INTRODUCTION TO ENERGY

Problem 1

An electric commuter vehicle uses a 24-hp electric motor and is to have a photovoltaic array on the roof to charge the batteries both while moving and parked. The average solar flux is 650 W_{em}/m^2. The commute is one hour each way and the vehicle is parked for 8 hours. Thus, for each hour of operation, you estimate that the vehicle will be parked for 4 hours during daylight hours. The overall electromagnetic-to-electrical-to-mechanical energy conversion efficiency is 13 % and the storage efficiency of the batteries is 60 %. Determine the area of the solar array required to provide sufficient energy for the commute.

Answer: Area = 62.3 m^2

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Problem 2 (ME436s20q1 / ME436s22q1 / ME405s22q1)

A coal burning power plant produces a net power of 300 MWe with a heat rate of 10 663 Btu_{th}/kW_e.hr. The heating value of coal is 28000 kJ/kg. The gravimetric air-fuel ratio is calculated to be 12 kg air / kg fuel.

(a) What is the thermal efficiency of the plant?

(b) How much fuel is consumed in 24 hours?

(c) What is the air flow rate?

Answer: (a) $\eta_{th} = 0.32\ kW_e/kW_{th}$; (b) $\dot{Q}_{in} = 937.5\ MW_{th}$; (c) $\dot{m}_{air} = 401.8\ kg_{air}/s$

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Problem 3

You are developing a hybrid motorbike using 2-hp, 2-strike gasoline engine to drive a generator that powers an electric motor. There is a small lead acid battery used for storing energy. The thermal efficiency of the engine is 25 %. The generator is 60 % efficient. The electric drive motor is 50 % efficient. The battery storage system is 75 % efficient.

(a) With battery system by-passed, what is the power delivered to the wheels?

(b) Power delivered using batteries?

Answer: (a) 0.45 kW_m ; (b) 0.34 kW_m

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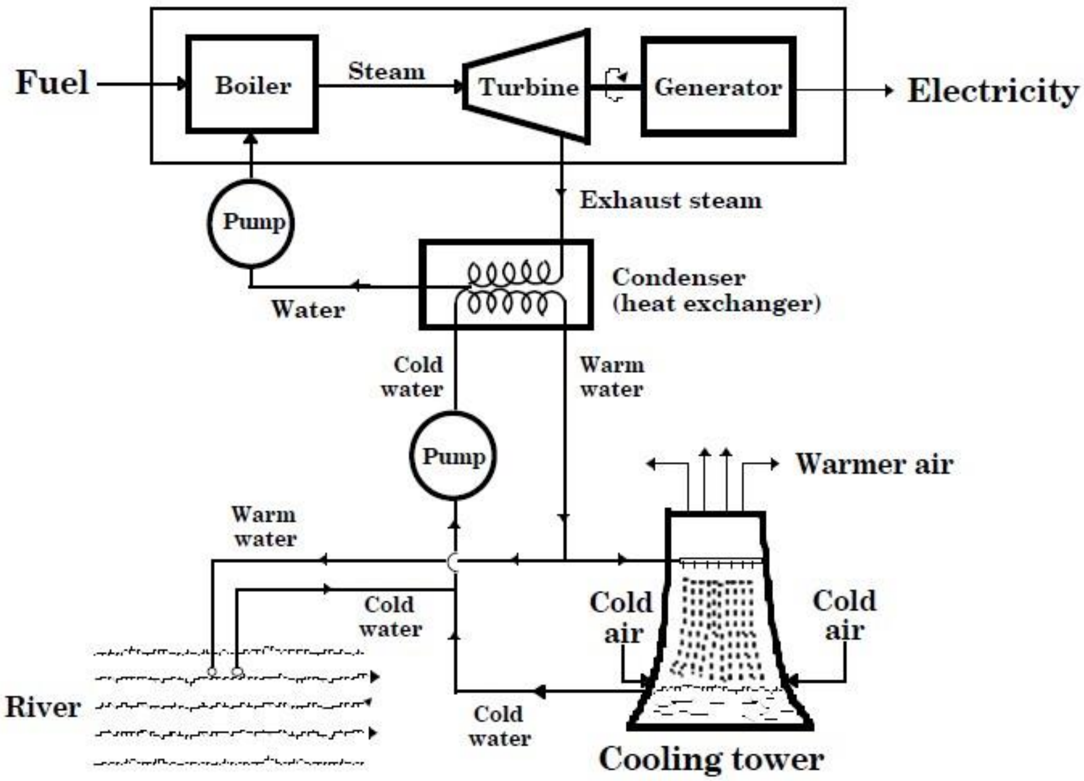
Problem 4

Calculate the efficiency of a power plant if the efficiencies of the boiler, turbine and generator are 88 %, 40 %, and 98%, respectively.



