Dana-Farber Cancer Institute

Safety in the Catalysis Research Lab

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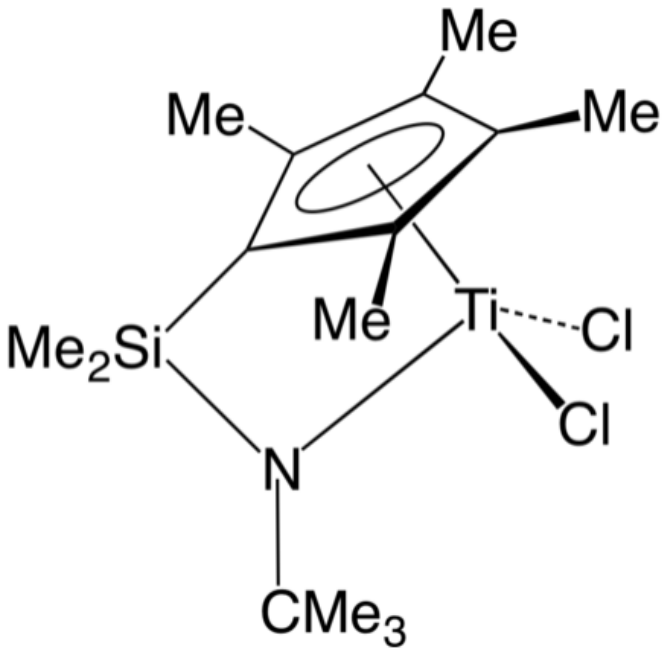
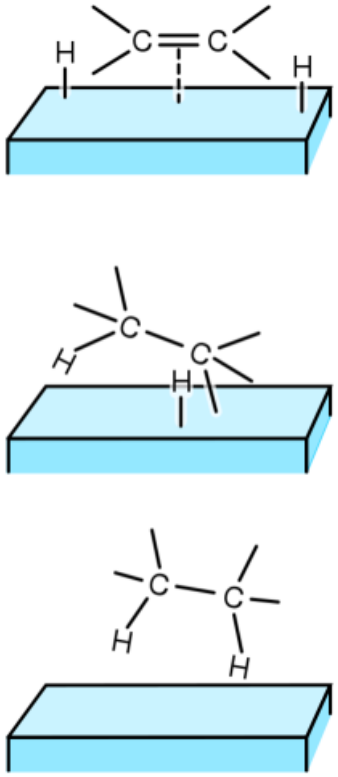
Homogeneous Catalysis



