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RECIRCULATION OF REACTIVE FINES

AN OPTIMIZATION STRATEGY FOR EXISTING DUAL FLUIDIZED BED GASIFICATION SYSTEMS

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Chalmers
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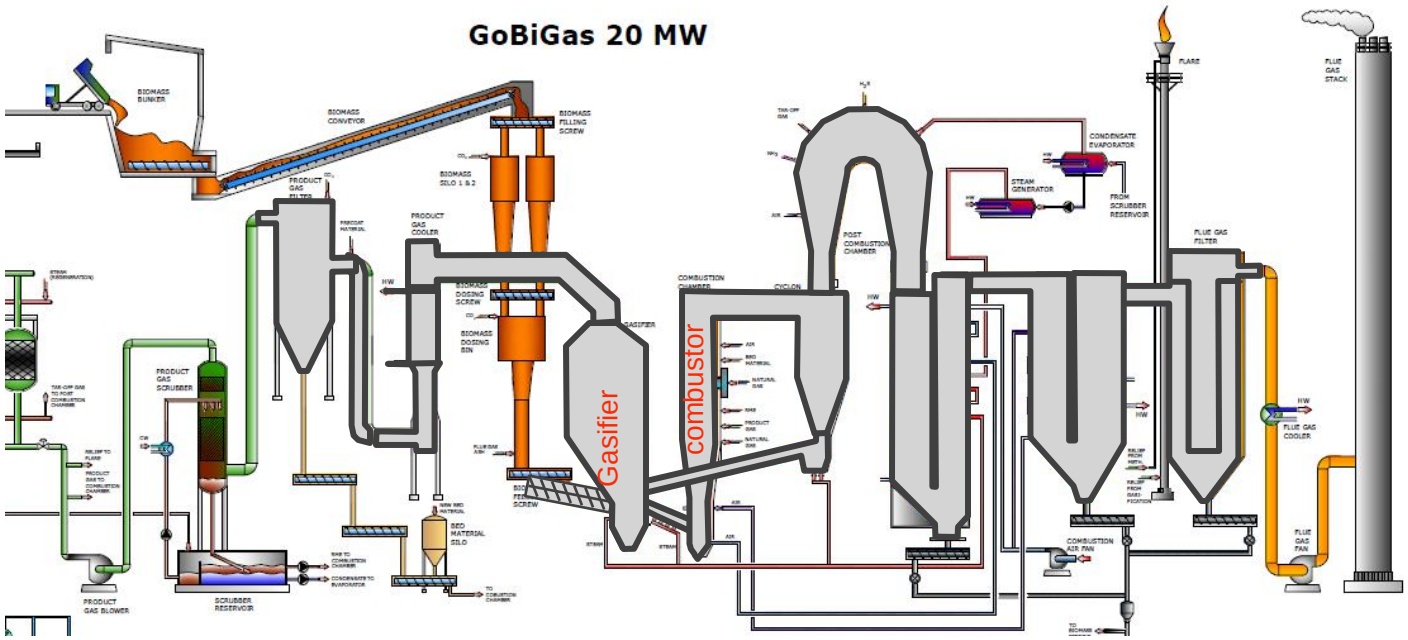
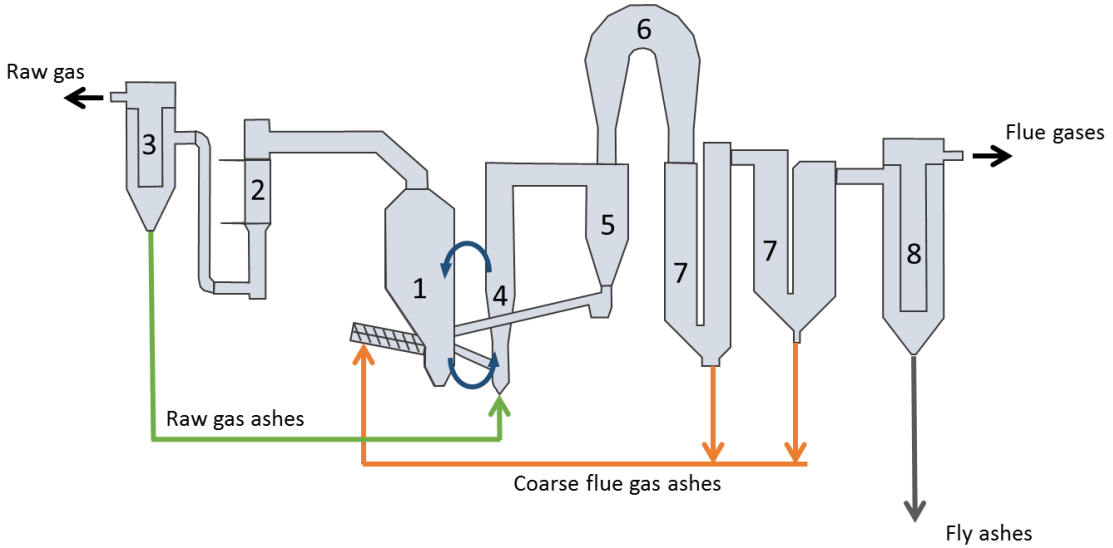
GoBiGas



