# CCS TECHNOLOGIES FOR APPLICATION IN CZECH REPUBLIC

**Lukas PILAR[1)], Tomas HROCH[1)], Jakub VYVADIL[1)], Tomas DLOUHY[2)], Pavel SLOUKA[1)]**

[1)]ÚJV Řež, a. s., Hlavni 130, Rez, 250 68 Husinec, Czech Republic

[2)] FME CTU in Prague, Technicka 4, 166 07 Prague 6, Czech Republic

## INTRODUCTION

The paper deals with calculation procedure that has been performed in order to evaluate suitability of CCS technology application in a current power plant in the Czech Republic. Two CCS technologies (post-combustion capture - ammonia scrubbing and oxy-fuel combustion) are considered. The basic block digrams power plant with and without CCS technology are shown in Figure 1. Comprehensive results and impacts of implementing both technologies are summarized on a case scenario of 250 MWe power plant.

## INPUT PARAMETERS

**Steam power plant:**

Subcritical unit with 250 MWe output

Fuel = czech lignite with basic composition shown in Table 1.

Boiler efficiency 91.16 %

Admission steam: temperature 575°C, pressure 18.3 MPa

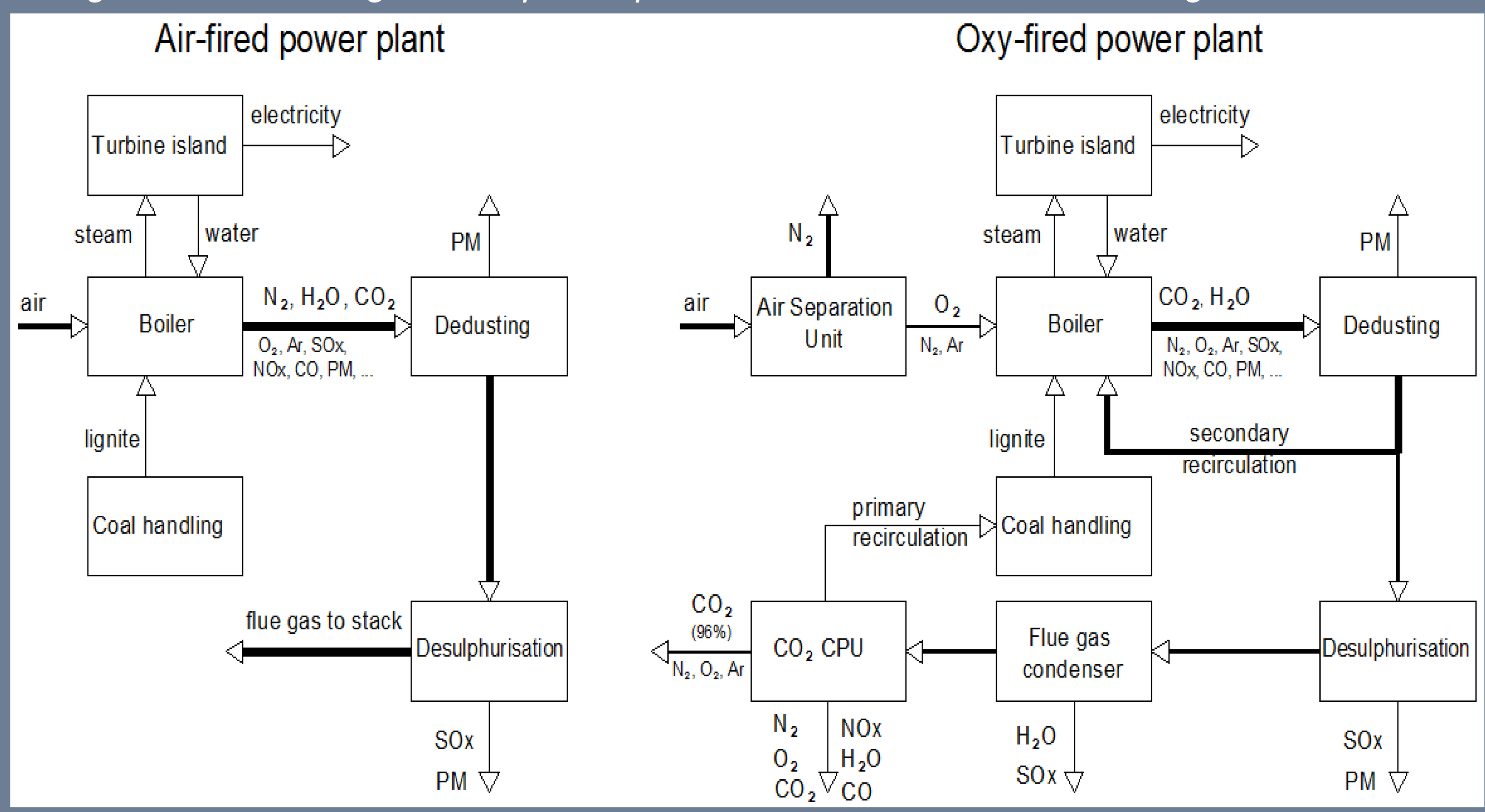
Reheated steam: temperature 580°C, pressure 3.6 MPa

