# Oxygen-Enhanced Turbulent Non-Premixed Swirling Methane Flames for CO2 Capture Applications

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# OXYGEN-ENHANCED TURBULENT NON-PREMIXED SWIRLING METHANE FLAMES FOR $CO_2$ CAPTURE APPLICATIONS

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$CO_2$ emissions remain the main greenhouse gas reduction targets in the industrial sector for the EU. The $CO_2$-Energicapt project aims to demonstrate the feasibility of $CO_2$ capture by coupling $CO_2$ capture technologies and oxygen enrichment systems. A pilot plant on a small scale is built to demonstrate the efficiency of a membrane based $CO_2$ capture technology integrated to an existing District Heating Plant in the Paris region.

This presentation focuses on the combustion part of the CO2-Energicapt project involving a specific burner technology, operating in partially premixed mode, well suited for oxygen-enhanced combustion. The combustion characteristics of methane oxygen-enriched air turbulent non-premixed swirling flames are presented. The main results concern the flame stability maps, $NO_x$, $CO_2$ and CO emissions, and flame dynamics for different oxygen addition rates. The exhaust gas compositions are measured using gas analysers. Stereoscopic Particle Image Velocimetry (Stereo PIV) is used to analyse the dynamics of swirling flows in non-reacting and reacting conditions. The measurements are performed for oxygen concentrations ranging from 21 % to 30 % by volume, with swirl numbers from 0.8 to 1.4 and global equivalence ratios from 0.8 to 1.

The Stereo PIV results (Fig.1) in the center plane and the transverse plane of the swirling jet illustrate the interactions between flame and large-scale vortices. Swirling rates, as well as the entrainment rates, are also quantified based on measured velocity distributions close to the burner exit in non-reacting and reacting conditions. The results show various flame types from purely diffusion flames (Fig.1b) to partially premixed ones depending on the fuel and oxidizer flow rates. Increasing the swirl number and the oxygen addition rate significantly improve the flame stability. The results demonstrate that the $CO_2$ emissions in the exhaust gases linearly increase with increasing $O_2$ content in the oxidizer. The CO emissions are shown to decay exponentially, whereas the $NO_x$ emissions, mainly produced through the thermal pathway, increase strongly with oxygen enrichment. Work is continuing to optimise the emissions namely to reduce $NO_x$ emissions.

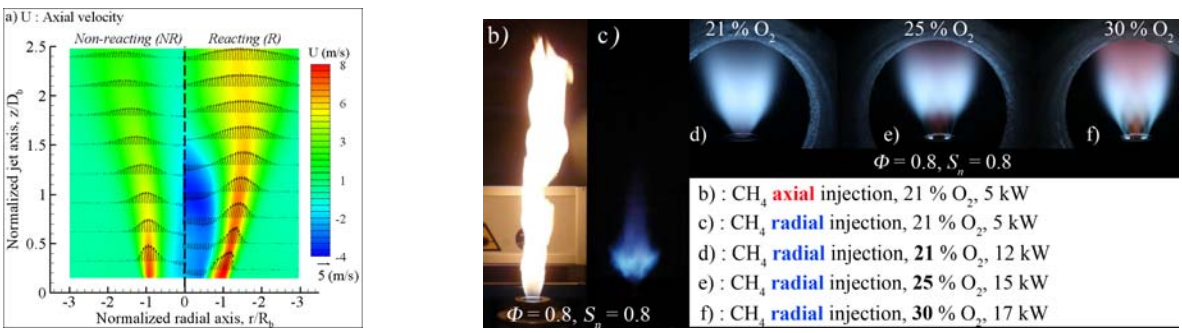


Fig.1 Field of axial velocity U (a) ($S_n$ = 0.8 and $\Phi$ = 0.8) and flame images (b,c,d,e,f).

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