FLASHBACK CHARACTERISTICS OF SYNGAS-TYPE FUELS UNDER STEADY AND PULSATING CONDITIONS

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1. OBJECTIVE

The objective of this project is to improve the state of the art in understanding and modeling of flashback, which is known to be a significant issue in low emissions combustors containing high levels of hydrogen. Measurements and analysis shall be performed under steady and oscillatory flow conditions. While particular attention shall be given to coal-derived gaseous fuels, consideration shall also be given to other candidate fuels, such as process gas or other fuels containing hydrogen or higher hydrocarbons.

The proposed project shall consist of three main thrusts. First, the recipient shall perform a systematic design of experiments that shall form the test matrix for the experiments performed under this project. Because of the significant number of independent parameters that need to be examined (e.g., fuel composition, pressure, pre-mixer design), a systematic effort is needed so that the resulting parameter studies are of sufficient breadth and detail, yet still realistic in scope. The second and third research thrusts shall investigate the flashback characteristics of synthetic gas fueled combustors under steady and pulsating conditions, respectively. The recipient shall perform an extensive series of tests that characterize the dependence of flashback characteristics upon fuel composition, pressure, inlet temperature, and pre-mixer configuration. Because flashback is often found to be strongly influenced by combustor oscillations, great effort shall be taken to characterize the effects of oscillations. Work shall be performed under conditions where the combustor is as "quiet" as possible and where external oscillations of varying amplitude and frequency are imposed. Parallel efforts shall focus on developing a computational methodology for correlating these results and predicting flashback behavior under steady and oscillatory conditions.

2. ACCOMPLISHMENTS TO DATE

Through the first two periods of this project all milestones given to the DOE have been met. For the fourth period of 2004 a literature review and Chemkin flame speed studies were performed. Chemkin studies of flame speeds and Markstein numbers of candidate fuels have been initiated. These results will be used to aid in correlating experimental data.

For the first period of 2005, a new premixer has been designed and built. The new premixer allows for easier instrumentation to detect/measure flashback. There are ports on the premixer that allow optical (through fiber optic cables) and thermal (through thermocouples) measurements. This will allow for proper flashback detection under steady and oscillatory flow conditions. Like other premixers used on the Georgia Tech/DOE combustor, there is a swirler (45^o) with a centerbody that allows for a converging, approximately constant cross-sectional area flow.

3. FUTURE WORK

For flashback characterization under non-oscillatory flow conditions, tests will experimentally characterize the dependence of the combustor's flashback characteristics upon fuel composition, combustor pressure, air preheat temperature, and pre-mixer configuration. The basic test sequence shall be to determine the conditions at which flashback occurs as a function of the above parameters. Because flashback is often found to be initiated by the onset of combustor oscillations, great effort shall be taken to minimize the effects of oscillations. Thus, an experimental database will be obtained, rational methods for correlating/predicting flashback will be developed, and communication with industrial partners to obtain valuable input for testing and data analysis.

4. STUDENTS SUPPORTED UNDER THIS GRANT

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