



2nd International Oxyfuel Combustion Conference ALSTOM Chemical Looping Technology Status

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1. Introduction

Chemical Looping has emerged as one of the very promising break-through technologies with the ability to cost-effectively capture CO₂ from new and existing coal-fired power plants while maintaining high plant power generation efficiency. This technology should provide significant performance and cost improvements compared to alternatives.

This concept for power plants is based on a hybrid combustion-gasification process utilizing high temperature chemical and thermal looping technology. The chemical and thermal looping technology is first developed for combustion; but in the future, it could also be configured as a hybrid combustion-gasification process producing a Syngas or hydrogen for various applications while also producing a separate stream of CO₂ for use, e.g., in Enhanced Oil Recovery or Saline Aquifer sequestration.

ALSTOM is developing alternate Chemical Looping Processes; one utilizing calcium oxides and another utilizing metal oxides as oxygen carriers to transport oxygen from air to the fuel. Each offers specific features in terms of oxygen carrier availability, durability, operating temperature, and the capability of firing a range of fuels.

2. ALSTOM's Prototype Program

The development and the introduction of a new technology requires a progressive scale-up with several validation steps: laboratory, small pilots, prototypes, and pre-commercial demonstration. After validation of the chemical

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looping technology at small pilot scale, a decision to build a prototype has been made for both the MeOx Chemical Looping and CaOx Chemical Looping processes.

The MeOx project called ÉCLAIR (Emission Free Chemical Looping Coal Combustion Process) is funded by ALSTOM with co-funding by the European Union – Research Funding for Coal and Steel (RFCS). It involves:

- Design and operation of a 100 kWth pilot plant at Chalmers University, Sweden
- CFD modeling of the entire 1 MWth prototype
- Computer modeling of the 1 MWth prototype in the reactive mode at Darmstadt University, Germany
- Assessment of technical, environmental and economical potential of CLC power plants

The main objective of this project is the validation of the process on a 1 MWth scale under autothermal operation with one oxygen carrier (ilmenite) and with a bituminous coal. Some other fuels might be tested during the Optimization phase of the testing.

In parallel to this project, ALSTOM is performing cold flow model testing and computer modelling to validate the design of the key components and to predict the hydrodynamic behaviour of the prototype.

The CaOx project is funded by ALSTOM with co-funding by the United States Department of Energy (US-DOE), and involves:

- 12 m high × 100 mm dia. cold flow model design and operation at ALSTOM Labs, USA
 - with arrangement similar to the 3MWth prototype
 - with coupled operation
 - with high solids circulation and transfer rates between reactors
- Validation of the process on a 3 MWth scale prototype under autothermal operation at ALSTOM labs, USA
 - with oxygen carrier (CaOx)
 - with a low sulfur, high agglomerating potential bituminous coal (Pittsburgh #8)
- Assessment of technical, environmental and economical potential of CLC power plants

3. Status Of ALSTOM's CLC development program

This presentation discusses the status of ALSTOM's Chemical Looping development that has just completed the initial testing of the two prototypes.

The 1 MWth MeOx prototype was erected on a green field site in a dedicated building at the Technical University of Darmstadt (TUD), Germany, as shown in Figure 1.

