WPI

EMRG
Energy Metals Research Group
Electrometallurgy Technology for the Toughest Sustainability Challenges

Advances in Magnesium Primary Production by Reactive Cathode Molten Salt Electrolysis with G-METS Distillation

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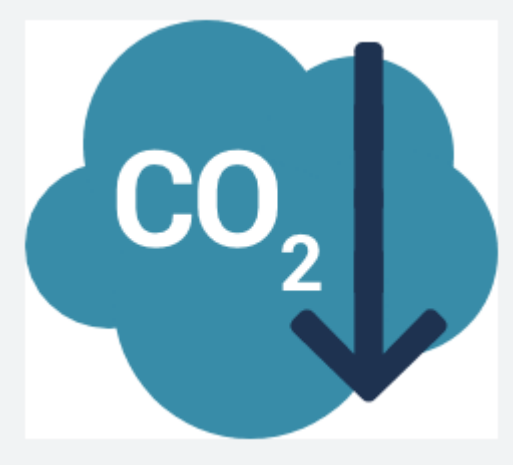
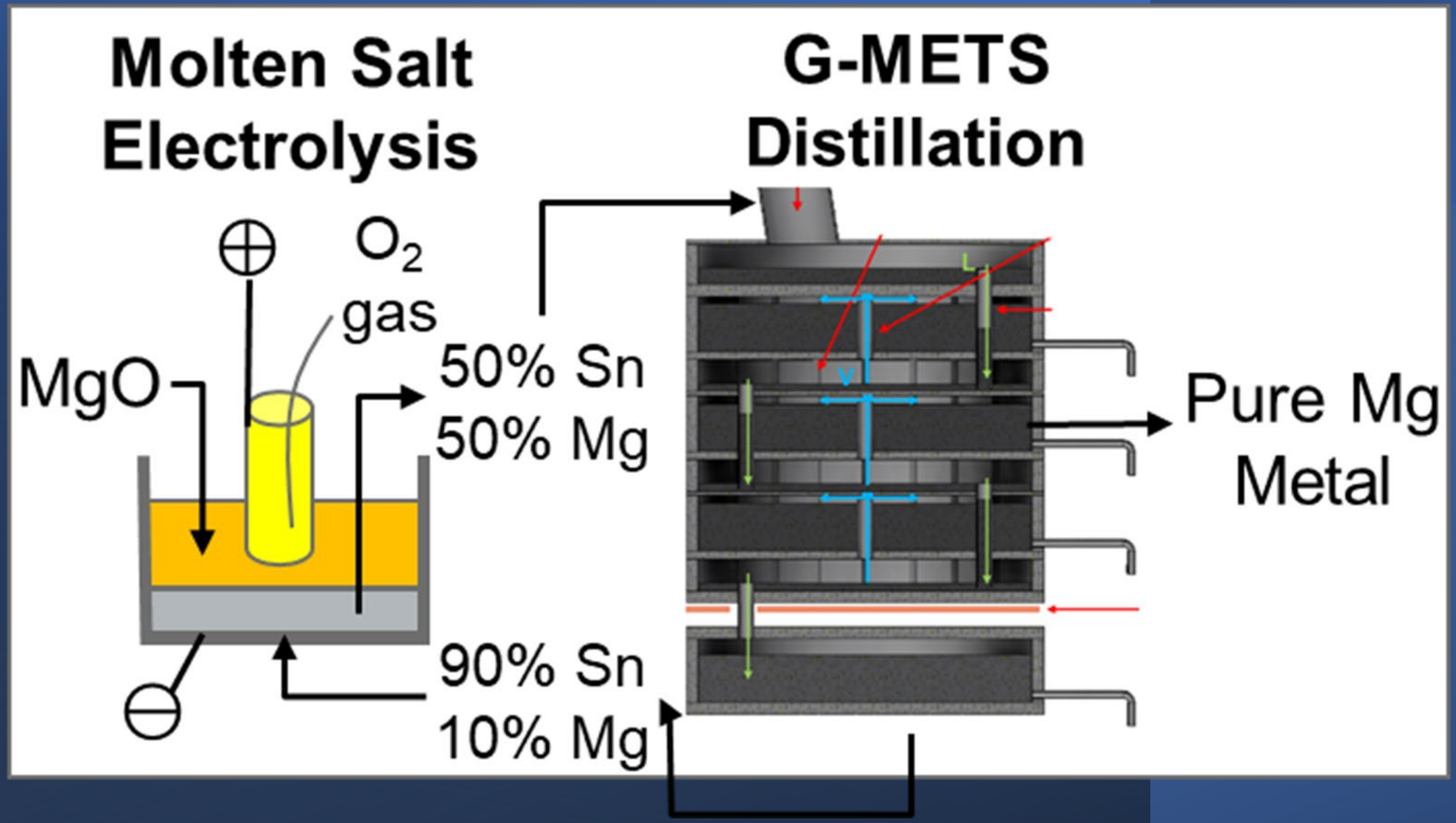
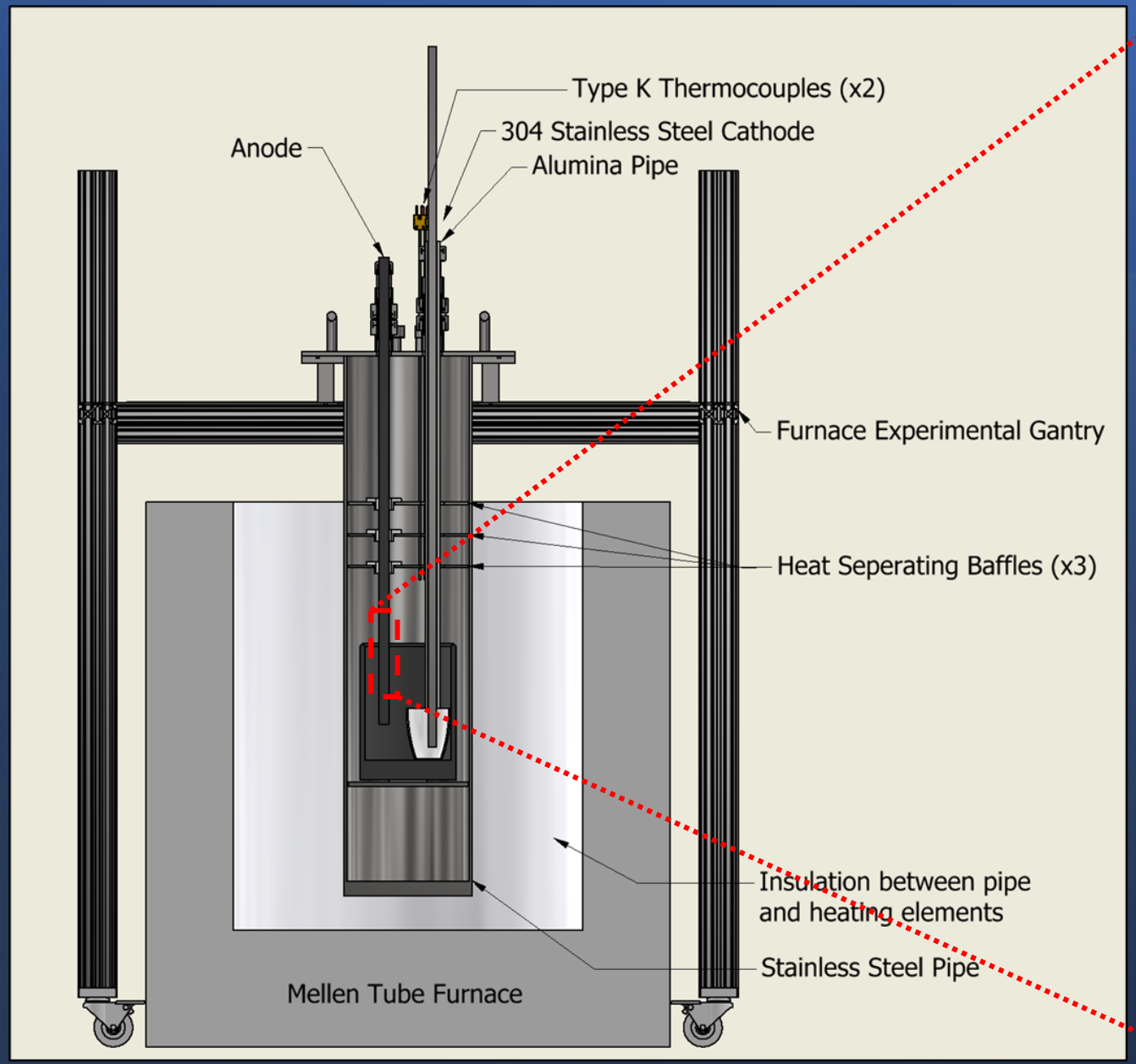
