青岛科技大学
Qingdao University of Science & Technology

Fluidization XVI May 26-31, 2019, Guilin, China

Design and experimental investigation of a novel interconnected fluidized bed for chemical looping conversion of solid fuel

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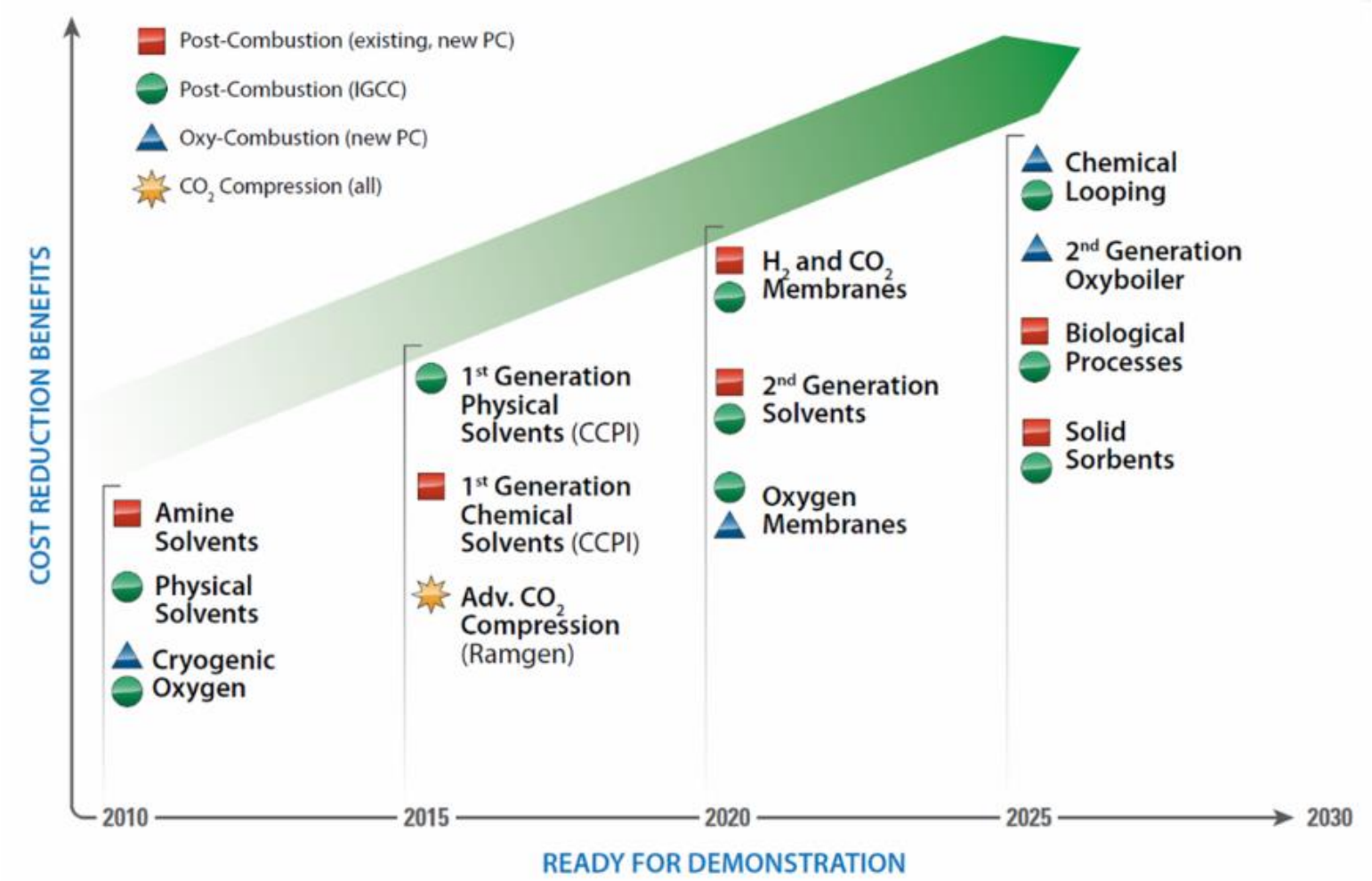
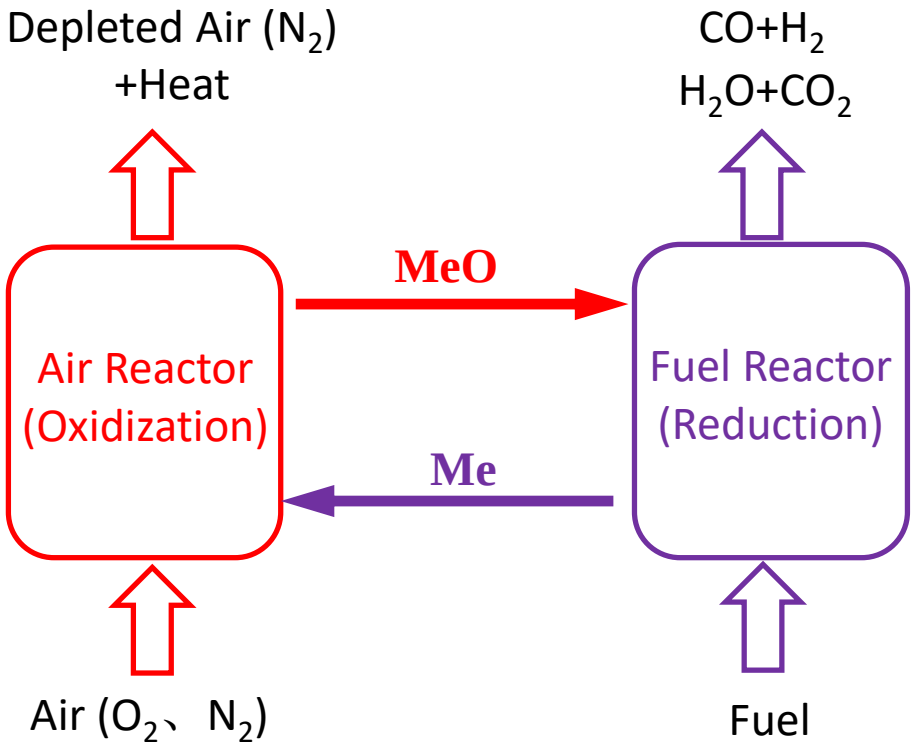
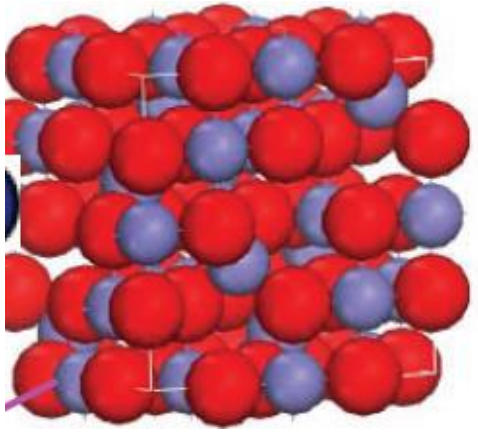
Background



- **Chemical Looping Combustion** was considered as a promising technology for CO_2 capture.
- **Chemical Looping Concept** can achieve clean, high-efficiency and low-carbon conversion of fossil fuel.

