

# Flow Chemistry

210+  
projects

30+  
reaction types

kilo to metric ton scale

## Application in safer, more stable, higher-yield processes

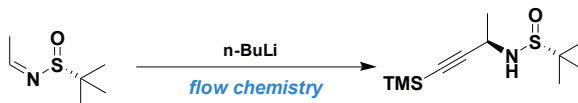
- High temperature/pressure
- Highly energetic
- Cryogenic
- Highly reactive and air-sensitive
- Toxic and/or stinky agents
- Unstable intermediates
- Oxidation and/or ozonization
- Diazotization

## Reactors

- Single-tube
- Multi-tube
- Static mixer
- Fixed/micropacked bed
- CSTR
- Electrochemistry reactor
- Photo-flow reactor
- Other materials

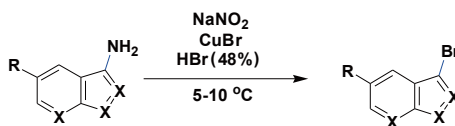
## Cases

### Cryogenic reaction



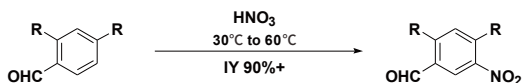
Entry	Comparison	Batch	Flow
1	Feasibility of scaling up	×	√
2	Temperature	-70 to -60°C	-40 to 10 °C
3	Yield	N/A	84%
4	Scaling-up risk	High	Low
<b>Result</b>	Completed 260 kg product with 240 mL continuous flow reactor in 30 hours		

### Diazotization



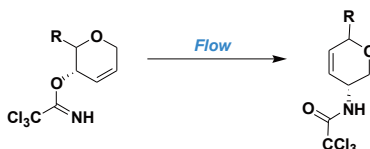
Entry	Comparison	Batch	Flow
1	Feasibility of scaling up	×	√
2	Temperature	N/A	5 to 10 °C
3	Yield	N/A	80 - 85%
4	Scaling-up risk	High	Low
<b>Result</b>	Completed 200 kg product with a set of 100 mL continuous flow reactor in 2-3 days		

## Nitration



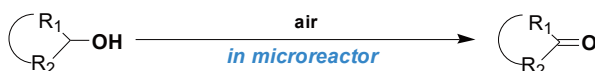
Entry	Comparison	Batch	Flow
1	Feasibility of scaling up	×	√
2	Temperature	20 - 30 °C	30 - 60 °C
3	Yield	N/A	90 - 93%
4	Scaling-up risk	High	Low
5	Automatic level	Low	High
<b>Result</b>	Over 300 kg of product completed with an integrated continuous tubing reactor		

## High temperature



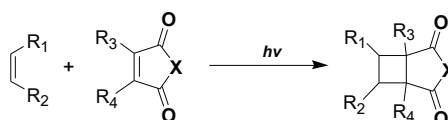
Entry	Comparison	Batch	Flow
1	Feasibility of scaling up	×	√
2	Temperature	200 °C	220 - 250 °C
3	Yield	N/A	> 94%
4	Scaling-up risk	High	Low
5	Automatic level	Diphenyl ether (BP: 258°C)	Toluene (BP: 110 °C)
<b>Result</b>	Over 100 kg of product completed		

## Oxidation



Entry	Comparison	Batch	Flow
1	PMI	15	7
2	Time	> 4 h	10 min
3	Yield	88 - 90%	95%
4	Complexity of work-up	High	Low
<b>Result</b>	Over 100 kg of product completed		

## Photocatalytic reaction



Entry	Comparison	Batch	Flow
1	Feasibility of scaling up	×	√
2	Time	30 h	40 - 50 min
3	Light source	Medium pressure mercury lamp	365 nm LED
4	Scaling-up risk	High	Low
<b>Result</b>	Over 500 kg of product completed		