

FALL QUARTER 2006
EME-107A
Gas Turbine Experiment and Instrumentation Design

Objectives

Demonstrate operating characteristics of a gas turbine and related instrumentation.

Description

This experiment uses a SR-30 Turbojet engine from Turbine Technologies, Ltd. This engine is a laboratory scale gas turbine that operates with liquid fuel and air. The engine can operate up to 85,000 RPM and is instrumented with a variety of pressure, temperature, speed, flow and force sensors.

Background

Read about the Brayton cycle in a thermodynamics text. For example, the following textbooks discuss this topic:

Moran, Michael J. and Shapiro, Howard N., *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons, 3rd Edition, 1995, Section 9.2.

Van Wylen, Gordon J. and Sonntag, Richard E., *Fundamentals of Classical Thermodynamics*, 3rd Edition, John Wiley and Sons, 1985, Section 9.12.

Acknowledgement

The Teaching Resources Center is gratefully acknowledged for providing funds to acquire the pressure, temperature and humidity instrumentation through the Undergraduate Instructional Improvement Project (UIIP).

Experimental Procedure

WARNING: There is liquid fuel in the fuel tank - NO SMOKING OR OPEN FLAMES!!

WARNING: Do not touch the exhaust pipe or engine components - THEY ARE HOT!

WARNING: Tie back all hair and loose clothing.

WARNING: Always wear safety glasses and hearing protection when operating the laboratory equipment!

WARNING: Always make sure the exhaust fan is on before operating the engine.

WARNING: Do not allow engine speed to exceed 85,000 RPM.

WARNING: Do not operate the engine without a carbon monoxide (CO) monitor in the laboratory.

WARNING: Do not stand in front of the inlet or behind the exhaust of the turbine while it is operating. Failure of the engine could result in fragments exiting at bullet-like velocity.

WARNING: Do not operate the engine controls unless Roger Littge is present and has instructed you on what you are to do. Roger Littge will be present at all of the gas turbine experiments.

WARNING: Do not open any part of the cabinet holding the engine or its components.

WARNING: Always make sure that the room doors are closed when operating the system. After the engine is turned off, open the room doors.

Experimental Procedure

Preliminaries

1. Put on your safety glasses (the TA will make these available).
2. Review the location and operation of the fire extinguisher as well as all other safety regulations that apply to this class (the TA will go over these with you).
3. Make sure that ventilation fans are turned on (ask the TA).
4. Identify each of the major components of the experimental apparatus.
- 4a. You will need to find the pinout locations on the left side of the control panel. Note the pinout locations and descriptions given in the operators manual. At this stage you only have a voltmeter and a K-type thermocouple reader. Although some of these signals are fed back to the displays on the control panel some signals are not. Start thinking about how you would acquire this data efficiently with a Data Acquisition Unit of your own design. Consult the operators manual on the sensors used and the existing output levels.
- 4b. This laboratory will require you to obtain data at various RPM between 50k and 80k. Set up a design of experiments so you could analyze any of the data obtained as a function of RPM.
5. Close the room doors.
6. Record values for ambient temperature, pressure and humidity.
7. Put on hearing protection.
8. Allow Roger Littge to start the engine and adjust the throttle so the engine is idling.

Engine Testing

WARNING: Do not stand in front of the inlet or behind the exhaust of the turbine while it is operating. Failure of the engine could result in fragments exiting at bullet-like velocity.

WARNING: do not exceed 85,000 RPM

9. Slowly adjust the throttle until the engine is running at speeds between 50,000 and 80,000 RPM
10. Note how long the engine takes to reach steady state and the degree of variability in the readings.
11. At each RPM record the values of P1 (compressor Inlet Pitot Static Probe), PO2 (Compressor Exit stagnation probe), P3 (combustion chamber static port), PO4 (Turbine stage exit stagnation probe), PO5 (Thrust nozzle exit stagnation probe), RPM (engine shaft Speed), FFS (Fuel Flow Sensor), FT (Thrust force), T1 (Compressor Inlet Temperature K-type thermocouple), TO2 (Compressor exit temperature K-type thermocouple Stagnation Probe), TO3 (Turbine stage inlet temperature K-type thermocouple Stagnation Probe), TO4 (Turbine stage exit temperature K-type thermocouple Stagnation Probe), TO5 (Thrust nozzle exit temperature K-type thermocouple Stagnation Probe).

Engine Shutdown Procedure

12. Reduce throttle setting until engine is running at idle.
13. Allow Roger Littge to stop the engine.
14. Open the room doors

SR-30 Turbojet Engine Sensor Locations