Introductions



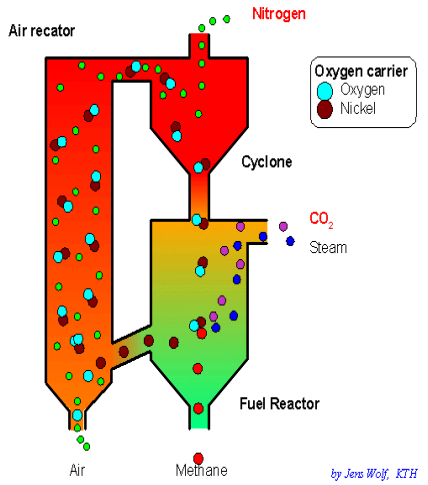


Oxygen Carrier

Higher oxidation ability → CO_2+H_2O+heat, Chemical Looping Combustion, CLC

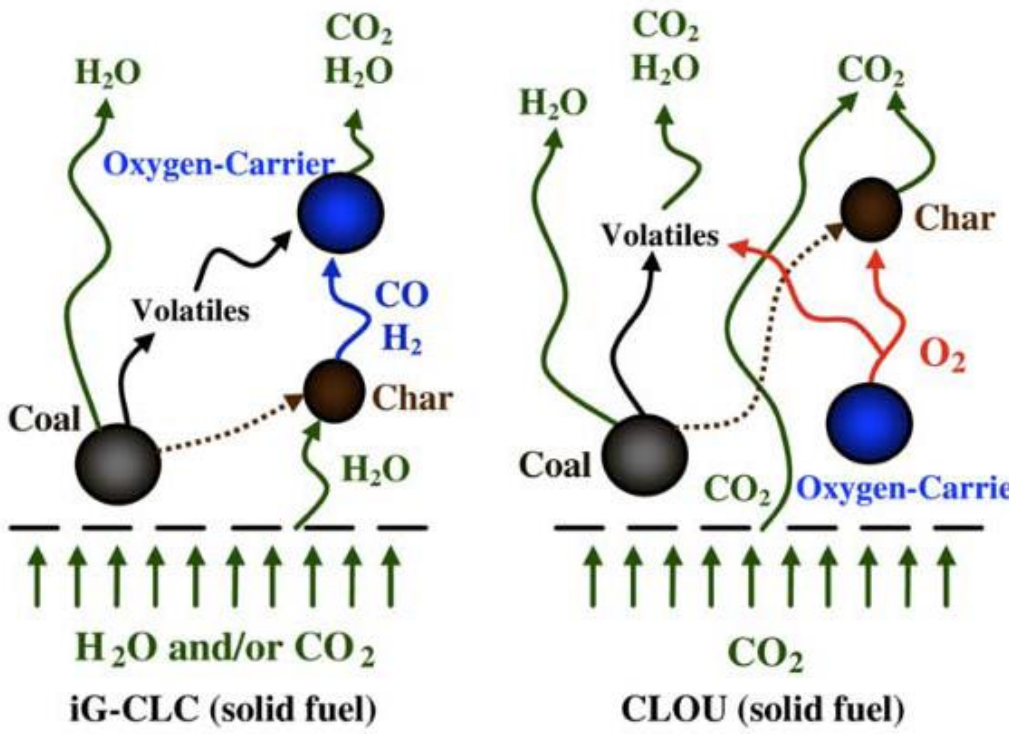
Lower oxidation ability → H_2+CO, Chemical Looping Reforming, CLR

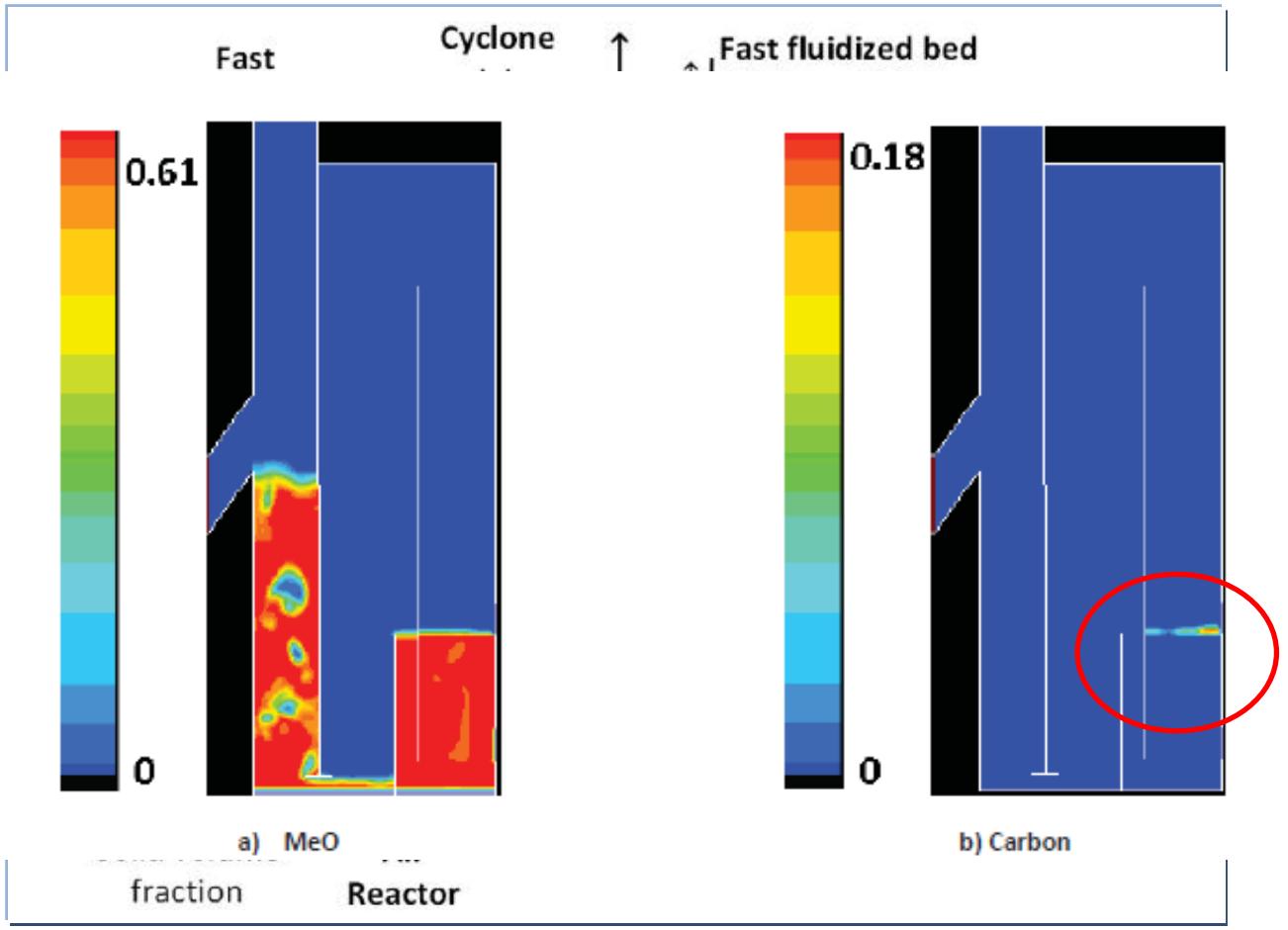
Chemical Looping Gasification, CLG



Chemical Looping Reactor

Introductions



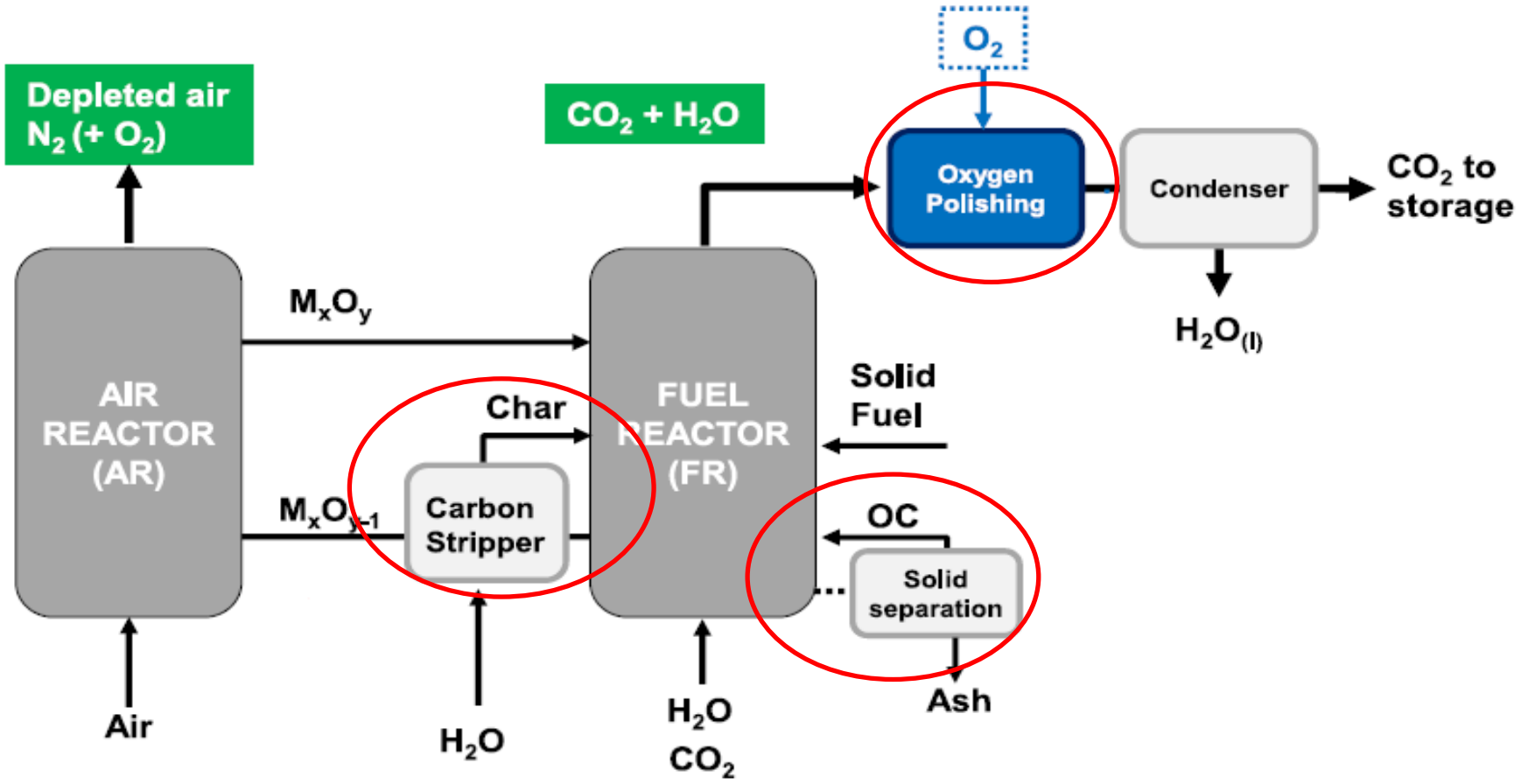


- ✓ Gasification of solid fuel is the **control step**, **extending the residence time of solid fuel** can improve the conversion rate of solid char.
- ✓ However, the fact of **the mixing and segregation of two particles with different density and particle size in the fluidization bed was** neglected.