Fly ashes

- From fuel ashes➔ rich in Ca and K
- From entrained bed material
- From attrited fragments of bed material
- Raw gas ashes ➔ unconverted carbon

Recirculation of coarse ashes in GoBiGas



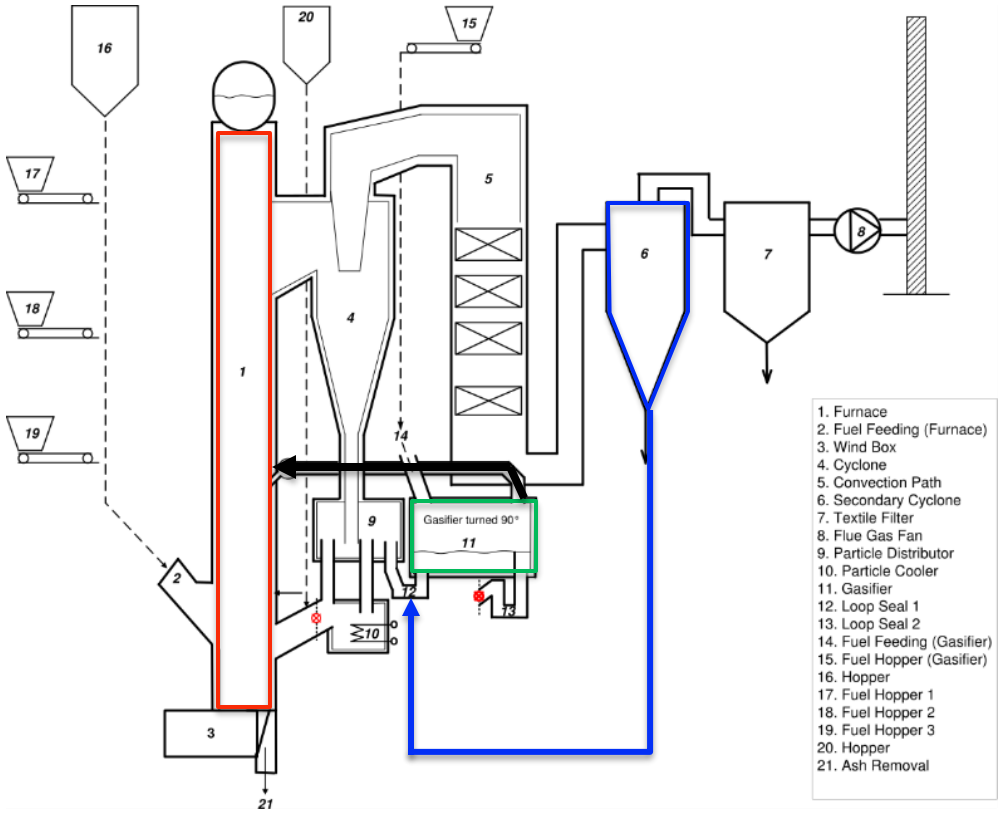
1. Gasifier	5. Cyclone
2. Raw gas cooler	6. Post-combustion chamber
3. Raw gas filter	7. Convection path and reversing chambers
4. Combustion chamber	8. Flue gas filter

But effect on gas quality??

