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FLUENT Simulations of the Westinghouse Multi-Annular Swirl Burner for Design Optimization

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Disclaimer

CRADA facts

DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

COMBUSTION PROJECT

FLUENT SIMULATIONS OF THE WESTINGHOUSE MULTI-ANNULAR SWIRL BURNER FOR DESIGN OPTIMIZATION

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Capabilities

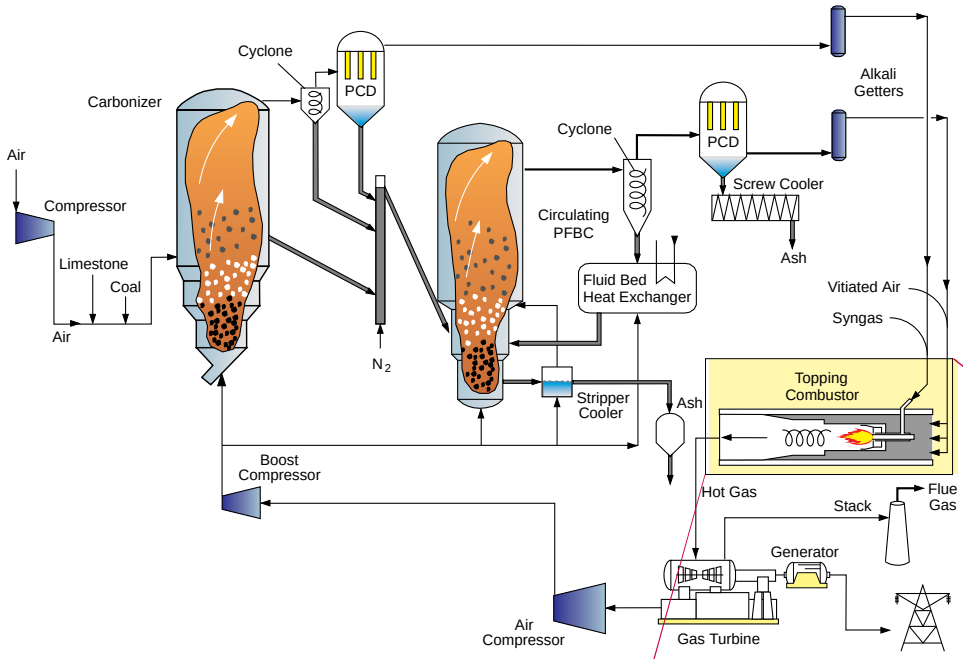
The FLUENT computational fluid dynamics code is being used to aid the design of the Westinghouse Multi-Annular Swirl Burner (MASB). The MASB is being designed by Westinghouse for use as a topping combustor in a Pressurized Fluidized-Bed Combustion System as part of the U.S. Department of Energy's Clean Coal Technology Program. The MASB will primarily burn low-energy, coal-derived gaseous fuel (syngas) with vitiated air, at elevated pressure, to supply a gas turbine for power generation. MASB operation will require dual fuel capability, i.e., the ability to burn a high heating value fuel as well as the lower energy syngas. Firing a high heating value gas, such as methane or propane, is required during plant start-up and other off-design conditions.

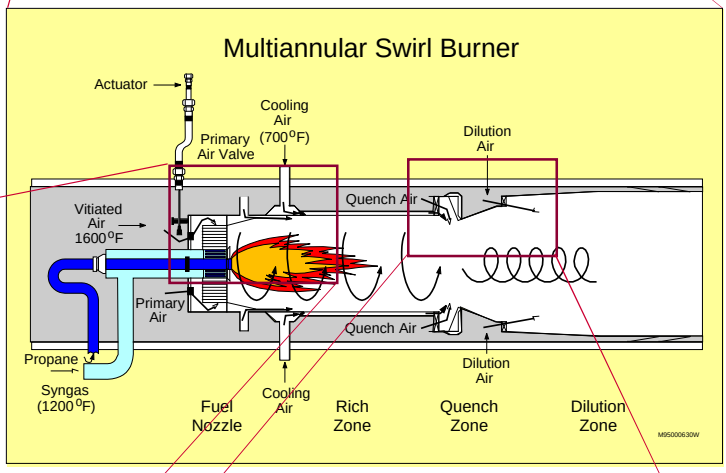
FLUENT is being used to study the adaptation of the MASB design to the Power Systems Development Facility (PSDF) in Wilsonville, Alabama. Simulations have been performed to investigate the steady, propane-fueled operation of the MASB. These simulations model the complex reacting flow field within the MASB, as influenced by the air-cooled transition piece connecting the burner to the turbine. Various design modifications have been considered in an effort to reduce the simulated radial temperature gradient, or "pattern factor," in the transition piece exit flow. This pattern factor is more of a concern than it would be in a typical commercial installation, because the physical constraints of the PSDF installation require a mildly converging transition duct, which acts to sustain the stratification of the swirling flow that emerges from the MASB. The goal of the current study was to devise a method for introducing dilution air into the MASB to produce an optimum pattern factor without significantly changing the existing design. This design modification must not adversely affect MASB performance when firing syngas.

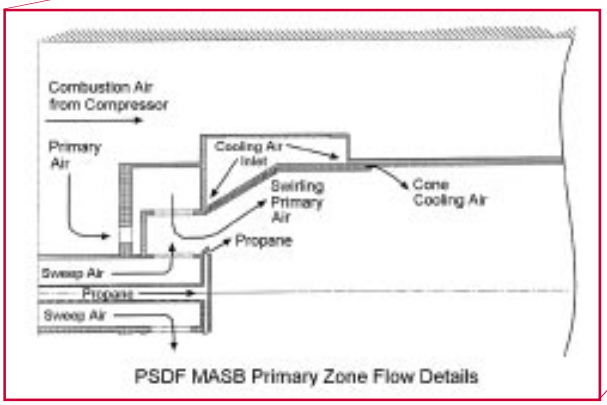
Opportunities

- Similar FLUENT simulation work is available for any future CRADA partner
- Features of METC modeling resources:
  - Close coupling between lab experiments and computer simulations for model validation
  - State-of-the-art hardware
    - Silicon Graphics workstation network
    - SGI multiprocessor supercomputer
  - Ongoing CRADA with Fluent, Inc., offers unique access to
    - Most current FLUENT code versions
    - Ongoing relationship with FLUENT development and applications groups

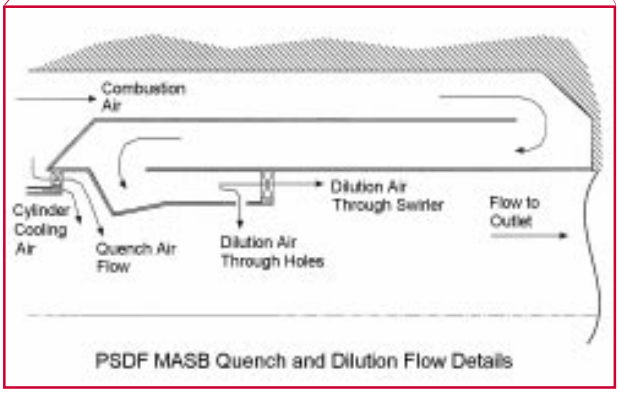
FLUENT Simulations of the Westinghouse Multi-Annular Swirl Burner for Design Optimization







PSDF MASB Primary Zone Flow Details



PSDF MASB Quench and Dilution Flow Details

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