ρ_{OC}= 3000~ kg/m^3

ρ_{SF}= ~800 kg/m^3

Introductions



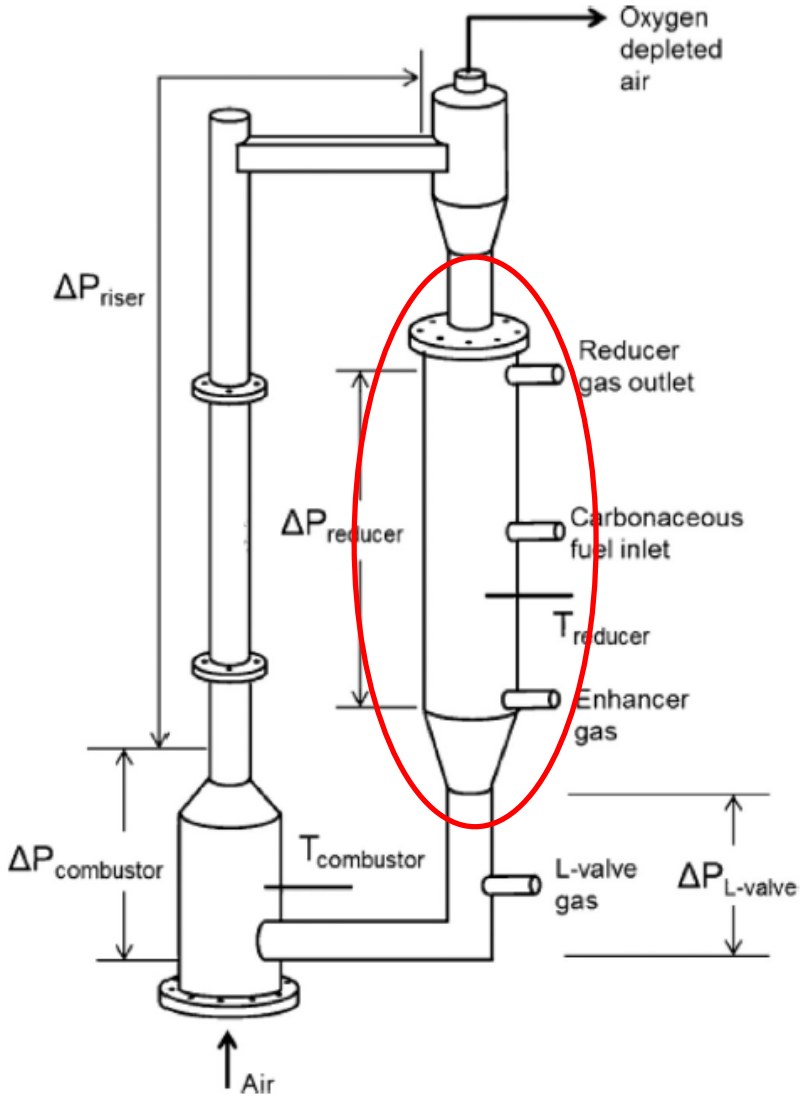
Challenges I: Good mixing and reaction between two solid particles (OC and coal particles)

Challenges II: High conversion of the volatiles escaping from the reaction system(only for CLC, not CLG).

Challenges III: Separation of un-reacted coal char from OC particles.

Challenges IV: Separation of ash and OC fine particles from the reaction system.

Introductions



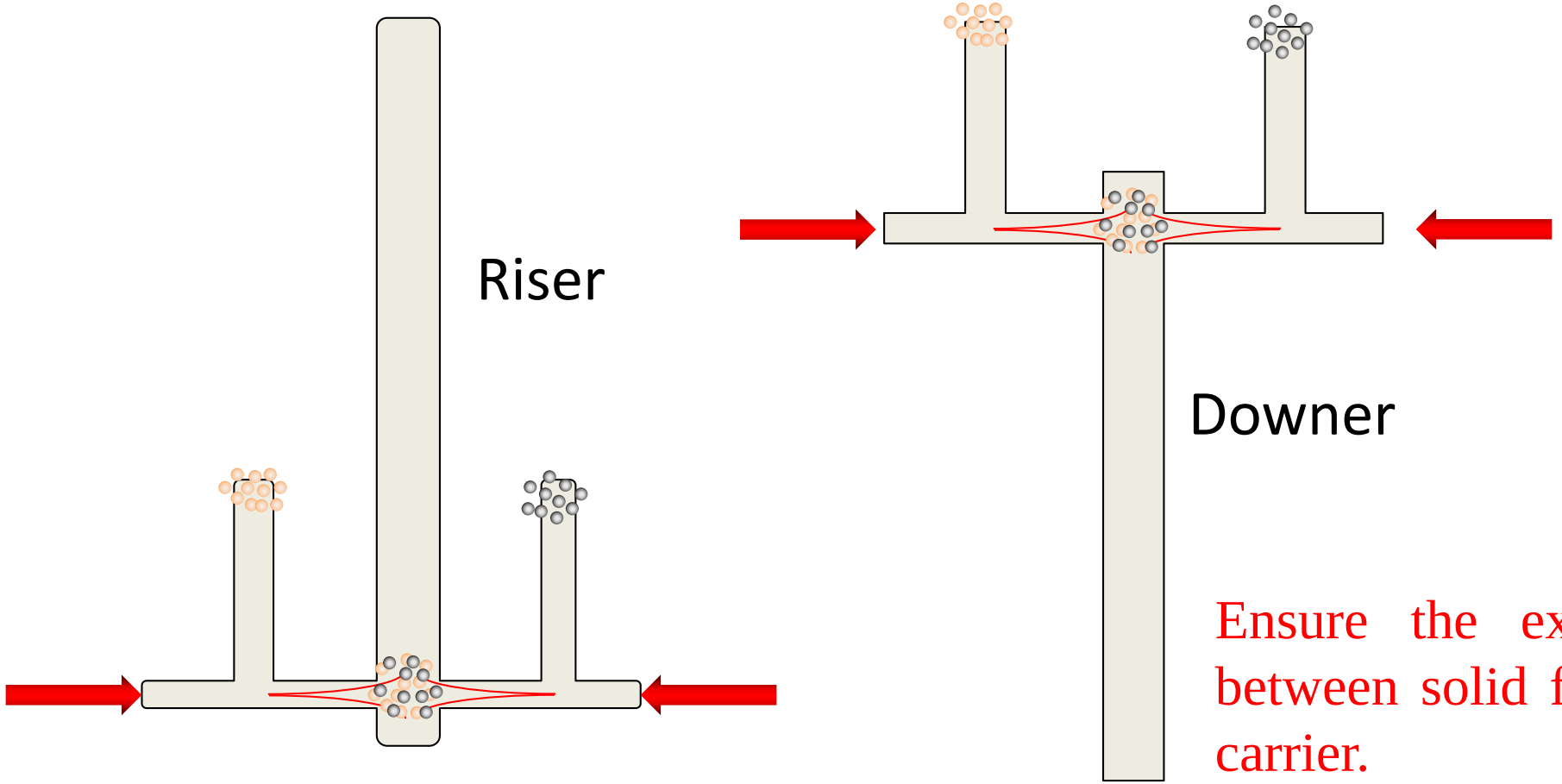
Chemical looping reactor proposed by Liang-Shin Fan

Moving bed: co-current or counter-current ensures the good contact of solid fuel with oxygen carrier, however, results to the poor mass transfer and heat transfer.

Fluidized bed with good contact of solid fuel with oxygen carrier as well as better mass transfer, heat transfer.

