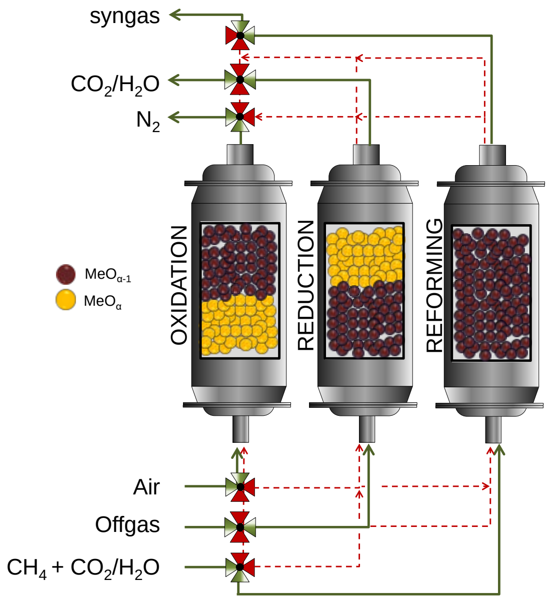
UKCCSRC Conference
Edinburgh, 4-5 September 2019

CLean hYdrogen and CHemicals production via chemical loopING



Vincenzo Spallina
Lecturer of Chemical Engineering
Department of Chemical Engineering and Analytical Science
University of Manchester

vincenzo.spallina@manchester.ac.uk

+44 (0) 161 30 69339

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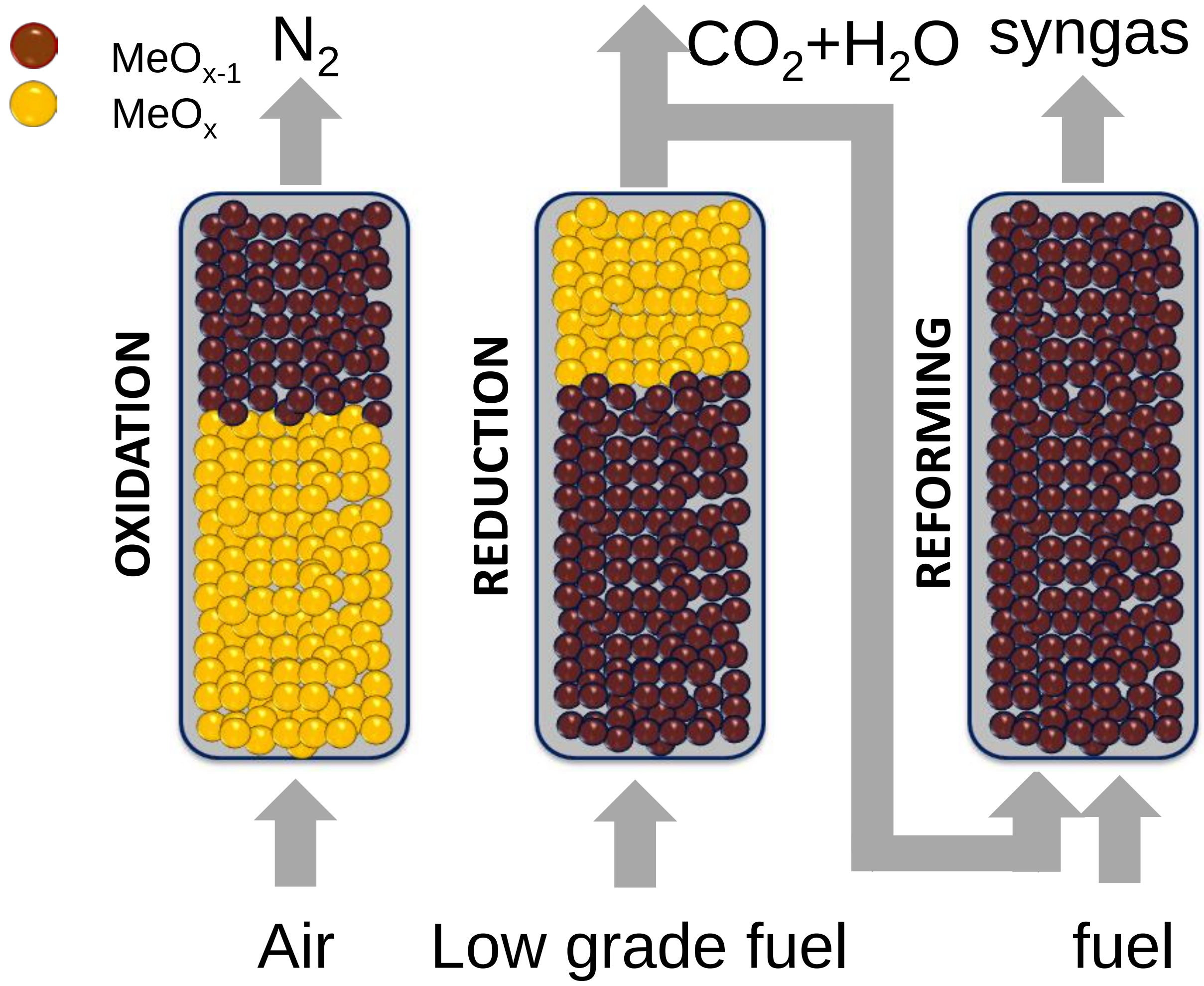
The concept



