

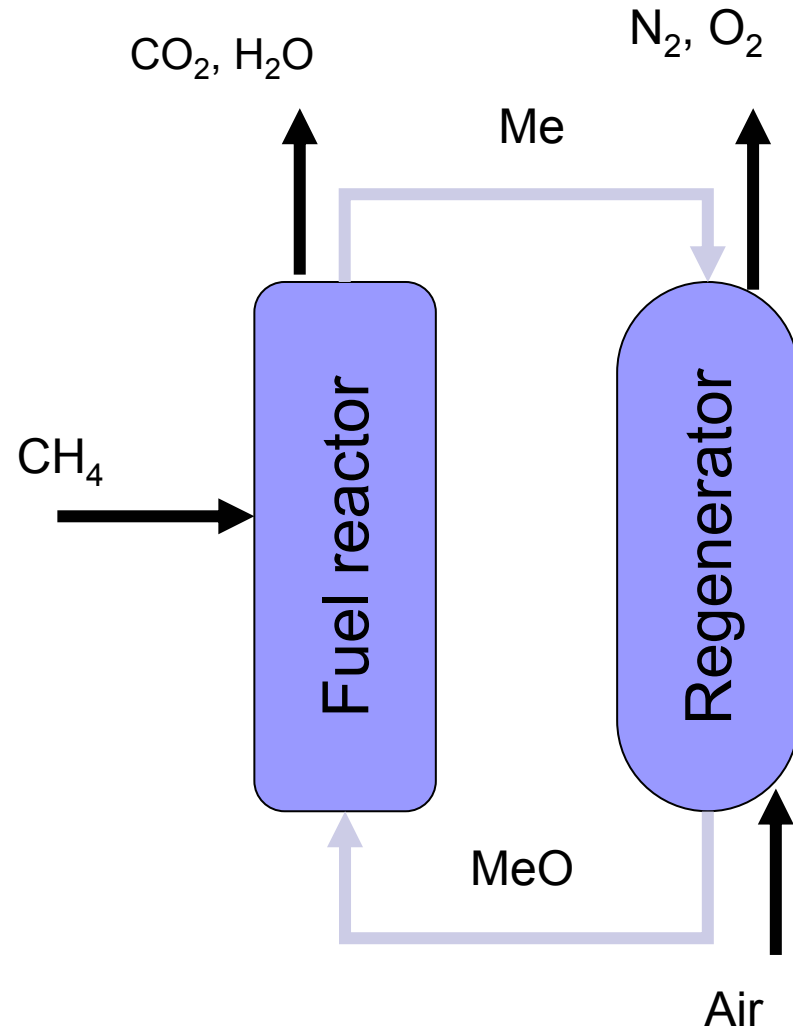
Solid fuels and looping cycles

Stuart Scott, Engineering Dept

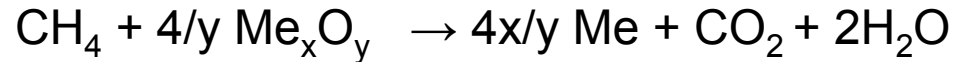
John Dennis, Dept Chemical Engineering.

Shin Yong Chuang, Dept Chemical Engineering

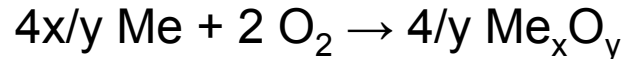
Chemical Looping Combustion



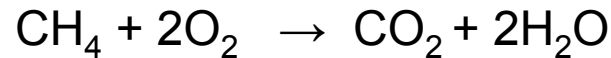
Fuel Reactor:



Regenerator:

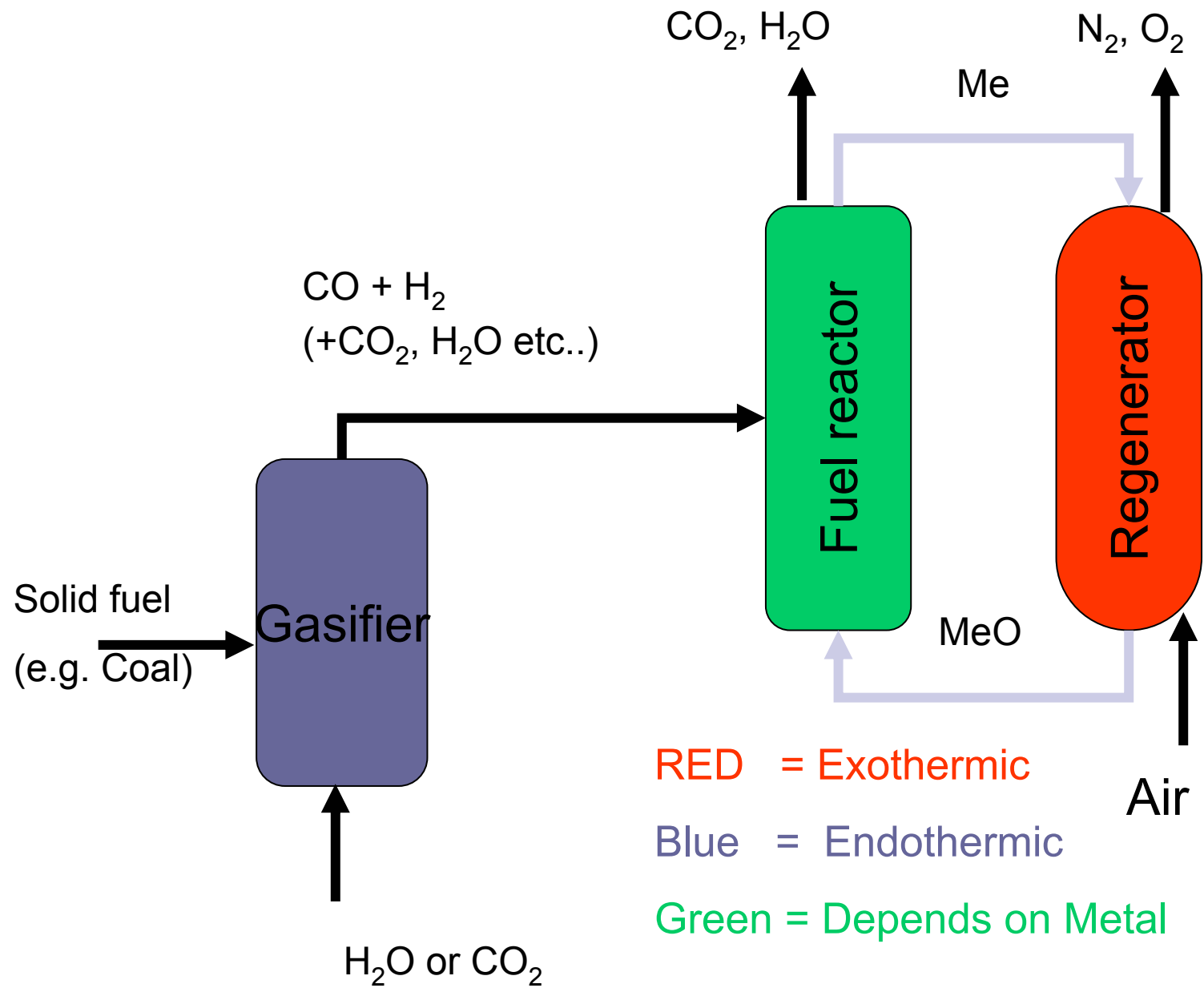


Overall:



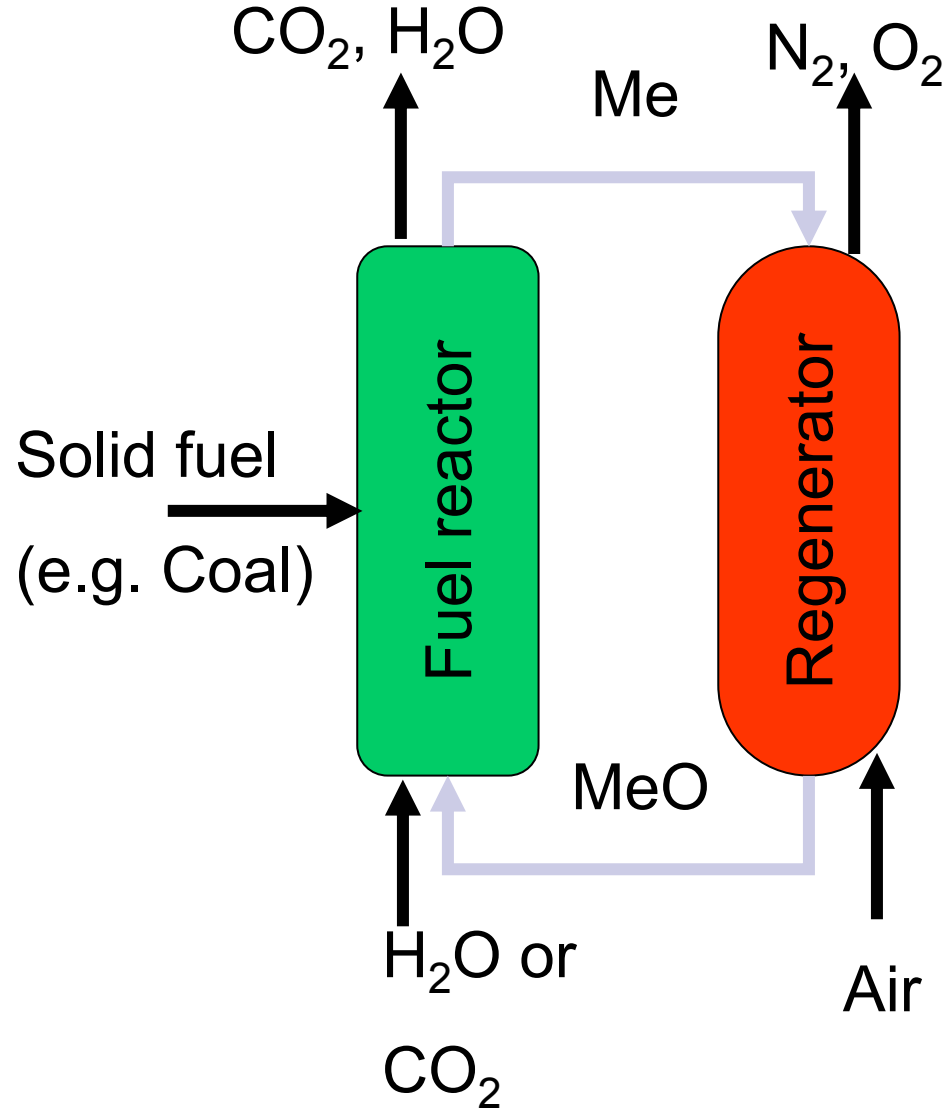
The exergetic efficiency of a plant using chemical looping combustion would be comparable with a conventional IGCC plant [1]

Chemical Looping Combustion (Solid Fuels)



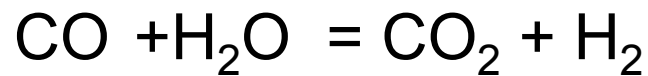
Chemical Looping Combustion (Solid Fuels)

Possible
MeO/Me:
 $\text{Fe}_2\text{O}_3/\text{Fe}_3\text{O}_4$
 $\text{Cu}_2\text{O}/\text{Cu}$



Iron oxide as a looping agent

Gasification:



Reaction with Iron Oxide:



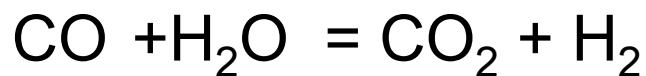
Overall



n.b Thermodynamics implies we can only use the Fe_2O_3 to Fe_3O_4 reaction

Copper oxide as a looping agent

Gasification:



