Autoignition Studies of Syngas and Hydrogen (SGH) Fuels

The Pennsylvania State University

Robert J. Santoro

SCIES Project 05-01-SR117

Project Awarded (8/1/05 36 Month Duration)
$419,036 Total Contract Value ($419,036 DOE)

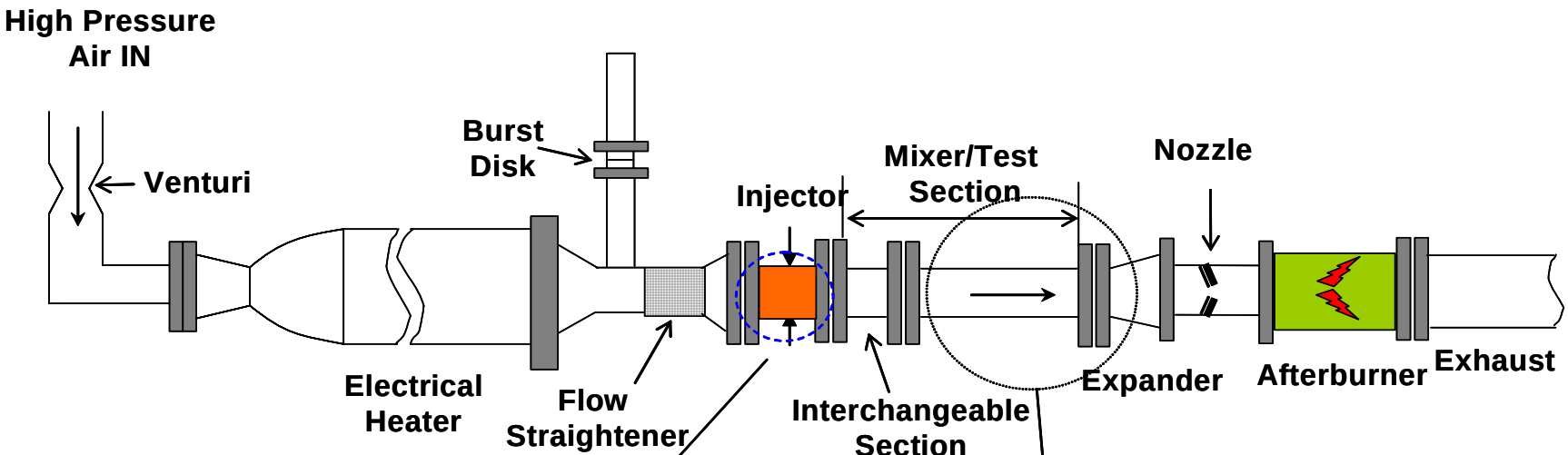
Motivation

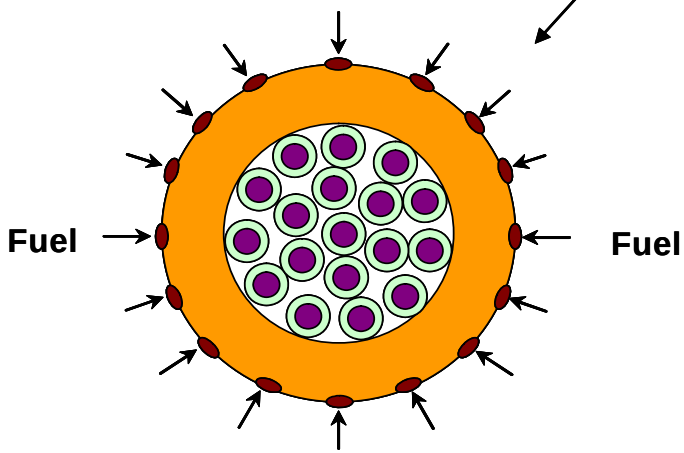
- Renewed interest in IGCC requires a fundamental understanding of syngas properties
- Of particular importance for lean premixed gas turbine power operation are the autoignition properties of syngas
- Additionally, these properties must be measured for pressure and temperature conditions representative of gas turbines