Active ashes

- **K and Ca known to be active in char gasification, WGS and tar reforming**
- **Ash components found to form ash layer on bed particles ➔ <u>Activation of the bed linked to these layer formation</u>**
  - **Attrited material mostly from surface ➔ relatively rich in ash layer component + unstability of ash layers**
- **Redistribution of active ash species**

Simulation of recirculation in Chalmers DFB

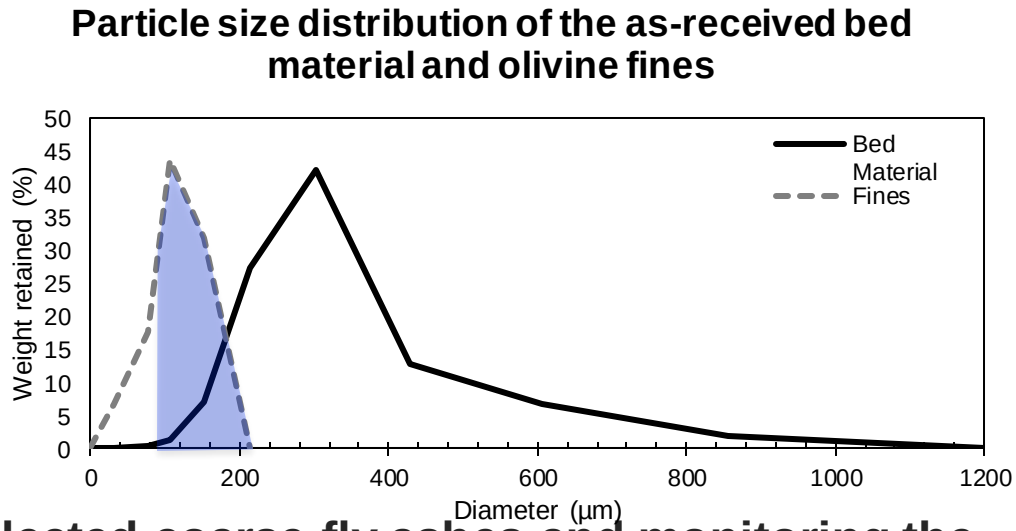


Particularities:

- No ash recovery under regular operation
- Constant feeding of fuel to boiler
- Raw gas burnt in the boiler ➔ internal circulation of raw gas ash

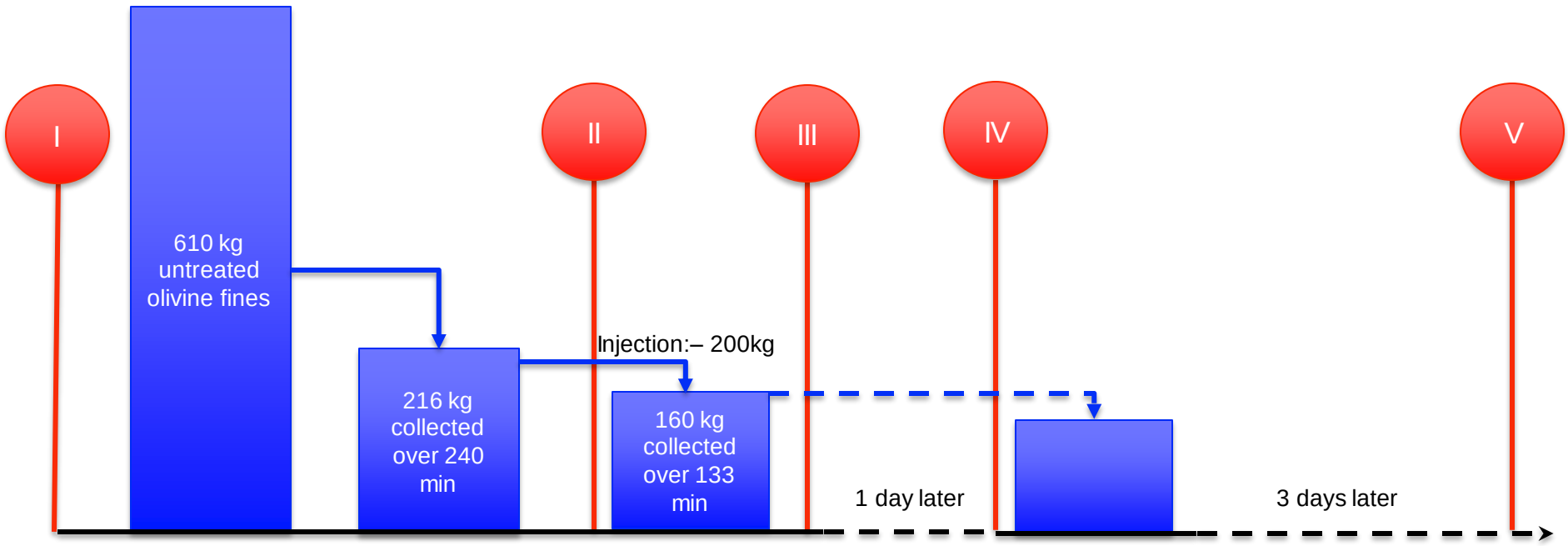
Procedure

- **Untreated olivine in fine fraction added to ”artificially” produce coarse fly ashes**

