Agglomeration in CIUDEN 30 MWth Circulating Fluidized Bed boiler under oxy combustion conditions

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1. Introduction

One of the most relevant European R&D&d initiatives focusing on Carbon Capture Utilization and Storage (CCUS) is the CIUDEN Carbon Capture and Storage Integral project, supported by the Spanish Government through the Foundation Ciudad de la Energía (CIUDEN).

CIUDEN is a public institution created by the Spanish Administration in 2006 and fully conceived for collaborative research, development and demonstration of efficient, cost effective and reliable CCUS and advanced CCT.

The es.CO2 Centre, located in Cubillos del Sil (Spain) incorporates the world’s most advanced equipment for the development of oxy-combustion based on two combustion technologies: pulverized coal, PC (20MWth) and circulating fluidized bed, CFB (30MWth). It is also equipped with a biomass gasifier (3MWth).

2. Experiences in agglomerations

Circulating fluidized-bed (CFB) combustion of solid fuels is a well-established and widely used technology. Yet, operational problems are encountered in industrial practice. One of the most important problems is the occurrence of agglomeration, meaning that bed particles adhere to each other to form large entities (agglomerates). This process is often not recognized until sudden defluidization occurs and may lead to costly shutdown of the whole installation.

A recent presentation on the current state of oxy-fuel CFB knowledge by IEA Greenhouse Gas R&D Programme stated that “issues regarding slagging and fouling should be elucidated” and further information is “still necessary regarding the composition of ash, size distribution, ash morphology, slagging and fouling propensity, etc.” The
reasons that cause these phenomena and their relation with the type of fuel and the operating conditions are being studied.

It is commonly agreed that the tendency of agglomeration in circulating fluidized bed (CFB) is a direct result of stickiness or adhesiveness of bed material. However, the meaning of the word “sticky” is rather ambiguous, it needs to be quantified. In addition, other aspects need to be addressed: How the adhesive particles affect the fluidization behavior and the formation of agglomerates? How the particles become adhesive?.

Deposit samples were taken during the CFB oxy-combustion of anthracite and pet-coke (70/30 wt%) experimental tests.

The following characterization and analysis are included in the study:

- Proximate, ultimate analyses and specific energy of the fuels
- Composition analysis (wt%) of: fuels, fly ash, bottom ash, sand, limestone.
- Particle size of: fuels, fly ash, bottom ash, sand, limestone.

The deposits were photo-documented and encapsulated in epoxy resin, to minimize damage during transit and then cut to reveal cross-sections.

The methods used to determine the quality parameters are subject to standardized procedures: TGA, ICP-OES, XRF, XRD, SEM/EDS, TMA, Diffraction Laser (Particle size).

Fig. 1. Agglomerates and deposits at Overflow Duct (Furnace Heat Exchanger, INTREX™, Foster Wheeler proprietary design) and Ash Duct to the furnace (Furnace Solid Return System), respectively.
3. Conclusions

This study is the forerunner of a more ambitious project, which aims at the understanding of the conditions and processes responsible for the formation of these agglomerates and at the proposal of remediation approaches.

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