V. Spallina, B. Marinello, F. Gallucci, M. C. Romano and M. Van Sint Annaland, *Fuel Process. Technol.*, 2017, **156**, 156–170.

Chemical Looping Reforming with dynamically operated packed bed reactor

Challenges (research topic):

1) Reaction and heat fronts velocities particle/reactor
(fundamental studies)

2) OC formulation
(cost, stability, toxicity, kinetics)

3) Product yields
(reactor/process performance)

4) Dynamic operation
(reactor/process engineering)

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The integration

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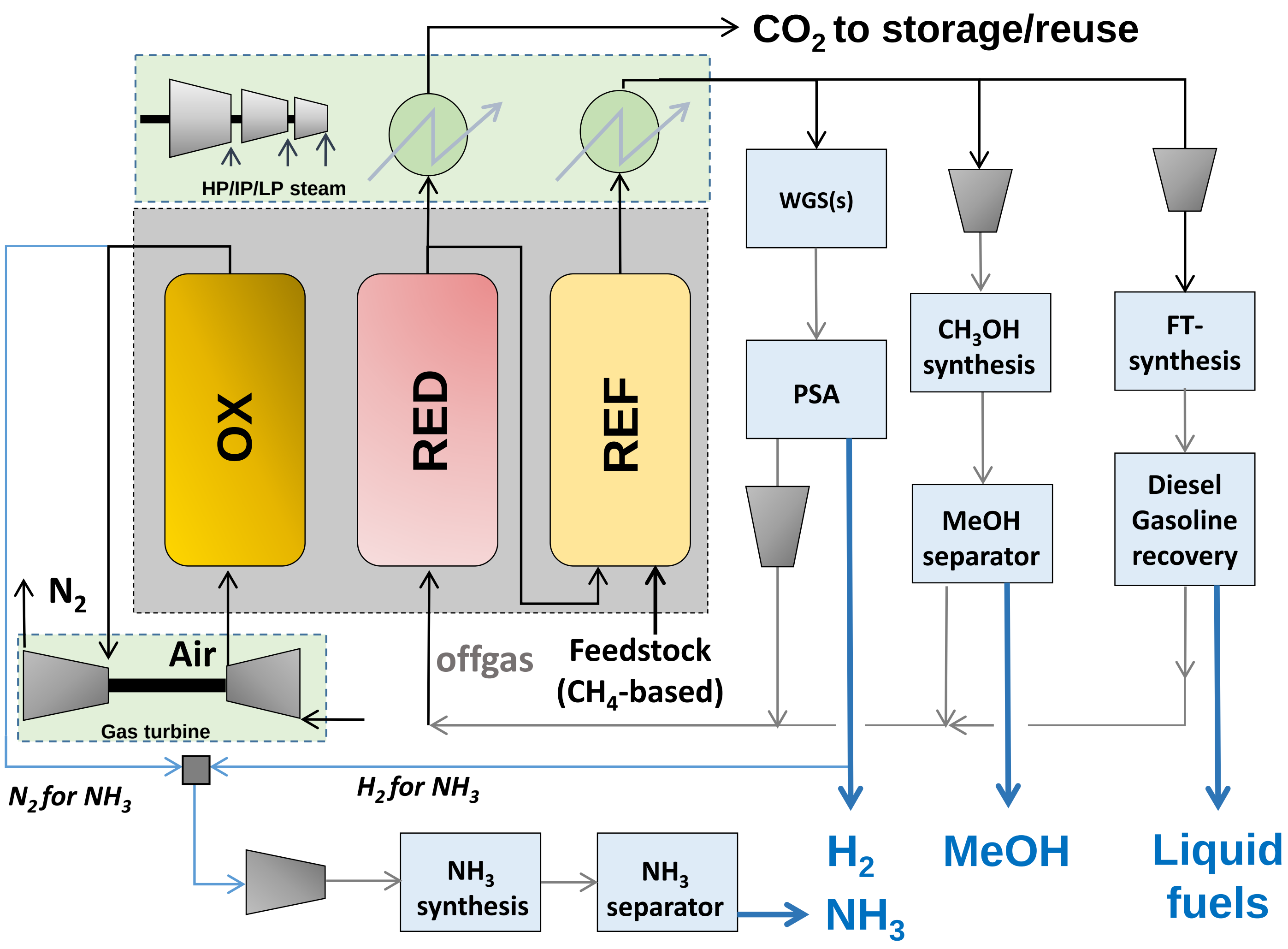

