DIAGNOSTICS AND MODELING

CFD Modeling

OVERVIEW

The mechanical engineering profession has the momentous challenge to provide transportation and energy without significantly degrading the environment. To meet this challenge the combustion community needs advanced engineering resources that can facilitate the economical research and development of low emission combustor designs. Computational Fluid Dynamics (CFD) is one of the major engineering resources utilized in combustion research. In this specific project, CFD is being applied to microturbine generator combustion systems to better understand the emissions characteristics.

OBJECTIVES

- Set up parallel CFD computation platform on NACS LINUX cluster
- Apply CFD to fuel injectors to quantify the mixing performance.
- Apply CFD to determine flow splits between combustion and dilution zones within the combustor
- Apply CFD to study the evolution of pollutants within the combustor and to evaluate the sensitivity of performance to fuel injection performance.

RESULTS

Examples of results obtained are shown below. Figure 1 illustrates the fuel air mixing within one premixing passage. The complex behavior of fuel air mixing and aerodynamics within the fuel injector are captured with the CFD simulation and can be utilized to determine steps to take in further optimizing the behavior for improved performance. Figure 2 illustrates the determination of flow splits using CFD simulations. In this case, a 3 million cell grid was generated and run on the UCI Beowulf Cluster for over a week to converge. The results help identify local variation in fuel air ratio.

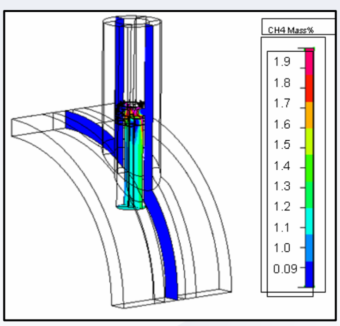

Figure 1. Injector mixing

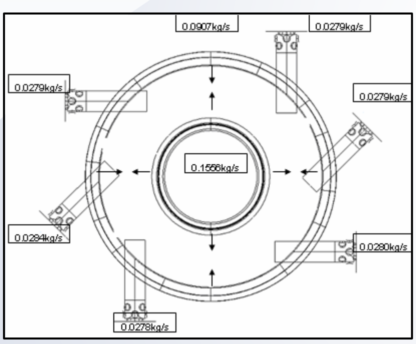

Figure 2. Flow Splits

Figure 3 illustrates an example of NOx formation rate within the combustor. These results are critical to help pinpoint key strategies to help reduced NOx emissions by allowing "visualization" of the complex behavior within the combustor.

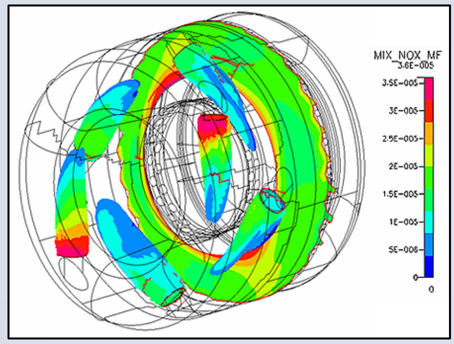

Figure 3. NO formation in combustor model

Figure 4 provides additional analysis done on the combustor simulation to further identify the evolution of NOx and CO within the combustion chamber.

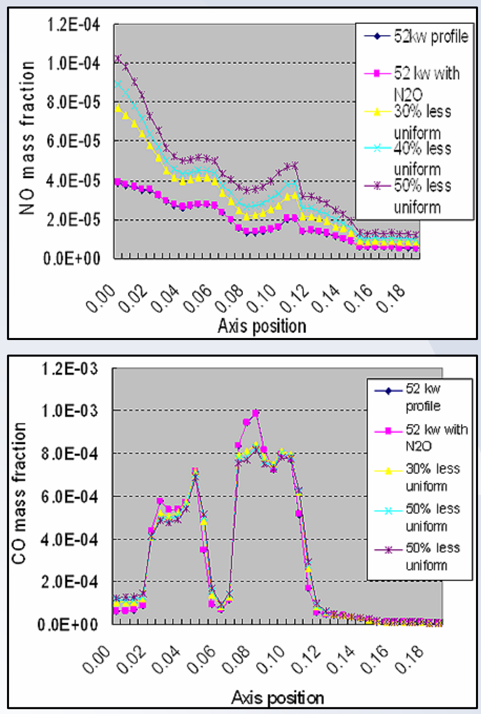

Figure 4. Average [NO] and [CO] along combustor centerline

RECENT PUBLICATIONS/PAPERS

CHARACTERIZATION OF EMISSIONS AND FUEL INJECTION PERFORMANCE FOR A COMMERCIAL MICROTURBINE GENERATOR (2003). Paper 03F-22, presented at the Fall meeting of the Western States Section of the Combustion Institution, Los Angeles, CA. (V.M. Phi, J.L. Mauzey, V.G. McDonell, and G.S. Samuelsen)

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