Objectives

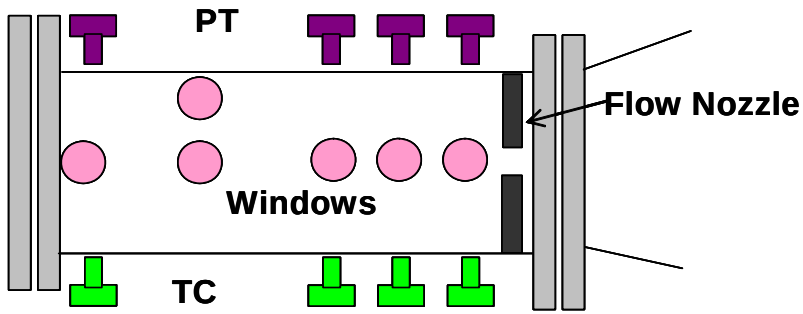
- Parametrically determine the autoignition delay time for CO/H_2 mixtures
- Vary CO concentration, equivalence ratio, pressure and temperature over a wide range
- Effect of water will be investigated for $CO/H_2/H_2O$ mixtures
- Measurements for pressures up to 3 MPa and temperatures of 860K (1100ºF)

Approach





Multiple Tube Co-stream Injector
(cross-section view)



Mixer/Test Section

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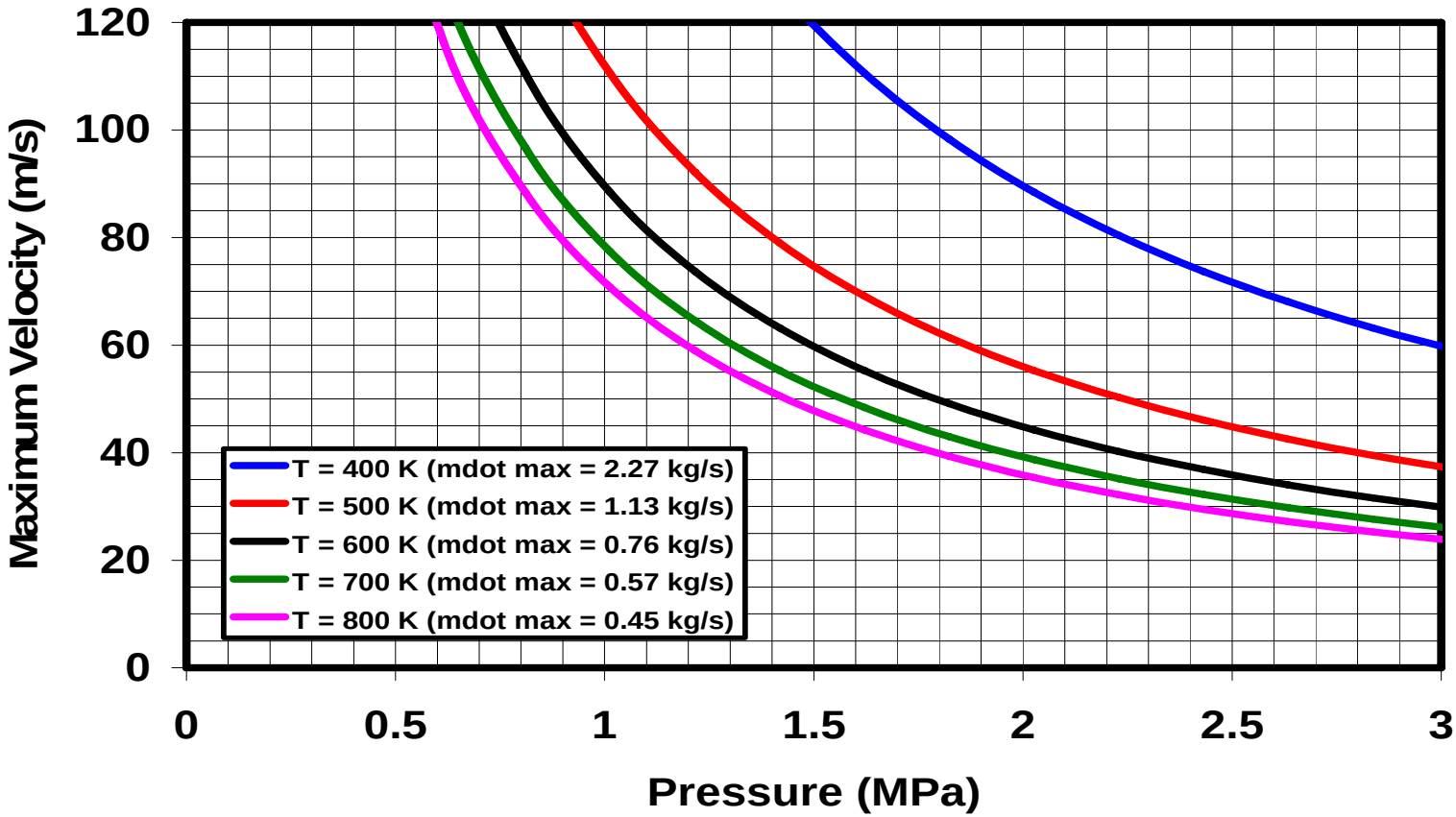
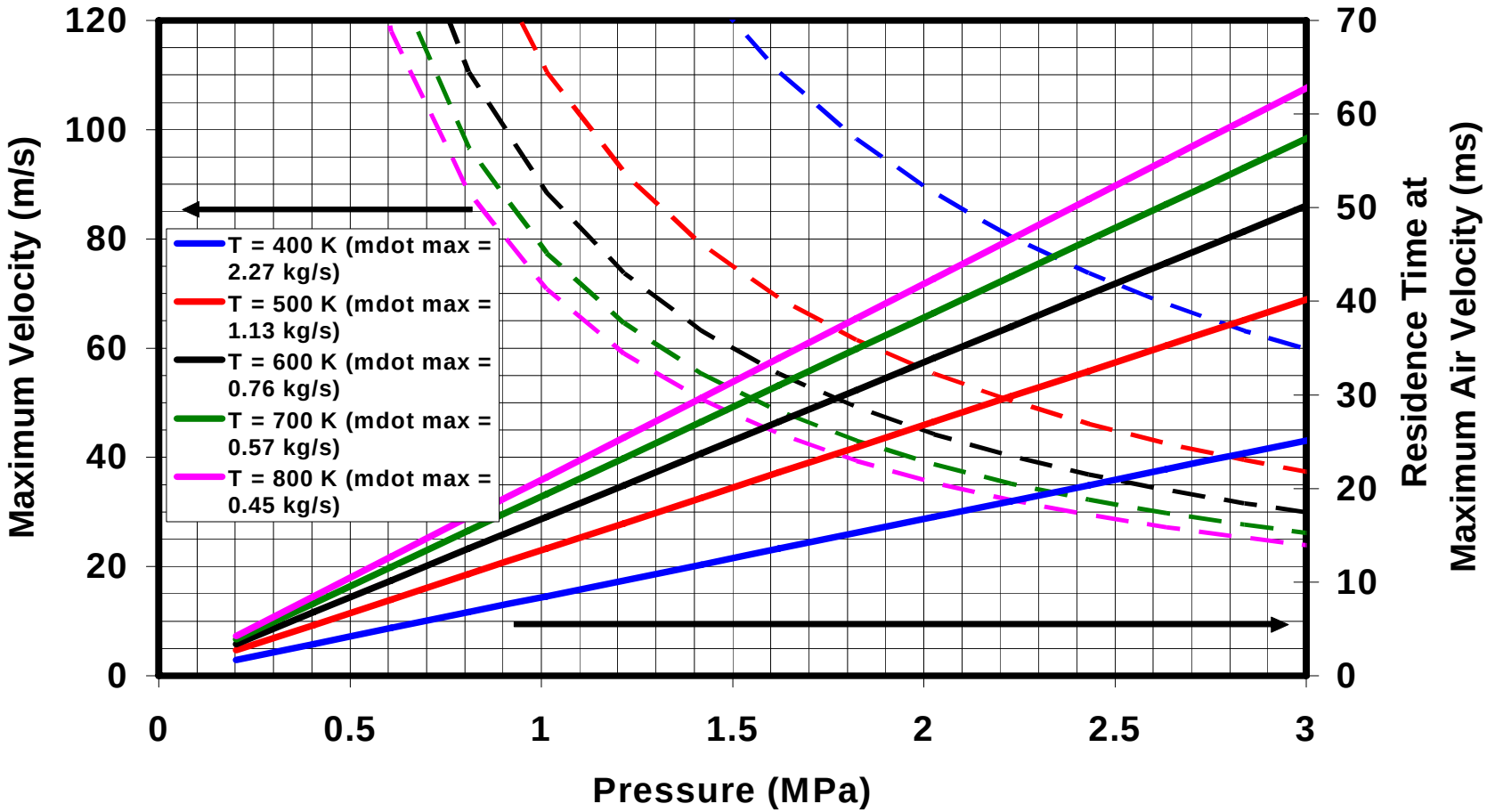
Approach



