

PS #7 132 SUSTAIN Spring 2015, Due Tuesday, June 2

1) I want to make a house out of adobe, (mud, cob, earth whatever you like to call it). If the wall is 10' x 20' and is 3' thick, when it is 70 °F inside and 30 °F outside,

a) Please calculate the temperature gradient

b) please calculate the rate of heat loss in Watts and BTU/hr through the wall.

2) Please go to: <http://www.animatedengines.com/> and pick out at least 4 engines that interest you and watch the apps for each. Please identify how and where WE put work INTO the machine, and then add heat and then the machine does work FOR us that we get out. Also be aware of why the work we get out is more than the work we put in and where that extra energy comes from.

3) Morro Bay boasts a dormant power plant. It used to pump out 1 GW of electricity in the day, fueled by petroleum kept in the tanks that you can see at the base of the three smoke stacks. It was later changed to cleaner, less expensive natural gas. Then they tried to turn it to a combined cycle, but pressure from local groups and environmental concerns shut them down.

a) It is/was a simple Rankin cycle plant. Please make a good drawing of a Rankin cycle plant and explain how it would work if we turned it on again.

b) About what was the efficiency of the plant?

c) What was the rate of power *input* in the form of natural gas? Look up the energy density of natural gas and calculate the rate of natural gas burning in kg/s.

d) About what was the rate of heat output of the plant?

e) If each molecule of methane burns to produce one molecule of CO<sub>2</sub>, what was the plant's rate of CO<sub>2</sub> emission?

f) A decade ago, I used to jump into the 70 °F water that came out of the waste heat (to go surfing). If the initial temperature of the ocean was 50 °F how fast did the pumps have to pump the water through the heat exchangers to heat the ocean water? Be careful of units.

g) Why did they want to heat the ocean?

h) If the combustion temperature for natural gas is 2000 °C, What would be the maximum theoretical efficiency for a natural gas facility by the Pacific ocean?

i) The power plant likely only ran the steam up to 500 °C. Why didn't they go higher? What is the maximum theoretical efficiency at 500 °C?

j) Why would they want to change the plant to a combined cycle?