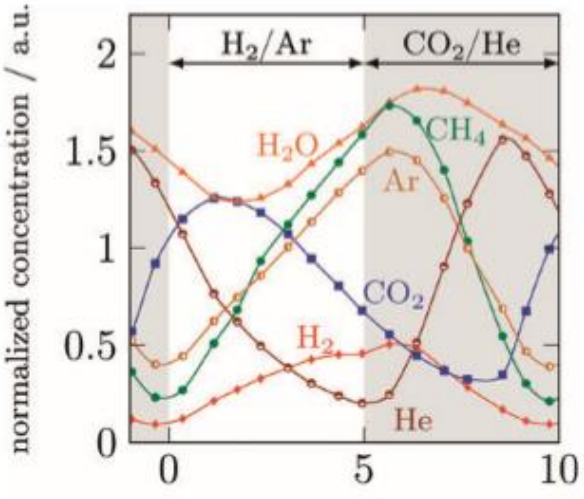
The R&D Solutions Provider

Integrated Lab Solutions

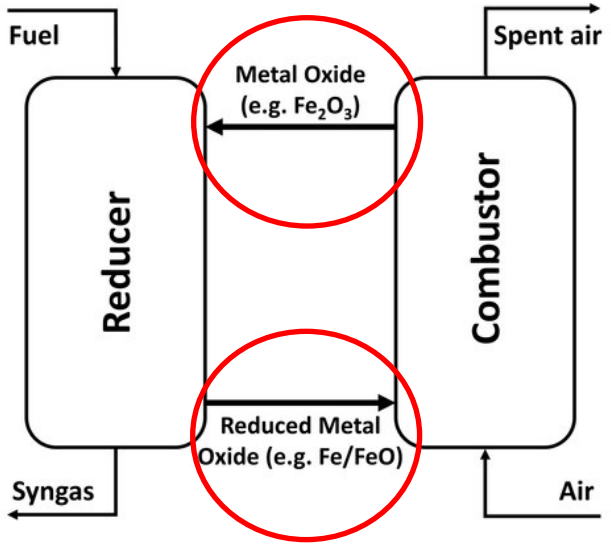
Accelerated oxygen-carrier testing for chemical looping applications

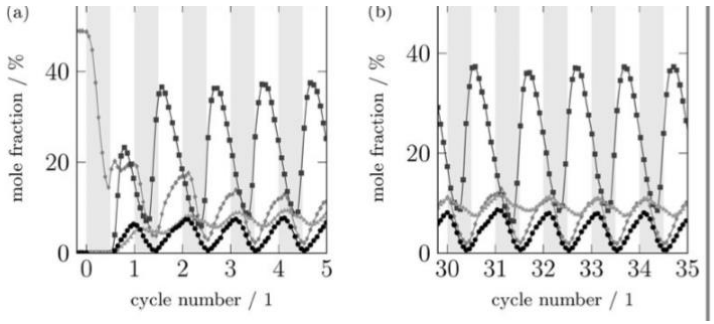


Integrated Lab Solutions

Dynamic Testing for Chemical Looping

Chemical Looping requires metal-oxide **oxygen carriers** which can undergo many redox cycles and maintain their chemical & mechanical stability as long as possible



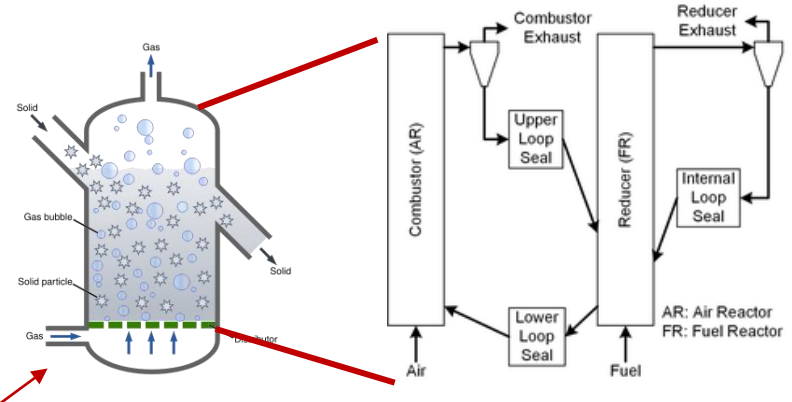


ILS dynamic testing units allow for **accelerated oxygen carrier testing** using rapid oxidation/reduction cycling

