Mercury Oxidation via Catalytic Barrier Filters

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Mercury Oxidation via Catalytic Barrier Filters

1. Background
2. Scope of Work
3. Phase I Results

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BACKGROUND

- Coal-fired utility boilers = 31% of the total U.S. anthropogenic emissions
- Gaseous & Particulate Hg^{2+} deposited near source
- $Hg^{(0)}$ stays in atm up to one year/can be transported over trans-continental distances

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BACKGROUND

- **Equilibrium calculations predict $Hg^{(0)}$ should convert to Hg^{2+} upon cooling**

- **Measurements of flue gas from boilers burning different coals typically show only 35% to 95% oxidation.**

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BACKGROUND

- Hg^{2+} removed from flue gas easily, **cost effective**

- $Hg^{(0)}$ removal difficult, **costly!**

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BACKGROUND

- $Hg^{(0)}$ removal involves oxidation to Hg^{2+}, then removal.
- Most cases: oxidation is rate limiting step
- Activated carbon: deactivation occurs at oxidation sites
- Thus, the efficiency of oxidation is the key to efficient Hg removal

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BACKGROUND

- Catalysis – method to improve oxidation
- Radian study – 70% to 96% $Hg^{(0)}$ oxidation with Pd/Pd-Carbon based catalysts
- UND/EERC study – TiO_2 and Al_2O_3 oxidize $Hg^{(0)}$

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PROJECT OBJECTIVE

- Explore the feasibility of oxidizing $Hg^{(0)}$ in coal combustion flue gas using catalytic material impregnated onto barrier filters
- Barrier filters = excellent contact between the mercury and catalyst
- Potential to reduce the amount of catalyst required (perhaps 2-3 orders or magnitude compared to activated carbon entrained injection)

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PROJECT SCOPE & STATUS

1. **Screen potential catalysts**
   - Pd on Al_2O_3
   - Al_2O_3
   - TiO_2

➢ **Determine most attractive candidates**

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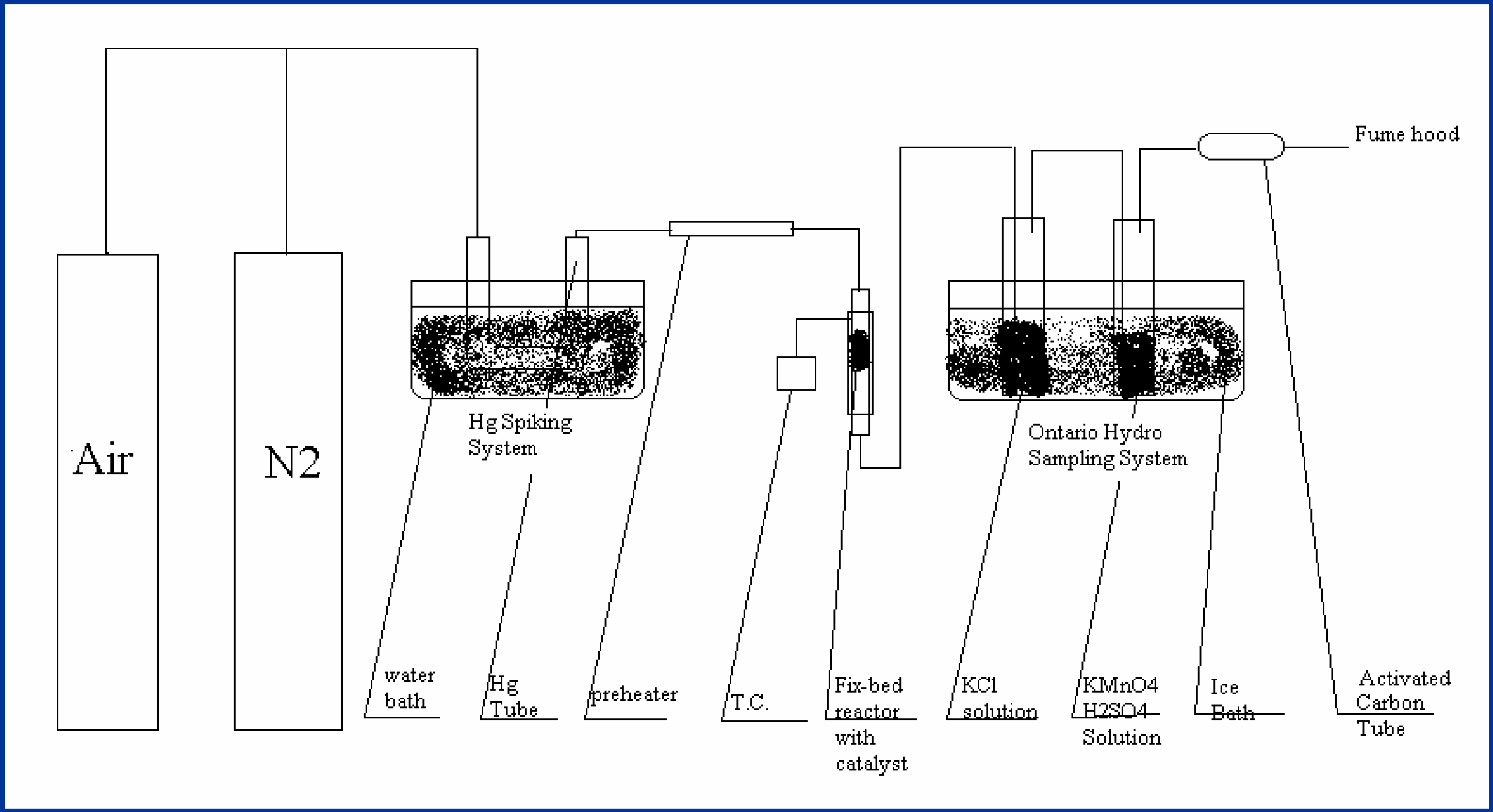
PROJECT SCOPE & STATUS