Answer: 0.35 %

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Problem 5

Determine the coefficient of performance of a refrigerator that consumes 800 Watts of power to remove heat at a rate of 5 Btu per second.

Answer: COP = 6.6

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Problem 6 (ME436s14q1 / ME405s23q1)

An automobile engine could operate between 2200 °C (the combustion temperature of gasoline) and 20 °C (ambient temperature).

(a) If it did, what would its maximum efficiency be?

(b) Compare this value with that of a typical car engine, and comment.

Answer: (a) 88 %

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Problem 7 (ME436s14q2)

A steam power plant rated at a power output of 150 MWe consumes coal at a rate of 60 tonnes per hour. The lower heating value of coal is 30 000 kJ/kg.

(a) Determine the overall efficiency of the plant.

(b) What are the major causes of low efficiency?

Answer: (a) 30 %

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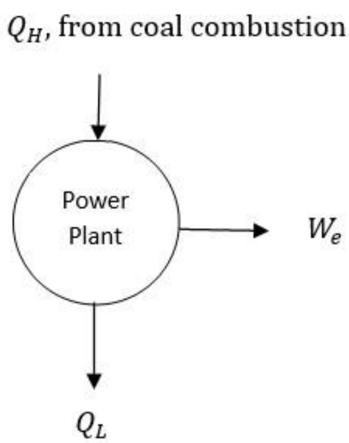
Problem 8 (ME436s14h2)

A 2400-MWe power plant has the following power demand for a given day:

12-5 a.m.: 850 MW	9-12 a.m.: 2150 MW	5-6 p.m.: 2250 MW
5-7 a.m.: 1250 MW	12-1 p.m.: 2040 MW	6-8 p.m.: 1850 MW
7-8 a.m.: 1840 MW	1-4 p.m.: 2400 MW	8-10 p.m.: 1500 MW
8-9 a.m.: 1960 MW	4-5 p.m.: 2350 MW	10-12 p.m. 1150 MW



Find the total power output in:

a) MW_e.days/day,

b) kW_e.h/day,

c) MeV_e/day,

d) J_e/day, and

e) Btu_e/day.

f) Assume that the plant burns coal with a heating value (energy content) of 26,400 kJ/kg with an overall efficiency of 37%. Determine the total mass of coal, in short tons (?) consumed during the day's operation

g) Find the maximum design coal rate, in short tons per hour, required for proper operation of the unit.

h) Evaluate the heat rate of the unit in Btu/kWh,

i) Evaluate the capacity factor of the unit for one day's operation, and

j) Evaluate the load factor for the same period of operation.

Answer: (a) 1660 MW_e days/day

(b) 39.84 10^6 kWh/day

(c) 8.95 10^{26} MeV/day

(d) 1.43 10^{14} J/day

(e) 13.59 10^{10} Btu/day

(f) 16188 short tons/day

(g) 975 short tons/hour

(h) 3413.6 Btu/kWh

(i) 69 %

(j) 69.16 %

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Problem 9 (ME436s14h3)

A coal burning steam power plant produces a net power of 300 MWe with an overall thermal efficiency of 32 %. The actual gravimetric air-fuel ratio (AF) in the furnace is calculated to be 12 kg of air / kg fuel. The heating value of the coal is 28000 kJ/kg. Determine

(a) The amount of coal consumed during a 24-hour period; and

(b) The rate of air flowing through the furnace.

Answer: (a) 33.48 kg/s ; (b) 401.8 kg air/s

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Problem 10

Expand the table below to include solar energy and geothermal sources.

Energy Transformation Matrix				
From	To:	Thermal Energy	Mechanical Energy	Electrical Energy
Chemical Energy		Furnace	Diesel Engine	Fuel Cell
Thermal energy		Heat Exchanger	Steam Turbine	thermocouple
Mechanical Energy		Refrigerator Heat Pump	Gear Box	Electrical Generator
Nuclear Energy		Fission Reactor	Steam Turbine	Nuclear Power Plant

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Problem 11 (ME436s14m1-1 / ME405f15h2 / ME436s16h2)

The world's nuclear arsenal has been estimated to be 13000 megatons of TNT.