Integrated Lab Solutions

Standard Chemical Looping Reactor Designs

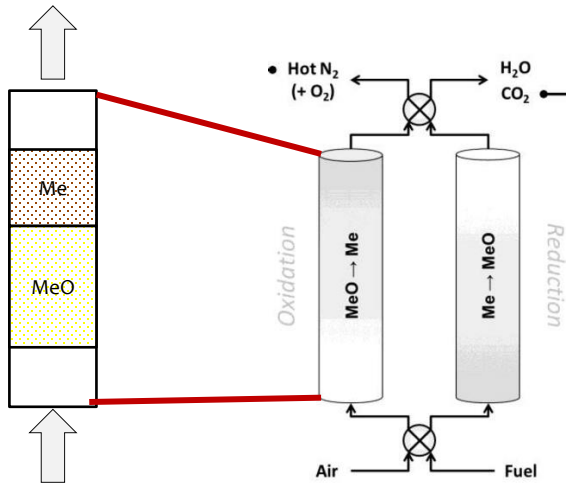
Fluidized Bed: Continuous gas glows with solids transport is **completely backmixed**



COMPLETELY DIFFERENT FLOW HYDRODYNAMICS

Fully Backmixed

Plug Flow



Fixed Bed: **Plug-flow** behavior with discontinuous gas-flows

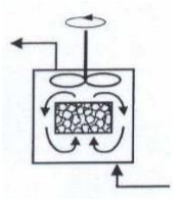
Integrated Lab Solutions

The Solution

ILS combines all 3 in a single unit:

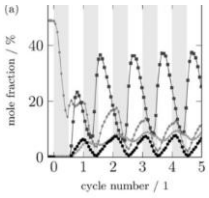
- Faster results (accelerated aging)
- Scalable (mimics true hydrocanmics)
- Lower cost (small footprint & fully automated)

Testing under completely-backmixed fluidized-bed conditions



Testing under plug-flow conditions

Can perform rapid redox cycling of oxygen carriers for accelerated aging testing



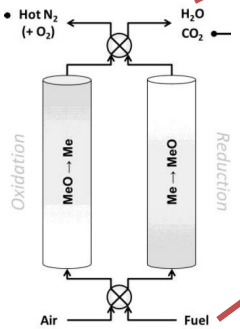
ILS Dynamic Systems

ILS Combined FBR/CSTR Dynamic Testing System

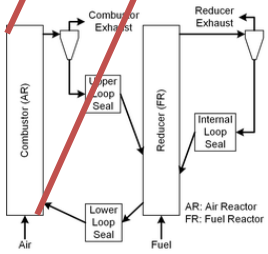
Accelerated Oxygen-Carrier Testing for BOTH Reactor Types in One Unit