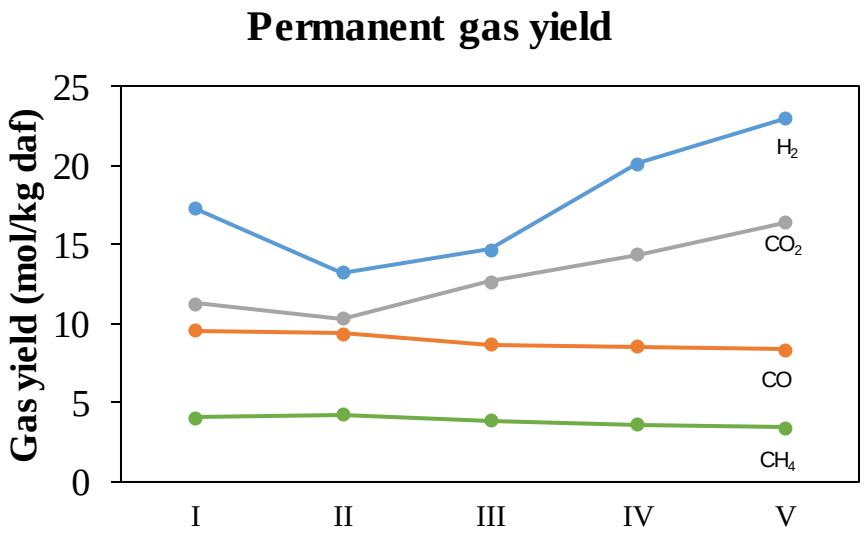


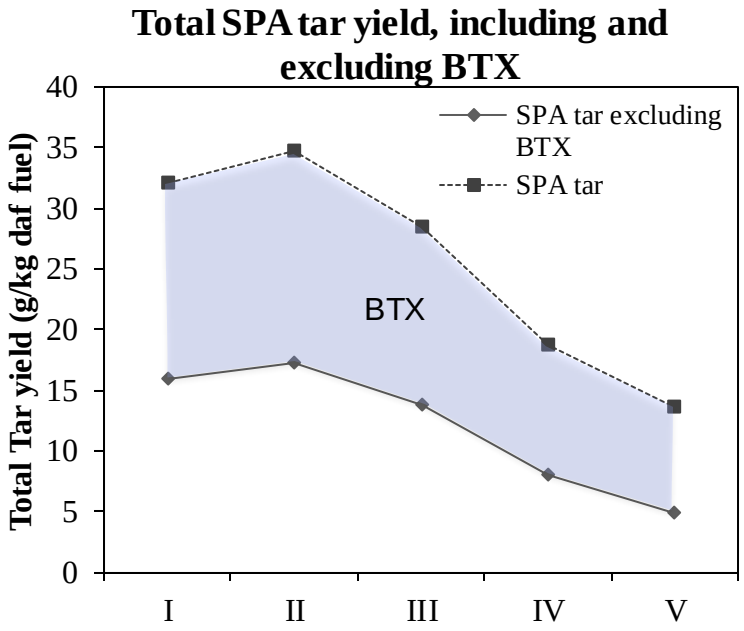
- **Recirculation of collected coarse fly ashes and monitoring the effect on the gas**

Procedure


I
610 kg untreated olivine fines
II
216 kg collected over 240 min
Injection:– 200kg
III
160 kg collected over 133 min
IV
1 day later
3 days later
V