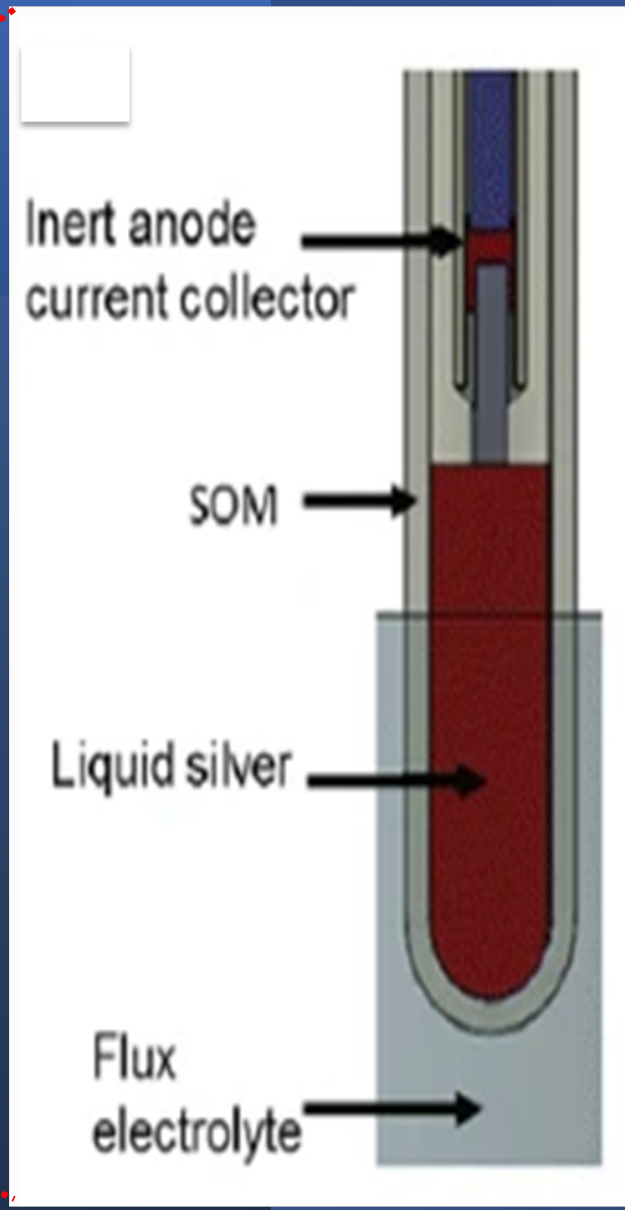
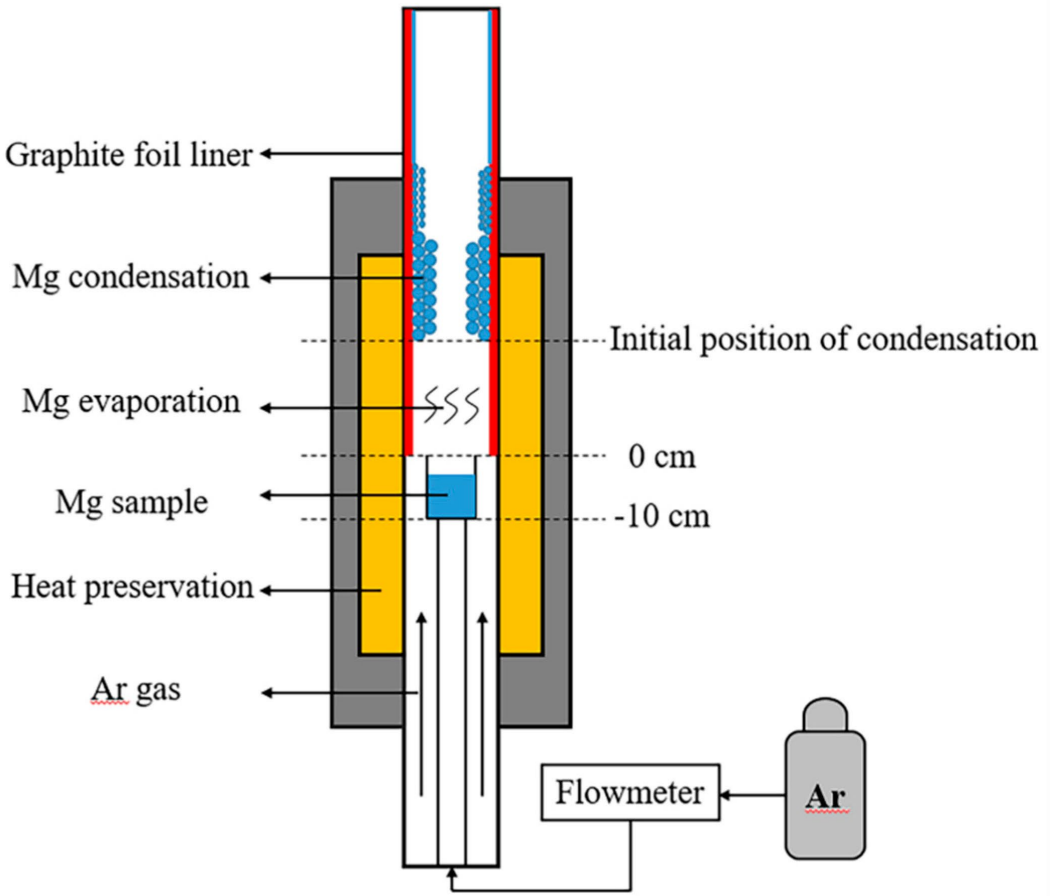
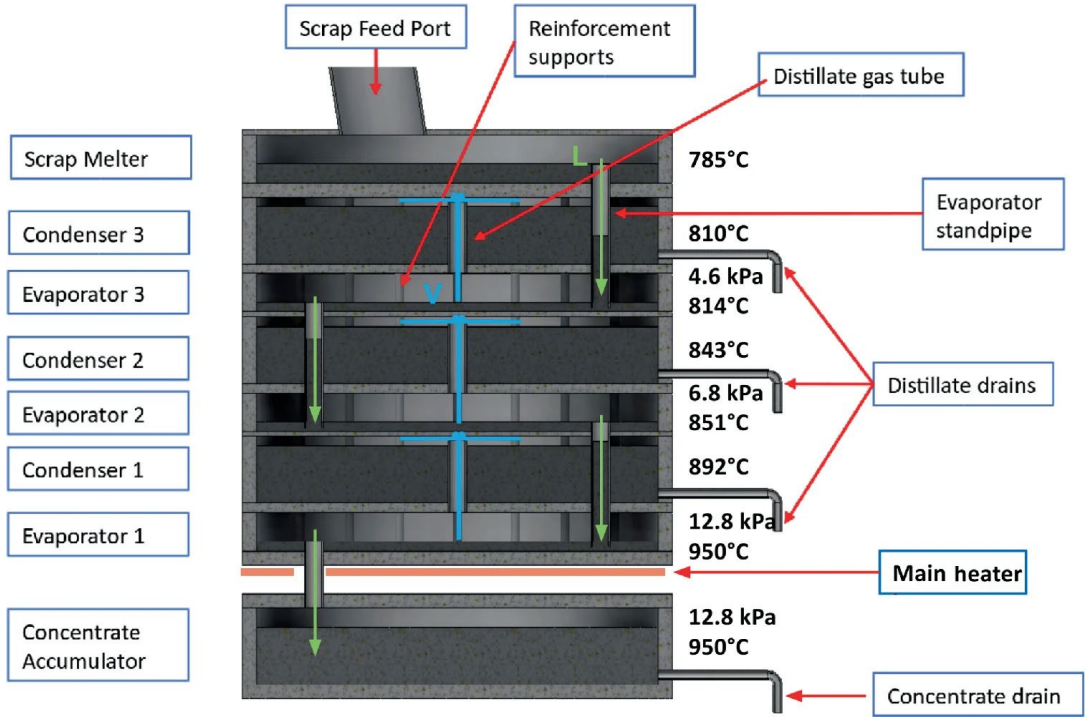