- Fixed Bed Reactor
- Internal Recycle Reactor

Ideal Plug-Flow Fixed-Bed Reactor



Completely Backmixed CSTR



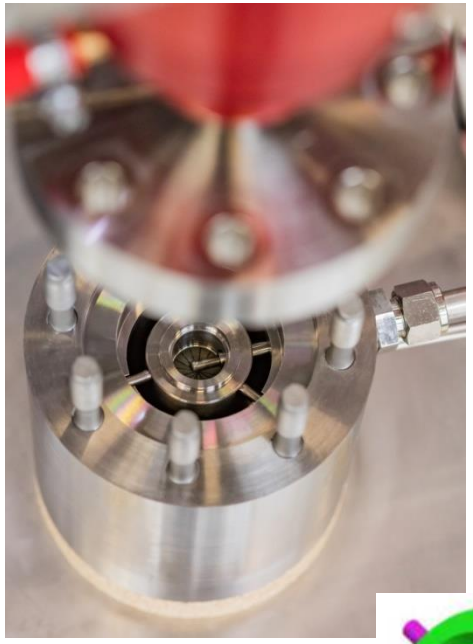
ILS Dynamic Systems

System Overview

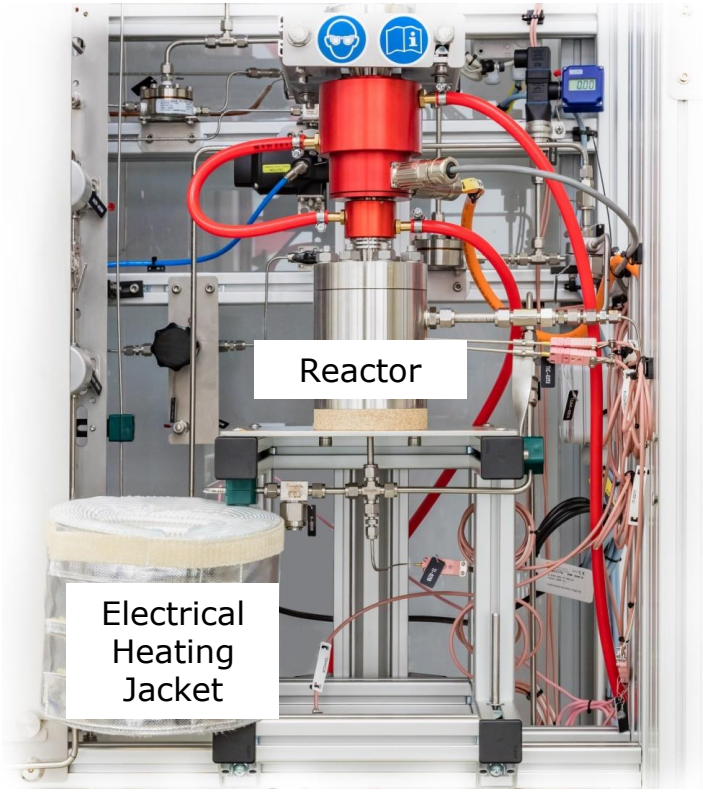
- BOTH FIXED-BED and FIXED/FLUIDIZED Reactors in a single unit
- Gas-Switching with up to 5Hz Frequency
- 100 Bar maximum operating pressure
- 700°C maximum operating temperature standard
  - 1000°C optional
- Fully Automated
- Time-Resolved quadropole mass-spectrometer or FTIR for product analysis