Heterogeneous Catalysis



Homogeneous Catalysis

Glovebox

Schlenk Line

Pyrophoric Reagents

Alkali metals for drying

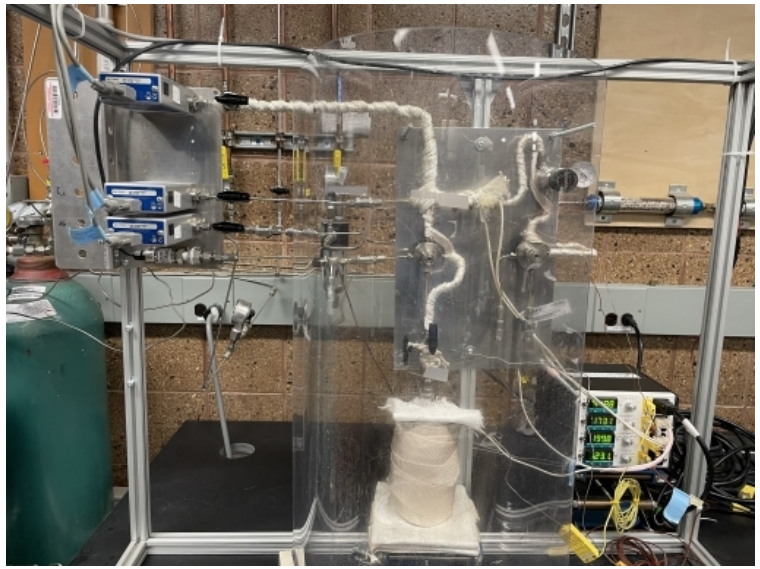
Solvent Purification Systems

Heterogeneous Catalysis

Catalytic Materials

Reactants & Products

Reactor



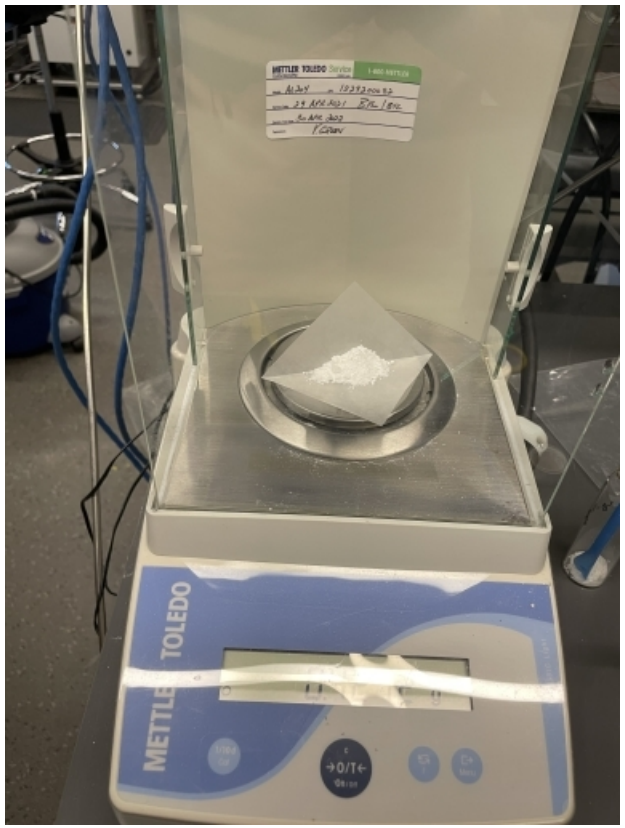
Heterogeneous Catalysis – Catalytic Materials

Materials

- Novel materials of unknown toxicity
- Fine particles handled on the benchtop
- Spent catalysts may differ from native materials (sintering, oxidation/reduction, pyrophoricity)