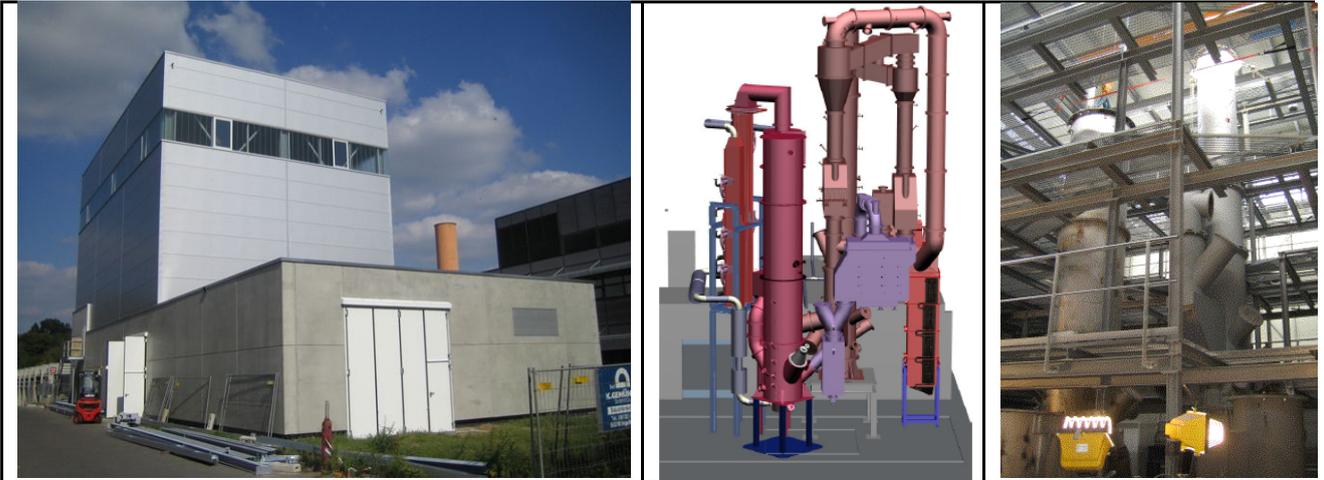


Figure 1 – 1 MW_{th} MeOx Prototype at TUD

A 3 MW_{th} prototype was retrofitted into ALSTOM's existing Multi-Purpose Test Facility (MTF) at the test site in Windsor, Connecticut, USA (Figure 2).

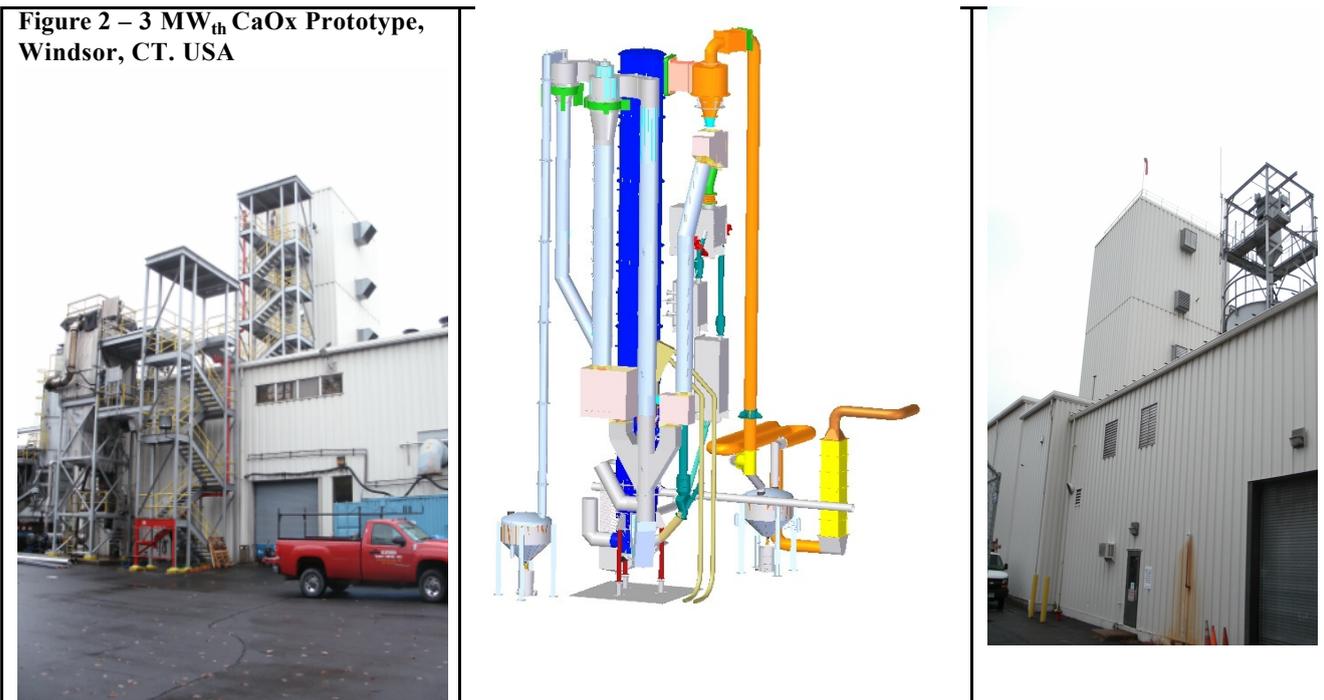


Figure 2 – 3 MW_{th} CaOx Prototype, Windsor, CT. USA

The first two phases of the calcium oxide chemical looping development program validated the chemistry required for the Chemical Looping process, while the third phase investigated the solids transport mechanisms and design requirements. The just completed initial part of phase four work involved the design, construction, operation and testing of a 3 MW_{th} prototype chemical looping facility. While incorporating the lessons learned in the first three phases, all of the equipment and systems required to operate the facility were integrated in this phase.

4. Summary

The testing of the 1 and 3 MW_{th} prototypes represents an important milestone leading to the larger scale demonstration of the technology. All significant results achieved to date will be discussed in this presentation. Chemical Looping has the potential to be a least cost technology for power generation with CCS and work continues to develop this technology to achieve this vision. ALSTOM is the global in the development of Chemical Looping for this application.