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Rose-Hulman Institute of Technology

Foundation Coalition Sophomore Engineering Curriculum

ES202 – Fluid & Thermal Systems Winter 2001-2002

Circle one:
Mayhew -05, Mayhew - 06, Adams - 07, Adams - 08

_____
Name

Exam 3

Feb. 11, 2002

Problem 1	_____/ 40
Problem 2	_____/ 40
Problem 3	_____/ 20
Total	_____/ 100

Show all work for full credit.

Open book, computer use for computational purposes.

Crunch numbers last!

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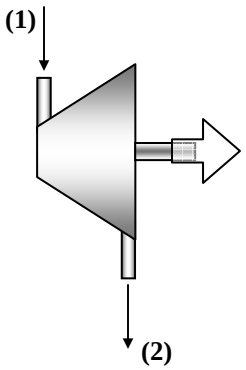
Problem 1 (40 points)

An adiabatic steam turbine operates at steady-state. The steam enters the turbine at 10 MPa and 550°C and exits at 20 kPa and a quality of 0.9. The mass flow rate through the turbine is 5 kg/s.

a) Calculate the power *output* of the turbine in kW.
b) Calculate the isentropic efficiency of the turbine.



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Problem 2 (40 points)

Find the minimum power required to operate an adiabatic air compressor with a pressure ratio of 30, an inlet temperature of -23°C, and a mass flow rate of 100 kg/sec. Plot the process on a T-s diagram. Assume steady-state operation and variable specific heats.

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Problem 3 (20 points)

a) (5 pts.)A saturated vapor is expanded at constant temperature until the volume doubles. Using phase diagrams, determine if the entropy change goes up, down or remains the same.

b) (5 pts.) Explain the difference in the following equations:

$s_2 - s_1 = s^0(T_2) - s^0(T_1) - R*\ln(P_2/P_1)$
$s_2 - s_1 = c_p*\ln(T_2/T_1) - R*\ln(P_2/P_1)$

c) (10 pts.) Using the Entropy Accounting Principle for a closed system undergoing a finite change in state, prove the statement:

Any two of the three terms adiabatic, reversible *and* isentropic *imply the third.*