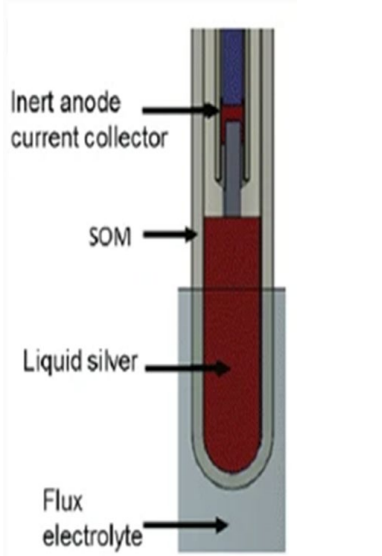

Molten Salt Electrolysis
G-METS Distillation
O2 gas
MgO
50% Sn
50% Mg
90% Sn
10% Mg
Pure Mg Metal
L
V

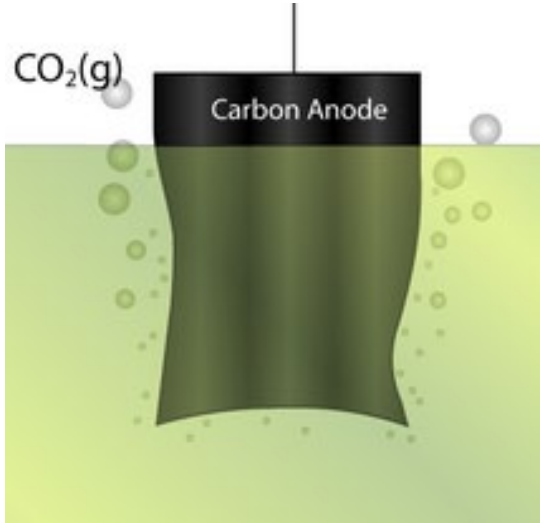

Type K Thermocouples (x2)
304 Stainless Steel Cathode
Anode
Alumina Pipe
Furnace Experimental Gantry
Heat Seperating Baffles (x3)
Insulation between pipe
and heating elements
Stainless Steel Pipe
Mellen Tube Furnace


Inert anode
current collector
SOM
Liquid silver
Flux
electrolyte


Graphite foil liner
Mg condensation
Initial position of condensation
Mg evaporation
0 cm
Mg sample
-10 cm
Heat preservation
Ar gas
Flowmeter
Ar

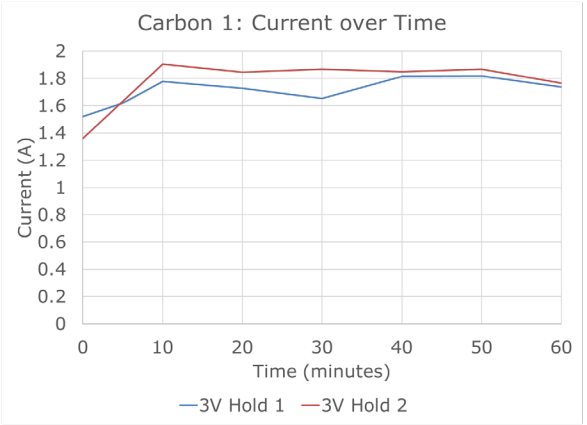

Scrap Feed Port
Reinforcement supports
Distillate gas tube
Scrap Melter
Condenser 3
Evaporator 3
Condenser 2
Evaporator 2
Condenser 1
Evaporator 1
Concentrate Accumulator
785°C
Evaporator standpipe
810°C
4.6 kPa
814°C
843°C
6.8 kPa
851°C
892°C
12.8 kPa
950°C
Distillate drains
Main heater
12.8 kPa
950°C
Concentrate drain

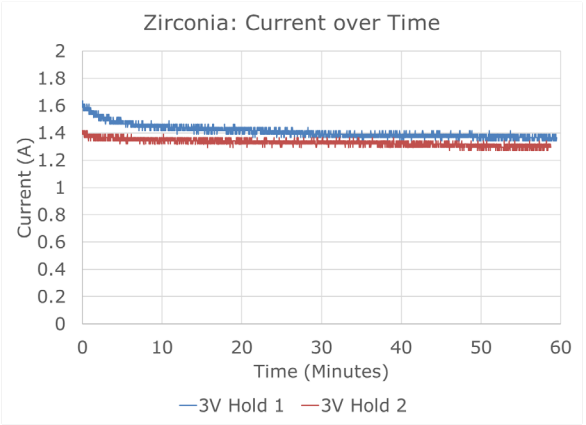




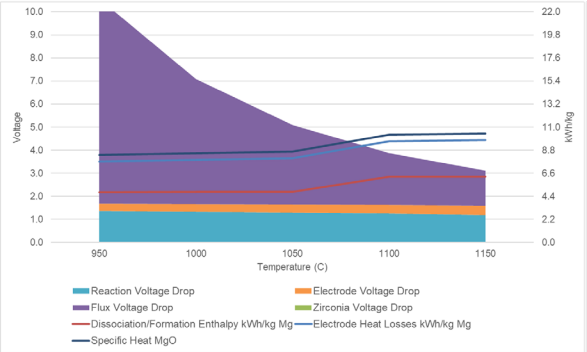
Carbon Current Efficiency: ***97%***
Theoretical Mg Produced: **2.6g**
Actual Mg Produced: **2.5g**