Internal-Recycle Reactor

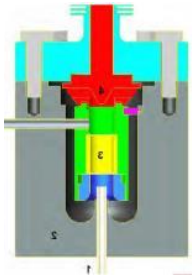
Complete Back-Mixing/Mini-Fluidized Bed

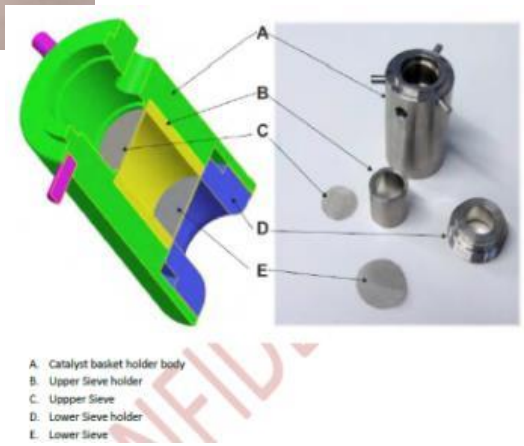


Temperature measurement directly above and below bed



Catalyst Bed Holder

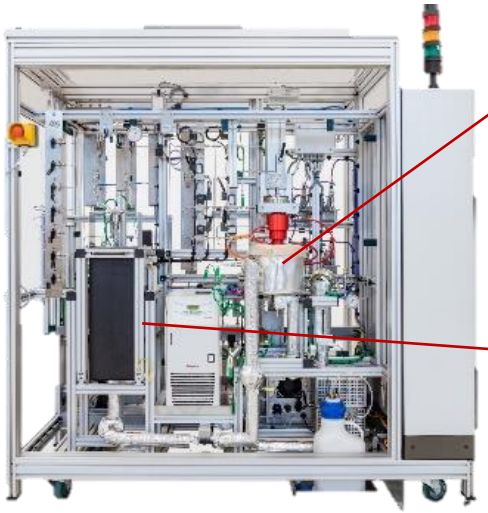




ILS Dynamic Systems

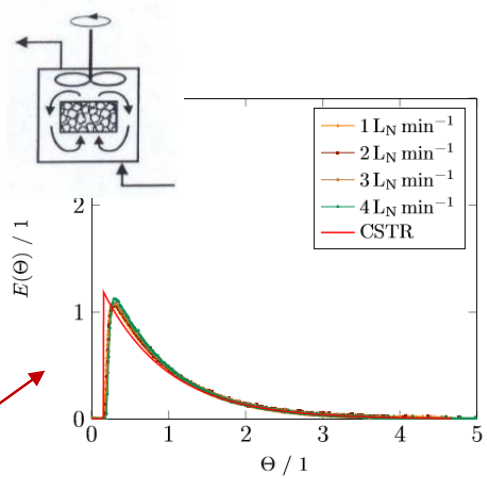
Fluid Dynamic Measurements with RTD Tracer Study

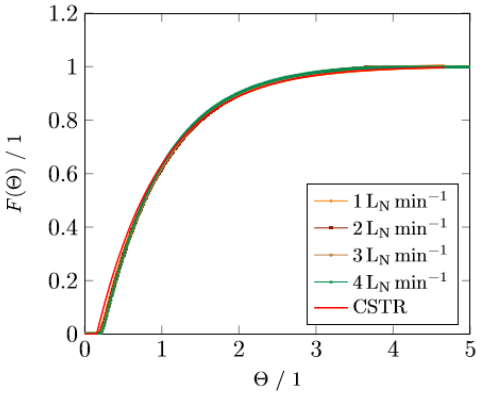
- **BERTY** reactor behaves as an ideal CSTR
- **FBR** behaves as an ideal PFR