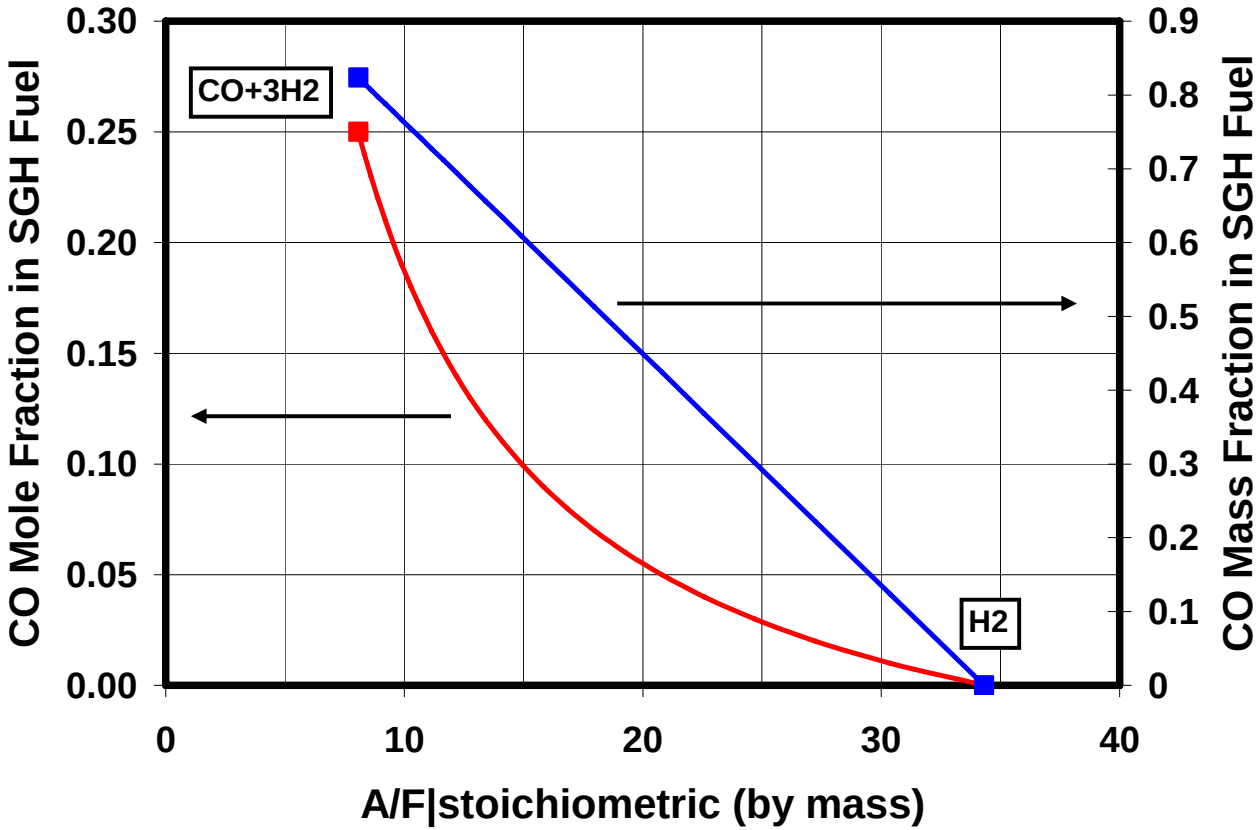
Maximum average air velocity in a 43 mm diameter flow reactor versus pressure

Approach



Residence time at maximum air velocity for a 1.5 m long flow reactor versus pressure

Approach



CO mole and mass fraction in SGH fuels versus air-to-fuel stoichiometric mass flow ratio.

Approach

1. Global Reaction Models

$$\tau = A \exp \frac{E}{RT} [CO]^x [H_2]^y [O_2]^z \ldots$$

2. Detailed Chemical Kinetics

- **ChemKin based**
  - **Incorporate Current Chemical Kinetic Mechanisms**
  - **Collaboration with M. Colket (UTRC)**

Results

- During the first two months of the program, preliminary design review was completed for the flow reactor.

- Fabrication to be completed during the 2nd quarter