Challenges (research topic):

1) Feedstock/products selection/utilisation (plant size, availability, industrial symbiosis)

2) techno-economic assessment (benchmarking, energy/cost analysis)

3) Route to scale-up (reactor/process engineering)

V. Spallina, G. Motamedi, F. Gallucci, M. Van Sint Annaland, *Int. J. Greenh. Gas Con.*, 2019, **88**, 71–84.

Aim and objectives

Aim:

ab scale demonstration of a new **enhanced auto-thermal** chemical looping process *to accelerate* the cost-effective production of **hydrogen** and other **chemicals** (such as ammonia, methanol and liquid fuels) with near zero emissions.

Objectives:

1) Experimental demonstration in the existing lab facility of the concept at **relevant operating conditions (up to 1000 °C, 10 bar, ≈5-10 kW$_{LHV,th}$)** in a 1 kg packed bed reactor, using Ni, and Fe-based OCs;

2) Design and modelling of a large scale reactor based on the above experimental campaign including **techno-economic assessment and comparison** with benchmark processes.

Modelling and Experiments

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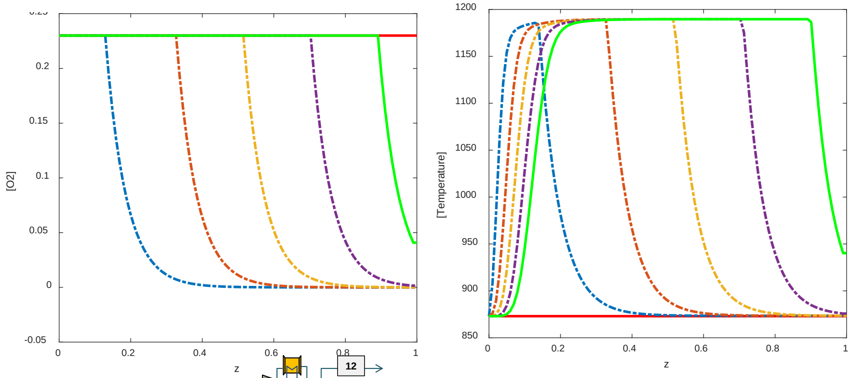
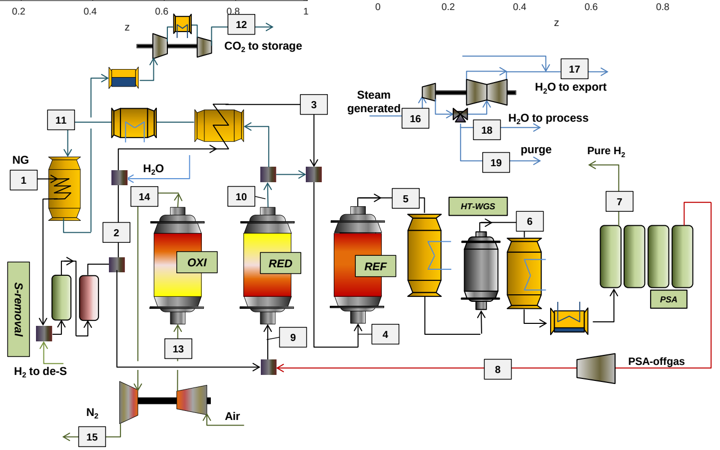
Reactor model



