Scaling of a cyclonic flow field under MILD conditions

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Abstract
In recent years, decarbonization in the energy sector has become a primary concern. To address this challenge, research has focused on developing new combustion technologies capable of meeting energy demands without increasing greenhouse gas emissions or producing solid particles such as soot.
Moderate or intense low oxygen dilution (MILD) combustion has emerged as a feasible option due to its low emissions of pollutants such as NOx and solid particles. This technology is characterized by the absence of a visible flame and low visible emissions, which poses a challenge for the control and stabilization of the oxidation process.
One of the key variables to consider in the design of a burner operating under MILD conditions is the fluid dynamics configuration. A cyclonic flow configuration appears to be appropriate for ensuring good mixing between the reactants and establishing internal conditions that maintain a stable oxidation process. The parameters involved in the correct stabilization process to achieve MILD combustion have been studied by this group using a Laboratory Unit Cyclonic Burner (LUCY). In the present work, a new burner was designed to be more optically accessible. This burner is a reduced version of LUCY in terms of dimensions but maintains the same aspect ratio while reducing thermal power by a quarter. To ensure similar fluid dynamics behavior inside the new burner, the design process was verified using CFD simulations under different geometric conditions. Furthermore, the residence time distribution was analyzed to verify the mean residence time of the reactants inside the burner, ensuring an appropriate conversion process.

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