(a) Determine the minutes of equivalent sunshine that would yield the same amount of energy to the earth.

(b) Evaluate the length of time, in years, this stockpile of TNT could supply one hundred 1000-MWe power reactors with a thermal efficiency of 34 percent and a capacity factor of 70 percent.

1 magaton = 10^6 ton

1 ton of TNT is equivalent to 4.184 10^9 Joules.

Solar constant (average rate of solar energy incident perpendicularly on a unit surface area outside the atmosphere) is: S =1453 W/m^2.

Radius of the earth is 6371 km.

The capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full capacity indefinitely.

Answer: (a) 5 minutes ; (b) 8.4 years

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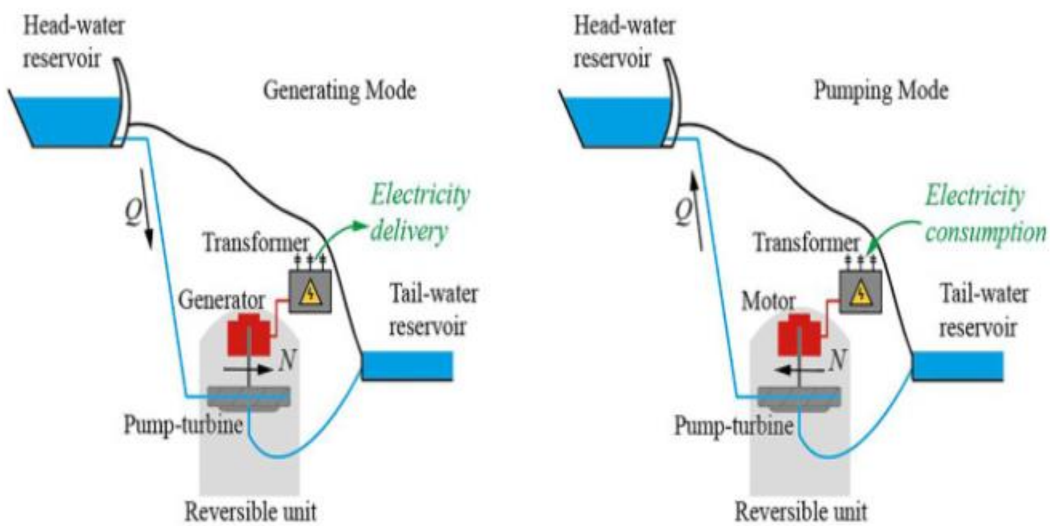
Problem 12 (ME405f22h1)

A proposed solution for the supply of electrical energy to a house involves the use of a windmill to pump water from a depth of 41 meters with a reversible water pump-turbine. The pumped water is then stored in a tank for use when there is no wind. The windmill shaft is not only connected to the water pump-turbine but it is also directly connected to an electrical generator. If the average household consumes 125 kW-hr/day, determine:

(a) the size of storage tank, in gallons, required to store water for a 3-day period of no wind. Assume that the combined mechanical-electrical conversion efficiency of the water turbine and generator unit is 60 percent, and

(b) the dimensions of the cylindrical storage tank if the diameter is equal to the height.



Answer:

(a) Volume of tank $= V = \frac{m_{water}}{\rho} = 5594 \text{ m}^3$

(b) D = H = 19.24 m

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Problem 13

Determine the area of solar cells required to drive a commuter electric car if the overall conversion efficiency of the propulsion system, including the electromagnetic-electric mechanical conversion is 13 percent. Assume that the car requires 24 hp and that the average gross solar input is 650 W/m^2. If the system can store energy while sitting in the parking lot and is storing energy at a rate of 4 hours for each hour of operation, find the required area of the solar-cell array. Assume the storage efficiency of the batteries is 60 percent.

Answer: 88.26 m^2

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Problem 14 (ME436s20h2)

Determine the tons of coal that could be saved per year if all the world's water and tidal power could be utilized. Assume that 76 % of this energy could be converted into electricity but that only 32 % of the coal's energy can be transformed into electricity. Assume that the heating value of the coal is 28000 kJ/kg.