Feed water: temperature 251°C

*Table 1: Czech lignite – selected parameters/compositions*

| Parameters | | Phys. unit | Value |
|---|---|---|---|
| Lower Heating Value LHV | $Q_i^r$ | MJ/kg | 8.5 |
| Water | $W_t^r$ | mass% | 31 |
| Ash | $A^d$ | mass% | 41 |
| Sulphur | $S_t^d$ | mass% | 3 |

*Figure 1: Block diagrams of power plants with/without CCS technologies*




**$CO_2$ capture process:**

$CO_2$ capture factor is defined 90 %. Captured/separated $CO_2$ is transported to storage (aquifer) in the gas form. Parameters of $CO_2$ mixture (from capture) are 50 ° C and 110 bar. Purity $CO_2$ (more precisely $CO_2$ rich mixtures) is based on the requirements set out in international studies.

## CCS TECHNOLOGY INTEGRATION – IMPACTS INTO POWER PLANT TECHNOLOGAL SYSTEMS

### AMMONIA SCRUBBING TECHNOLOGY

By integration of Post-combustion, the power plant unit will be extended new technological system:

- Raw flue gas/ clean flue gas heat exchanger
- Flue gas cooling
- Flue gas fan
- $CO_2$ absorption
- Clean flue gas after-cleaning
- $CO_2$ desorption
- Desorbed $CO_2$ final purification/cooling
- $CO_2$ compression
- Cooling water circuit
- Auxiliary cooling source
- Ammonia management

**The existing systems of the power plant unit are not modified.**

### OXY-FUEL TECHNOLOGY

By integration of Oxyfuel technology, the power plant unit will be extended by several technological complexes:

- Air separation unit - Oxygen is provided by cryogenic distillation of air at 95% purity.
- Coal dryer - fluidized bed dryer with heat originated from condensation of compressed waste vapors (of vapors)
- Flue gas condenser
- $CO_2$ purification and compression unit - $CO_2$ is compressed by multi-stage radial compressor.

Other parts of the power plant unit are then modified to respect new conditions.

- Boiler
- Fly ash separation – electrostatic precipitator
- Flue gas desulphurization – wet limestone method

## RESULTS

*Table 2: Selected impacts of CCS technologies integration into power plant (PP)*

| Parameters | Unit | PP without CCS | PP with CCS (Ammonia scrubbing) | PP with CCS - Oxyfuel | PP with CCS Oxyfuel and lignite drying |
|---|---|---|---|---|---|
| Power output of the Unit | MWe | 250 | 238 | 262 | 262 |
| Coal consumption | t/h | 214 | 214 | 217 | 202 |
| Electricity demand | MWe | 24 | 75 | 94 | 92 |
| $CO_2$ production | t/h | 211 | 211 | 216 | 201 |
| Captured $CO_2$ | t/h | 0 | 190 | 190 | 177 |
| $CO_2$ emission in the air | t/h | 211 | 21 | 26 | 24 |
| Net electricity production | MWe | 226 | 163 | 168 | 170 |
| **Total net efficiency** | **%** | **38.99** | **28.12** | **28.53** | **31.13** |
| **Efficiency decrease** | **p.p** | **0** | **10.87** | **10.46** | **7.86** |

## CONCLUSION

The present study has show that the ammonia post-combustion $CO_2$ capture method and oxy-fuel combustion are from the technology point of view applicable for current 250 MWe power plant running on lignite coal. However, the impact is very significant. The calculations have show that the addition of CCS technology decreases the total efficiency of the power plant by nearly **11 p.p.** for post-combustion (ammonium scrubbing) and **8 p.p.** for oxyfuel combustion.

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Contact information

www.czech-norway-pilotccs.com

email: nfccs05@gmail.com