Design strategy of chemical looping reactor

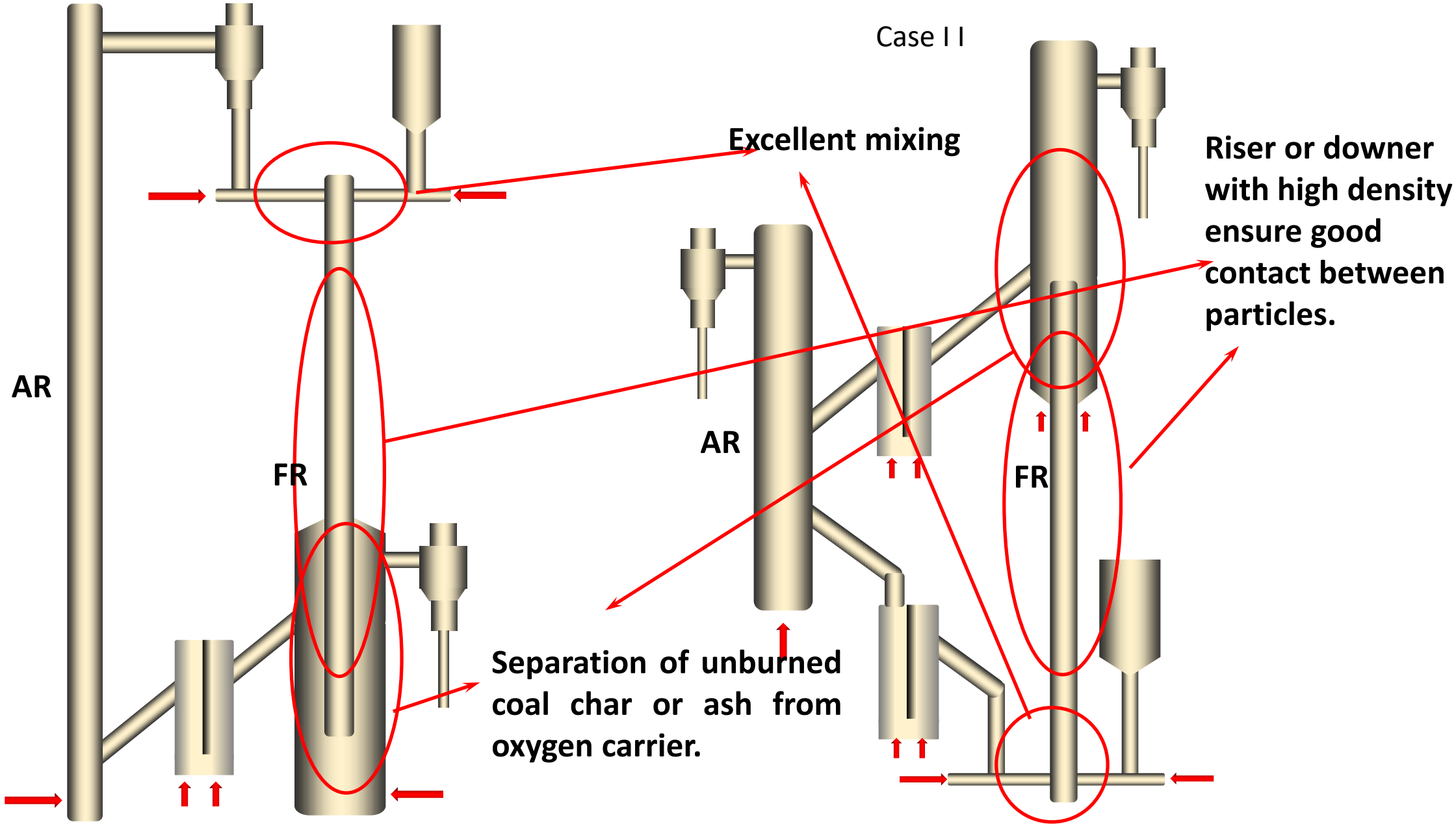
Mixing scheme



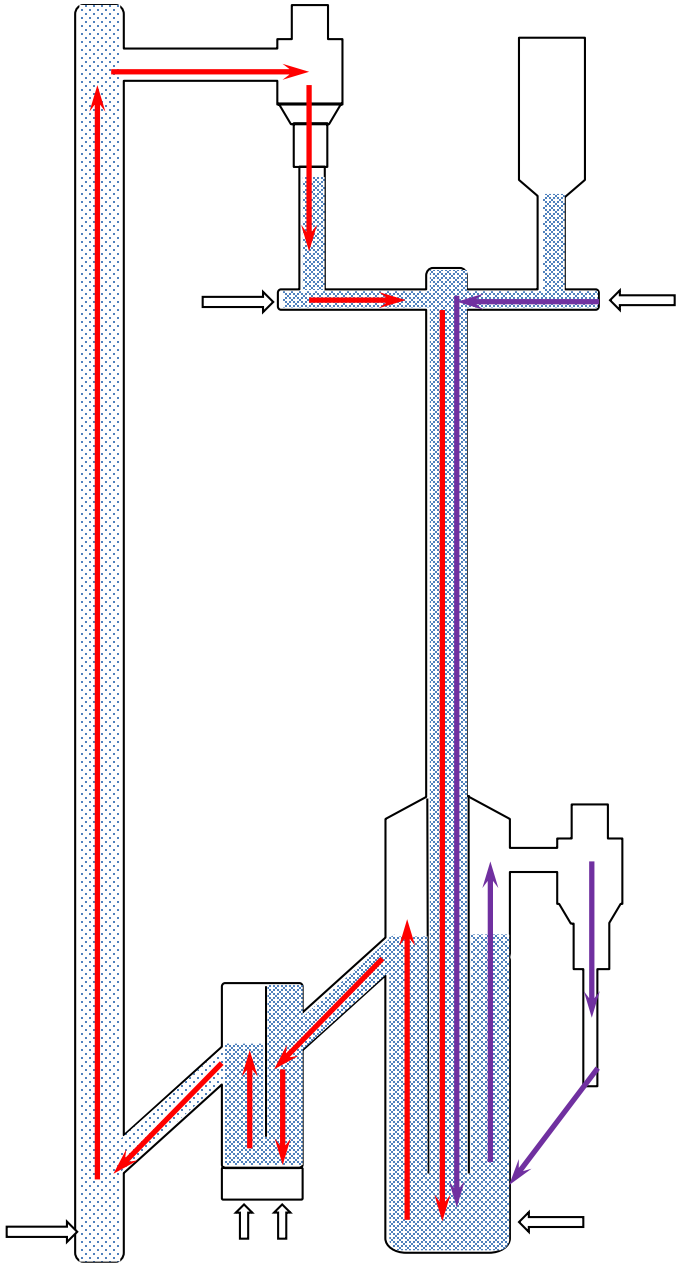
Ensure the excellent contact between solid fuel and oxygen carrier.

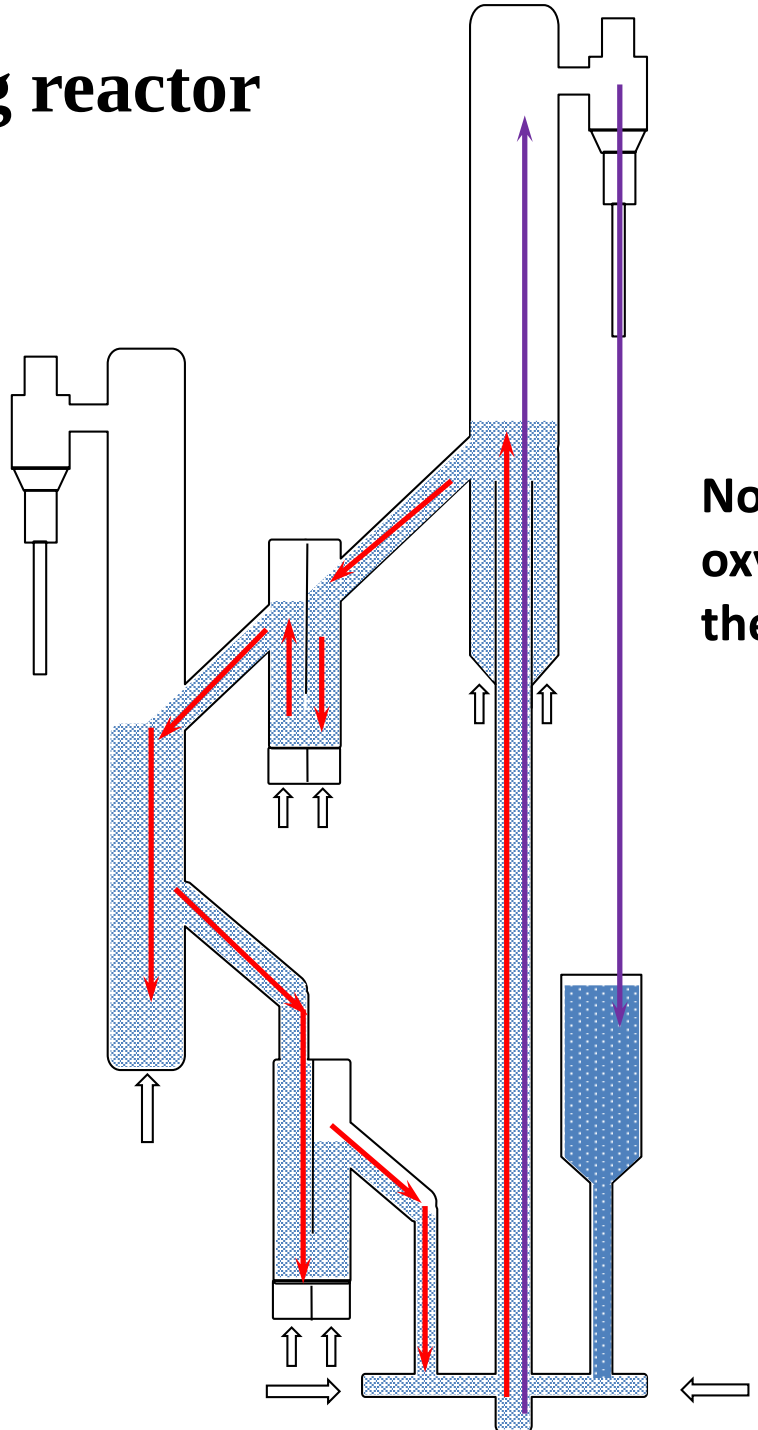
Feeding approach-----jetting or impinging flow