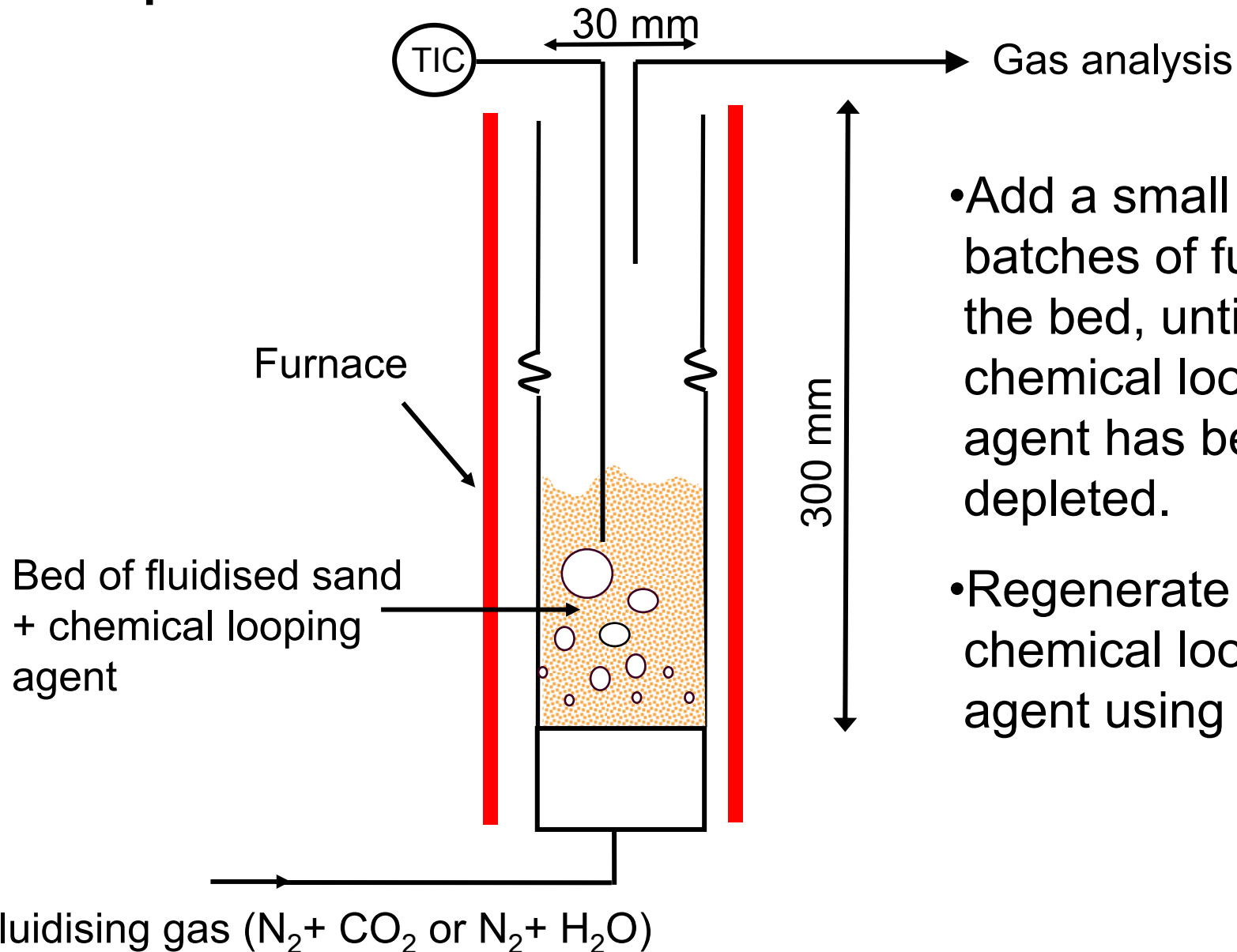
Reactions with Copper Oxide:



Overall:



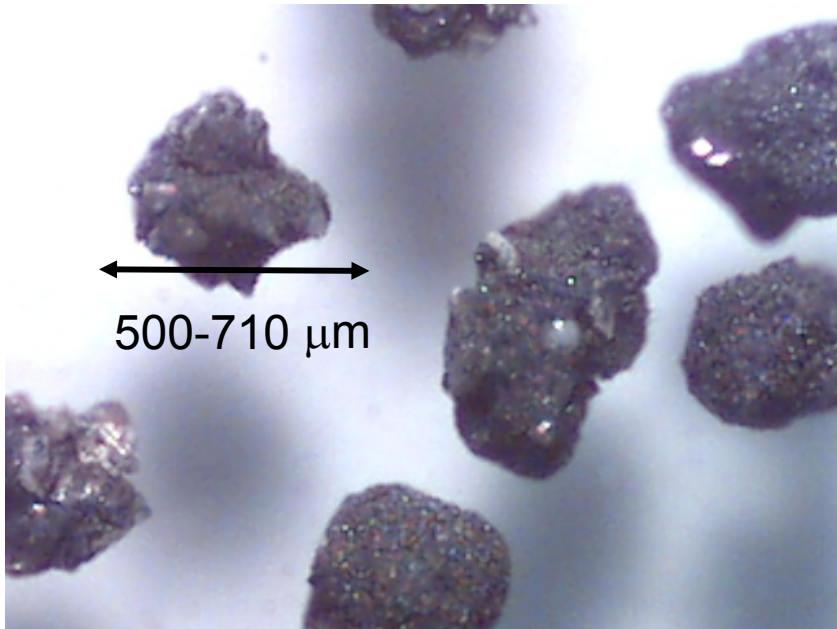
Experimental Fluidised Bed



- Add a small batch of fuel to the bed, until all the chemical looping agent has been depleted.
- Regenerate the chemical looping agent using air.