Powder

Extrudates



Heterogeneous Catalysis –Reactants & Products

Reactants & Products

- Toxicity
- Flammability
- Oxidizers
- Unknown products

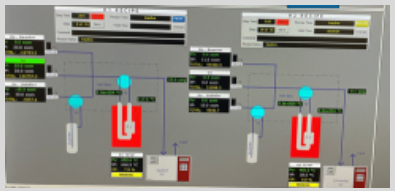
Exhaust

- Emissions
- Scrubbers
- Ductwork

Heterogeneous Catalysis - Reactor Design

Compressed Gas Management

Controls



Heating

Plumbing

Electrical

Reactor Design - Compressed Gas Management

Gas Source

- Tanks
- Generators

Engineering Controls

- Walk-in hood
- Gas Cabinet
- Snorkel

Transportation

- Hand trucks

Lockout

- Prevent accidental mixing of incompatible gases

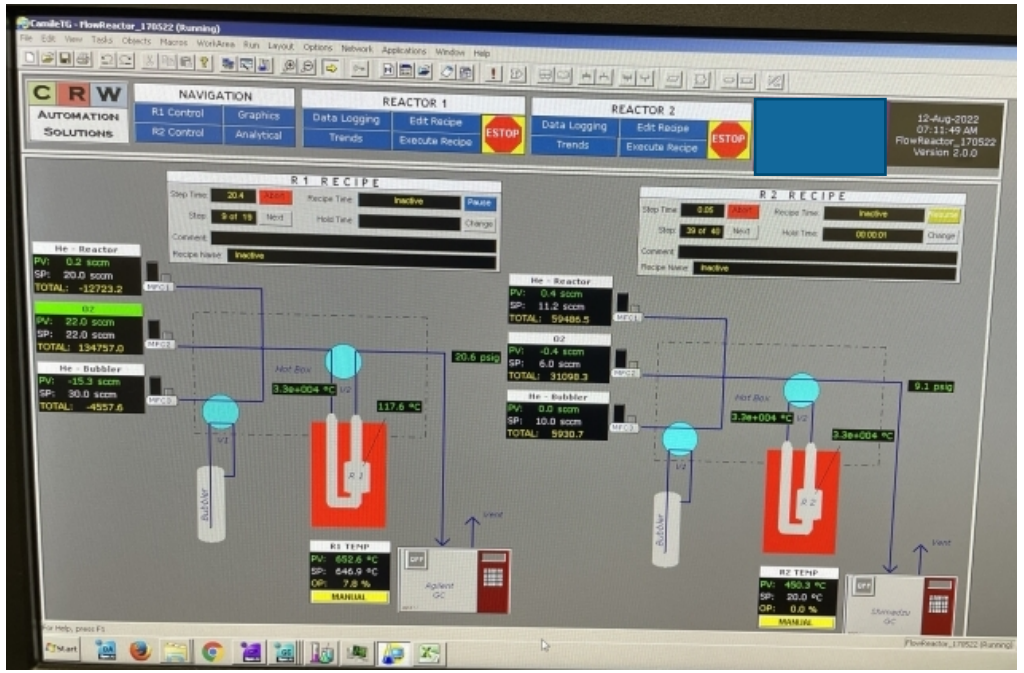
Reactor Design - Controls

Automated

- Easy to determine gas flow path
- Expensive
- Difficult to modify
- Difficult to troubleshoot
- Easier emergency shutdown

Manual

- Difficult to determine gas flow path
- Less expensive
- Easier to modify
- Easier to troubleshoot
- Difficult emergency shutdown



Reactor Design - Heating

Furnaces

- Commercial
- Homemade

Heat Tapes

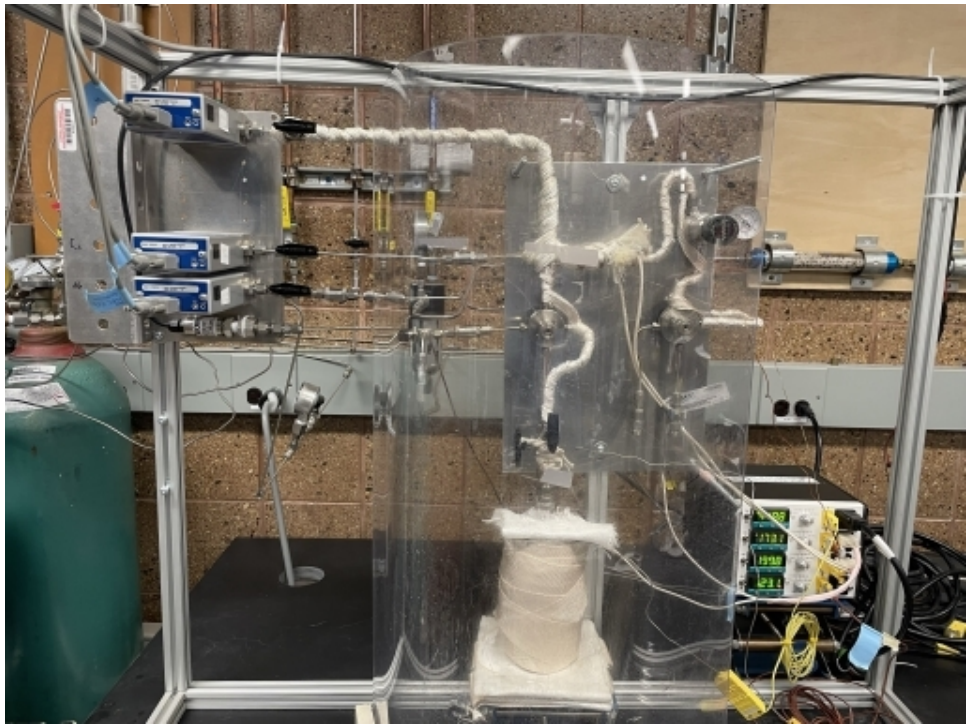
- Cold spot/condensation
- Burning

Temperature Controllers

- Limit controllers
- Exothermic reactions

Reactor Design - Plumbing

Pressure Relief



Leak Detection

Reactor Design - Electrical

Electrical Service

- High power consumption
- Multiple circuits per reactor
- Understanding circuits & why tripped

Cords

- Integrity
- Materials of composition
- Extension cords

Parts Bin

Contamination

- Unknown residue
- Sticky reactants (sulfur)
- Oxygen service
- Valves difficult to clean
- Metals not 100% inert

Composition

- Stainless vs. brass
- Warped threads
- Improper use of PTFE tape

Catalysis Safety Training Opportunities in Academia

Current Training

- Knowledge passed down in group
- Senior level ChemE industrial-scale process safety

Electrical Safety

- Inspecting equipment & outlets
- Power cords & extension cords
- Circuit breakers

