

Fluidization XVI conference

Combustion behavior of high ash bituminous coal in a pilot scale circulating fluidized bed rig

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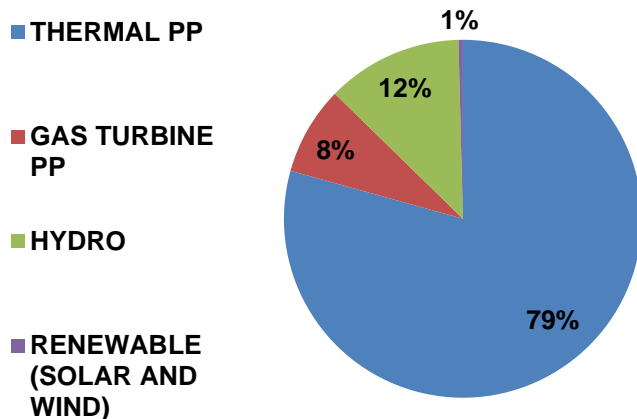
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Content

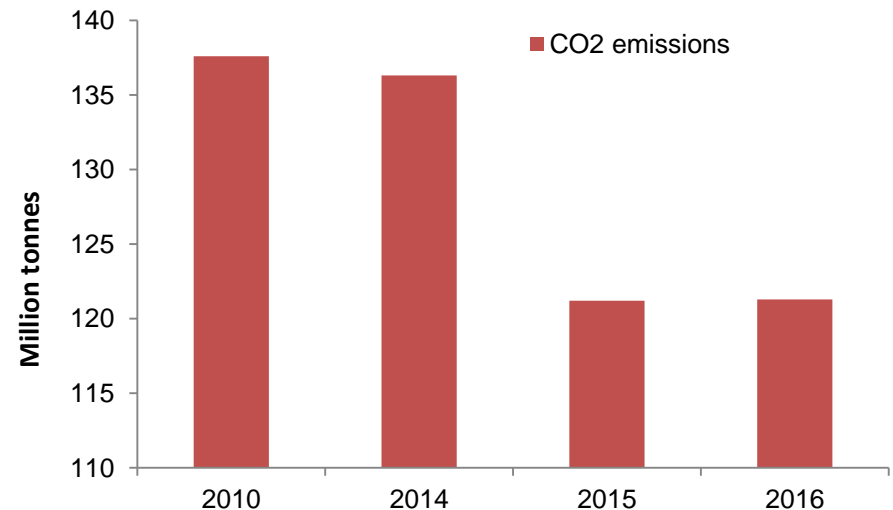
- Introduction
- Aims and objectives
- Experimental CFB set up
- Preliminary results, NO_x, SO_x emissions
- Pressure drop profiles
- Ash composition
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- Acknowledgements

Why important

- Huge amount of residual ash (bottom ash) being landfilled around the country;
- Reduction of NO_x and SO_x emissions due to the low temperature combustion;
- Mitigation of CO₂ emissions;



