UNIFIED ENGINEERING   Fall 2003
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Problem T7 (Unified Thermodynamics)

MIT's gas turbine power plant operates on a Brayton cycle. The current operating
conditions are shown at http://cogen.mit.edu/unified/. (The login name is "unified", the
password is a popular MIT acronym.) Assume the cycle is ideal and the gas behaves as an
ideal gas with constant specific heats $c_p = 1.0035$kJ/kg-K, and $c_v = 0.7165$kJ/kg-K. The
maximum temperature at entrance to the turbine is 1400K. From the web page, determine
current atmospheric conditions and also the compressor discharge pressure (labeled COMP
DEL PRESS). Use this to determine the pressure ratio for the cycle. (LO #4, LO#6)

   a) Starting from the measured atmospheric conditions, calculate the pressure and
      temperature at each point for the ideal cycle.
   b) Calculate the thermal efficiency and work per kilogram for the ideal cycle.
   c) Assume the compressor discharge temperature is fixed. What is the difference in
      efficiency between a hot summer day and a cold winter day?
   d) How does the efficiency you calculated in part (b) compare with the actual efficiency
      of the plant? [You can determine this from the data on the web page. If you get a full
      listing of variables, the fuel flow is listed under "total gas energy flow" and the net
      power is listed under "active load". If you use the buttons next to the picture, you
      need to add up the main and primary fuel flows to get the total gas energy flow.
      Note that 1 BTU is 1055 Joules, and 1 KBTU/s is 10^3BTU/s.] Why is the actual
      efficiency different from that you calculated in part (b)?
   e) You modeled the compressor as quasi-static and adiabatic. Test how good this
      assumption is by comparing the temperature rise you calculate across the compressor
      with the measured temperature rise across the compressor.
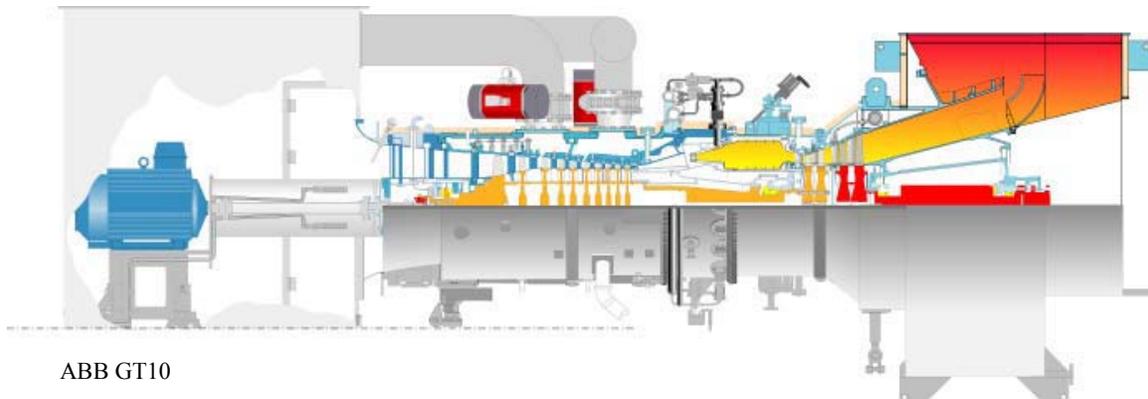

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