Power generation system laboratory

School of Mechanical Engineering

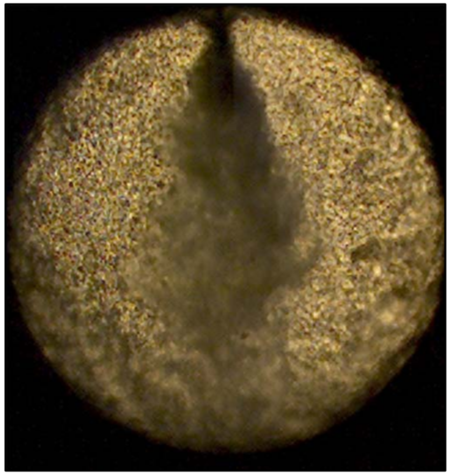
Juhun Song

Outlines

1. Spray characteristics of Liquid CO2
2. Pyrolysis and combustion of Liquid CO2/coal slurry
3. Liquid fuel combustion and soot reduction

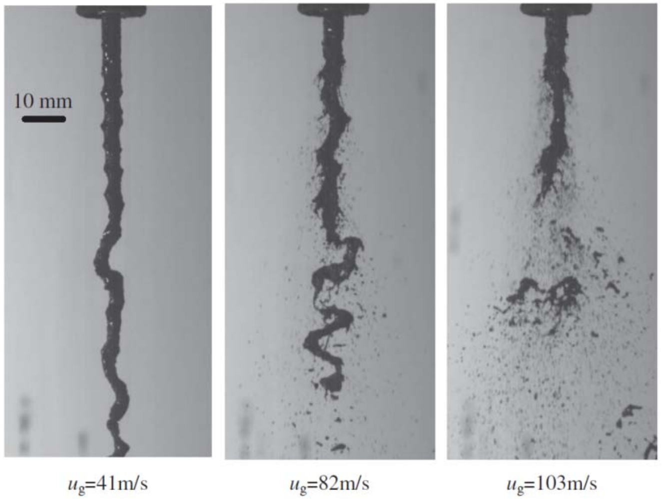
1. Liquid CO2 spray characteristics

- Coal-LCO2 slurry



Song et al., Korean J. Chem. Eng. (2016)

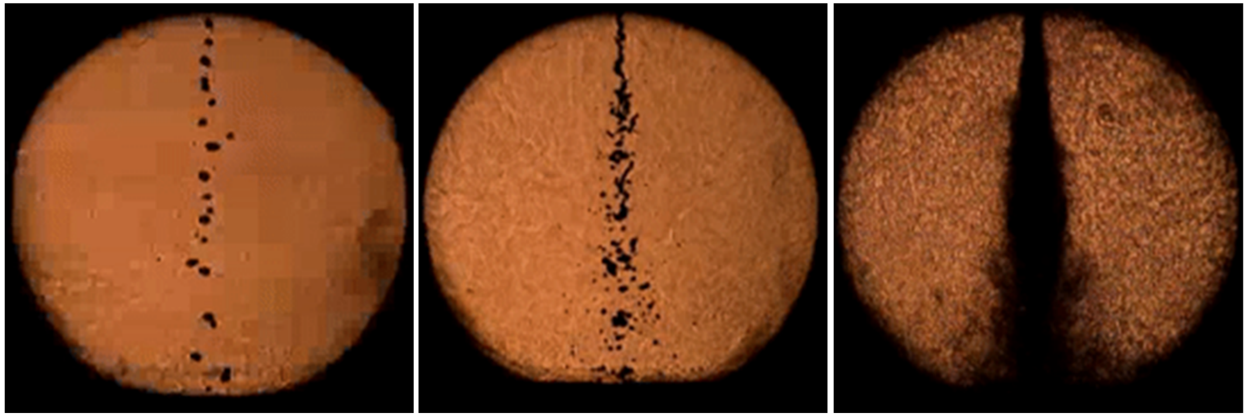
- Coal-water slurry



Zhao et al., Chemical Engineering Science (2012)

- Compared to H2O slurry, LCO2 slurry may produce better atomization behavior, which is crucial for performing the gasification.
- Different flow phenomena of liquid carbon dioxide is due to surface tension, viscosity and phase changes compared to water spray.

