2nd Oxyfuel Combustion Conference

Risk Analysis of FORTUM's 560MWe net Power Plant Retrofit to Oxyfuel Combustion

Kati Kupila[a], Pauli Dernjatin[a] and Risto Sormunen[a] , Tadashi Sumida[b] and Kenji Kiyama[b], Alain Briglia[c], Ivan Sanchez-Molinero[c] and Arthur Darde[c]

[a]*FORTUM, Power Division POB 100,FI-00048, Finland,*

[b]*BABCOCK-HITACHI KKK Division, Thermal Power Division,6-9 Takara-Machi, Kure-shi,HIroshima-ken,737-8508 Japan,*

[c]*AIR LIQUIDE ENGINEERING, 57 Ave. Carnot BP 313, Champigny-sur-Marne F-94503, France*

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1. INTRODUCTION

Over several years, FORTUM conducted a technology analysis that would allow carbon capture at Meri-Pori supercritical power plant (565 MWe, net) owned by FORTUM and TVO and operated by FORTUM. One option was to modify the plant to oxyfuel combustion as offered in spring 2009 by HITACHI and AIR LIQUIDE, who jointly developed a technical solution in cooperation with FORTUM for Meri-Pori.

It was agreed between FORTUM, HITACHI and AIR LIQUIDE that a deeper analysis of the risks associated with the oxyfuel retrofit would be necessary for learning more about oxycombustion technology and to clarify the actual risks.

The presentation will highlight the most important conclusions of this joint effort. The three companies not only dedicated one week in the Plant to conduct the risk analysis, they also allocated significant resources in the following weeks and months to better assess the probability and criticality of all the risks induced by modifications of the power plant equipment use and/or the addition of new pieces of equipment. Several mitigations measures will be highlighted during the conference presentation.

2. METHODOLOGY

Fortum, Babcock Hitachi and Air Liquide formed a team of experts on all units impacted by the retrofit to oxyfuel combustion. Fortum risk assessment experts chaired the discussion and defined the methodology.

The team met for one week to elaborate the risk analysis on the power plant site. The first day was dedicated to the construction of a functional analysis that served as the basis of the risk assessment during the following days.

The team evaluated every identified impact on each piece of equipment existing in the power plant. All failure scenarios of new pieces of equipment such as improper oxygen and flue gas mixing in the mixing device, loss of oxygen production or pressure or purity (from Air Separation Unit), etc. were considered in the study as potential sources of new risks for the power plant.

The preliminary results were then challenged by Fortum and TVO managers.

3. CONCLUSIONS OF THE RISK ANALYSIS

The team met again several times to improve the risk analysis coherence and precision. Many statements were then backed by internal evidence from Hitachi and Air Liquide. Sources of evidence were experimental oxycombustion tests, engineering studies and actual industrial references. Hence, the conference presentation material will be enriched by many contributions from the R&D and Engineering departments from Hitachi and Air Liquide companies. Fortum risk assessment specialists were involved in all modifications of the risk analysis from the initial version.

The risk analysis team conclusion is that oxyfuel retrofit and oxyfuel operation at the Meri-Pori coal fired power plant would only involve low magnitude risks according to the evaluation of the Fortum, Hitachi and Air Liquide experts.

Appropriate design, operation and maintenance procedures following international best practices from the relevant industries are necessary and sufficient to reduce all potential risks to the manageable 3rd and 4th categories.

The risk analysis expert group recognized several serious risk scenarios with high impacts either in failure costs, duration of unavailability, personnel or environmental safety. However, all of those risk scenarios were evaluated with low probability (criticality in level 3 out of 4, 4 being fully manageable risks). Those risks were:

- ASU explosion
- ASU – CPU venting in contact with human beings
- O_2 supply isn't stopped when required leading to boiler and or mill explosion
- Risks raised by a new working environment for operators

No critical risk identified (categories 1 and 2).

Risk list for 3rd category (risks with limited magnitude) (yellow):

- ASU explosion due to hydrocarbon ingress in liquid oxygen bath. **The probability is very limited**.
- ASU trips, gaseous buffer allows smooth transition to air mode, increased power production available but lower carbon capture. Gravity is very limited (level 4) but probability is high (ASU trips are expected in the range of 5 per year). Note: With liquid oxygen back-up, the probability of not delivering oxygen becomes a level 3 (once every 10 years) and criticality falls to green (level 4).
- Oxygen shut-off valves don't close when required, pure oxygen may fill the mills and or boiler and lead to mills and or boiler explosion. **The probability is very limited**.
- Waterwall corrosion, probability is estimated to be low due to higher control possibilities of reducing atmosphere around burners in oxyfuel conditions. Failed tube replacement would request up to one week power shut-down.
- CPU vents can lead to anoxia. Normal operating and maintenance procedures will avoid the risk. **The probability is therefore estimated to be very low**.

- CPU trips and operation is switched smoothly to air mode. There is no negative impact on the plant, but the scenario has an estimated probability of around 5 trips per year.

- Ducts changed from air to flue gas transport within the boiler house will raise an anoxia risk in case of leakage. Similar detection means as in the desulphurisation unit (SO2 detection) shall help mitigate the risk of anoxia.

- The working environment will change, including new units such as especially ASU and CPU. The operators shall be properly trained to operate and maintain those plants so as to avoid typical risks such as cold burn, anoxia or explosion risks due to pressurised vessels and pipes.