Energy balance of Kazakhstan, 2016

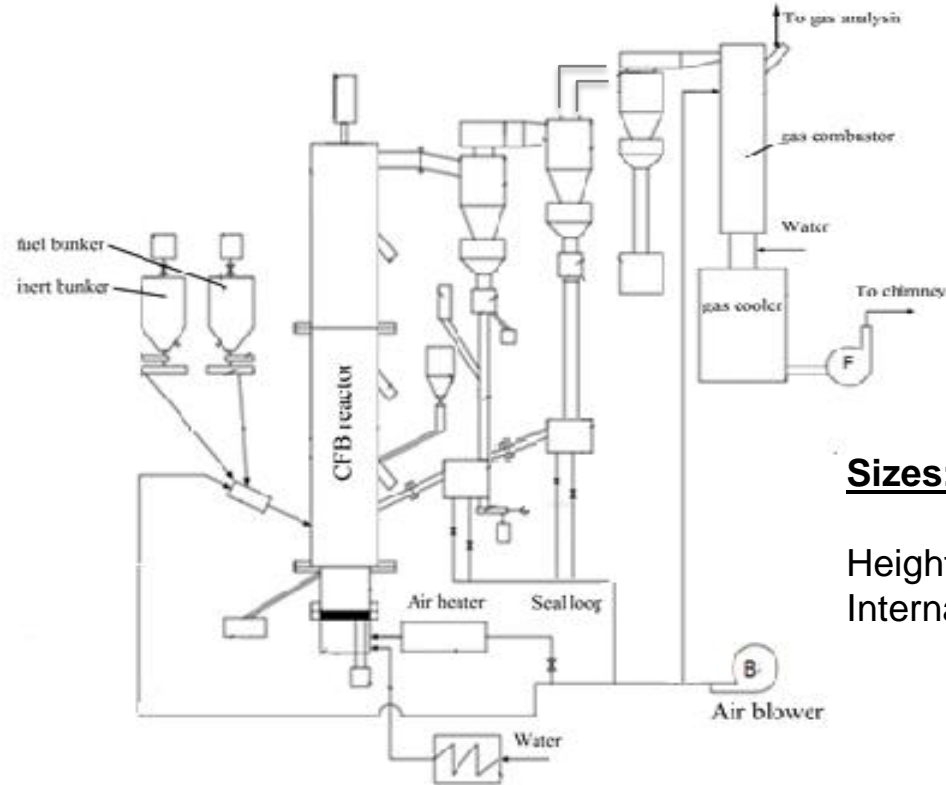


CO₂ emissions of Kazakhstan from coal combustion (IEA-2018)

Objectives

- Combustion behaviour of high ash coal in fluidized beds;
- Ash build up investigation in the dense zone;
- NO_x and SO_x emissions;
- Residual ash analysis by XRF;

Experimental setup: pilot-scale CFB rig



Sizes:

Height of riser: 5300 mm;
Internal diameter: 180 mm;

Gas measurements:



Experimental conditions:

- Fuel feeding rate: 18 - 20 kg/hr;