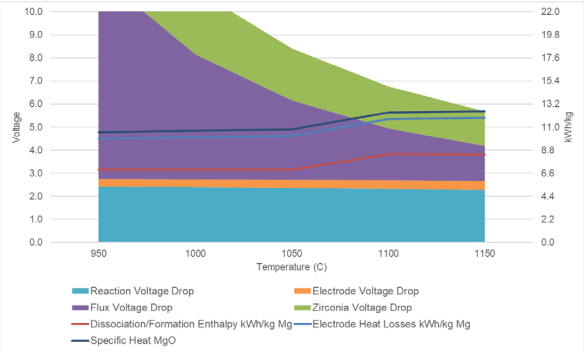
Zirconia Current Efficiency: ***84%***
Theoretical Mg Produced: **3.4g**
Actual Mg Produced: **2.8g**





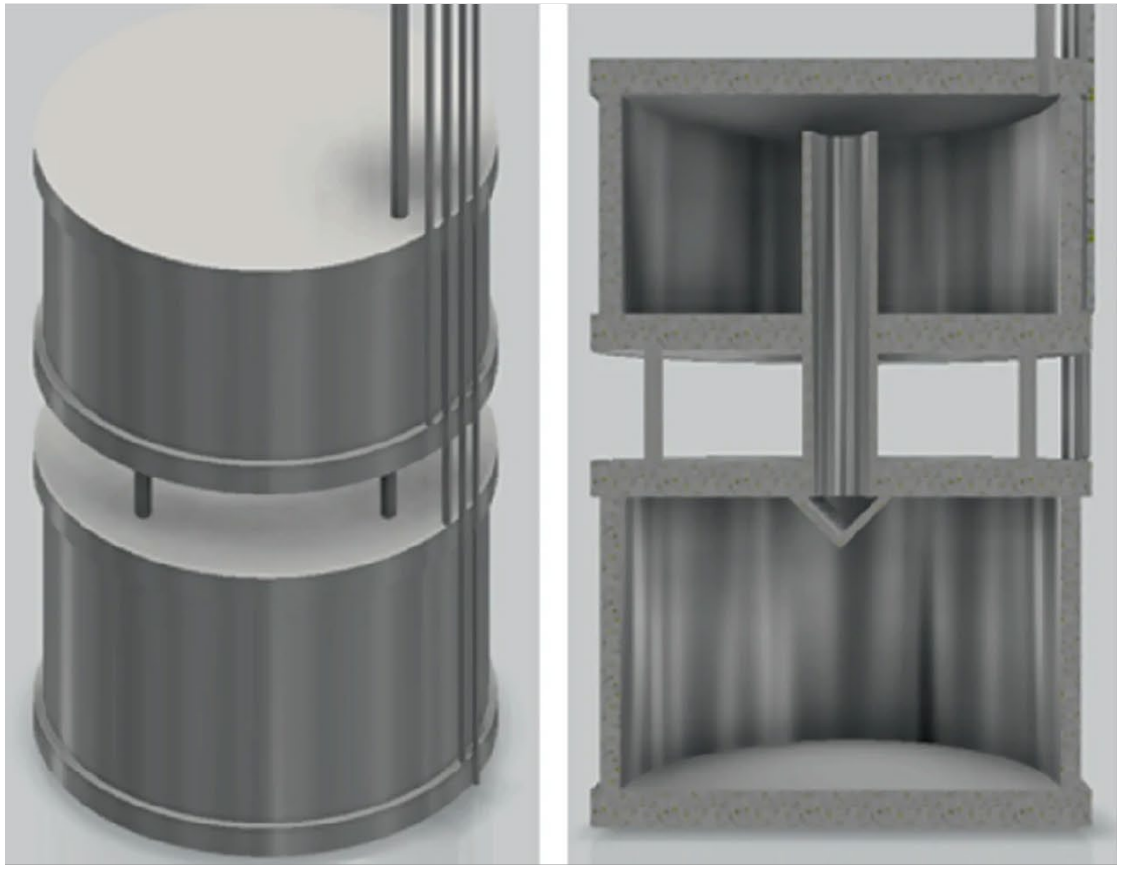
The zirconia anode reported overall lower current efficiencies and current efficient than the carbon anodes in both scenarios.