Results

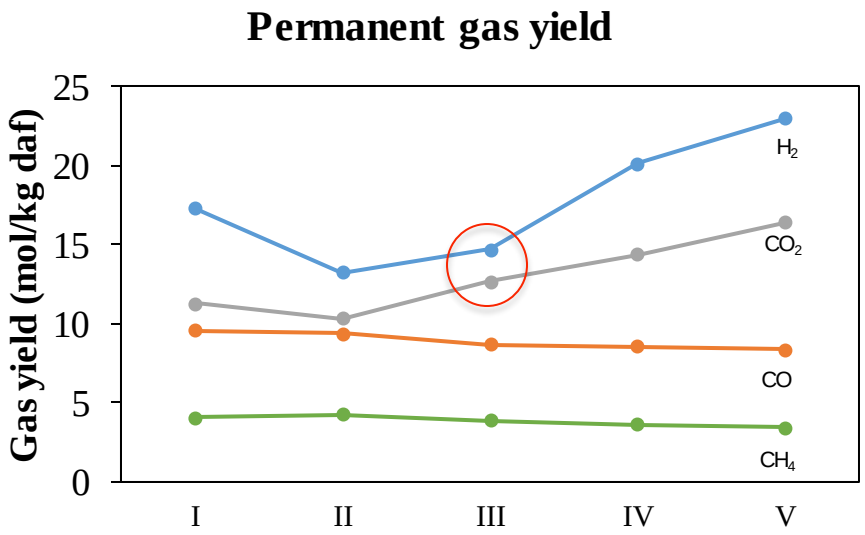


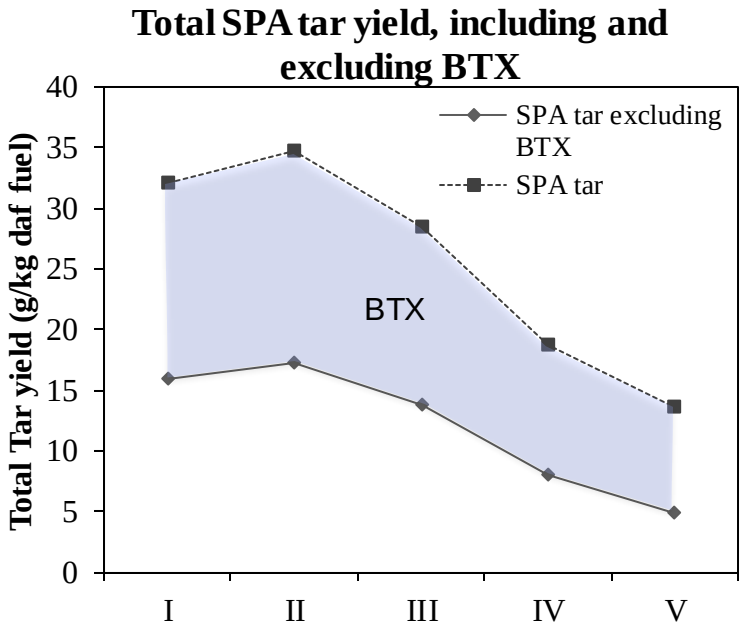


- 430 kg of material injected on first injection remained in the system
  - 40 kg at most from fuel ashes ➔ at least ca. 390 kg is untreated olivine fines
- Decrease in catalytic activity expected as non-active material introduced

