Chemical-Looping Combustion of Coal with Carbon Dioxide Capture
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Chemical-Looping Technology
• CLC is a solid or gas fuel combustion technology with an inherent separation of CO2.
• A metal oxide (MeO) is used as an oxygen carrier (OC) to oxidize the fuel in the fuel reactor (FR).
• Exhaust of the fuel reactor contains mainly CO2 and H2O.
• Almost pure CO2 can be produced by condensing the water from the exhaust.
• The reduced OC particles (MeyOx-1) is transferred to the air reactor where the OC is oxidized with air.

Fuel reactor major reactions
Coal → volatiles + char
Char + H2O → H2 + CO
Char + CO2 → 2CO
Volat. + H2 + CO + MeyOx → CO2 + H2O + MeyOx-1
MeyOx + CnH2m → MeyOx-1 + mH2O + nCO2

Air reactor reaction
MeyOx-1 + 0.5O2 → MeyOx
The net heat released from both the reactions is similar to that of combustion.

Process Description
• Reduction: Coal is brought into contact with iron oxide at 30 atm and 1200 °C. The coal is converted to CO and CO2, and the iron oxide is converted into elementary iron.
• Oxidation: Iron is brought into contact with steam. The conditions for this reactor are the same as the first. This reactor produces a stream consisting of only water and H2, which can easily be separated netting us our second product, 99.9% pure H2.
• Air Reactor: The partially oxidized iron is sent into a final air reactor to be converted completely to iron oxide. The flue gas from this process is sent to a turbine, and we recycle the iron oxide back into the first reactor.

Periodically operated chemical-looping technology in packed bed system.

References
B. Moghtaderi, Energy Fuels, 2012, 26, 15-40