

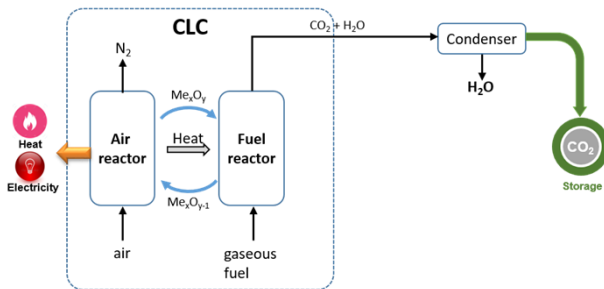
CL unit for GASEOUS fuels (0.5-10 kW_{th})

The **10 kW_{th} unit** was built in 2005 for the first demonstration of natural gas combustion using Cu-based oxygen carriers, when these materials had been discarded due to agglomeration problems. 100% carbon capture was obtained for the first time with one material prepared by impregnation.

The **500 W_{th} unit** was built in 2009, to test oxygen carriers in continuous units for long periods of time with different gaseous fuels and for both Chemical Looping Combustion (CLC) - for CO₂ Capture and Storage - and Chemical Looping Reforming (CLR) - for the production of hydrogen without CO₂ emissions. The unit can control and measure the solids circulation rate and was specially kanthal-built to test sulfur-containing fuels.



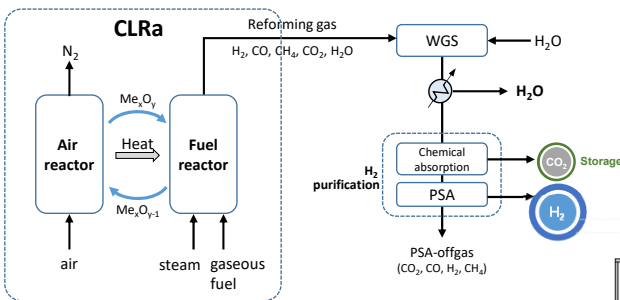
Chemical Looping Combustion



Fuels
CH ₄
Syngas
Biogas
PSA offgas
Acid gas (15% H ₂ S)
Sour gas (15% H ₂ S)
Solid sulfur

Oxygen carriers	
Synthetic	Mineral/Residues
Cu14Al, CuZr	Fe-ESF (red mud)
Ni18aAl, Ni21gAl, Ni14CaAl	Tierga (iron ore)
Fe20Al	FS_GR (waste water residue)
Perovskites	
MnFe	
CuMn-kaol	

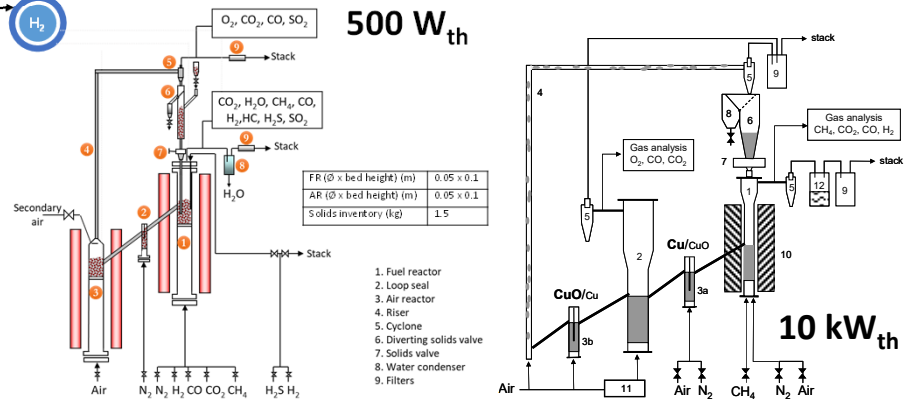
Autothermal Chemical Looping Reforming



Fuels
CH ₄
Biogas

Oxygen carriers	
Synthetic	Mineral/Residues
Cu14Al	FS_GR (waste water residue)
Ni18aAl, Ni21gAl	
MnFeTi	

- ▶ About **2000 h** of operational experience (≈25% world hours)
- ▶ Special interest for testing sulfur-containing fuels



MILESTONES

Long term operation (200 h) with **Cu-based** oxygen carriers at **10 kW_{th}** scale

First successful CLC operation with **sour gas (H₂S)** using **Fe-based** oxygen carriers

2000

2005

2010

2015

2020

2025

First successful CLC operation with **solid sulfur**