Chemical-Looping Combustion of Coal with Carbon Dioxide Capture

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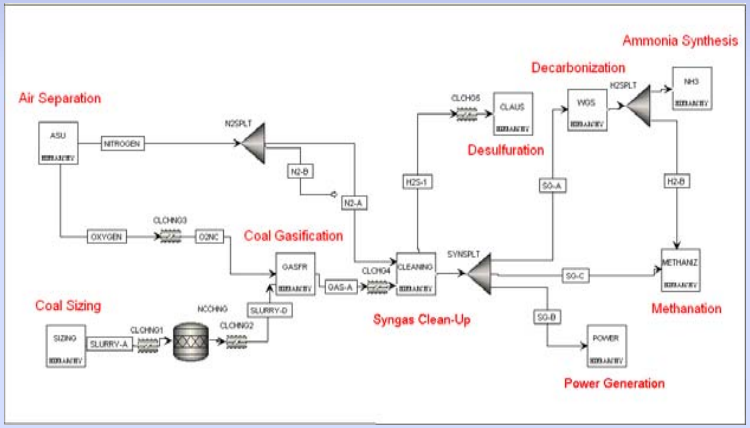
Chemical-Looping Technology

- CLC is a solid or gas fuel combustion technology with an inherent separation of CO_2 .
- 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 CO_2 and H_2O.
- Almost pure CO_2 can be produced by condensing the water from the exhaust.
- The reduced OC particles ($MeyO_{x-1}$) is transferred to the air reactor where the OC is oxidized with air.



Fuel reactor major reactions

Coal → volatiles + char

$Char + H_2O \rightarrow H_2 + CO$

$Char + CO_2 \rightarrow 2CO$

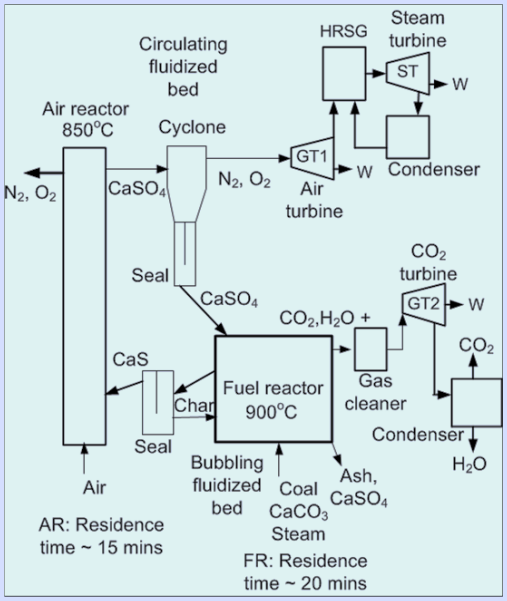
$Volat. + H_2 + CO + Me_yO_x \rightarrow CO_2 + H_2O + Me_yO_{x-1}$

$Me_yO_x + CnH_{2m} \rightarrow Me_yO_{x-1} + mH_2O + nCO_2$

Air reactor reaction

$Me_yO_{x-1} + 0.5O_2 \rightarrow Me_yO_x$

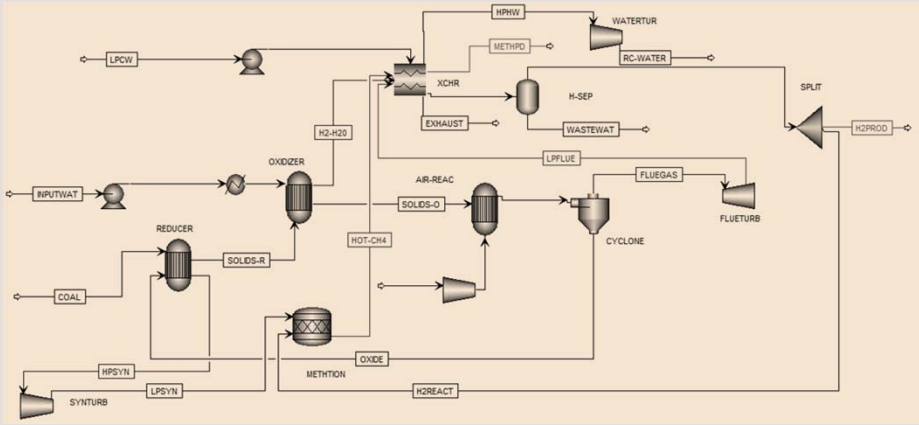
The net heat released from both the reactions is similar to that of combustion.

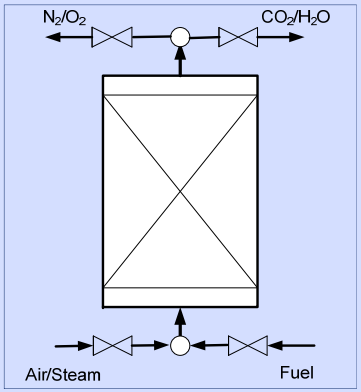


Fluidized bed and solid circulation

Process Description

- **Reduction:** Coal is brought into contact with iron oxide at 30 atm and 1200 ^{0}C. The coal is converted to CO and CO_2, and the iron oxide is converted into elementary iron.
- **Oxidation:** Iron is brought into to contact with steam. The conditions for this reactor are the same as the first. This reactor produces a stream consisting of only water and H_2, 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.

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