AME 40431: Gas Turbine Propulsion

Gas Turbine Group Lab Experiment (1)
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Objective: A pure turbojet, the SR-30 is representative of all straight jet engines in which combustion results in an expanding gas that is sufficiently capable of producing useful work and propulsive thrust. Consisting of a centrifugal flow compressor, annular combustor and axial flow power turbine, the SR-30 is typical of the gas generator core found in turbofan, turboprop and turboshaft gas turbine engines, which are typically used for aircraft and marine propulsion, as well as stationary and industrial power generation.

Preparation: In preparation for engine operation and data analysis, answer the following questions:

Determine the fuel you are using to power the system.

What is the energy content per unit volume of fuel?

What is the fuel's density per unit volume?

Compare this fuel to other fuels used in the aerospace industry. Be creative in your chose of fuels.

Barometric Pressure: The barometric pressure reading can be taken from the barometer inside of the Hessert Aerospace Laboratory.

What is the present barometric pressure in your area?

Why would barometric pressure be important when planning to operate the Gas Turbine System?

What is another possible reliable source for accurate barometric pressure readings?

Data Acquisition: Recording and using the data properly in an important part of successfully completing the lab. Please reference the propulsions SR 30 lab 1.pdf from the first demonstration lab for more details.

Operation of lab unit: Using the laptop provided, and following the required safety protocols, acquire approximately 5 minutes of data. Make sure you progress through the RPM range in increments that are sufficient in length to allow the measurement devices to settle out. Do not exceed $\approx 70K$ RPM.

After data acquisition has ended you must convert your data from binary format to a text file that can be read by Matlab. This can be done by following the instructions of the TA at the end of the data acquisition process. A USB thumb drive would be useful if you would like to take your data with you immediately. If not, the laptop can be used to e-mail your acquired data to yourself. A folder will be kept on the computer for reference in the unlikely event that your data is lost or otherwise misplaced.

Data Run Plots: Graphically plot the engine run data in preparation for system analysis and performance calculations.

Plot the following using Matlab.
Compressor Inlet/Outlet Pressure vs. Time
Compressor Inlet/Outlet Temperature vs. Time
Turbine Inlet/Outlet Temperature vs. Time
Turbine Inlet/Outlet Pressure vs. Time
Fuel Flow vs. Time
RPM vs. Time
Thrust vs. Time
Fuel Flow and Thrust vs. Time (on one plot)
Exhaust Gas Temperature (EGT) vs. Time

In the lab report include comments on the required graphs. Other than Time, what is another measured variable that would be useful to plot the other measured values against?

Analysis Point: Chose and mark an analysis point on each plot for the same time point. For this exercise pick an analysis point where the engine RPM is near 65K RPM. This will be the basis for system/performance analysis calculations. Remember, the barometric pressure recorded earlier is included in this analysis point. List the analysis point in a table.

System Analysis: Perform a system performance analysis using the First Law of Energy Conservation Equation for Steady State, and Steady Flow Conditions. The data for these calculations comes from the information plotted and recorded during lab session. Also, a schematic of the Brayton Cycle for Gas Turbines will be provided during the lab. Please draw arrows from each cycle point to its correct location in the engine, and include this with the lab report.

1) For the chosen analysis point, find the **Specific Enthalpy** at each cycle point (using air tables).

$h_1 =?$, $h_2 =?$, ...

2) For the compression stage, find specific work done by the compressor (1-2).
3) For the combustion stage, find specific energy added by the fuel (2-3).
4) For the turbine expansion, find the specific work of the turbine (3-4)
5) Find the specific work done by the cycle.
6) Calculate the thermodynamic efficiency of the cycle.

Deliverables:
This lab report will be group written, and 10 pages maximum. Do not hand in a report with one graph per page. Be sure to comment intelligently on the results acquired and calculated. Should a plot (or calculation) yield a result that is found to be inconsistent with what was expected, be sure to try and explain why this might be the case. Include units on all calculations and plots.

Required Lab Report Components:
Introduction
Preparation section results.
Barometric Pressure section results.
Comments on the data acquisition process.
Required data run plots, and comments.
Chosen analysis point table.
Brayton cycle schematic (w/ arrows)
System analysis answers
Conclusions