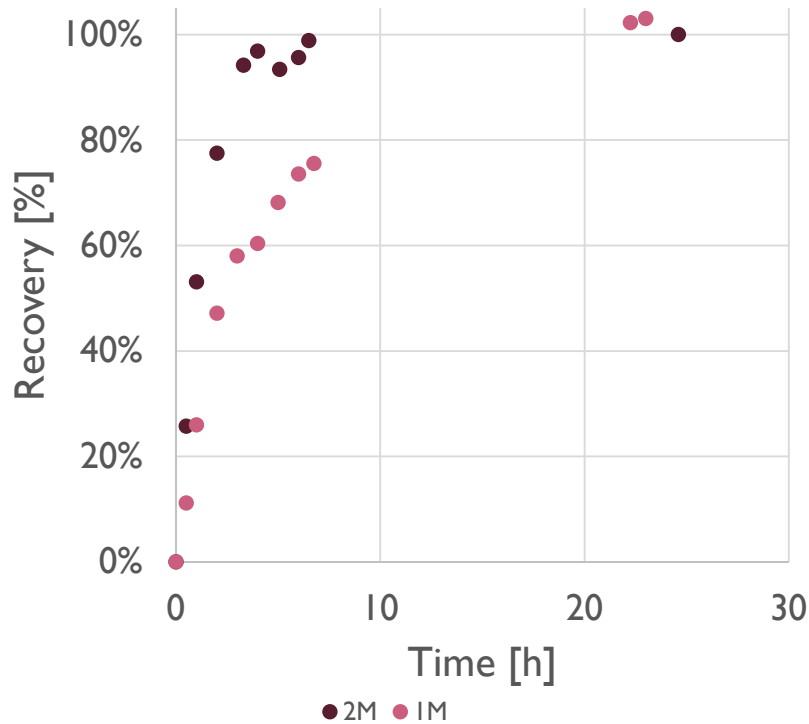


# Influence of Glycine concentration (Pyrolysis residue)





# Influence of Glycine concentration (Oxidised residue)





- Significant improvement in leaching rate with heat treatment.
- Recoveries up to 80% - 90% after 30+ hours compared to 95%+ after 6 hours for heat treated boards (2M Glycine)
- The large influence of glycine concentration oxidised residue is not satisfactorily explained by current experimental work and require further investigation





## Acknowledgments

---



- DST (Waste Roadmap)



science  
& technology

---

Department:  
Science and Technology  
**REPUBLIC OF SOUTH AFRICA**



# Questions