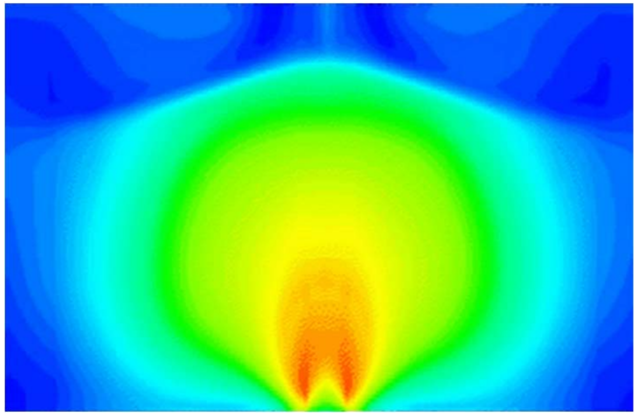
Spray visualization



Δp=0 kPa (V=0.8 m/s) | Δp=100 kPa (V=5.2 m/s) | Δp=1700 kPa (V=23 m/s)

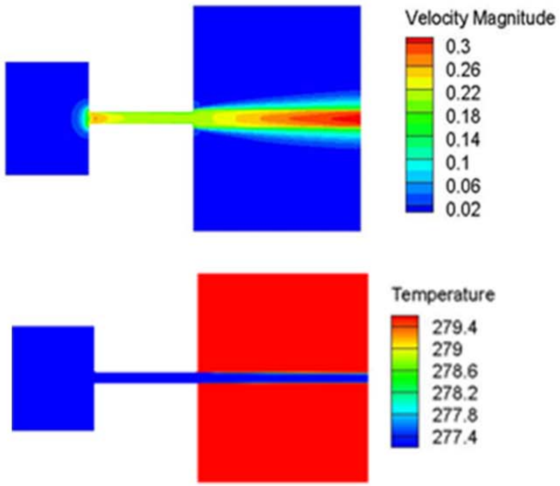
- We can change break up regime from Rayleigh breakup regime to normal atomization as we increases the velocity.

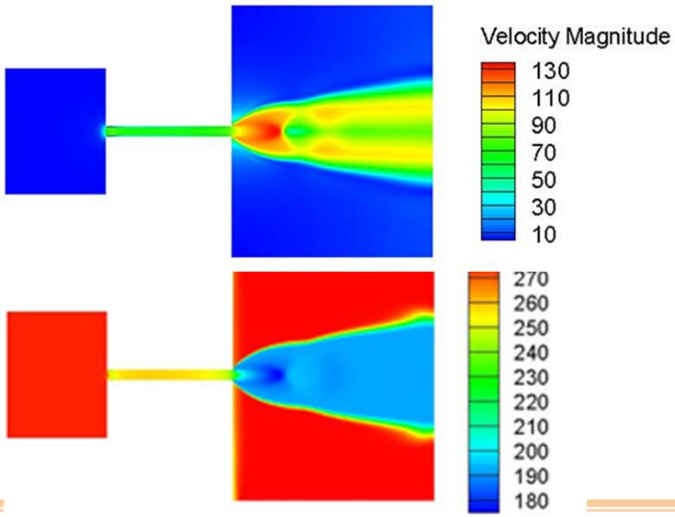
Simulation modeling of flash boiling behavior



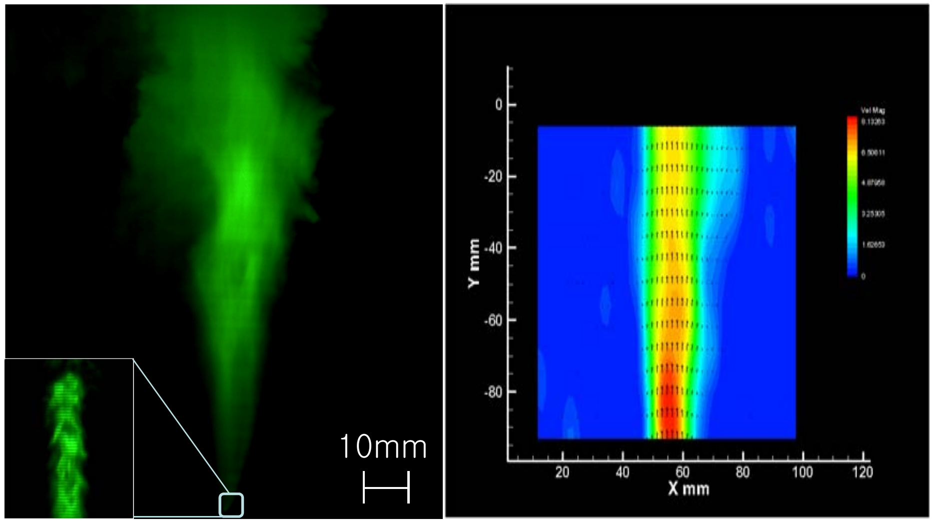
Δp=0bar(gravity case)

