Project No:
764697

Project acronym:
CHEERS

Project full title:
Chinese-European Emission-Reducing Solutions

Type of Action: **RIA**

Call/Topic:
European Horizon 2020 Work Programme 2016 – 2017, 10. 'Secure, Clean and Efficient Energy', under the low-carbon energy initiative LCE-29-2017: *CCS in Industry, including BioCCS*

Start-up: 2017-10-01
Duration: 60 months

Deliverable
D2.2: CLC system design

Due submission date: 2018-07-31

Actual delivery date: 2019-06-18

Organisation name of lead beneficiary for this deliverable:
IFP Energies nouvelles

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Dissemination Level		
PU	Public	
CO	Confidential, only for members of the consortium (including the Commission Services and MOST)	X
INT	Confidential, only for members of the consortium	

Abstract for publication on the website of CHEERS

CHEERS conforms to the European Horizon 2020 Work Programme 2016 – 2017, 10. 'Secure, Clean and Efficient Energy', under the low-carbon energy initiative (LCE-29-2017: CCS in Industry, including BioCCS). The ambition is to improve the efficacy of CO_2 capture in industry, and help ensuring sustainable, secure, and affordable energy.

The action involves a 2nd generation chemical-looping technology tested and verified at laboratory scale (150 kWth). Within the framework of CHEERS, the core technology will be developed into a 3 MW_{th} system prototype for demonstration in an operational environment. This constitutes a major step towards large-scale decarbonisation of industry, offering a considerable potential for retrofitting industrial combustion processes.

The CHEERS project is financed by the European Union's Horizon 2020 research and innovation programme under grant agreement No 764697, and co-funded by the Chinese Ministry of Science and Technology (MOST).

CHEERS started from 1 October 2017 and is scheduled to end by September 2022. The estimated budget is 16 mill. EUR.

WP2 of the CHEERS project deals with the design of the chemical-looping section. From the design philosophy to the Process Design Package (PDP), this work package considers all stages required to proceed with the basic engineering in WP4.

This deliverable D2.2 provides the design of the CLC section that will be implemented in the CHEERS demonstration unit. It's the concatenation of internal report D2.2_a about the reactor model and internal report D2.2_b about the conceptual design.

Several challenges need to be addressed to achieve high combustion efficiency by CLC: a high residence time required for petcoke gasification, a close contact with oxygen carrier for gas combustion, and the recycling of unburnt compounds after separation from oxygen carrier into the carbon stripper.

Two different concepts have been explored in detail through the CHEERS project: one handled by IFPEN/TOTAL and the other one handled by TSINGHUA/DONGFANG. The first objectives of this note are to explain the different design philosophies promoted by each group and provide the calculation methods which have led first to a cold mock-up design relevant for evaluating both technologies.

The second part is dedicated to the conceptual design. A detailed description of the process is first given based on the Process Flow Diagram (PFD) of the whole CLC section.

Then the conceptual design of the CLC section is provided by considering different running cases to cover the whole range of operating conditions. Studied parameters are the thermal input (from 2 to 4.5 MW_{th}), the fuel (petcoke, lignite, natural gas), oxygen carrier properties (density, actual oxygen transport capacity) and hydrodynamics (AR oxygen carrier recycling and gas velocity into the reactors). Modelling results provide the significant operating conditions and the limits to be considered for the design.

Finally, a 2D drawing of each configuration is presented. Air reactor (AR), Fuel reactor (FR), cyclones and loop-seals are common to both configurations. The main differences between the two designs are the carbon stripper (CS) which allows the separation of unburnt char from oxygen carrier, the divided fluidized bed only used in European configuration (a mechanical valve is used in Chinese configuration), and the way to control the solid circulation (L-valves only used in European design).

The design provided by IFPEN and TSINGHUA allows to test both concepts one after the other by minimizing the intermediate retrofit.