DILUTED COMBUSTION OF LOW CALORIFIC, ALTERNATIVE FUELS ON A 30 kW FURNACE

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Diluted combustion, known as Flameless Oxidation or MILD Combustion too, is a very high efficiency combustion technique, successfully applied on industrial furnaces to have very low NOx emissions, stable working conditions and significant energy savings by high air preheating. A specific configuration of air and fuel injectors guarantees a strong recirculation of flue gases inside the chamber, with consequent high dilution of reactants into the flue gases and a temperature increase above the fuel auto-ignition threshold. The formation of hot-spots is significantly prevented: the result is a reduction of NOx and carbon monoxide emissions.

This combustion technique is particularly interesting for alternative fuels such as biogas, gasified waste or by-product gases, for which the generation of a stable flame can be difficult due to their highly variable calorific value. Diluted combustion avoids the formation of a flame front because fuel and oxidizer are continually mixed with recirculating combustion products and the combustion occurs in homogeneous and extended way once the auto-ignition temperature is reached. Without constraints due to the stability of a flame front, diluted combustion allows larger fuel flexibility compared to conventional burner.

Experimental tests have been performed on a 30kW, laboratory scale furnace, designed to operate in diluted combustion and able to reproduce some of the main features of industrial furnaces (injection system, geometry, variable load). An electrical air preheater is used to get the desired air inlet temperature and a mixing unit supplies the desired composition of the fuel from gas bottles. Thermocouples, suction pyrometer, radiometer, gas analysers, and intensified UV camera have been used to respectively measure wall and recirculation temperatures, flue gases temperature, radiative emissions, O_2, CH_4, CO_2, CO, NOx flue gases contents on dry basis, and OH chemiluminescent levels.

The furnace was designed to work with natural gas and was deeply tested with this fuel. In the test campaign 2013 the behaviour of blends of CH_4, CO, H_2, CO_2, N_2 (coke oven gas and its mixtures with blast furnace gas) with lower heating value than natural gas has been investigated and compared in terms of powers balance, combustion efficiency, emissions, shape and position of the reaction zone, and effect of air preheating temperature.

Test campaign 2014 is focused on the study of other blends (biogas and synthetic gas) to enrich the database of experimental tests in diluted combustion of low calorific, alternative fuels, to determine the working conditions limits in specific configurations for these fuels and to analyse the effect of the inlet fuel speed changing the fuel injectors diameter. Comparisons are always realized in terms of temperatures, powers balances, combustion efficiencies, combustion products contents and emissions, and OH images.

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