Δp=44bar





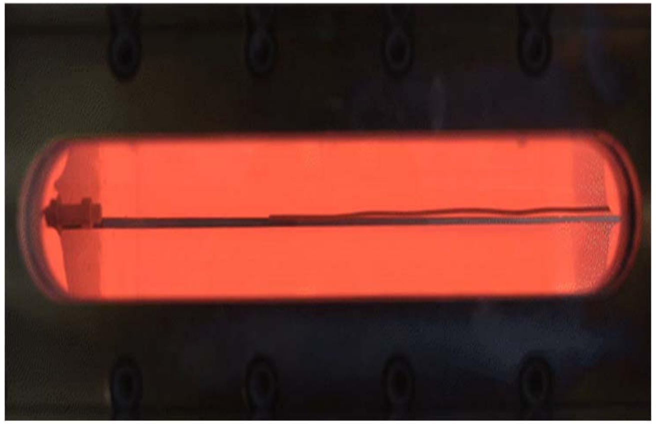
Velocity visualization for cold LCO2 jet

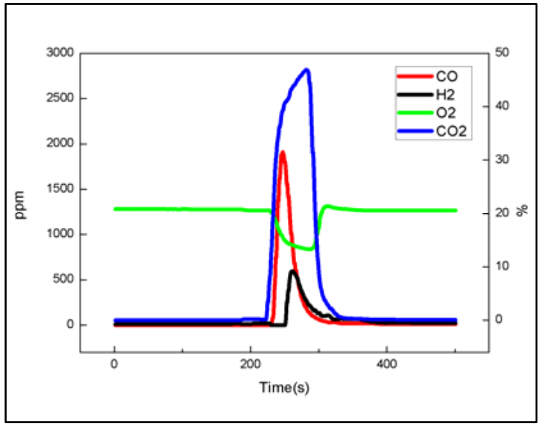


- We could visualize the spray pattern using particle scattering method for cold LCO2 jet.
- From this data, we further obtain velocity information for LCO2 jet.

2. Pyrolysis and combustion of coal slurry

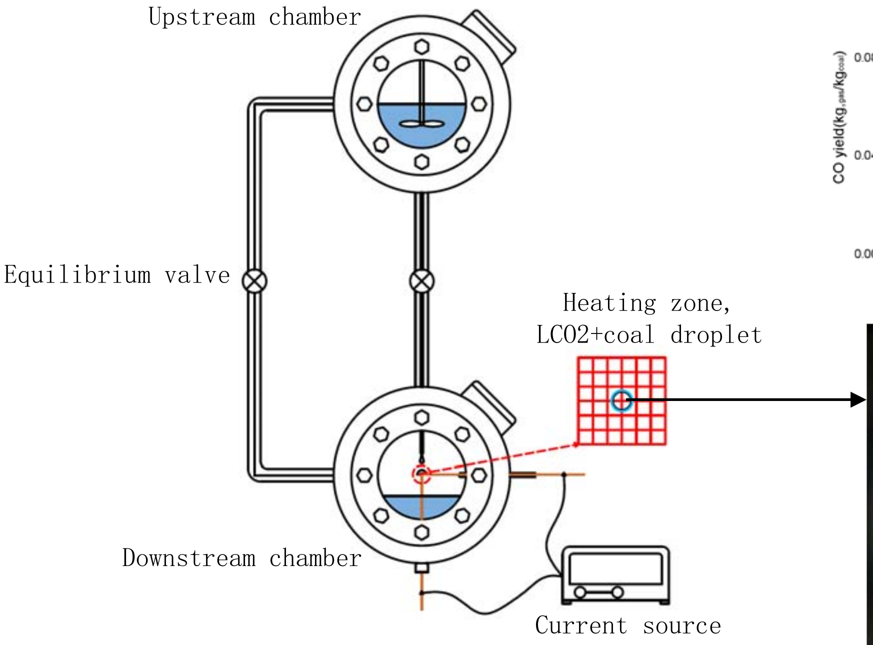
Combustion phenomena of LCO2-coal slurry at 1 bar condition

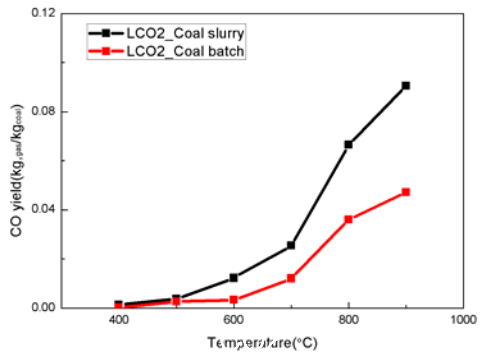




- We observed rigorous combustion and ignition phenomena at atmospheric condition when LCO2 coal slurry is supplied in pure oxygen condition.
- We could observe that the combustion reaction produces CO and H2 gas species, and reduces O2.

