



Developments in CO₂ Compression and Purification Unit (CPU) for Oxy-fuel Combustion Power Plant

Introduction

Key Findings:

- The developments of this technology are led by several gas suppliers, including: Air Products, Air Liquide, Linde and Praxair.
- The application of a CPU leads to near zero emissions from oxy-fuel power plants in addition to producing high purity CO₂ (>99%).
- Different CPU technologies have been investigated in several oxy-fuel demonstration (≤30 MW) projects.

Novel Process Concept

Chemical reactions in the ozone CPU process:

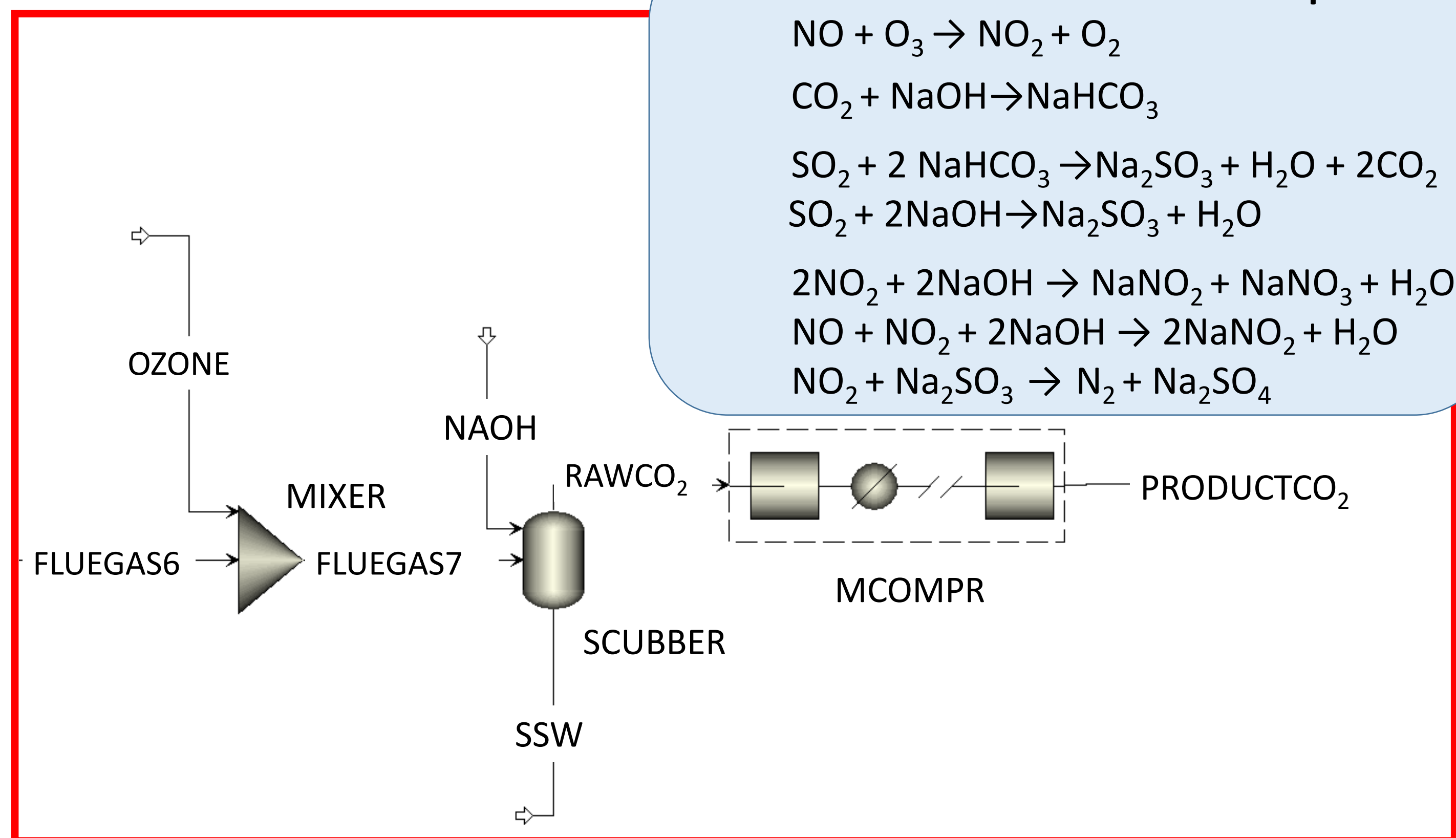
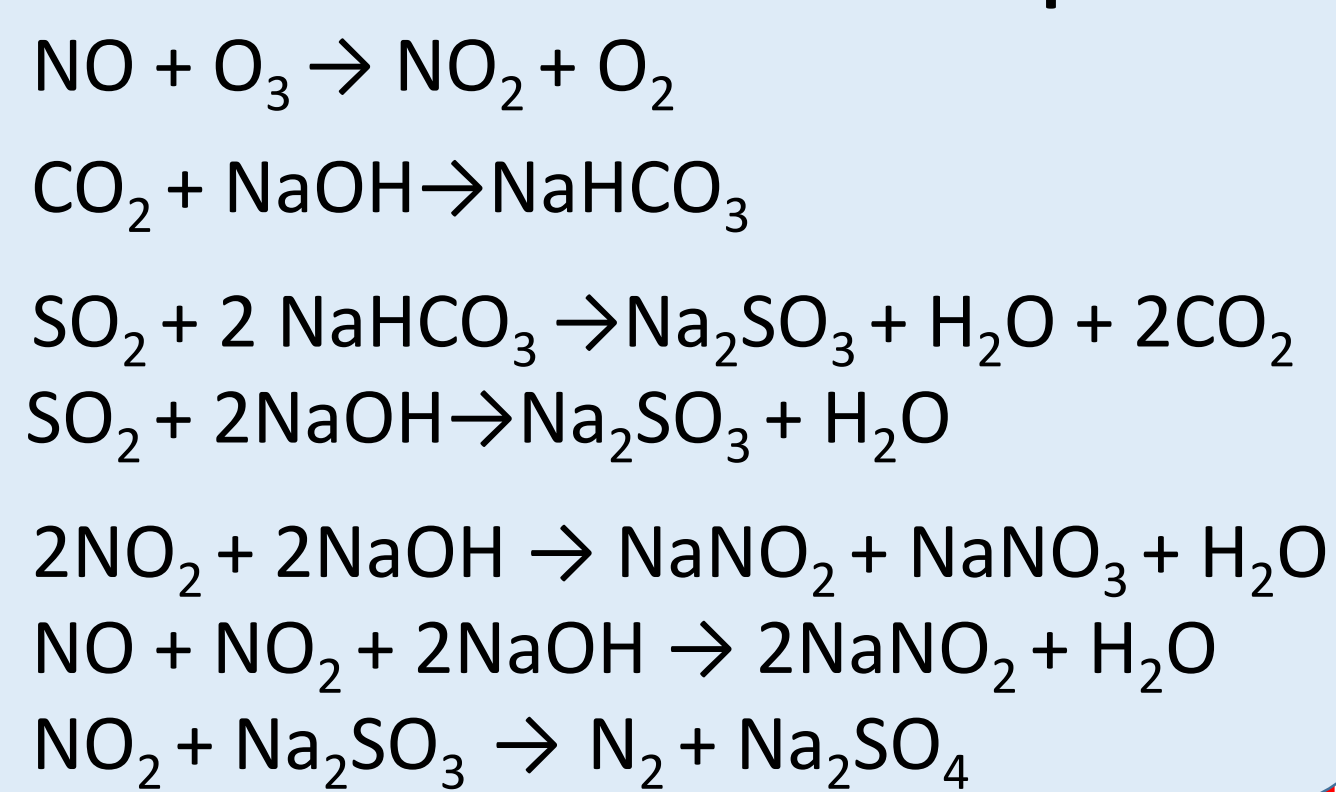


Figure 1 Modelling schematic of ozone-scrubbing for CPU by Aspen Plus.