- Combustion temperature: 870-900°C
- Superficial gas velocity, U/U_{mf} : 3.3–3.8

Preliminary results: Complete combustion, NO_x, SO₂ emissions

Coal particles

| | |
|--------------------|----------|
| PSD of coal, mm | 0-8 |
| Fine fraction <1mm | 0.4-0.47 |

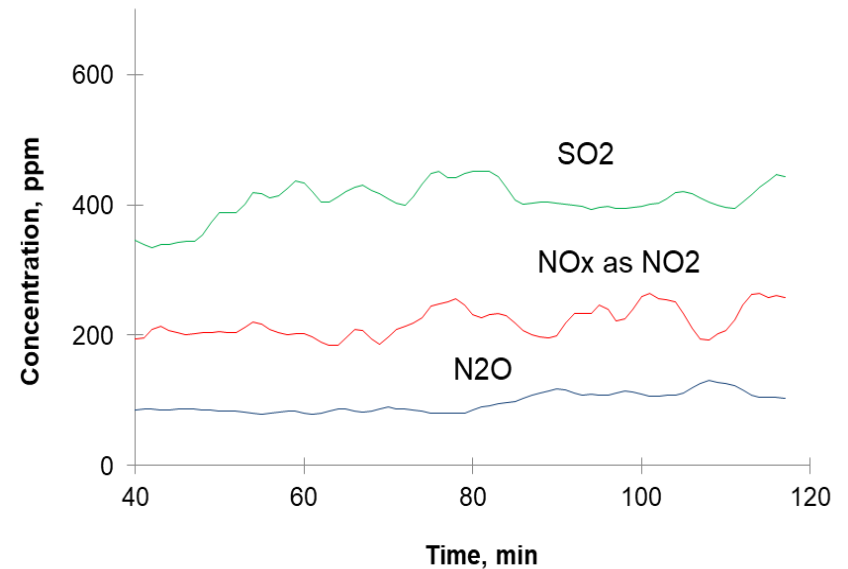
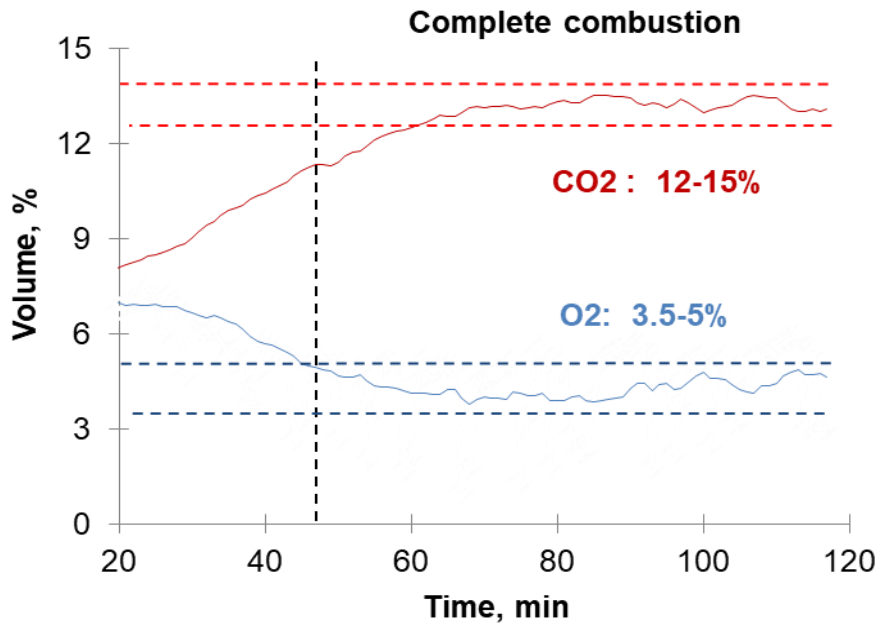
| Bed material (sand) | PSD | Weight |
|---------------------|------------|--------|
| Riser | 1 – 4 mm | 6 kg |
| Loop-seal 1 | 0.2 – 1 mm | 9 kg |
| Loop-seal 2 | 0.2 – 1 mm | 9 kg |

