Commercial and Lab Scale Reactors

1. Background

Catalytic reactors are essential tools for evaluating catalyst performance, studying reaction kinetics, and simulating commercial-scale processes. However, selecting or designing the right laboratory reactor can be a complex task. Different research goals require specific reactor types to ensure accurate and meaningful results. This application note summarizes common laboratory reactor configurations and offers guidance on selecting the appropriate reactor design for catalyst screening, kinetic studies, or process scale-up.

2. Common Catalytic Experiments and Recommended Reactor Types

Application 1: Catalyst Screening and Evaluation

Objective: Compare the activity and selectivity of multiple catalyst formulations.

Recommended Reactor Types:

✓ Small Fixed-Bed Reactors[1]
- Simple design and easy fabrication
- Requires small catalyst quantities
- Operable under isothermal conditions with minimal transport effects
- Ideal for detecting trends across a large number of catalysts

✓ Pulse Fixed-Bed Reactors[2]
- Reactants pulsed periodically over the catalyst bed
- Allows quick screening but generates non-steady-state data—careful interpretation required

Best Practices:

Keep overall conversions low to highlight differences in catalytic activity without masking effects from high conversions.

Application 2: Intrinsic Kinetic Studies

Objective: Obtain kinetic data free from heat and mass transfer limitations.

Recommended Reactor Types:

✓ Batch Reactors[3]
- Easy construction
- Versatile
- Good control over reaction conditions

✓ Continuous Stirred-Tank Reactors (CSTR)[4,5]
- Most commonly used
- Reacting mixture has the same composition as the exit stream
- Designs include impeller-mixed vessels, externally recirculating systems, and internally recirculating reactors (e.g., Berty and Carberry designs)

- ✓ Plug-Flow Reactors (PFR)[6]
  - Excellent thermal control
  - High conversion rates
  - Best for large-scale industrial processes

Best Practices:
Operate under isothermal conditions and conduct transport limitation tests to confirm kinetic data accuracy.

Application 3: Process Parameter Determination and Scale-Up

Objective: Simulate large-scale reactor conditions to collect process-relevant data.
Recommended Approach:

- ✓ Use the same reactor type as the commercial reactor[7]
  - Match phase distribution, catalyst shape, and operating conditions (temperature, pressure, concentrations).
  - Maintain geometrical and operational similarity to the industrial unit.

Best Practices:
Replicate commercial conditions as closely as possible to ensure laboratory data scales accurately.

Reactor Type	Ease of Analysis	Isothermality	Ease of Construction	Transport Effects	Quality of Data
Fixed - bed, differential	P – F	G	G	F	P – G
Fixed - bed, integral	G	P – F	G	P – F	P – F
Pulse	P – G	G	G	F	P
Batch	P	G	F	P	P – G
CSTR	G	G	P	P – F	G
External recirculating	G	G	P	P	G
Internal recirculating	G	G	P	G	G
Trickle bed	G	P	P – F	P	P
Fluidized bed	P	P	P	F	P – F
Bubble column	G	G	G	F	F

G = Good, F = Fair, P = Poor

Table 1: Strengths of various reactor types

3. AMI Reactor Solutions

AMI provides a full range of customizable reactor systems for catalyst screening, kinetic studies, and commercial process simulation. Whether you require small-scale fixed-bed units or sophisticated recirculating reactors, **AMI's** engineering team can tailor solutions to meet your specific research goals.

4. References

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