II

Results

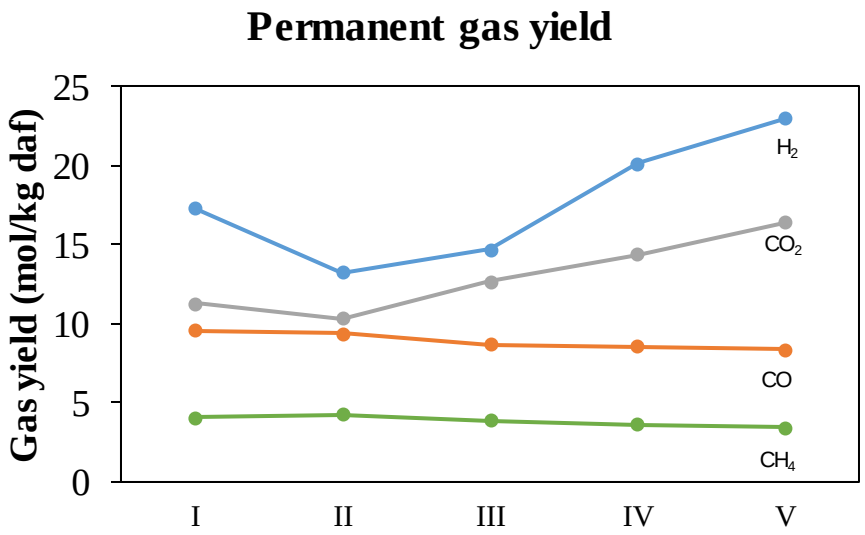


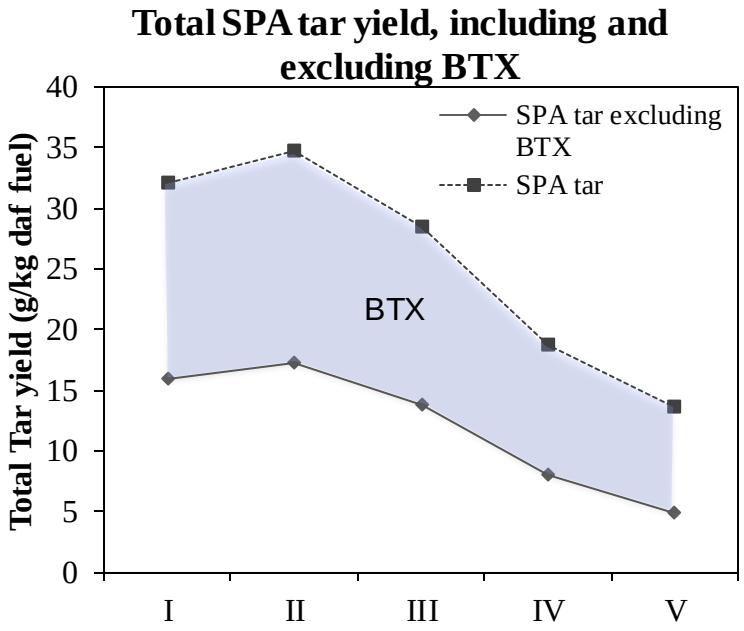


- Increased activity compared to II + Lower tar than on reference (I)
- But H_2 level below I ➔ could be a result of oxygen transport ➔ explains strong CO2 increase
- Lower CO ➔ oxygen transport + WGS despite higher char gasification