Materials – making particles

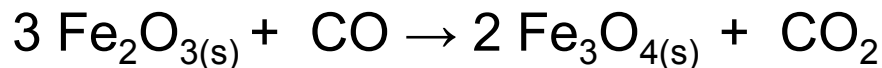
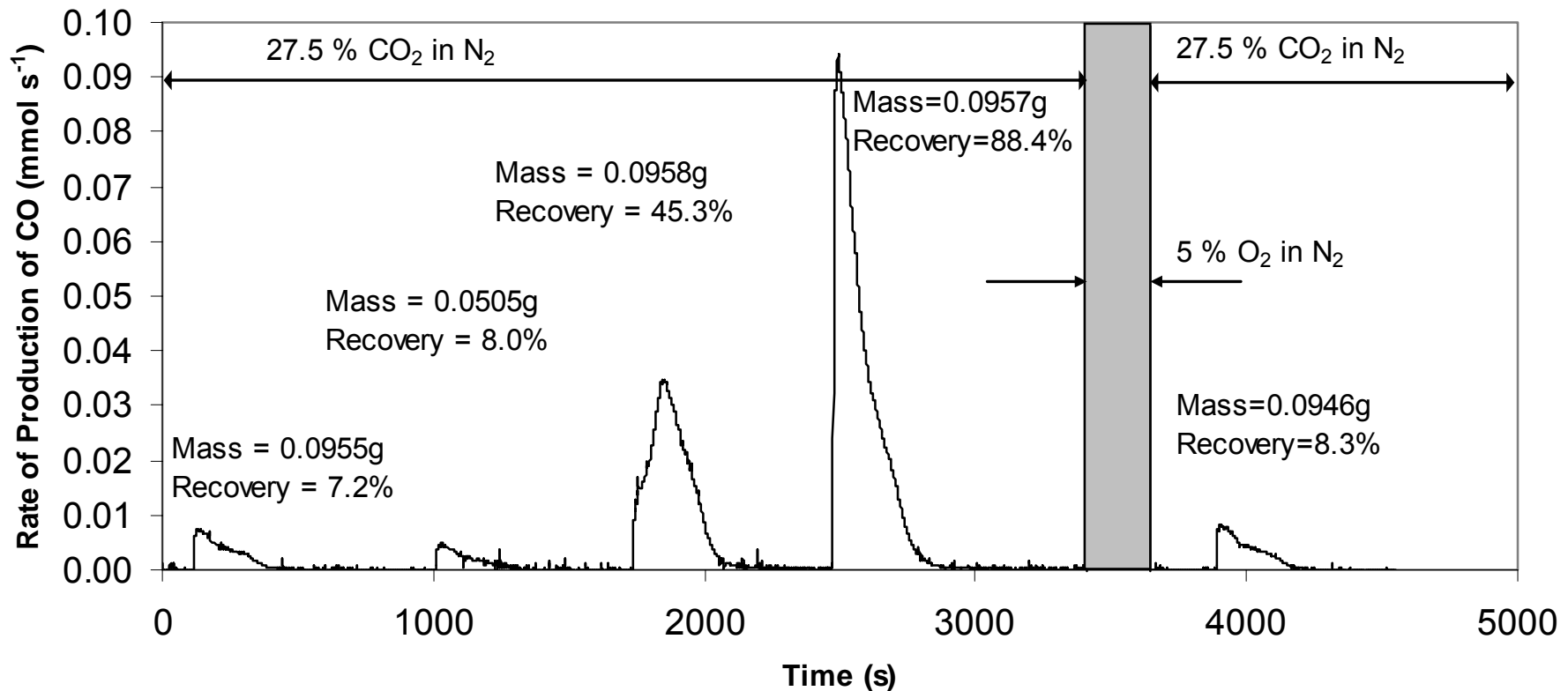
- Several possibilities options for producing particles suitable for use in a fluidised bed
 - natural ores
 - particles made from from powdered reagents
 - Particles made by impregnating a support material with the metal oxide



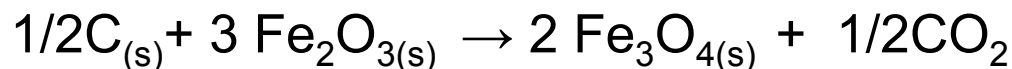
Example, Copper oxide particles.

