

CO₂ DILUTED PREMIXED COMBUSTION IN A HIGH INTERNALLY RECIRCULATED BURNER

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A key issue in combustion research is the improvement of combustion efficiency to reduce fossil fuel consumption and carbon dioxide emission. Researchers are involved in the development of a combustion technology able to accomplish energy savings with low pollutant emissions. Premixed combustion of natural gas and air is one of the most commonly methods used for reducing NO_x emissions, by maintaining a sufficiently low flame temperature. Diluents such as nitrogen, carbon dioxide and water, or other technique, such as MILD combustion, can also be employed to lower flame temperature and hence NO_x.

In the systems experimented so far, the trapped vortex technology is mainly limited to the pilot part of the whole burner and use combustion in cavities as pilot flames for premixed high speed flows. In the last years we have developed a device operating entirely on the principle of trapped vortices, which is able for its intrinsic nature of improving mixing of hot combustion gases and fresh mixture, that represents a prerequisite for a diluted combustion and at the most a MILD combustion regime. The possible introduction of MILD technology in gas turbines is of great interest because it is potentially able to answer two main requirements: 1) a very low level of emissions; 2) an intrinsic thermo acoustic stability (humming).

The trapped vortex technology offers several advantages as gas turbines burner: 1) it is possible to burn a variety of fuels with medium and low calorific value; 2) NO_x emissions reach extremely low levels without dilution or post-combustion treatments; 3) produces the extension of the flammability limits and improves flame stability.

With an increasing concern on global warming, the studies on the reduction of greenhouse gas emissions, with the dominant contributor being CO₂, have attracted increasing attention in recent years. The oxy-fuel combustion which burns the fuel in oxygen with dilution rather than air is one of the most promising technologies for CCS. Recycled flue gas (mainly CO₂ and H₂O) is generally needed for temperature control and material safety consideration. With pure oxygen as the oxidizer, the NO_x problem during the combustion process may be solved and the CO₂ concentration in the exhaust gas is high and much suitable for CCS.

In order to verify our device in oxy-fuel operating conditions and with the aim of increase its capability to generate a MILD regime, we have investigated its functioning when the CH₄-O₂ mixture is diluted with CO₂, through CFD simulations. A sensitivity analysis has been conducted with respect injection velocity, CO₂ dilution, equivalence ratio, preheating temperature.

The simulations, performed with the ANSYS-FLUENT code, have been carried out according to a steady RANS approach. The models adopted for chemical reactions and radiation are the EDC, in conjunction with a reduced mechanism and the P1, respectively.