PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Advanced Turbine and Engine Systems

05/2000

DEVELOPING THE 21ST-CENTURY GAS TURBINE — THE UNITED TECHNOLOGIES/ PRATT & WHITNEY PROJECT

PRIMARY PARTNER

United Technologies/Pratt & Whitney
East Hartford, CT

MAIN SITE

East Hartford, CT

TOTAL ESTIMATED COST

$4,092,000

COST SHARING

DOE	$2,170,000
Non-DOE	$1,922,000

Description

The Humid Air Turbine (HAT) cycle is a direct-fired turbine application in which natural gas or low-Btu gaseous fuels are burned with water-enhanced air at high pressure. This project is a joint effort between United Technologies/Pratt & Whitney (P&W) and the DOE National Energy Technology Laboratory (NETL). The project entails kinetic modeling and fundamental database generation, computational fluid dynamic modeling of nozzle/combustor performance, and NETL combustion evaluation studies.

P&W is conducting bench-scale experiments and kinetic modeling studies to develop fundamental data on the combustion of high-moisture, high-pressure air-gas mixtures for the HAT cycle. The fuels are natural gas and low-Btu gaseous fuels. The effects of temperature, pressure, fuel composition, and H_2O content on CO, NO_x and unburned hydrocarbon (UHC) production, flame stability, and ignition are being defined. Kinetic mechanisms are being evaluated and modified as necessary to accurately describe the experimental results. Researchers are evolving validated kinetic mechanisms into reduced reaction sets for integration in computational fluid dynamic (CFD) codes.

CFD combustion simulations are being used to model the nozzle and the liner experiments being conducted at the NETL facilities. CFD codes are used to guide the design of nozzle concepts where possible. Kinetic models developed as part of the kinetic modeling and bench-scale experiments are being adapted for use in the CFD modeling.

P&W is also designing and fabricating nozzle and liner hardware that will be tested in the Low Emissions Combustion Test and Research Facility at NETL. The NETL testing is in three phases over a 3-year period. Nozzle hardware design was investigated during three different test periods in the first phase (year one) of the program. Emission performance and nozzle durability have been evaluated at different HAT-cycle conditions. One design will be selected for further investigation. During phase 2 of the program (year two), combustor liner design and flame stability were investigated in three different test periods. As an option, low-Btu gas will be tested in the third phase (during the third year) of testing.

Duration

Start Date	09/30/1996
Projected End Date	09/30/1999

NETL

Developing the 21st-Century Gas Turbine — The United Technologies/ Pratt & Whitney Project

Goal

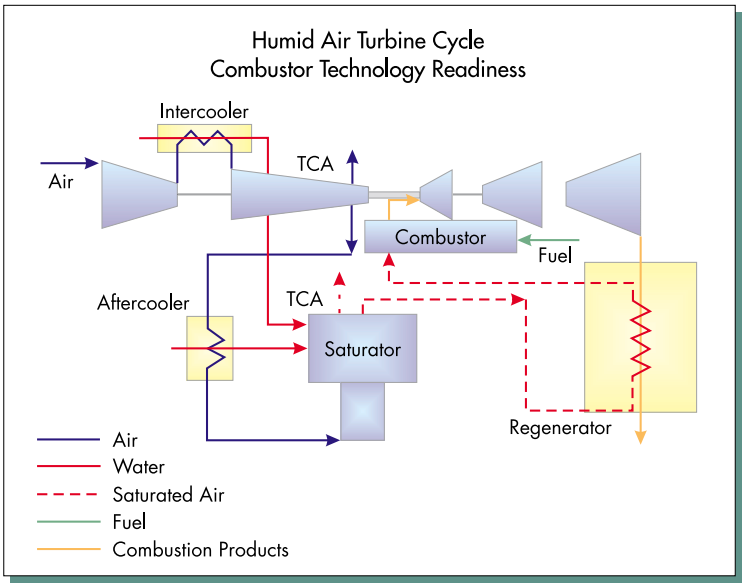
The goal of the project is to fill in technological data gaps in the development of the HAT cycle. A combustor configuration needs to be identified that will efficiently burn high-moisture, high-pressure gaseous fuels with low emissions. The major emphasis is on development of kinetic data, computer modeling, and evaluation of combustor configurations. The project scope is sufficiently broad so that by the end of the project, the combustor can be scaled up to test rigs using full-scale nozzles. Significant testing will be performed at the NETL facilities.

Benefits

The HAT cycle is a direct-fired turbine application in which natural gas or low-Btu gaseous fuels are burned with water-enhanced air at high pressure. Limited or no data exist for this type of pressurized combustion. Adding water to a combustion chamber reduces combustion temperature, which reduces the production of NO_x. Adding water also increases the mass flow through the turbine, which increases power output.

Key Milestones

10/1997	Decision on Combustor Configuration
11/1997	Dry Low NOx Combustor Development Testing
02/1998	Performance Analysis of FT8 Applications
10/1998	Complete Testing of Selected Configuration
03/1999	Cycle Analysis
04/1999	Performance Analysis of FT4000 Applications
06/1999	Decision On Performing Phase 3 Option
10/1999	Kinetic Modeling and Fundamental Data Base
10/1999	CFD Modeling of Nozzle/Combustor Performance
10/1999	Combustion Evaluation Studies



CONTACT POINTS

Abbie W. Layne
Advanced Turbine and Engines Systems Program
Product Manager
National Energy Technology Laboratory
(304) 285-4603
(304) 285-4469 fax
abbie.layne@netl.doe.gov

Norman T. Holcombe
Project Manager
National Energy Technology Laboratory
(412) 386-4557
(412) 386-5917 fax
norman.holcombe@netl.doe.gov

William H. Day
Manager, Advanced Industrial Programs
Pratt & Whitney
(860) 565-0086
(860) 565-0213 fax
dayw@pweh.com

PROJECT PARTNER

U.S. DOE
National Energy Technology Laboratory
Morgantown, WV, and
Pittsburgh, PA