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Numerical Modeling of Wood Gas Combustion in a Cyclone Combustor Prototype

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Abstract

CFD Analysis is used to predict non-adiabatic and non-isotropic, 3D and steady state, combustion of bio fuel (wood gas) in a novel design of cyclone combustor. The Reynolds Stress Turbulence model and the PDF model for combustion were used to represent the underlying processes occurring. The vertically mounted combustor is novel in that it incorporates two stages of dust removal, via a central conical hopper and a small vortex collector pocket mounted next to the exhaust, coupled with the use of a tangential off take as exhaust to minimize pressure loss whilst ensuring gases pass directly across the inlet aperture of the VCP so that fine particles are collected. The residence time is substantially increased due to the cyclonic nature of the flow and allows efficient stable combustion of fuel gases with very varying properties. Flame stabilization with variable calorific value fuels is enhanced by lining part of the system with refractory. Mixing, combustion and heat losses are described as one scalar variable, the mixture fraction, via the use of the PDF combustion model. CFD analysis is used to calculate the formation of species such as CO, CO_2, NO NO_2, H_2O and soot in accord with the aerodynamics of the cyclone combustor prototype. A Lewis number equal to unity is used. The bio fuel or wood gas was produced by cyclonic gasification of sawdust and the work is evaluated in terms of emissions and combustion characteristics.
The results have indicated ways in which the applicability and range of the device can be extended

Keywords: wood gas, cyclone combustor, and emissions