Design strategy of chemical looping reactor



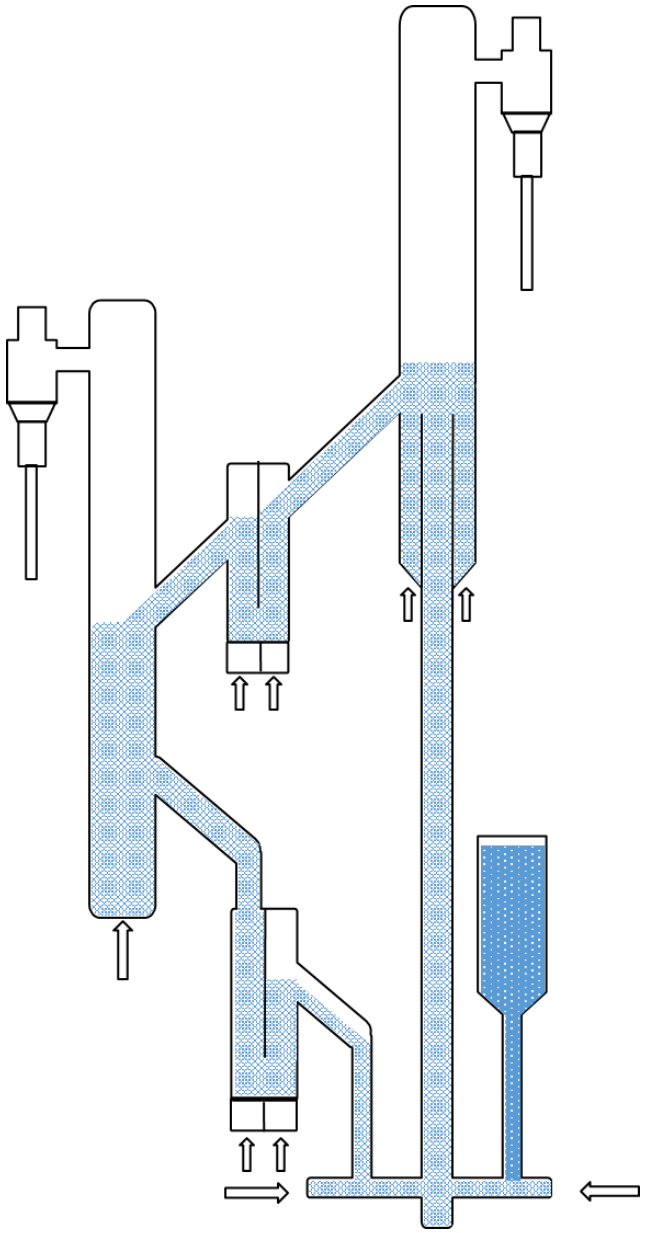
Design strategy of chemical looping reactor



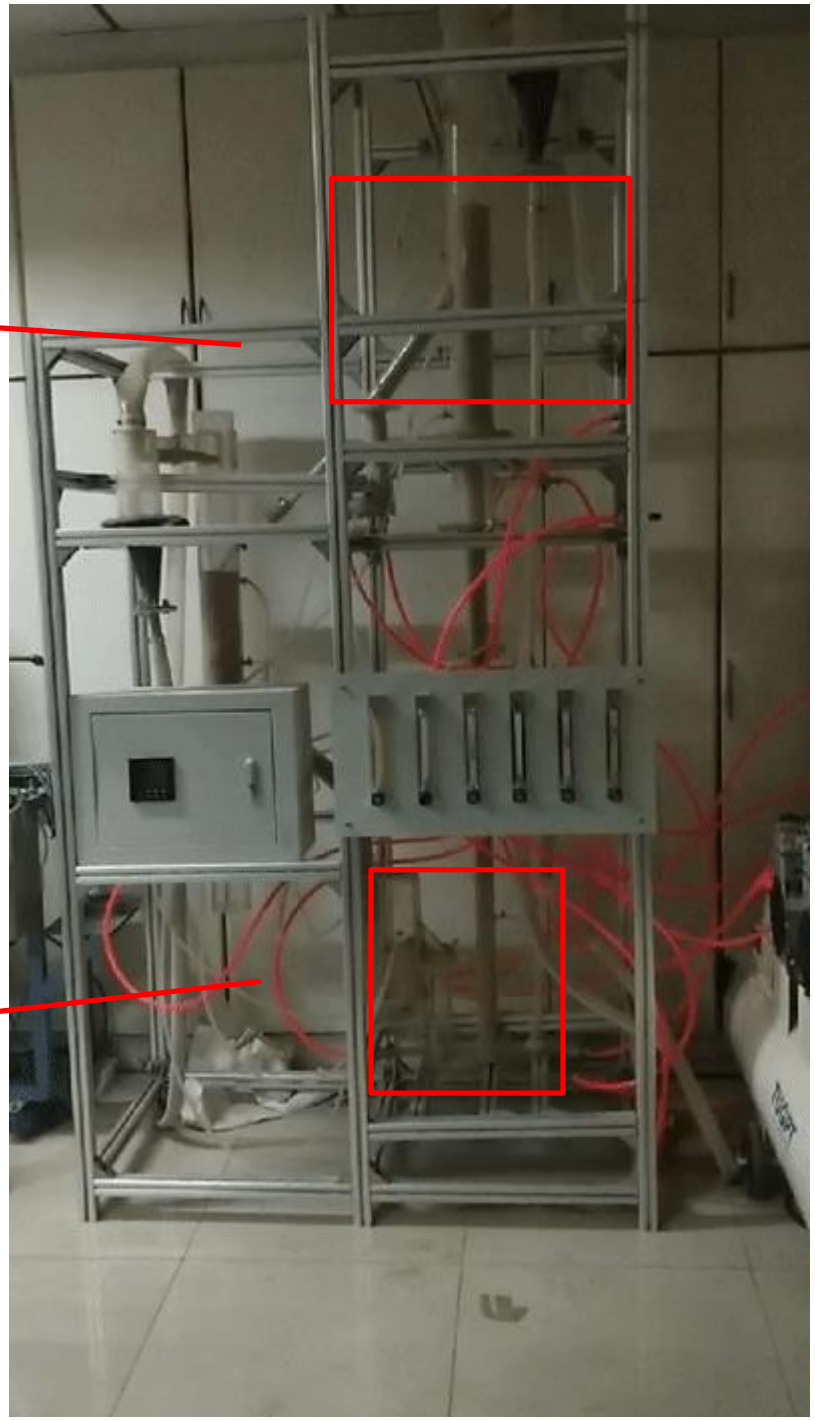


No cyclone in the whole oxygen-looping, reducing the abrasion of OC.