Proximate analysis (%)

| | |
|-----------------|------|
| Moisture | 2.1 |
| Volatile matter | 19.9 |
| Fixed carbon | 39.3 |
| Ash | 38.5 |

Ultimate analysis (%)

| | |
|------------|------|
| C | 61.2 |
| H | 3.5 |
| N | 2.1 |
| S | 0.7 |
| O | 32.4 |
| GCV, MJ/kg | 19.4 |

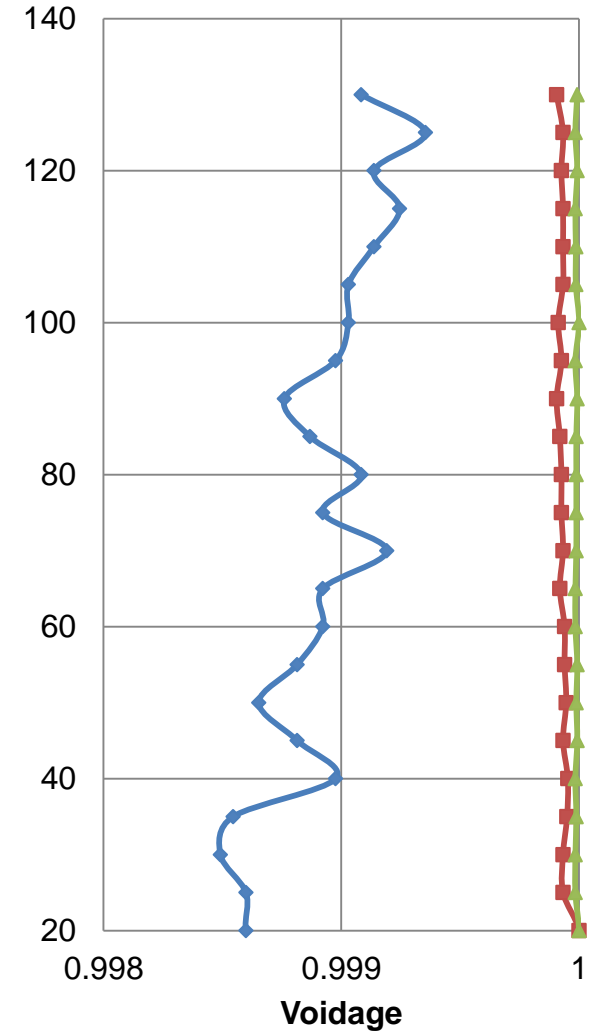
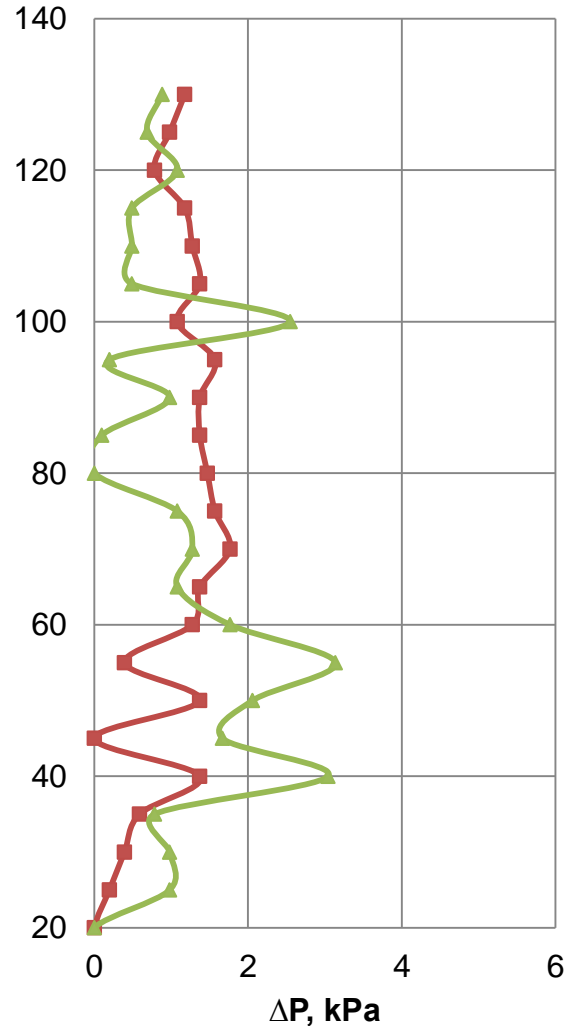
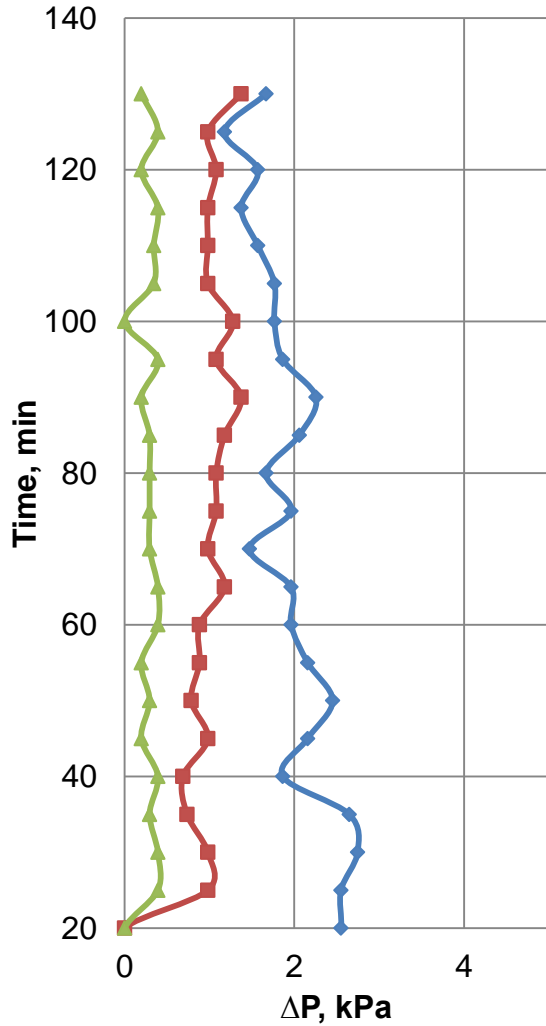


