Homework 2

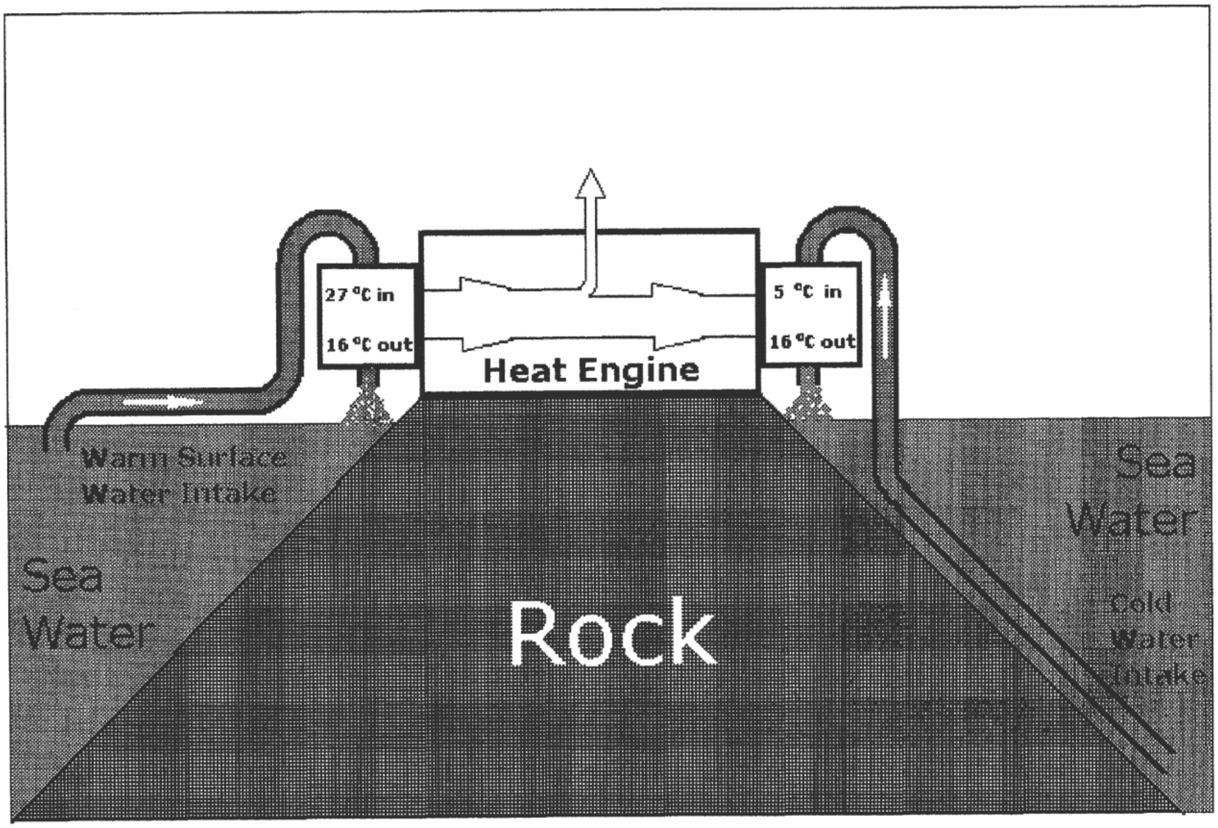
A 250 kW Ocean Thermal Energy Conversion (OTEC) pilot installation operating at Kona at the Hawaii's Big Island has demonstrated that OTEC is indeed a feasible method of generating energy at tropical islands and coastal regions. An OTEC power plant uses warm surface water as a "hot source",and cold water pumped from the depth of about 1000 m as a "heat sink". A design has been prepared for a new larger plant. Water of 5°C temperature will be pumped from a 1000 m depth at the rate of 1750 kg/s, and water of 27 °C temperature will be pumped from the surface at the same rate.

(a) Find the Carnot efficiency of an ideal thermal engine that uses a hot source and a heat sink of such temperatures;

(b) What is the "realistic" power-maximizing efficiency of a power plant that uses a a hot source and a heat sink of such temperatures?

(c) Based on the "realistic" efficiency you have calculated, find the total power that will be generated by the new plant. The heat capacity of water is 4.18 kJ /kg-°c, which means that if 1 kg of water is cooled by 1°C (or by 1 K), it gives away the energy of 4.18 kJ. Assume that the 1750 kg of warm surface water that enters the plant's system every second is cooled down to 16 °C, and all the thermal energy transferred out of it in the process constitutes the "thermal energy input" for the plant's thermal engine, as illustrated by the picture on the next page (the engine also "dumps" heat to cold water, so that it gets heated up from 5°C to a slightly lower temperature than 16°C; the temperatures are measured with the precision of 0.5°C, so it’s not necessarily so that the <u>entire</u> thermal energy extracted from the “hot” water is used for heating up the cold water pumped from the depths).

(d) It is estimated that a total of 1 MW of power will be needed for pumping the cold and the warm water. What will be the *net* power output from the plant?



27 °C in
16 °C out
Heat Engine
5 °C in
16 °C out
Warm Surface
Water Intake
Sea
Water
Rock
Sea
Water
Cold
Water
Intake