gasNatural fenosa

Pilot Plant 300 kWt, La Robla

Capture of CO_2 from biomass combustion in a fluidized bed using CaO

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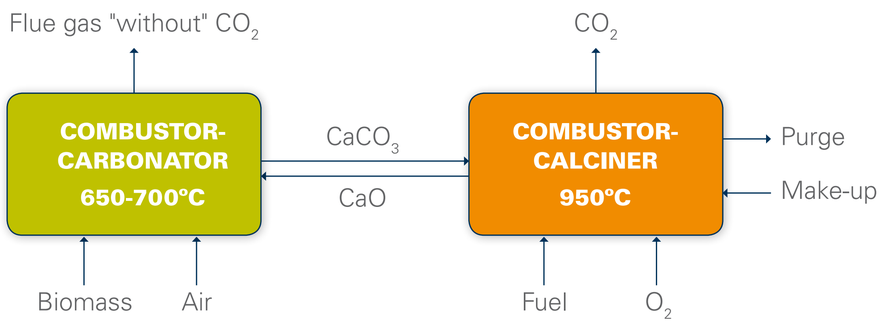
Introduction

Gas Natural Fenosa supports the integration of CCS with biomass energy system in the generation of electricity **promoting** the concept of CO_2 negative emissions.

Gas Natural Fenosa, one of the main utilities company in gas and electricity, **both** in Spain and **worldwide is promoting** a new technology based in this concept. We are being supported by some of the most important scientific and technological entities in Spain (Spanish Research Council, CSIC-INCAR and CIRCE).

In the pilot plant, the CaO is able to capture the CO_2 "in situ" during the combustion of biomass in a circulating fluidized bed reactor. In a second reactor, the combustor-calciner, the reverse calcination reaction of $CaCO_3$ takes place. Heat for the calcination reaction is supplied through the oxyfuel combustion of a fuel.



Experimental Validation

Experimental tests have been carried out in a 300 kWt pilot plant which is made up of two interconnected circulation fluidized bed reactors with an internal diameter of 0.4 m. The combustor-carbonator and the combustor-calciner are both 12 m in high. Several tests have been carried out at different operational conditions. Many periods in stationary state (of up to 14 hours) have been achieved. In the initial experiments we have achieved biomass combustion with CO capture in situ at the same time over the experimental run, one of the aims of this activity. Efficiency of capture reached 70%

Purpose of the experiments

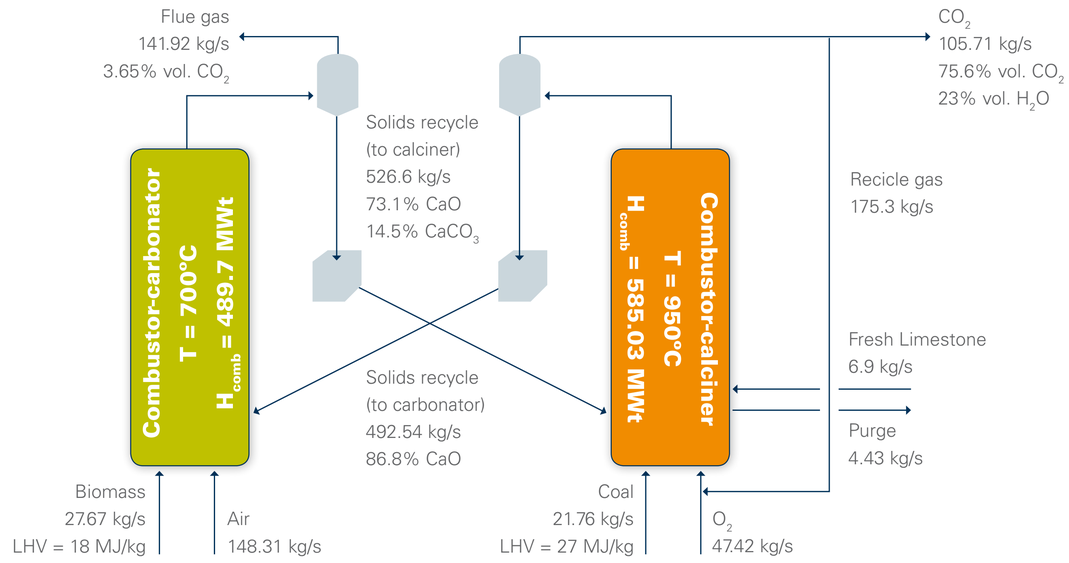
- Increase biomass data base
- Increase sorbent data base
- Increase knowledge on potential side reactions with ashes, K and Na
- Develop reactor models to design larger plants
- Determine global energy balance
- Scale to industrial plant

With the partial support of CDTI through the projects: CENIT CO_2 & MENOS CO_2

Centro para el Desarrollo Tecnológico Industrial

Economics

The similarities of the proposed process with existing and emerging CFB power systems allows for an economic analysis and the comparison with other technologies for CCS for biomass. The target is to estimate the cost of electricity and the CO_2 avoided costs with respect to a well defined reference case at same scale of 250 MWe.



		Coal Ref.	Bio. CFBC	Coal Oxy.	Bio. Oxy	Bio.Ca loop
Biomass cost, FC	€/kWh		0.03		0.03	**0.03**
Coal cost, FC	€/kWh	0.01		0.01		**0.01**
Capital cost, TCR	€/kWe	1400	1400	2500	2500	**1994**
Fixed fraction cost, FOM	% (CC)	3.7	3.7	3.7	3.7	**3.7**
Capacity factor, CF	%	90	88	90	88	**88**
Fixed charge factor, FCF		0.1	0.1	0.1	0.1	**0.1**
Variable cost, VOM	€/kWhe	0.01	0.01	0.01	0.01	**0.01**
Carbonator capture efficiency, Ecarb						**0.8**
Capture efficiency, Eoxy				0.95	0.95	**0.95**
Overall capture efficiency, E				0.95		**0.88**
Power fraction non oxycomb		1	1	0	0	**0.46**
Penalty ASU				0.07	0.07	**0.04**
Penalty Compresion				0.05	0.05	**0.05**
Penalty Biomass			0.03	0	0.03	**0.01**
Penalty total			0.03	0.12	0.15	**0.10**
Net efficiency, h	kWhe/kWh	0.45	0.42	0.33	0.30	**0.35**
emission factor	kg CO_2/MWhe	880	0	60	-1463	**-457**
ETS price	€/t CO_2	14	14	14	14	**14**
Green certificate	€/MWh		50	50	50	**50**
Cost of electricity without revenues, COE	€/kWhe	0.051	0.100	0.073	0.144	**0.092**
Avoided cost without revenues, AC	€/t CO_2 avo.		56	27	40	**31**
COE with ETS only	€/kWhe	0.063	0.100	0.074	0.123	**0.086**
Avoided cost with ETS only	€/t CO_2 avo.		42	13	26	**17**
Cost of the electriciy with revenues, COE	€/kWhe	0.063	0.050	0.074	0.073	**0.036**
Avoided cost with revenues, AC	€/t CO_2 avo.		-14	13	4	**-21**

Conclusions

The process proposed is experimentally feasible when operating at around 700º C to maximize both combustion and CO_2 capture efficiencies.

High capture efficiencies need an intense circulation flow of solids between reactors, as well as, a high sorbent solids inventory of active CaO in the combustor-carbonator.

The estimation of the main cost figures reveals that the concept can be compared to the capture technology in development.

Collaborating Entities

CIRCE

CSIC
Consejo Superior de Investigaciones Científicas