Preliminary results: Pressure drop vs time

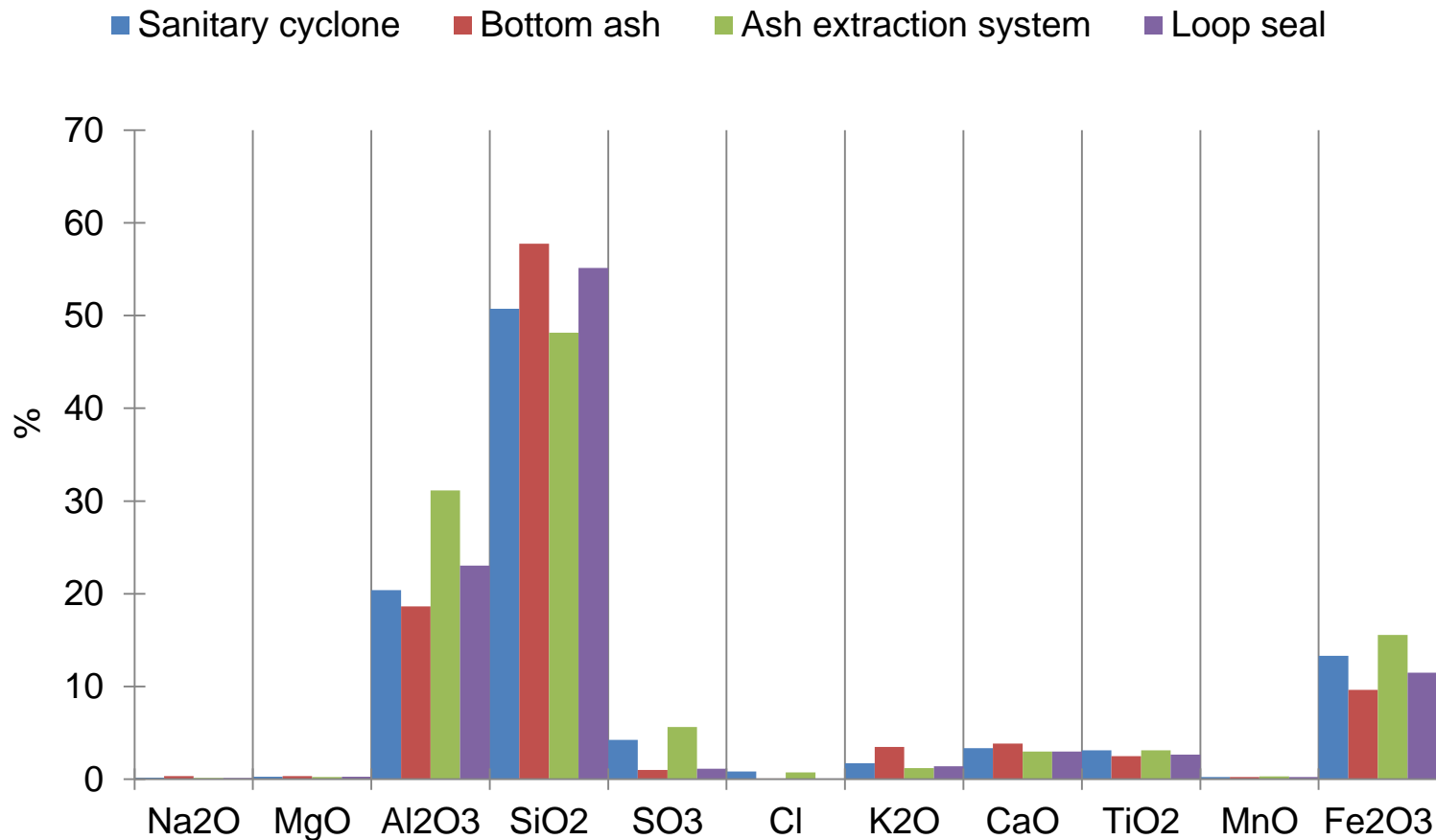
◆ $\Delta P1$ (dense zone)
 ■ $\Delta P2$ (splash zone)
 ▲ $\Delta P3$ (lean zone)

■ $\Delta P2$ (Loop seal 1)
 ▲ $\Delta P1$ (Loop seal 1)

◆ $\Delta P1$ (dense zone)
 ■ $\Delta P2$ (splash zone)
 ▲ $\Delta P3$ (lean zone)



Ash composition



Conclusions

- Preliminary results has showed that ash particles are carried away at higher gas velocities (CFB conditions);
- Combustion temperature of CFB were stable and kept between 870-900°C;
- Based on PSD analysis of residuals, **attrition of ash particles** could be the main reason for the loss of ash material;
- Further experimental campaigns are needed to understand ash formation mechanisms in a bench scale unit;

Acknowledgements

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Thank you for your attention!