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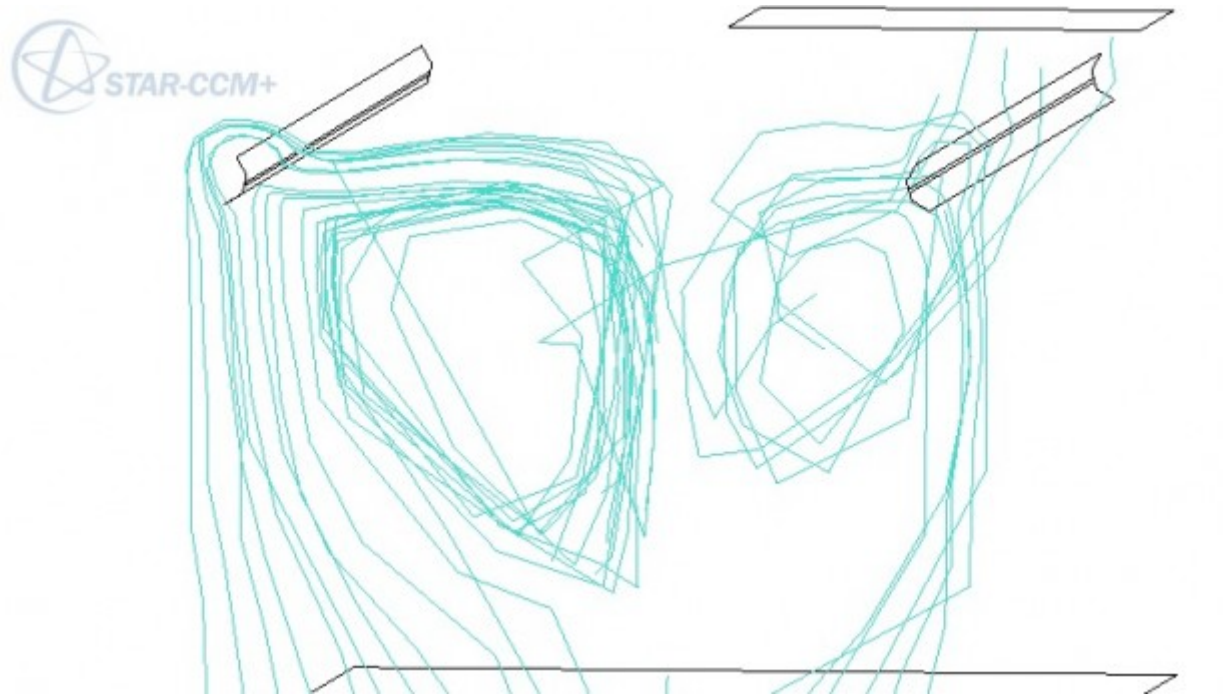
Gas residence time analysis for efficiency improvement of small-scale straw fired boilers



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Abstract:

This paper reports a computational fluid dynamics (CFD) study on influence of flow field on to gas residence time in boiler furnace. Specifically, investigated was secondary air nozzle direction
influence on level of elimination of dead and recirculation zones.As residence time is a ratio between effective furnace volume and gas flow rate from the solid bed,increase of the former through elimination of dead zones would lead to increase of the residence time,and it as a consequence would have an increase of combustion efficiency. Small-scale biomass boilers are specific in a way that their design has not been studied as extensively as boilers on fossil fuels or large scale power boilers. And straw itself has properties such as high volatile content that differs it significantly from other solid fossil fuels.Gas residence time distribution in boiler furnace is calculated by Lagrangian approach, using massless particle tracks calculated in StarCCM+ CFD software. Cold flow model was used for optimization sake, which could be upgraded to hot flow with no difficulties other from computing power demand. Any fuel type can be analyzed in this way when appropriate solid fuel bed models are applied which would generate boundary conditions for gas phase model. Results show increase of 10 percent of the average gas residence time.

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