Experimental investigation of cold model

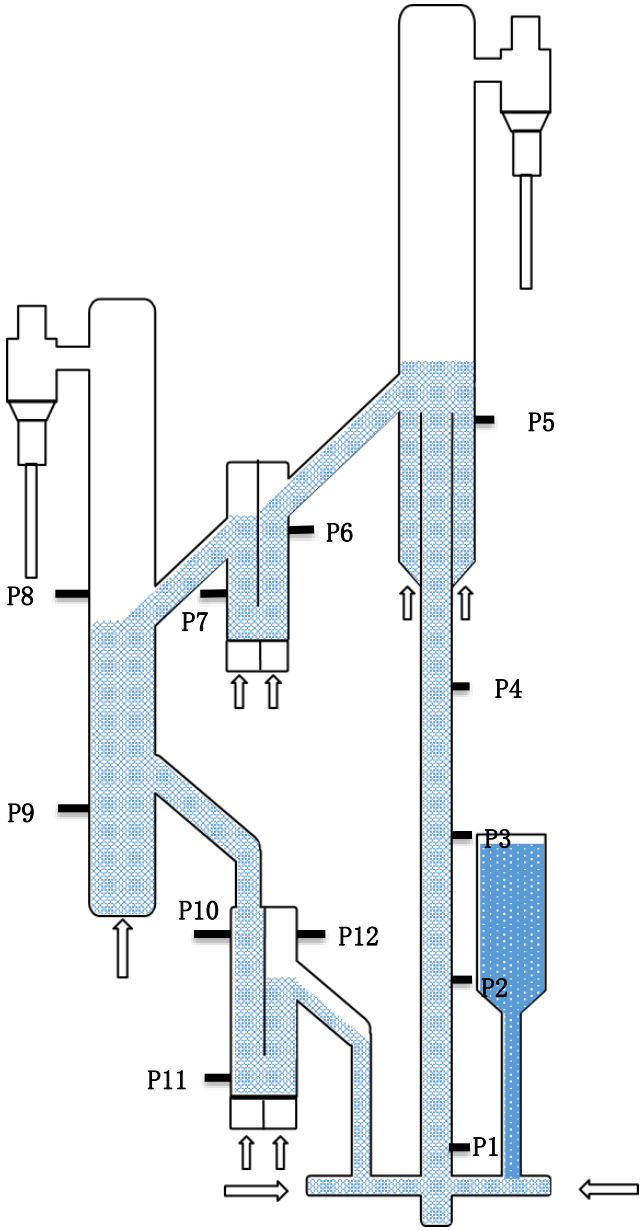


15kg



Experimental investigation of cold model

AR



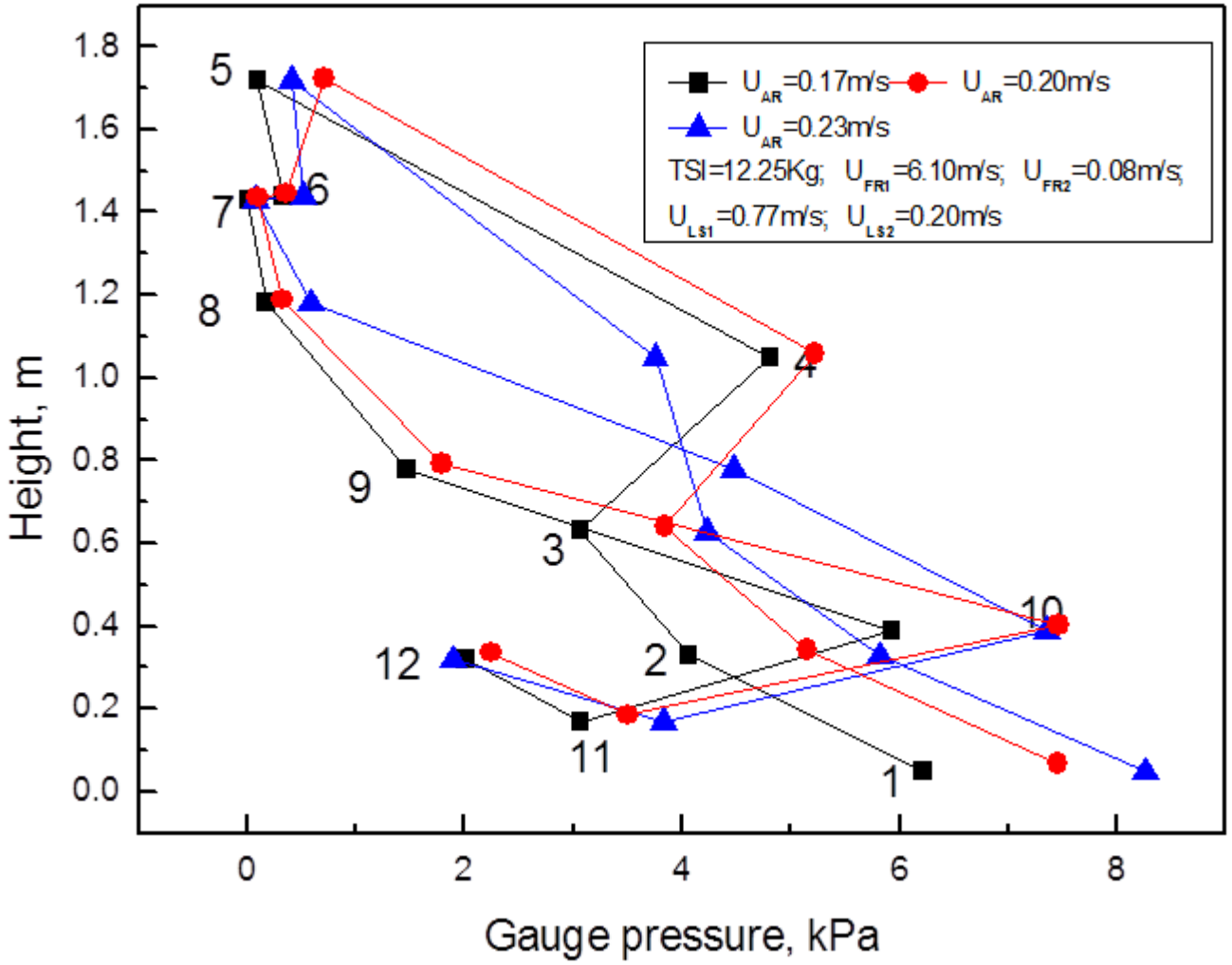
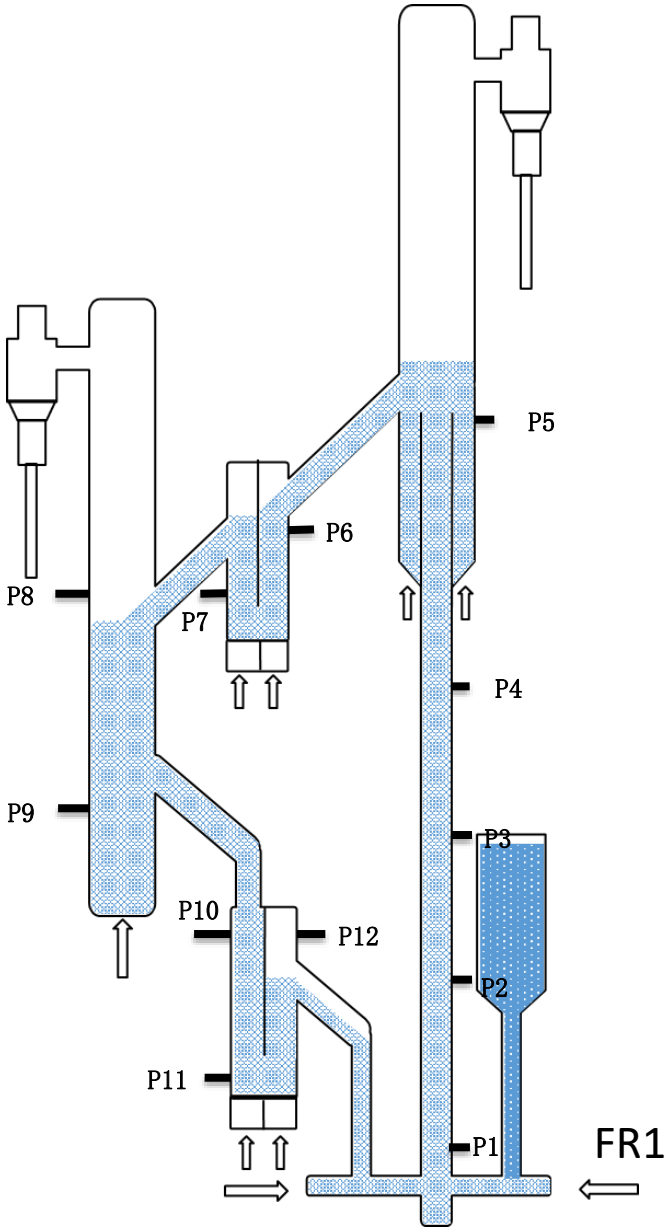


Fig 1. Pressure profile during the operation of the cold-model CL system.