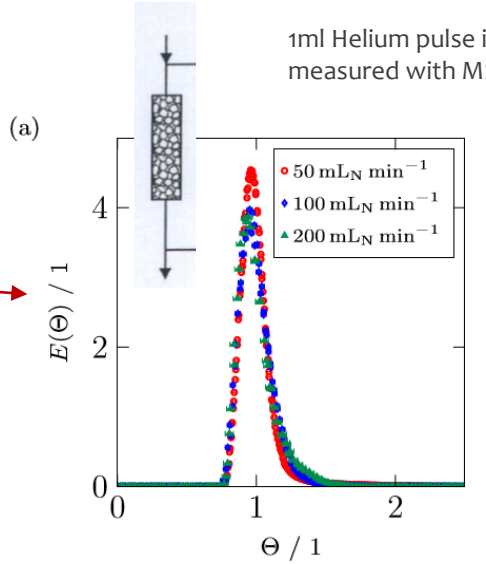
Fully Backmixed

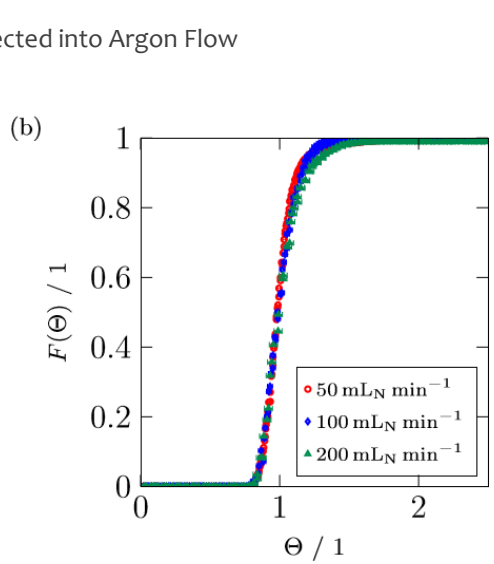
Plug Flow





1ml Helium pulse injected into Argon Flow
measured with MS





ILS Dynamic Systems

Dynamic CO2 Methanation Testing

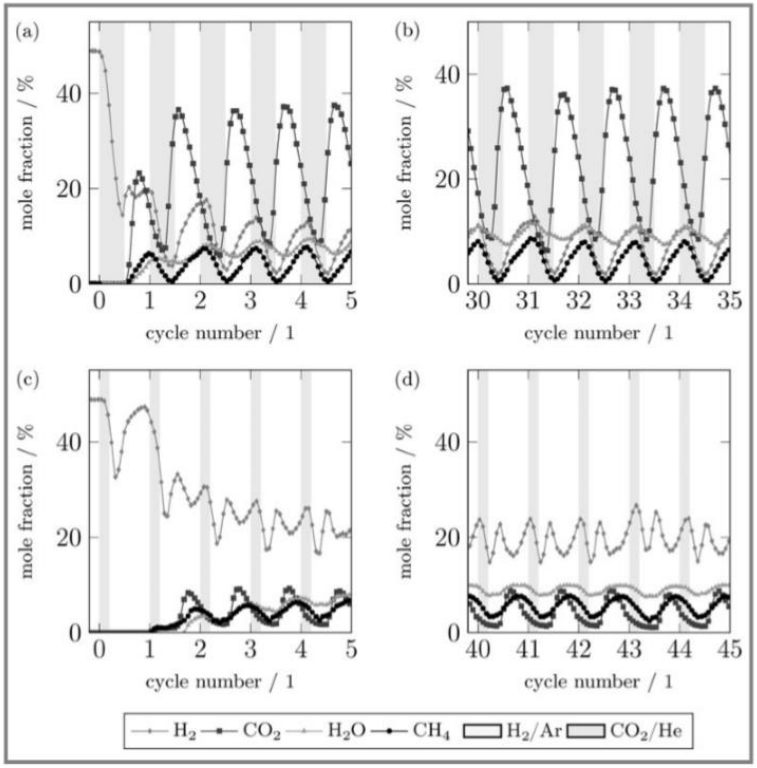


Figure 2. Concentration profiles for a cycle time of 10 s and cycle-split ratio of 0.5 (a, b), and for a cycle split of 0.2 (c, d). The start-up of the concentration forcing is shown in (a, c) and the quasi-steady state is presented in (b, d).