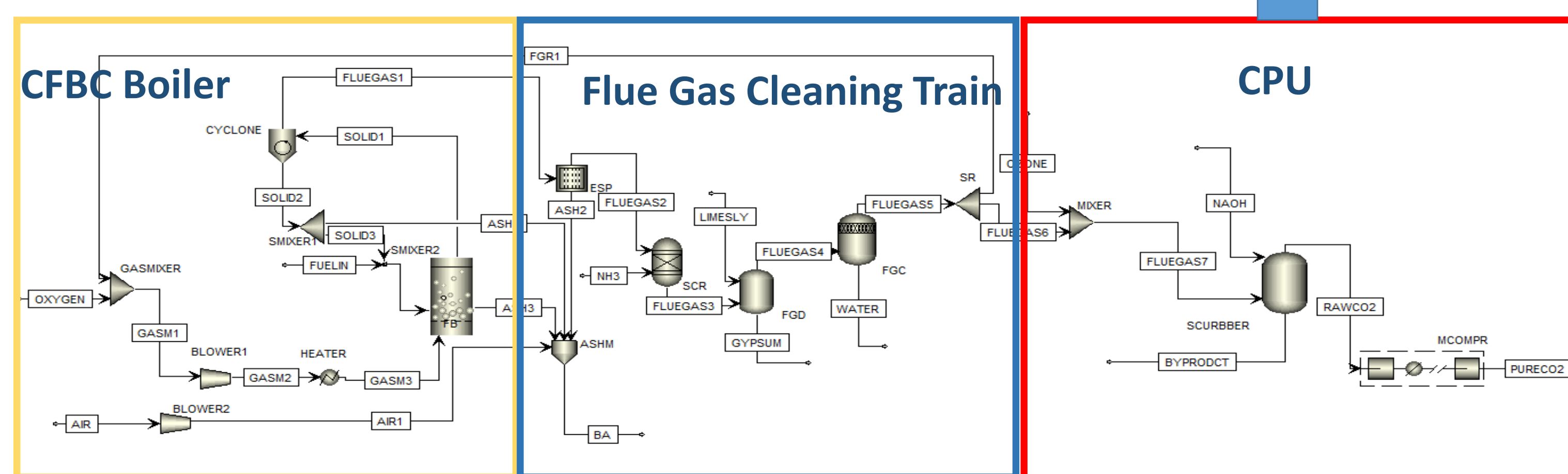


Figure 2 Modelling schematic of oxy-CFBC power plant with ozone-scrubbing for CPU by Aspen Plus.

Future Work

- The feasibility and tech-economic analysis will be modelled using an established oxy-CFBC power plant with ozone CPU by Aspen Plus.
- Experimental investigation of the performance of ozone oxidation and scrubbing for the oxy-derived CO₂ will be conducted when completing its feasibility and tech-economic analysis.

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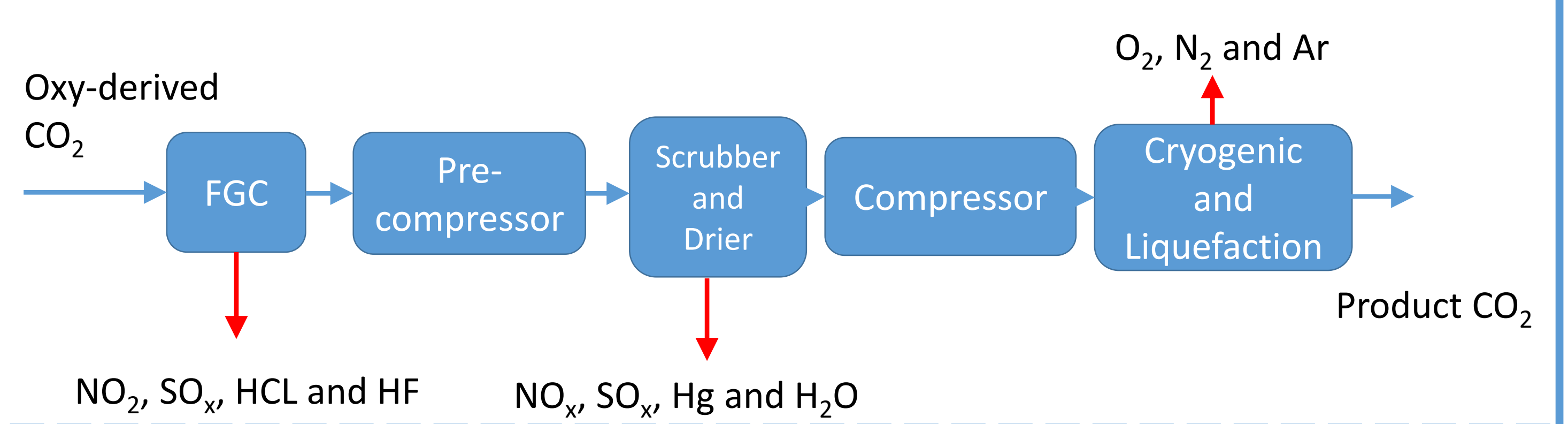
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Overview of Current CPU