1. Screen potential catalysts



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PROJECT SCOPE & STATUS

1. **Screen potential catalysts**
   - **Packed bed designed to ensure kinetically-limited regime**
   - **Catalyst empty bed residence time = 0.16s**
   - **Test Gas stream:**
     - **27 ppb gas $Hg^{(0)}$ concentration**
     - **8.4% O_2 concentration**
     - **Balance is N_2**

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PROJECT SCOPE & STATUS

1. Screen potential catalysts
   - Sampled inlet/outlet streams
   - Ontario hydro method sampling
     - 0.1M KCl impinger solution for Hg^{2+}
     - 4% $KMnO_4$ / 10%H_2SO_4 impinger solution for total Hg
   - CVAAS Hg analyses

➢ Status: completed

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PROJECT SCOPE

1. Screen potential catalysts
2. Test candidate catalysts in a simulated flue gas stream
   - One or two candidates tested using flowing tests through a packed catalyst/media bed
   - SO_2/NO_x poisoning explored
   - ➢ STATUS: just beginning

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PROJECT SCOPE

1. Screen potential catalysts
2. Test candidate catalysts in a simulated flue gas stream
3. Impregnate barrier filter with the best catalyst and test its performance
   - Metal oxide catalysts deposited via techniques such as simple wash-coating
   - Lab-scale barrier filter installed in simulated flue gas system
   - ➢ STATUS: barrier filter acquisition in progress

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PHASE 1 RESULTS

- 3 Catalysts studied:
  - Al_2O_3
  - Pd on Al_2O_3
  - TiO_2
- 3 Temperatures:
  - 150^{o}C
  - 250^{o}C
  - 350^{o}C