Example Data for Dynamic CO2 Methanation Over Nickel Catalysts

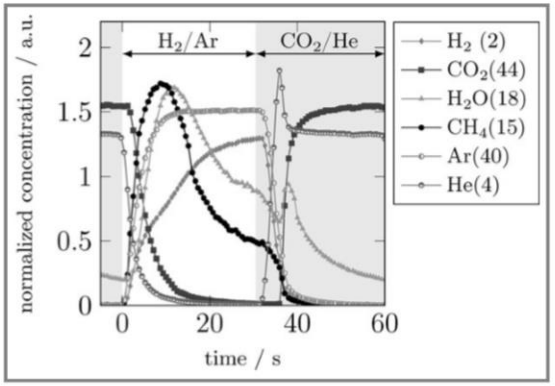


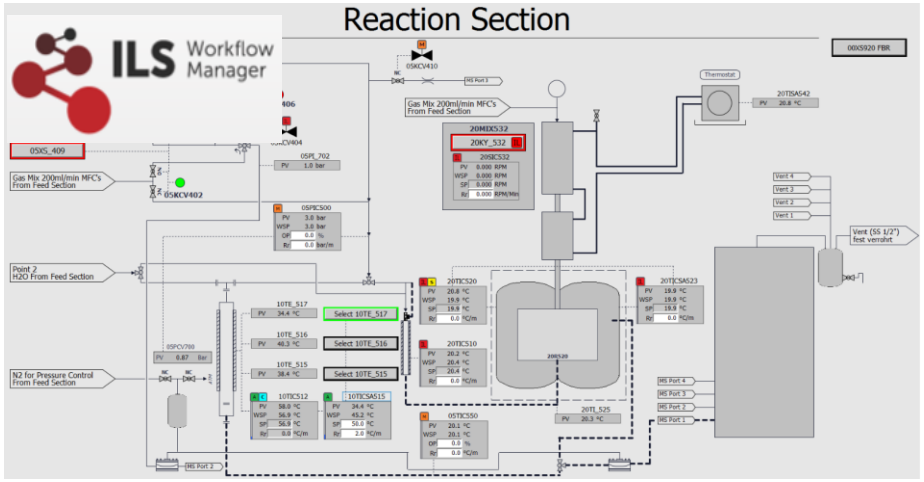
Figure 3. Normalized ion current profiles for a cycle time of 60 s and a cycle-split ratio of 0.5 in the quasi-steady state operation (cycle number 25). The *m/q* ratio on which the component is measured is given in parentheses. Normalization is performed for each signal individually, so the amplitudes of the signal cannot be compared.

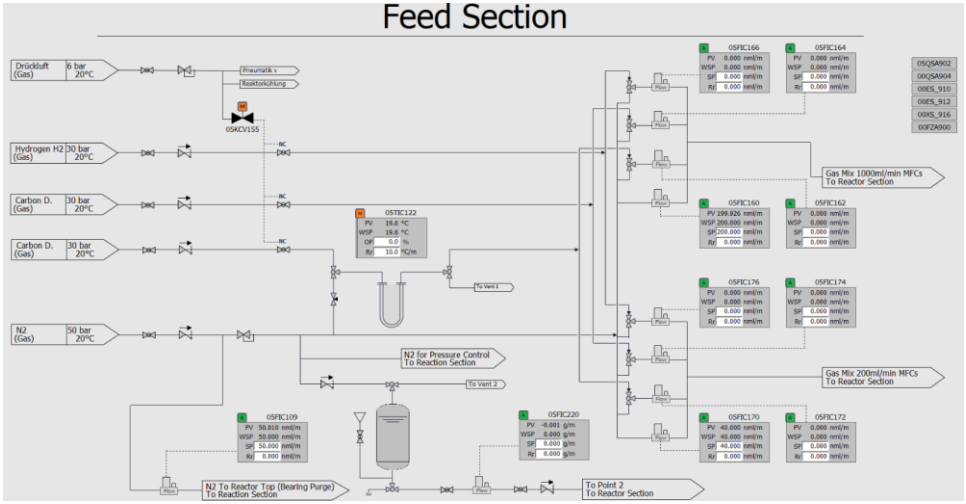
Data taken from: „Dynamic methanation of CO2-Effect of Concentration Forcing, Kreitz, Frieland, Güttel, Wehinger, Turek, Chem Ing. Techn. 2019, 91, No. 5 1-8

ILS Dynamic Systems

ILS Workflow Manager for 24/7 Automation

- Siemens S7 Process-Control
- ILS Workflow Manager allows for automated execution of multistep experiments
- ILS Workflow Manager provides seamless integration of on-line analytics
- Improved accuracy/Less work





ILS Workflow Manager

Company Overview

Key facts

- Driven by visionary scientists and engineers
- Technology leader in chemical R&D systems
- Integrated in Germany's largest science and technology park
- Over 16 years of experience in the industry
- 50 employees
- Over 400 reactors delivered worldwide

Headquarter	Berlin
Type of company	Private
Foundation	2003
Phd, Ms Chemical Engineers and Chemists	50% staff

Company Overview

Extract of References

ILS actively collaborates with the world's leading research centers

Contact us for more information

Contact one of our experts to learn more about how we can help you improve and accelerate your catalyst R&D

info@integratedlabsolutions.com

http://www.integratedlabsolutions.com