Process model



1) phenomenological reactor model for gas-solid reactions to be validated against the experiments
2) conceptual design of a large-scale process and its cost assessment

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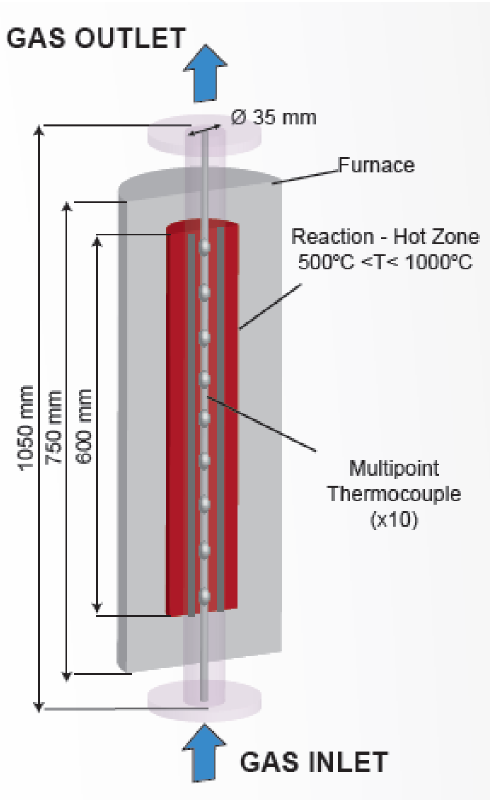
Setup:
T: up to 1000°C

P: up to 10 bar
(upgrade to 20 bar)

Capacity:1 kg material
(Fe-based/Ni-based)

Gases: up to 30 nL/min
$CO/CO_2/N_2/H_2/CH_4$/He/Air
In-situ steam generator



Reactor specifications

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Conclusions and future work

New route for chemical looping will be explored to combine syngas generation and CO_2 capture at high pressure/high temperature

Chemical Looping in fluidised bed has been demonstrated at atmospheric pressure; syngas generation is industrially convenient at high pressure (20-50 bar)

Process design at different plant size and utilisation

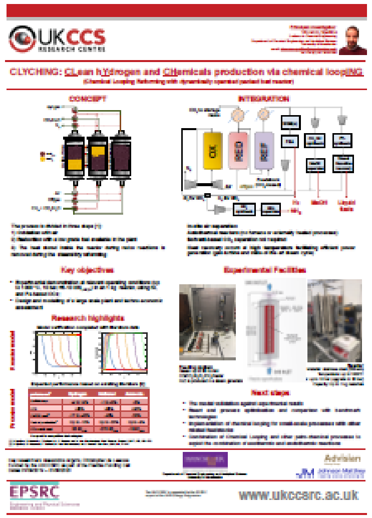
Apart from conventional H_2 and GtL process, this concept is suitable for: i) de-hydrogenation, ii) steam-iron, iii) offgas valorisation, iv) pure CO_2 production; v small-scale production

Improved performance compared to existing commercial processes

performance	Hydrogen	Methanol	Ammonia
Δefficiency#	+4 to +14%	-1 to +3%	-3%
CCR	>95%	>95%	>90%
CAPEX#	-17 to +40%	-40%	-20%
Cost of production#	**Up to -10%**	**Up to -20%**	**Up to -6%**
CO_2 avoid. cost	**55 €/t_{CO2}**	**-270 €/t_{CO2}**	**-13 €/t_{CO2}**

respect to competitive technologies

Thank you for your attention!



Poster number 16

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Acknowledgement

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Back-up SLIDES