III

Results

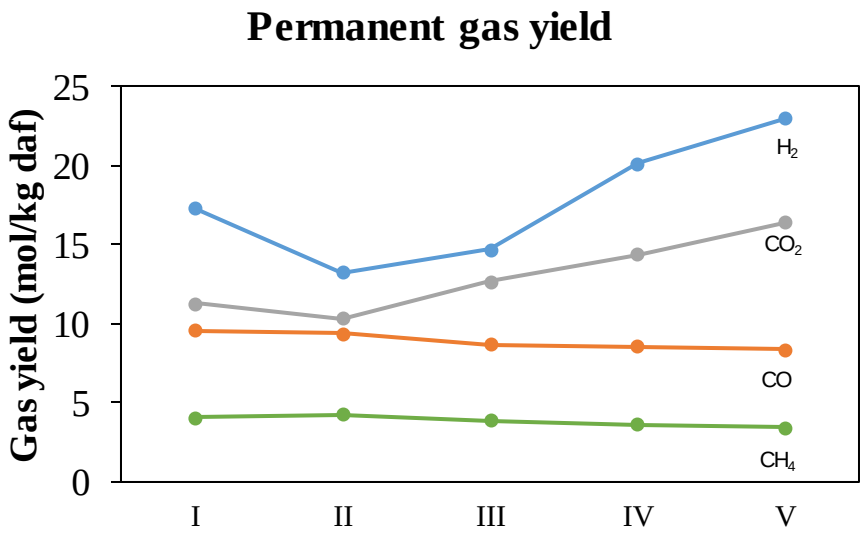


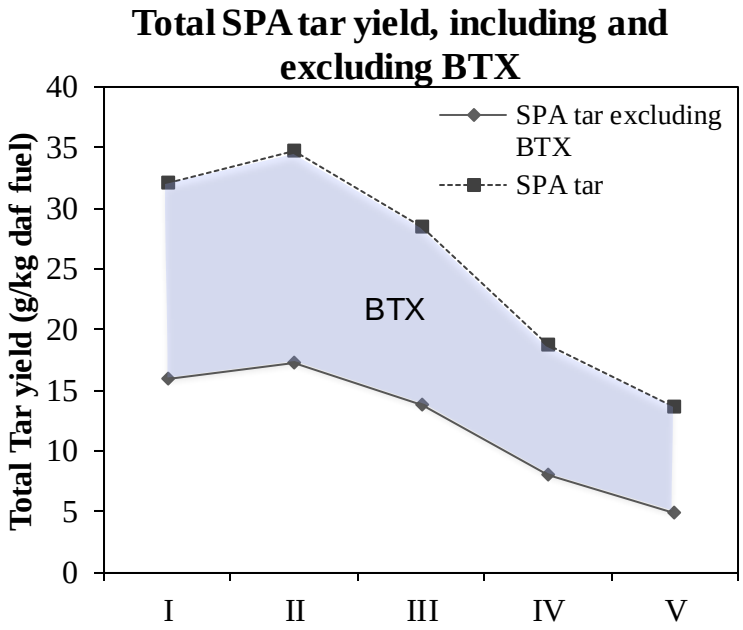


- Activity gain preserved ➔ Lasting effect of ash recirculation suggest modification of the bed material
  - Continuous activation process of fine fraction retained + possibly older bed material
  - Redistribution of ash component, particularly Alkali ➔ increased amount of catalytic species + availability for gas phase reaction and further interaction with bed material

IV

Results





- Very high activity reached <u>despite extensive regeneration</u> over 2.5 days ➔ 1.7 tons untreated olivine injected !
- <u>57% decrease</u> in SPA-detectable tar yield compared with reference
- 19.7% increase in total gas yield ➔ H_2/CO ratio 2.75 reached and H_2 45% in volume of cold dry gas

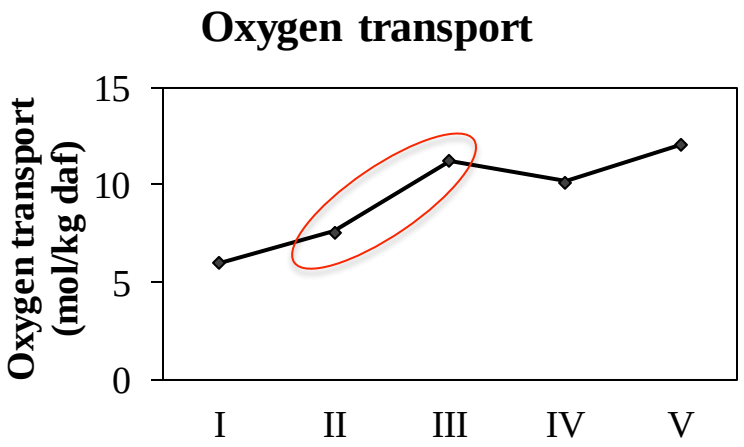
V

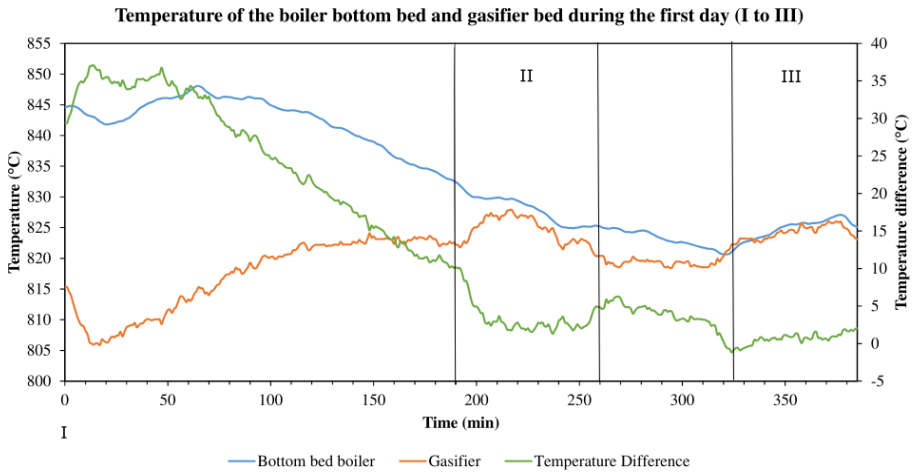
Conclusion

- **Catalytic activity enhanced by recirculating active coarse fly ashes**
  - **Lasting effect suggesting change in bed material composition**
- **In addition to bed material and carbon recovery ➔ mean to control activity of the bed**
- **For start-up ➔ diluted source of active species could be used to reach operational window faster**

Thank you !

Results – Oxygent transport and circulation rate





- Determined from O, C and H balance on the gasifier + furnace
- Oxygen transport x1.5 between II and III
- Linked to circulation rate ? ➔ fines particles enhance circulation

III