Valves & Tube Fittings

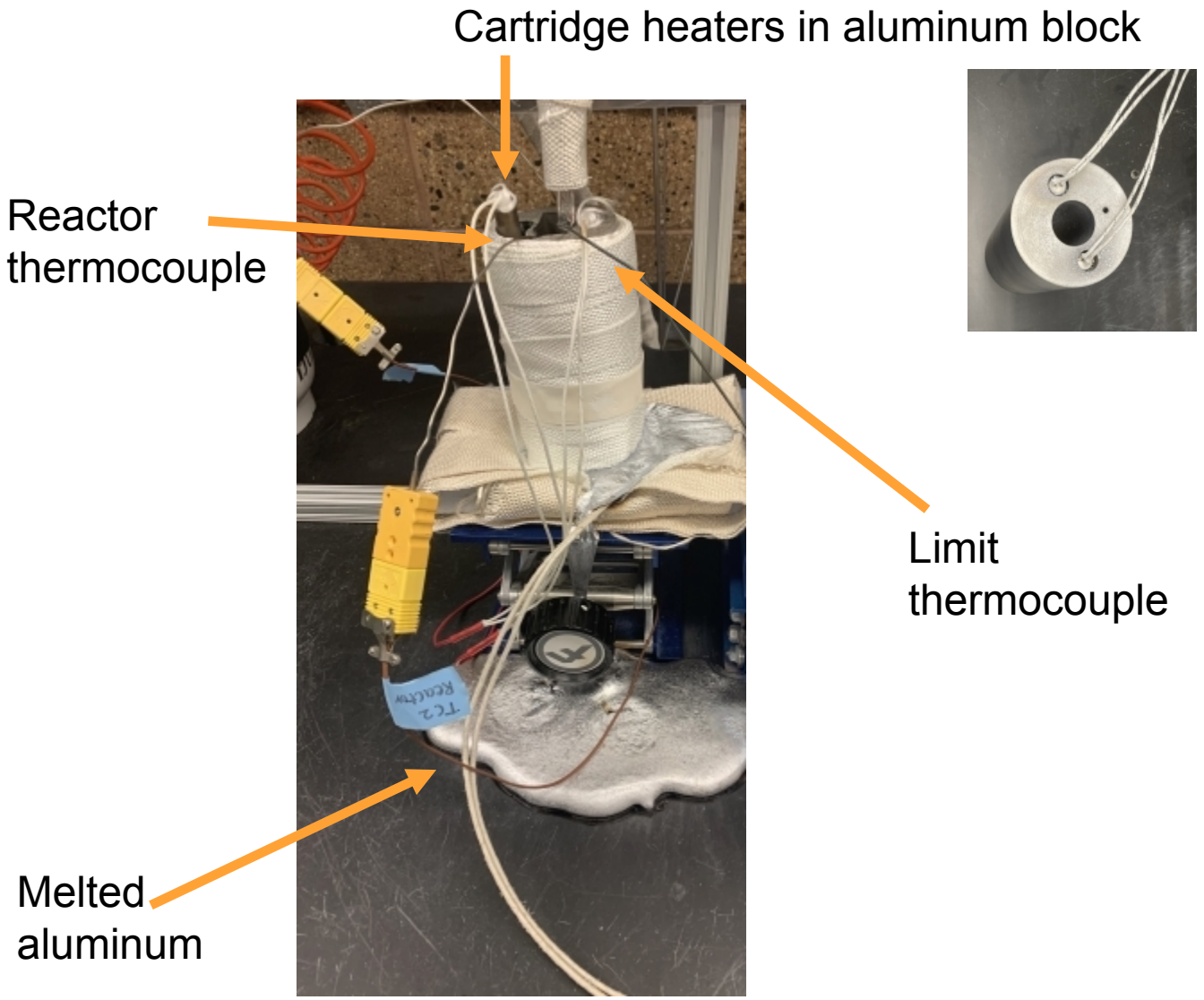
- Valve & fitting types
- Swagelok, NPT, others
- Sizing
- Materials of construction

Incidents

- Hot plate fires
- Other smaller lab incidents

What if the fail-safes fail?

- Control board managing two reactors
- Error caused power to be sent to one reactor and temperature read from the other
    - Never tripped the high temperature shutoff
- Melted aluminum heating block on unattended empty reactor
- Do we need an independent temperature controller which would cut the power? What level of redundancy is needed?



Acknowledgements

CH&S
CONNECTING CHEMISTRY AND SAFETY

CATL
ACS Division of Catalysis Science and Technology