Equal masses of CuO and alumina powder mixed with a little water, sieved then heated to 950 °C and held at 950 °C for 5 hours

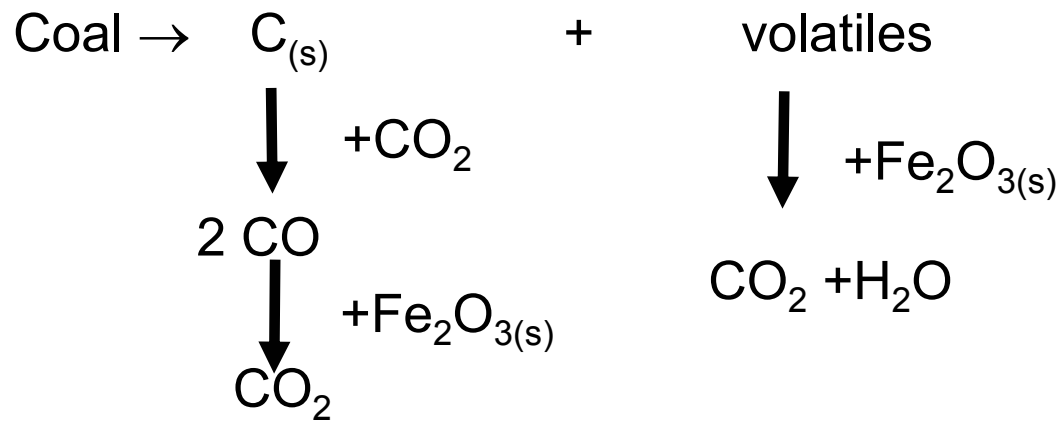
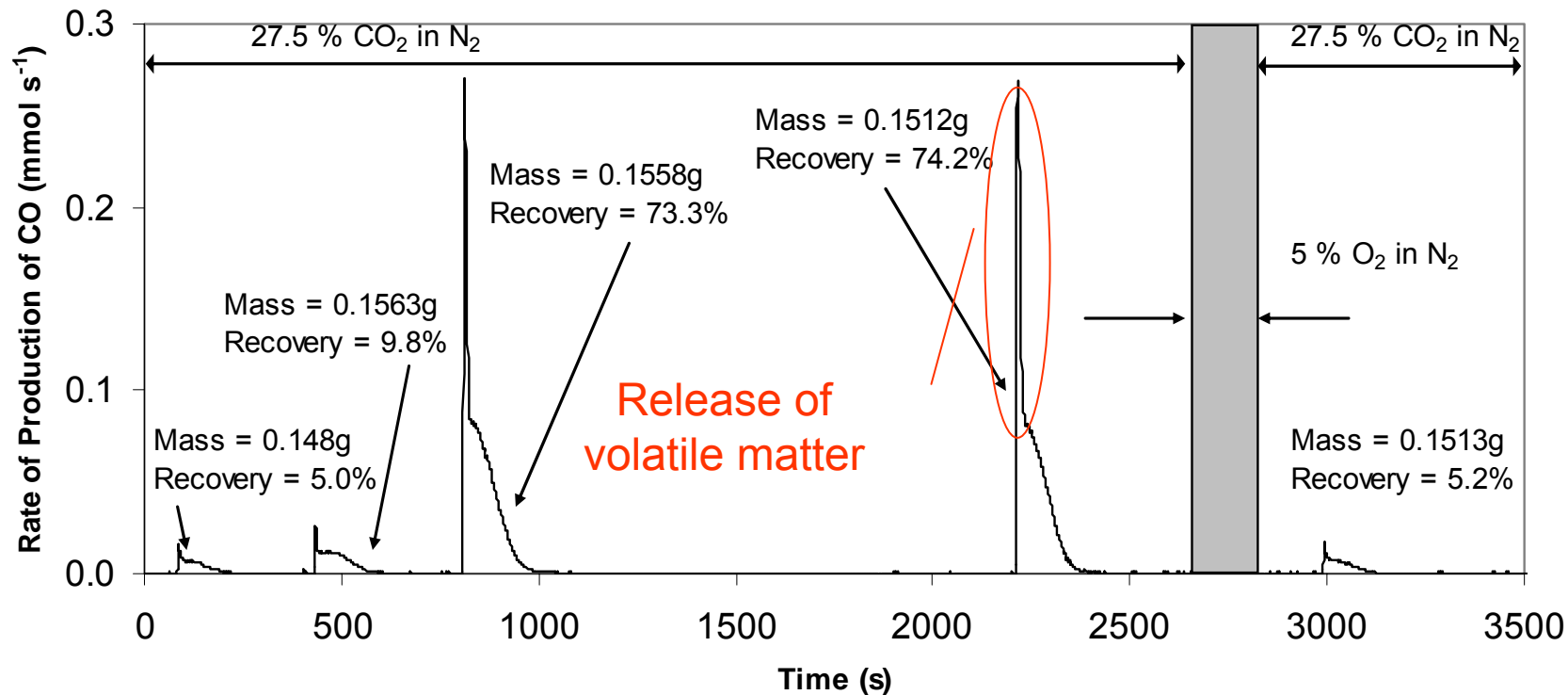
Results – Iron Oxide + Char+ CO₂