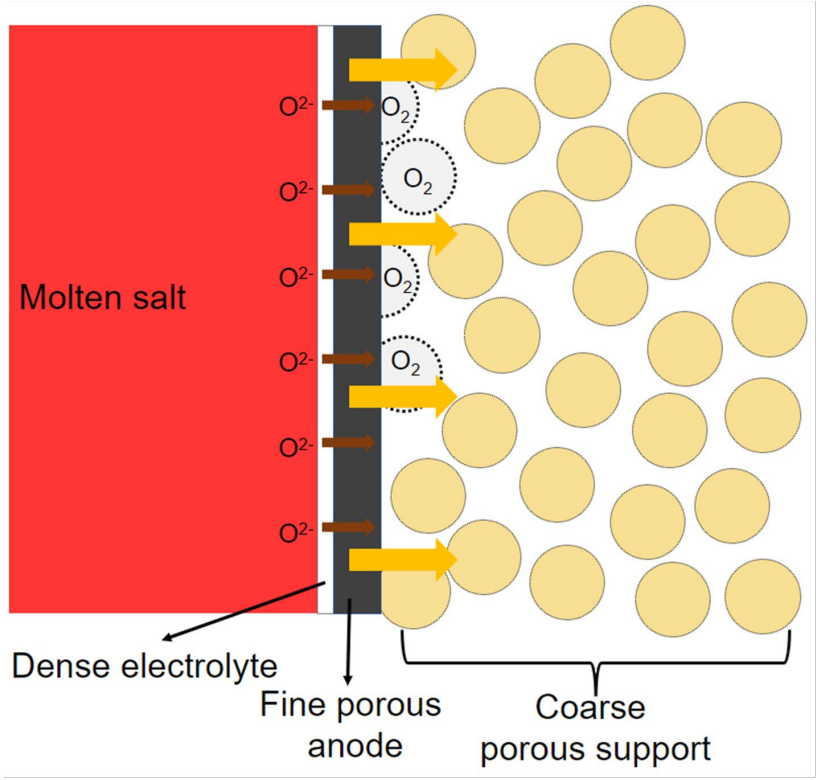


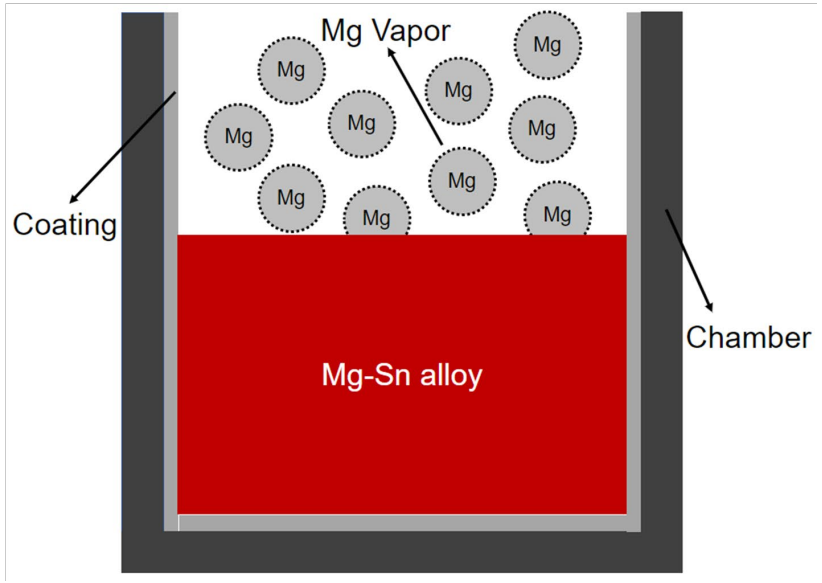
In addition to having a higher current efficiency, the carbon anodes have an overall lower electricity requirement.

Added resistance and energy to form O2 in place of CO2 increase the zirconia anode's electricity requirement.




Pure Mg over 99%





Future Work

- Analyze process with continuous MgO feed
- Scale-up process from benchtop to pilot level
- Continue work on next step in the process – G-METS distillation
- Develop thin SOM anode to reduce the energy consumption.

Thank You