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Chemical, thermal and dilution effects of carbon dioxide in oxy-fuel combustion of wood in a fixed bed

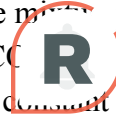
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Abstract

Experimental and numerical modeling was performed on eucalyptus wood combustion under oxy-fuel conditions using a fixed bed reactor in order to isolate the role of various carbon dioxide effects on the burning rate. Wood combustion was investigated under four different mixtures of O₂ and Ar/CO₂/N₂: 21 % O₂/79 % N₂; 21 % O₂/22.5 % CO₂/56.5 % Ar; 40 % O₂/60 % CO₂; and 40 % O₂/47 % CO₂/13 % Ar. The first three mixtures were designed to have the same peak temperatures in order to isolate chemical and dilution effects of CO₂. The fourth mixture was achieved by substituting some percentage of CO₂ with Ar in O₂/CO₂ mixture while maintaining a constant



concentration of O₂. The fourth mixture was meant to isolate the thermal effect of CO₂. The results were obtained from both the experimental rig and numerical simulation for a fixed bed configuration. Wood combustion in the fixed bed was modeled using Lagrange-Euler method, where gas-phase was calculated using computational fluid dynamics (CFD), that is Euler phase, while solid-phase was tracked in Lagrange phase using discrete element method (DEM). The results show that ignition time in CO₂ environment decreases gradually as O₂ concentration is increased. On the other hand, burning rate and flame front speed increase as O₂ concentration is increased. It was established that dilution effect is the most influential parameter on the burning rate of wood combustion in an oxy-fuel system.

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