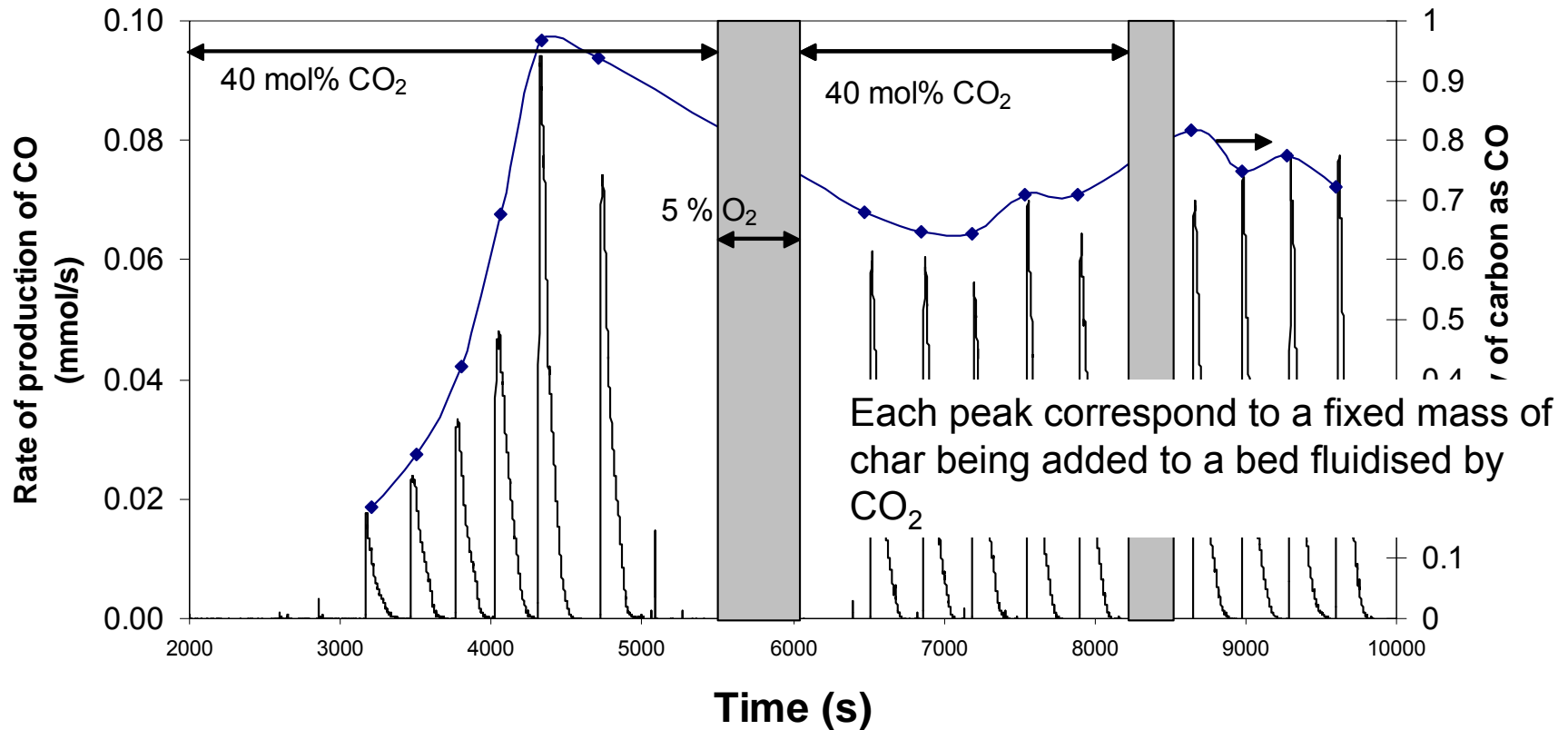
Overall



Results – Iron Oxide + Coal + CO₂

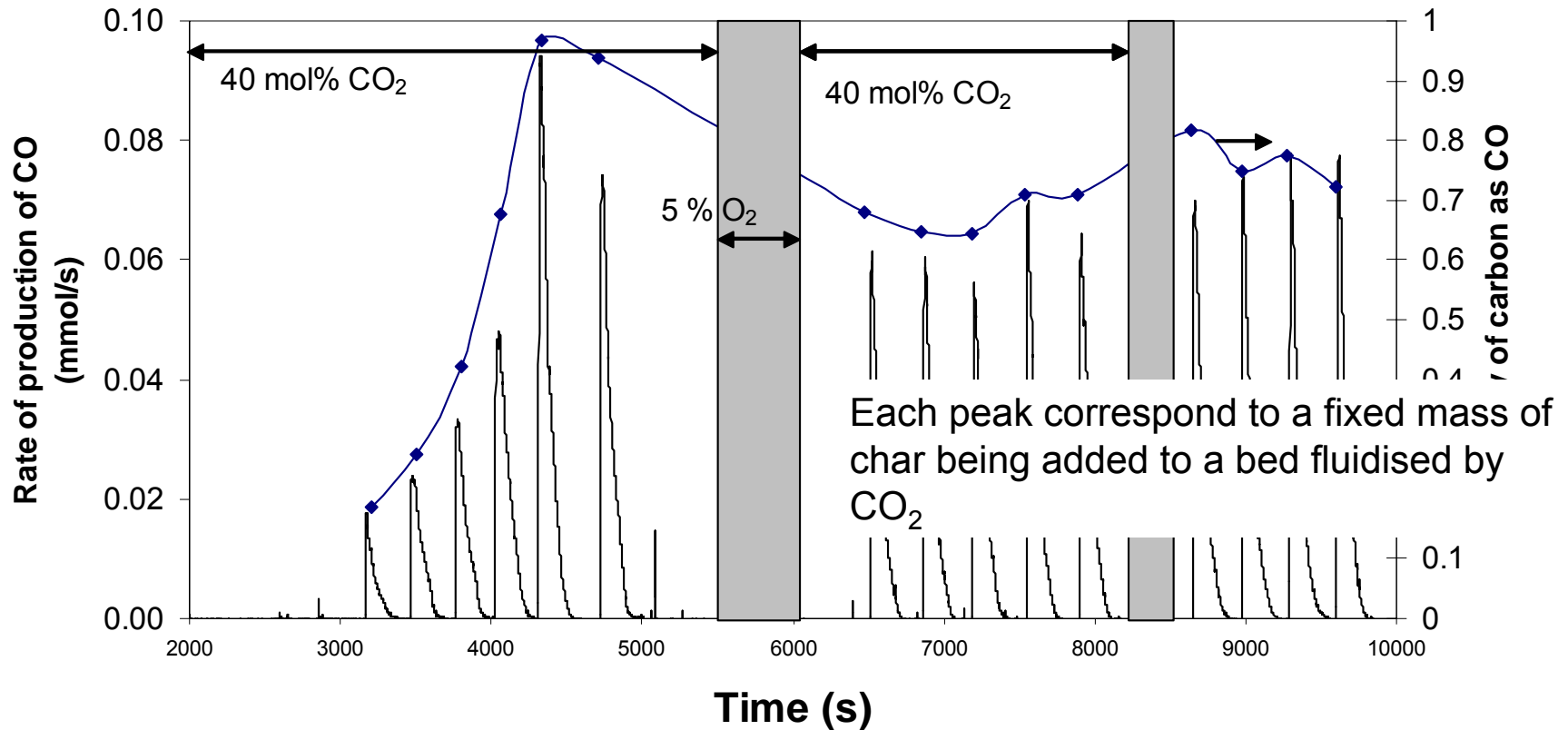


First attempt at using Copper Oxide



- Over the first cycle, the copper oxide will react with the CO produced by gasification
- The Copper Oxide was not regenerated by O₂

First attempt at using Copper Oxide



- Operating fairly close to the melting point of copper
- Sintering and agglomeration were a problem

Summary

- You can use a solid to carry oxygen to a solid fuel
- Fe_2O_3 reacts sufficiently rapidly with H_2 and CO to be an effective chemical looping agent
- The rate limiting step appears to be the gasification of the char to produce the H_2 and CO , which then react with the Fe_2O_3 .
- The iron oxide also reacts with the volatile material released by coal to produce CO_2 and H_2O .
- The reduction of Fe_2O_3 is not sufficiently exothermic to counter to the heat requirements of the gasification reactions. A heat input is needed.
- Copper ?.. ongoing