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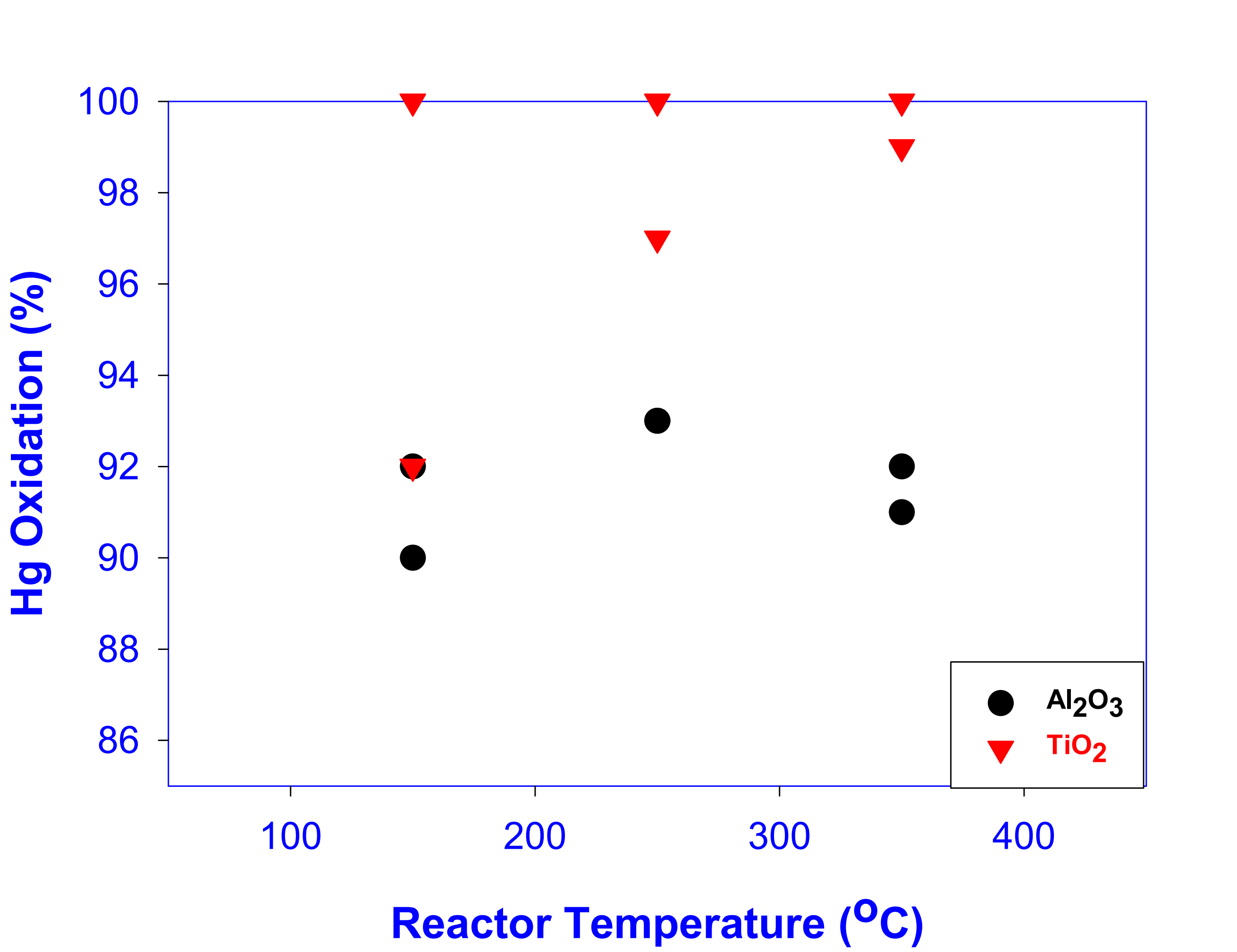
PHASE 1 RESULTS