Experimental investigation of cold model



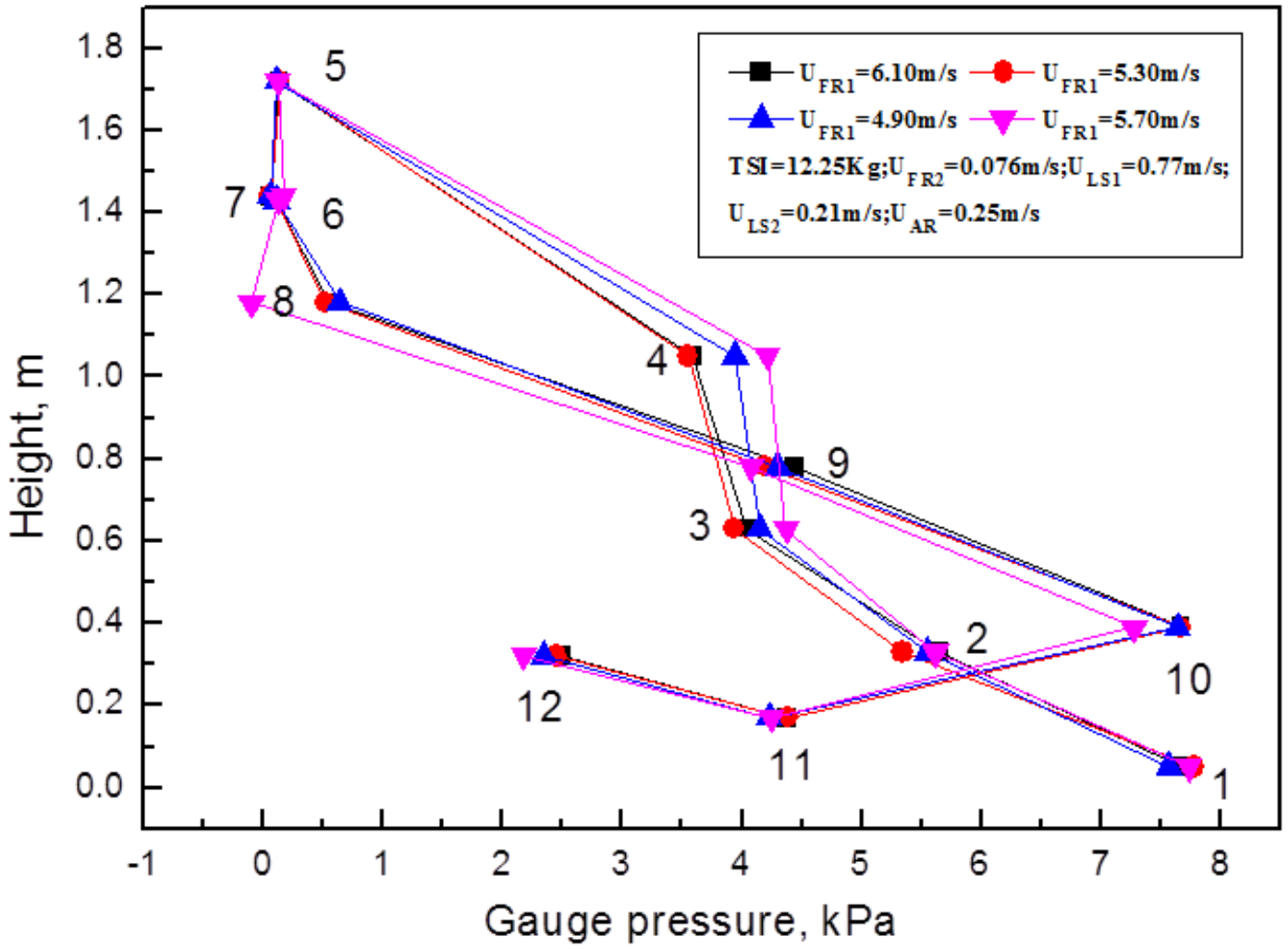
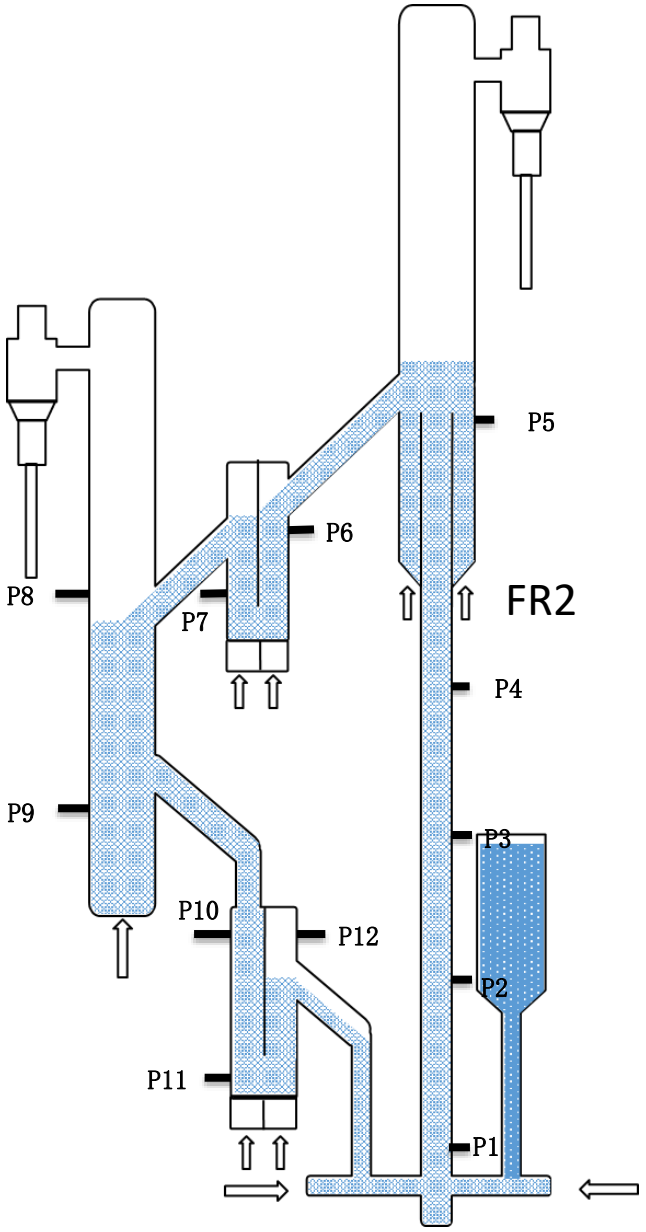


Fig 2. Pressure profile during the operation of the cold-model CL system.