Answer: 16 10^9 tons/year

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Problem 15

It is proposed to power an automobile with a hybrid mechanical-electrical drive system. The prime mover is a 50-hp, external combustion steam engine with a thermal efficiency of 30 percent. The steam engine drives an alternator with an overall thermal efficiency of 60 percent. Power from the alternator is either stored in a lead-acid battery system or fed directly to an electric traction motor with an electromechanical efficiency of 80 percent. The storage-battery efficiency, including charging, discharging, and storage losses, is around 65 percent. Find the power delivered to the drive wheels, in kW, and the overall conversion efficiency of the system when:

(a) The storage batteries are bypassed.

(b) The storage batteries are not bypassed.

Answer: (a) 5.268 kW ; (b) 3.49 kW

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Problem 16 (ME405s23h1)

(a) If the world's supply of fossil fuels is uniformly consumed over a 10-year period, find the ratio of the fossil-fuel energy release to the amount of solar energy absorbed by the earth for the same time period.

- In the determination of the amount of solar energy received by the earth, use the "solar constant" of 1367 W_{em}/m^2 as the incident energy flux at the earth's orbital position.
- Assume that the earth receives solar energy as a disk and that 30 % of the incident energy is reflected.
- The diameter of the earth is 12,756,000 m and the distance from the sun to the earth is 1.49 10^{11} m.

(b) Using these values, also determine the rate at which the sun is converting mass into energy.

Answer: $E_{released}$ = 4.79 10^{21} J in 10 years ; $E_{received}$ = 3.86 10^{25} J in 10 years

m = 4.24 10^9 kg/s

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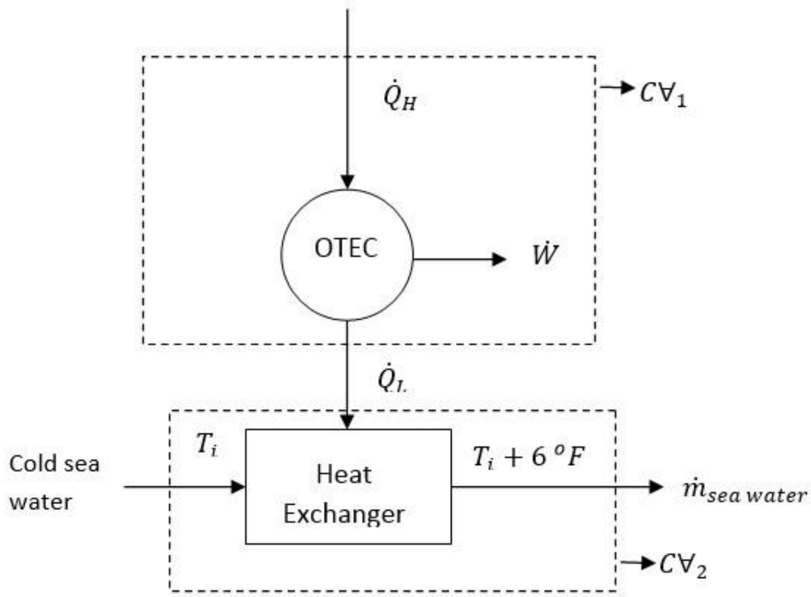
Problem 17

An Ocean Thermal Energy Conversion (OTEC) power plant, built in Hawaii in 1987 was designed to operate between the temperature limits of 86 °F at the ocean surface and 41 °F at a depth of 2100 ft. Approximately 13300 gpm (gallons per minute) cold sea water was to be pumped from the deep ocean through a 40-in-dia. pipe to serve as a cooling medium, or heat sink. If the thermal efficiency is 2.5 % and the temperature rise of the cooling water from inlet to outlet of the heat exchanger is 6 °F, determine the power generated. The density of sea water can be assumed constant at 64 lbm/ft^3.



Answer: 311 kW_e

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Problem 18 (ME436s14mu1-1)

A coal burning steam power plant produces a net power of 400 MWe with an overall thermal efficiency of 30 %. The actual gravimetric air-fuel ratio (AF) in the furnace is calculated to be 12 kg of air / kg fuel. The heating value of the coal is 25000 kJ/kg. Determine

(a) The amount of coal consumed during a 24-hour period; and

(b) The rate of air flowing through the furnace.