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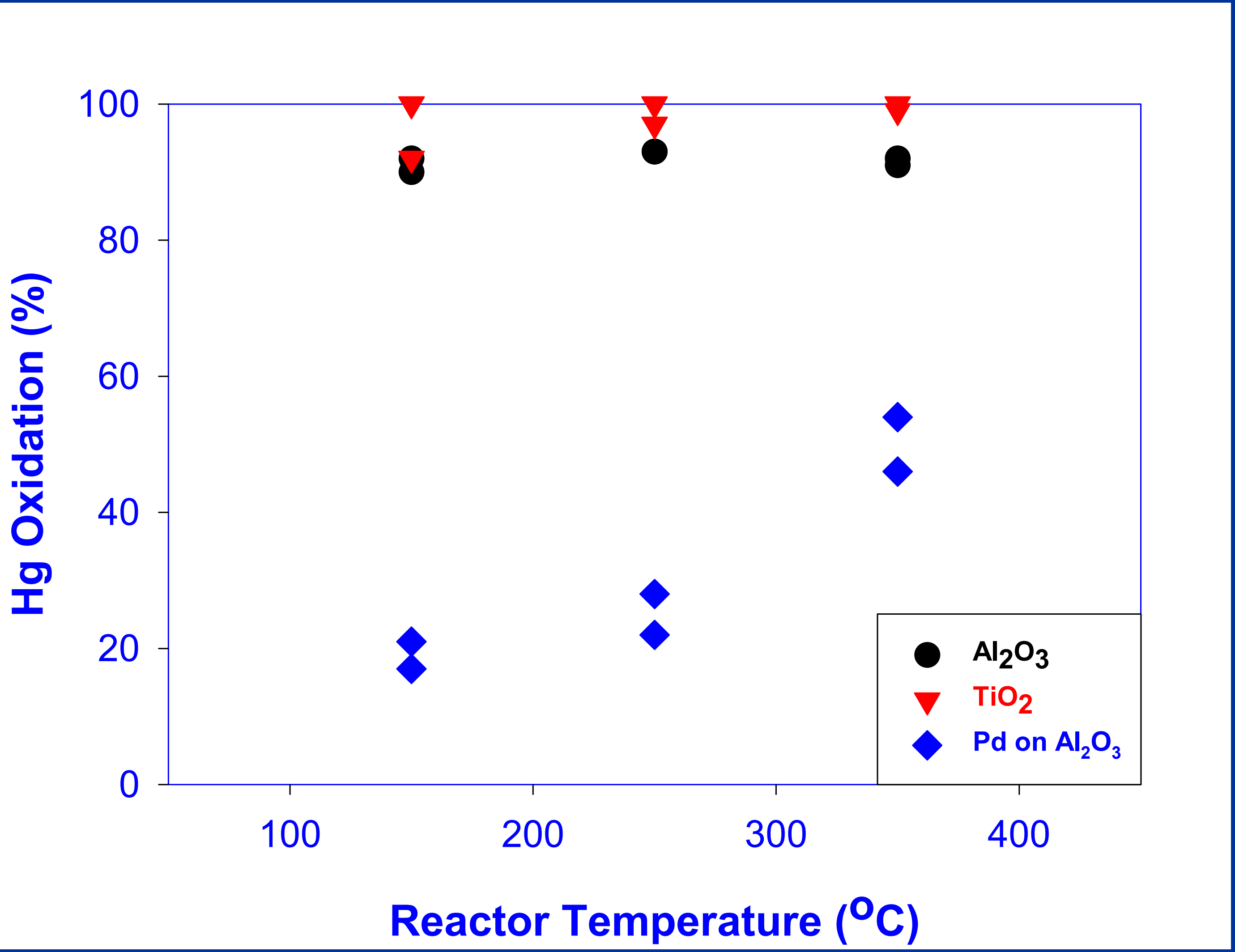
PHASE 1 RESULTS



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PHASE 1 Conclusions

- Both Al_2O_3 and TiO_2 appear to be good Hg oxidation catalysts
- Pd on Al_2O_3 may not be as effective
  - Poor mass balance closure
  - Probably strongly adsorbing Hg even after 12 hour run

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PHASE 1 Conclusions

Comparing Al_2O_3 and TiO_2:

- **Catalyst lifetime is probably more important than difference in oxidation rate**
- **Sulfur poisoning is biggest concern; this will be tested in Phase 2**

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