Experimental investigation of cold model



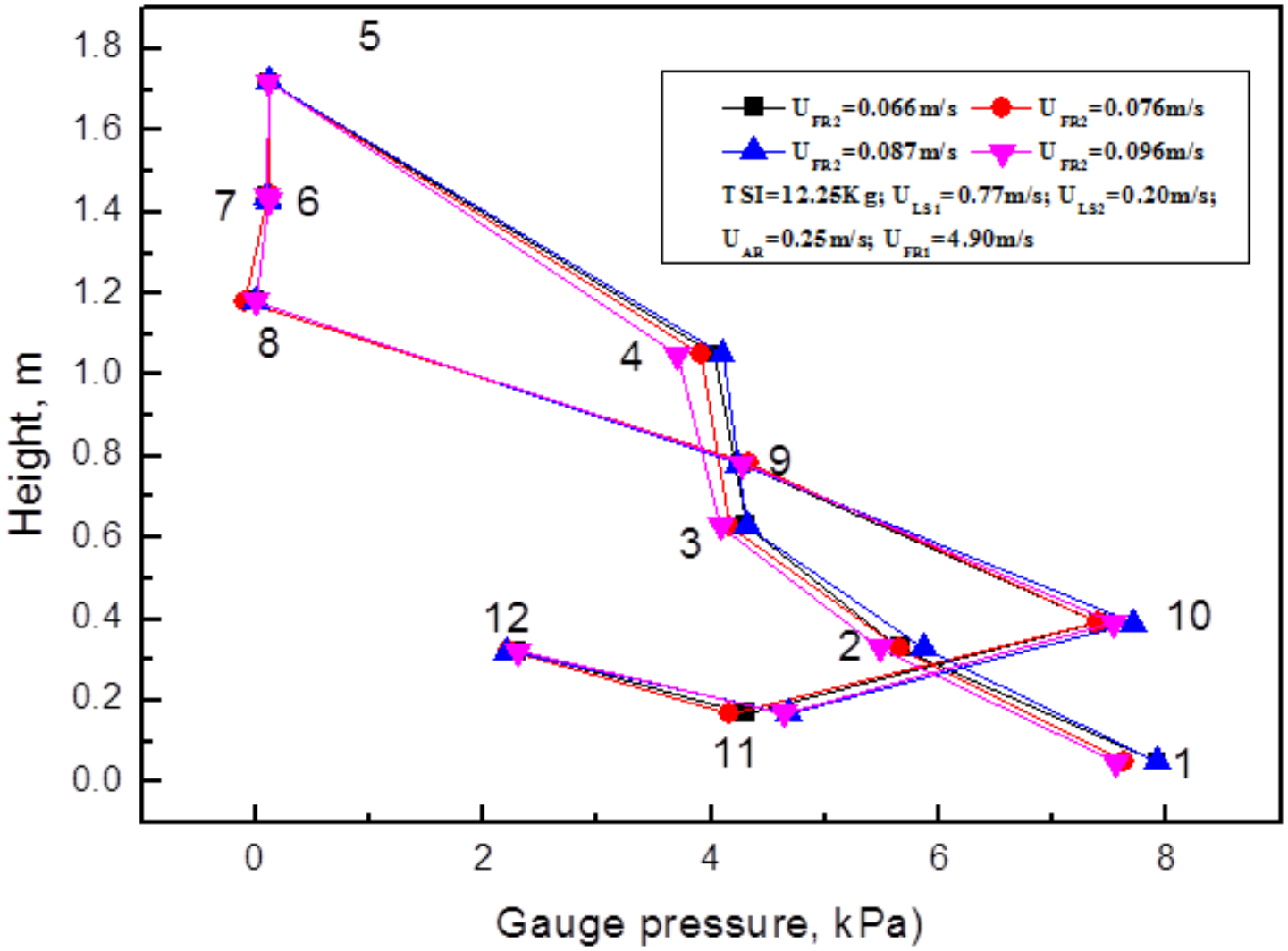
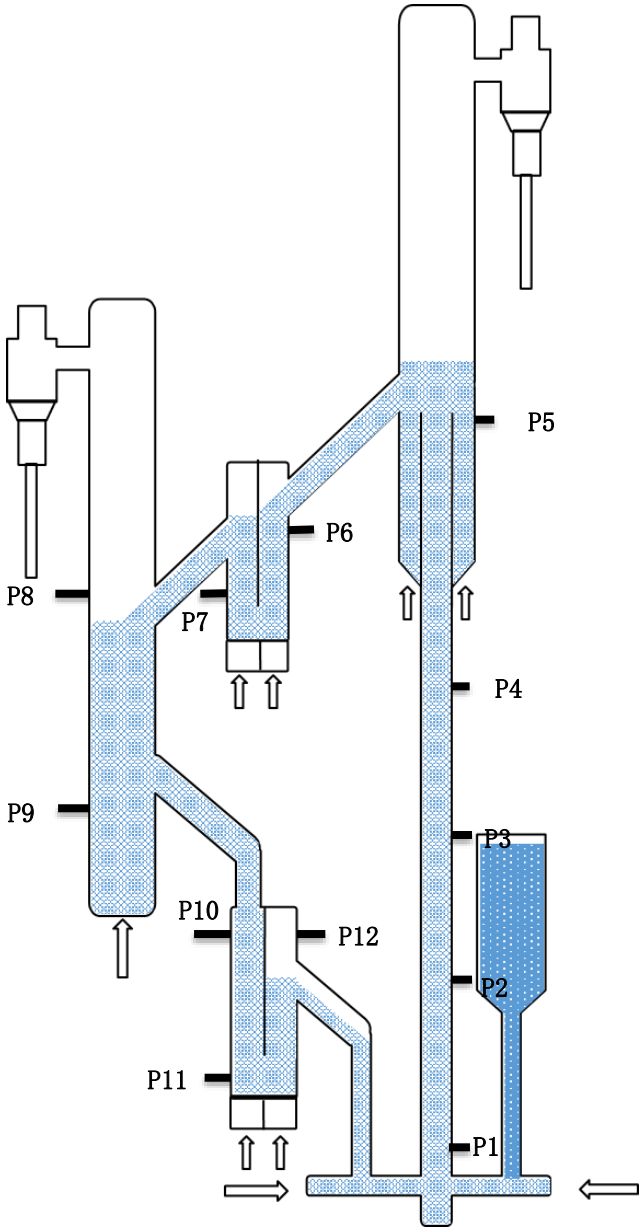


Fig 3. Pressure profile during the operation of the cold-model CL system.

Experimental investigation of cold model

Total solid inventory



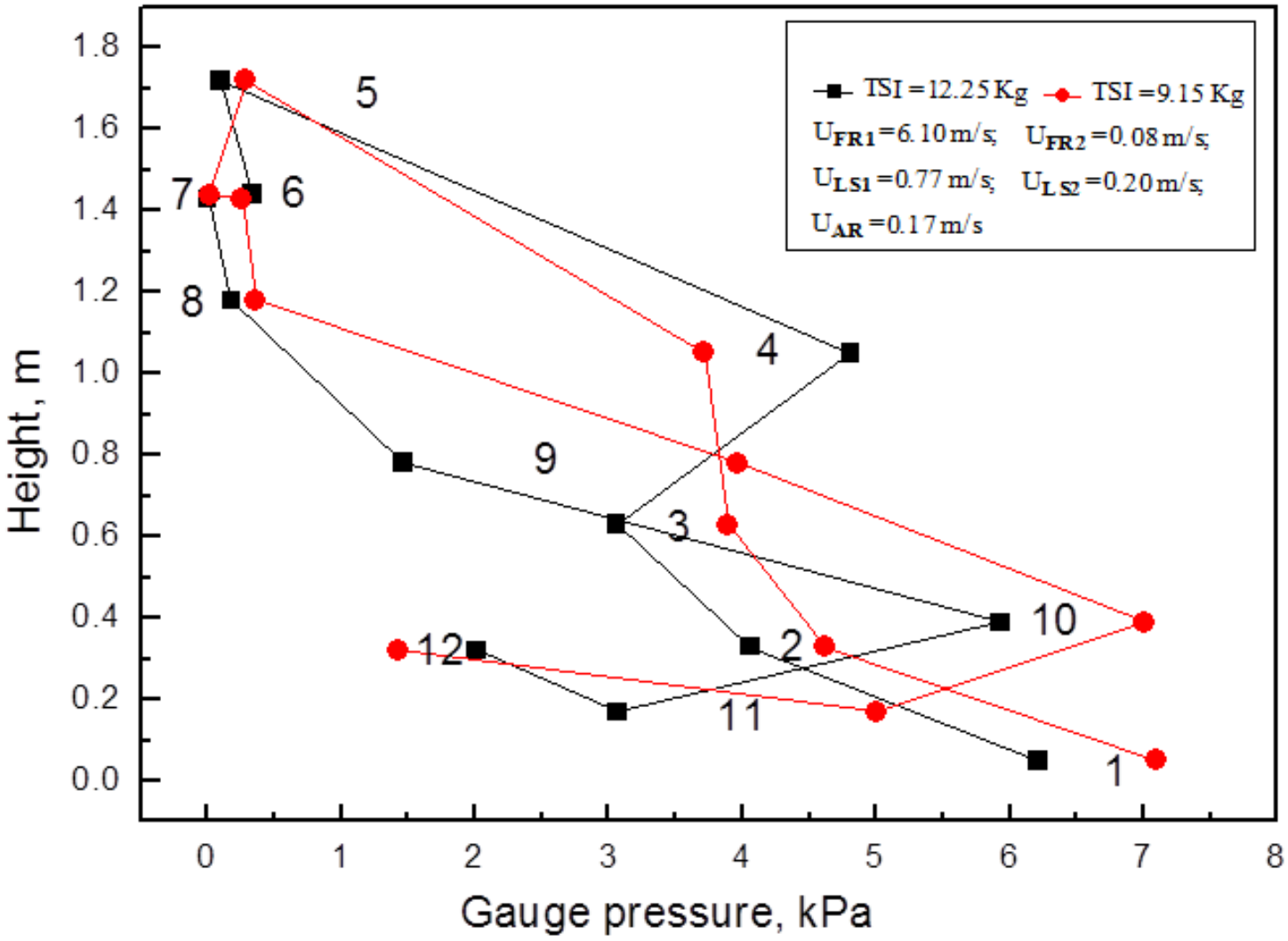


Fig 4. Pressure profile during the operation of the cold-model CL system.

Next work

Further experiments including:

- ✓ The mixing of solid fuel and oxygen in the feeding section
- ✓ The concentration profiles of FR
- ✓ The separation characteristics of ash and oxygen carrier
- ✓ The gas leakage of both looping seals
- ✓ the hydrodynamics of the high density riser and downer
- ✓ The hot model should be investigated.

Conclusions & outlook

- ✓ Based on the mixing and segregation characteristics of two particles with different density and particle size, a novel interconnected fluidized bed for chemical looping conversion of solid fuel was proposed.
- ✓ Jetting or impinging feed and high-density riser or downer can provide the good contact of solid fuel with oxygen carrier as well as better mass transfer, heat transfer.
- ✓ Turbulent fluidized bed or Spouted-fluidized bed of upper fuel reactor can realize the separation of unburned carbon or ash from oxygen carrier.
- ✓ A cold model was erected and proven to have a wide stable operation range. More experiments should be carried out.

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THANKS FOR YOUR ATTENTIONS!

The authors acknowledge the support from Nature Science Foundation of China (51506105) and Key R&D program of the Shandong province (2017GSF16101).