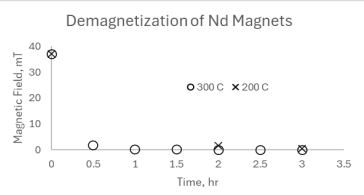
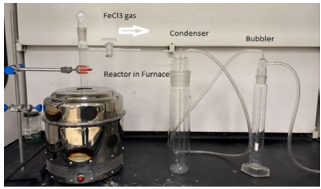


# Recovery of Critical Materials from E-Waste

- PI: Vivek Utgikar  
Co-PI: Krishnan Raja
- Grant #: IGEM25-007
- Reporting Period:  
7/1/24 –12/31/24



# Summary of progress towards proposed milestones

<p><b>Milestone 1:</b> <b>Pretreatment of Magnetic Material</b></p>	<ul style="list-style-type: none"> <li>•Short narrative of progress: Two steps sequential treatment of magnetic material to convert the magnet into a particulate form suitable for chemical reaction processing optimized</li> <li>•<b>Demagnetization</b></li> <li>•Time and temperature conditions for complete demagnetization determined experimentally.</li> <li>•<b>Particle size reduction:</b></li> <li>•A grinding cycle was established to achieve a particle size of less than 38 microns using a planetary ball mill (Model PQ-N2).</li> </ul>	 <p>The graph shows the demagnetization of Nd magnets over time at two different temperatures. The y-axis represents Magnetic Field in mT, ranging from 0 to 40. The x-axis represents Time in hours, ranging from 0 to 3.5. Two data series are plotted: 200 C (represented by 'x' markers) and 300 C (represented by 'o' markers). Both series show a rapid initial drop in magnetic field, reaching near-zero values within the first hour. The 300 C series reaches zero field slightly faster than the 200 C series.</p>
<p><b>Milestone 2:</b> <b>Development of Experimental Setup for Solid-State Chlorination</b></p>	<ul style="list-style-type: none"> <li>•Short narrative of progress: Experimental setup shown in the figure;</li> <li>• The system is configured to evacuate FeCl<sub>3</sub> formed during the reaction and condense it in a condenser. This step potentially permit more efficient separation of neodymium (Nd) from iron (Fe). Glass reactor and other pieces fabricated</li> </ul>	 <p>The photograph shows a laboratory experimental setup. It includes a stainless steel reactor placed inside a furnace. A glass condenser is connected to the reactor to collect FeCl<sub>3</sub> gas. A bubbler is also part of the setup. Labels indicate 'FeCl<sub>3</sub> gas', 'Reactor in Furnace', 'Condenser', and 'Bubbler'.</p>
<p><b>Milestone 3:</b> <b>Solid State Chlorination Experimentation</b></p>	<ul style="list-style-type: none"> <li>•Short narrative of progress: Setup completed as described above.</li> <li>•The setup is designed to operate with ~100 mg of magnetic material. Preliminary experiments have indicated successful conversion of metals into chlorides. In addition, experiments are proposed to be conducted using thermogravimetric analysis/differential scanning calorimetry (TGA/DSC) which required &lt;10 mg of metal.</li> <li>•Troubleshooting of the TGA/DSC instrument (NETZSCH STA-409) in progress.</li> </ul>	
<p><b>Milestone 4/5:</b> <b>Chloride Reduction and Electrowinning Experimentation</b></p>	<ul style="list-style-type: none"> <li>•Short narrative of progress; To be initiated</li> </ul>	
<p><b>Milestone 6:</b> <b>Technoeconomic Analysis and Life Cycle Assessment</b></p>	<ul style="list-style-type: none"> <li>•Short narrative of progress: To be initiated</li> </ul>	

# Summary of expenditures and budget performance

- **Key Insights**

- Spending is ON TRACK with proposal progress, but slightly under anticipated expenditures
- Major expenditures included
  - Personnel: PI summer salary, graduate student stipend
  - Supplies: Reactor fabrication; reagent, gases, and laboratory supplies;
  - Graduate student tuition

- **Challenges/Changes**

- Two graduate students budgeted for, successful hiring of one student: experimental effort supplemented through hire of undergraduate students

	Budgeted	Spent	+/-
<i>Personnel (Salary + Fringe) PI, co-PI, two Graduate Students,</i>	87,752	38,247	49,505
<i>Operating Expenses (Materials/Supplies, Publication)</i>	26,832	3,759	23,073
<i>Graduate Tuition and Health Insurance</i>	25,416	5,583	19,833
Total	140,000 (100%)	47,589 (34%)	92,411 (66%)
...			

# ***Projection of work in next reporting period***

- Experimental Studies
  - Analysis and characterization of the material
  - Solid-state chlorination using TGA/DSC and the large-scale reactor setup
  - Investigation of chloride reduction for the separation of Fe from rare earths
  - Electrowinning of Nd/rare earth metals
- Process Development and Analysis
  - Conceptual development and finalization of the process flow sheet
  - Preliminary technoeconomic analysis (TEA)
  - Preliminary life cycle assessment (LCA)
- Publications and Conference Presentations