# Overview

Options for FCC lab testing

<table>
<thead>
<tr>
<th>MAT</th>
<th>ACE</th>
<th>MDU*</th>
<th>CRU*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactor</strong></td>
<td>Fixed bed</td>
<td>Fixed fluidized bed</td>
<td>Entrained flow</td>
</tr>
<tr>
<td><strong>Amount catalyst [g]</strong></td>
<td>5</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td><strong>Amount feed [ml]</strong></td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td><strong>Time on feed [s]</strong></td>
<td>10 - 30</td>
<td>30 - 60</td>
<td>0.5 - 4</td>
</tr>
<tr>
<td><strong>p [bara]</strong></td>
<td>1</td>
<td>1</td>
<td>1 - 4.5</td>
</tr>
</tbody>
</table>

*Entrained flow laboratory reactors simulating commercial FCCU.*
Advantages / process parameters

- Low back-mixing
- 5 C/O measurements per 8 hour shift, up to 18 in progress
- Feedstocks with CRC’s 0-10% (15%) or crude can be used
  - Feed rate range: 3 to 12 g/min, mostly 7g
  - C/O: 5 to 50 (100)
- Can be run under pressure like riser and FCCU
  - Pressure: ambient to 3.5 barg
- Catalyst temperature: 600 to 950°C
- Oil pre-heat: up to 250°C
- Variable stripping efficiency
- Cost effective (operation, catalyst, feedstock)
- Fully automated lab system

*Patent and patent applications by ITQ / hte
MDU
Applications

- Conventional FCC
- FCC additives
- Propylene-on-purpose
- Naphtha cracking
- Crude-to-chemicals (CtC)
- Short contact time pyrolysis
- Light alkane activation / dehydrogenation
- Methanol-to-olefins
- Conversion of biogenic feedstocks
- Conversion of intermediates from plastics recycling
MDU
Next generation available in lab at hte
MDU
Simplified process scheme

Hopper
• Fluidization for faster heat-up
• Fits up to 1.4 kg of catalyst

Feed dosage
• Flexible dosage of VGO, crude or light hydrocarbon

Cat recovery
• Collection of catalyst for coke analysis
Data evaluation
Integrated workflow / Lab 4.0

- Prozess data
- Online GC
- Liquids by SimDist
- Coke by Leco
- PIANO Prefac
Data evaluation
Online / offline analyses

Online chromatograms
Global peak assignment
Offline SimDist
Definition of cutpoints

- **C5+**
- Methane
- Ethane
- Ethene
- Propane
- Propene
- 1-Butene
- n-Butane
- 2-Methyl-2-butene
- 2-Methyl-1-butene
- i-Butane
- i-Butene
- i-Pentane
- n-Pentane
- C5+

<table>
<thead>
<tr>
<th>Enabled</th>
<th>From temperature</th>
<th>To temperature</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>0</td>
<td>450</td>
<td>Gasoline</td>
</tr>
<tr>
<td>✔️</td>
<td>450</td>
<td>650</td>
<td>LCO</td>
</tr>
<tr>
<td>✔️</td>
<td>650</td>
<td>750</td>
<td>HCO</td>
</tr>
<tr>
<td>✔️</td>
<td>750</td>
<td>1300</td>
<td>CLO</td>
</tr>
</tbody>
</table>
CRU vs. MDU vs. ACE
Showcase: VGO Cracking / E-Cat
MDU
Temperature control

Colorcode by time:
TOS = 0 s: blue
TOS = 120 s: red

Simulation of temperature gradients existing in FCC operation

DOT corresponds to the downflow outlet temperature comparable to ROT (riser outlet temperature)
Summary

- MDU can be tuned to match yield distribution of CRU
  - Bottoms to coke
  - LPG / Gasoline selectivity / Olefinicity
- Fully integrated workflow solution
  - Mass balance 95-100%
  - Reproducibility equivalent to ACE or CRU
- Broad parameter range
- Tolerance to a variety of feedstocks
  - VGO (with atmospheric resid)
  - Light cut naphtha
  - Bio-derived feeds
  - Crude
THANK YOU!