Pyrolysis behavior of LCO2-coal slurry at high pressure condition (45 bar)

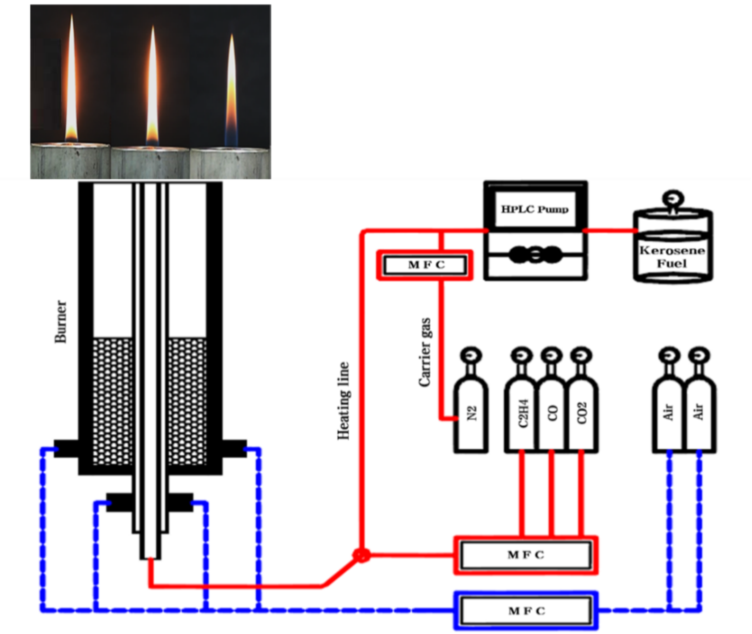


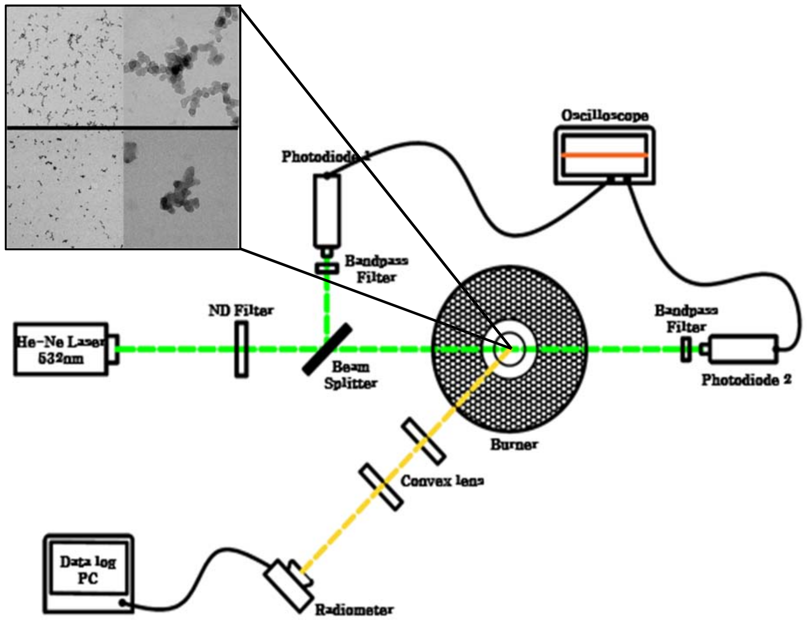


- We heated up and evaporated LCO2-coal slurry, after which pyrolysis occurred in the high pressure condition.
- We measured CO and H2 gas yield, which is compared with coal-water slurry.

3. Liquid fuel combustion and soot reduction

- Combustion and soot formation mechanism of a liquid hydrocarbon fuel





- We developed experimental equipment to burn a liquid fuel using HPLC pump and vaporizer.
- We could measure the soot fraction and flame luminosity using A 532nm laser and a PD module.

Thank you for your attention !