Table 1 Comparison between current and ozone CPU technologies for oxy-fuel power generation

| | Advantages | Disadvantages |
|--------------------------|---|---|
| Current CPU technologies | <ul style="list-style-type: none"> Existing experience. High purity CO₂ (>99%) proven. | <ul style="list-style-type: none"> High CAPEX, OPEX and energy penalty. Corrosion issues. |
| Ozone CPU | <ul style="list-style-type: none"> Avoid corrosion of compressor. Reduce the size of CPU. High SO_x and NO_x removal efficiency. | <ul style="list-style-type: none"> Only proved for simultaneous removing NO_x and SO_x. The feasibility and tech-economic analysis haven't been investigated for the CPU. |

Current



This Work

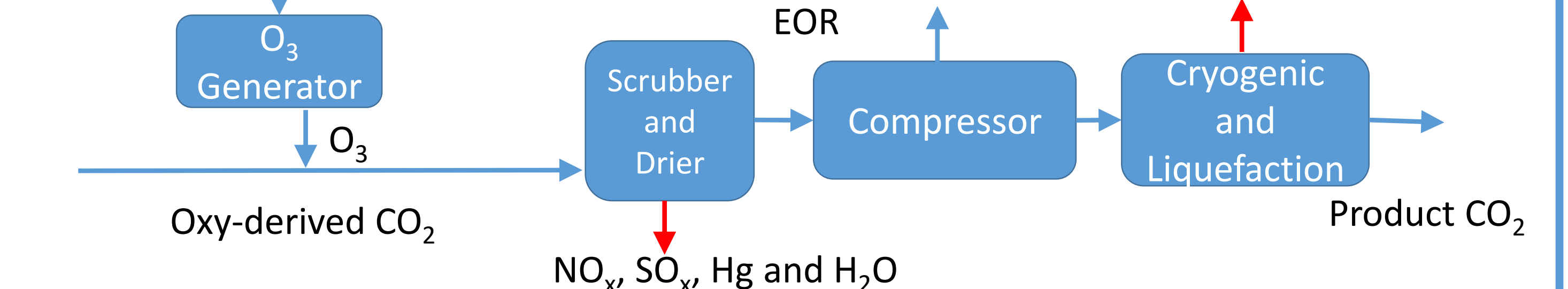


Figure 3 Schematic of current and ozone CPU technologies for oxy-fuel power generation.

| Mass Flow | Units | Before (FLUEGAS6) | After (FLUEGAS7) | % change |
|-----------------|-------|-------------------|------------------|----------|
| O ₂ | kg/hr | 4391.09 | 4409.52 | |
| NO ₂ | kg/hr | 0.02 | 1.73 | |
| NO | kg/hr | 1.13 | 0.01 | 99% |
| SO ₂ | kg/hr | 690.34 | 655.82 | 5% |
| SO ₃ | kg/hr | 43.31 | 86.44 | |
| O ₃ | kg/hr | 45.36 | | |

Previous literature results:

- 99% NO, 90% NO₂ and ~100% of SO₂ was removed at pH 11 before compression¹.
- Byproduct: Sodium nitrate → Fertilizer Sodium sulphate → Paper production¹

Conclusions

- A novel process concept of ozone oxidation and alkali scrubbing technology with CPU has been proposed in this work and will be studied in Aspen Plus.
- This has the potential to remove the need for the pre-compressing and flue gas cleaning step within conventional CPU trains.
- The impacts of impurities, gas quality control and cost are the main concern to develop the oxy-fuel CO₂ purification technology.

References

- J. Zhang et al., "Simultaneous Removal of NO and SO₂ from Flue Gas by Ozone Oxidation and NaOH Absorption," Ind. Eng. Chem. Res., vol. 53, no. 15, pp. 6450–6456, Apr. 2014..