

Homework Assignment #4 Due: Thursday, Oct. 9

- If the capital cost of a 250-MWe combined cycle power plant is \$550 per kWe, find the cost of electric energy in ¢/kWe·hr (the unit capital and fuel costs only, neglect O&M). The plant has an expected capacity factor of 35%. The levelized annual fixed charge rate is 7% per year. The plant efficiency is 55%, and the fuel costs are \$5.50 per million kJ. [8 pts]
- The fuel cost for an 800-MWe steam power plant is 120 cents/million kJ. (a) Find the annual fuel cost for the plant if the overall thermal efficiency is 34% and the capacity factor is 78%. (b) Also, determine the savings in the annual fuel cost if the overall thermal efficiency of the unit can be increased by one percentage point. [12 pts]
- A 600-MWe power plant with a heat rate of 9100 Btu/kWh is operated at a capacity factor of 65% for an operating period of 335 days. If 30 days/year are allotted for scheduled outages, find (a) the annual fuel cost, dollars/year, (b) the area of coal field that must be mined, in acres/year, and (c) the total annual income from the sale of electricity produced by the plant. Assume the fuel cost is 120 cents/million Btu and that the company receives 4.5 cents/kWh of electrical output. The density of coal is 1200 kg/m³, the higher heating value (HHV) equals 10,800 Btu/lbm and the coal seam is 6 ft thick. [12 pts]
- Determine the tons of CO₂ produced per kWe·hr generated for the following four 500-MWe power plants. [24 pts]

Electric Power Plant	Thermal Efficiency	Fuel Constituency (percent by mass)					
		C	H	O	N	S	Ash
Pulverized Coal	40%						
Integrated Coal Gasification Combined Cycle	51%	80	5	5	1.5	1.0	7.5
Natural Gas Combined Cycle	59%	75	25	–	–	–	–
Municipal Solid Waste	13%	33.9	4.6	22.4	0.7	0.4	38.0

- A coal-fired station burning low-sulfur coal can be constructed for \$575/kWe, while a station burning high-sulfur coal with stack scrubbers will cost \$750/kWe. Both plants are assumed to have the same operating and maintenance costs, and a thermal efficiency of 42%. The levelized fixed charge rate is 12% annually. The heating value (HV) of the high-sulfur coal is 11,000 Btu/lbm, and the HV is 10,500 Btu/lbm for the low-sulfur coal. The station burning low-sulfur coal is expected to have a 70% capacity factor, while that burning high-sulfur coal is expected to have a capacity factor of 65%. Determine the premium in dollars per short ton that can be paid for the low-sulfur coal. *Note:* the answer is not a single number, rather a functional relationship between the coal costs; therefore, it may be useful to present your answer in the form of a graph of low-sulfur coal cost premium (ordinate) vs. high-sulfur coal cost (abscissa). [24 pts]

Chapter 8

Problems: 1, 3(a)

Points: (6), (15)

Selected Answers:

2: (a) Fuel Cost = \$69.5 million/yr

8-3: (a) $T_1 = 60^\circ\text{F}$, $T_{2s} = 482^\circ\text{F}$, $T_3 = 1800^\circ\text{F}$, $T_{4s} = 788^\circ\text{F}$ [this is not all the required temperatures, also need T_2 , T_2' , and T_4]