Answer: (a) 33.48 kg/s ; (b) 401.8 kg air/s

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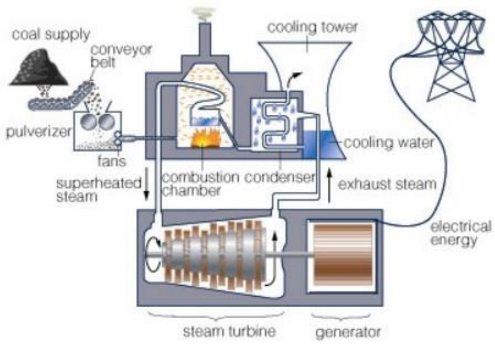
Problem 19 (ME436s15h1 / ME436s17h1)

Determine the tons of coal that could be saved per year in Turkey if all of the undeveloped potential for hydropower were utilized. Assume electrical conversion efficiencies of 36 % and 84



% for coal and hydropower, respectively. Use an average higher heating value (HHV) of 28,000 kJ/kg for the coal. Be sure to explain any assumptions and equivalencies.

Answer: 111.6 10^6 tons/year

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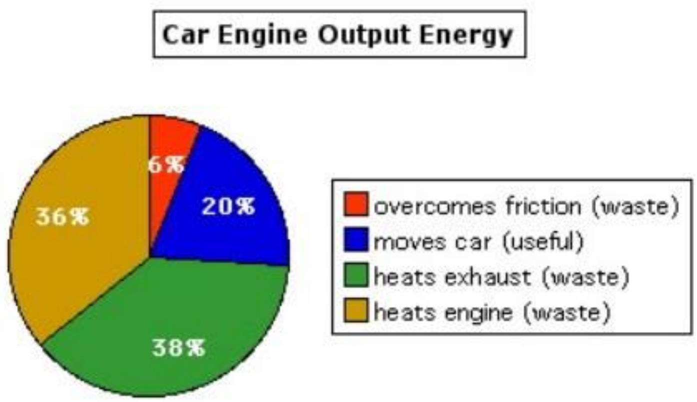
Problem 20 (ME436s15q1-1)

The diagram shows what happens to the output energy of a typical car engine. What is the most reasonable conclusion based on this evidence?



a) Car engines are already so efficient that there is very little room for further improvement.
b) Reducing friction offers the greatest opportunity to make use of energy that is now wasted.
c) Making use of energy that is now wasted by the engine cooling system offers the greatest opportunity to improve efficiency.
d) Reducing the amount of thermal energy in hot exhaust gases offers the greatest opportunity to improve efficiency.

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Problem 21 (ME436s15q1-2)

The diagram shows the main parts of a thermoelectric generating plant. What energy conversion takes place in the steam turbine?

a) Chemical potential energy into thermal energy
b) Thermal energy into kinetic energy

c) Kinetic energy into electrical potential energy

d) Chemical potential energy into electrical potential energy

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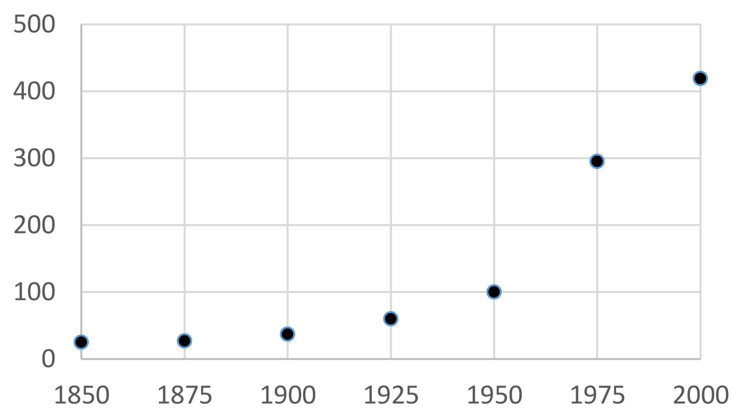
Problem 22 (ME405f15q1 / ME436s16q1)

The values of world energy consumption are given below. The result of nonlinear least-squares fitting shows that the best-fit curve to the six data points 1850-1975 is given by the equation

$$E(t) = 4.096\ e^{0.034\ t}$$

Use this curve to predict the value of energy consumption in 2000. If the actual value in /2000 is 419 EJ, by how much does the projected answer differ from the actual value? Comment.

Year	Energy use, EJ
1850	25
1875	27
1900	37
1925	60
1950	100
1975	295
2000	419



Answer: 672 EJ

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Problem 23 (ME405f15q4)

You are to evaluate a solar PV investment in a sunny location where each 1 kW of capacity generates on average 115 kWh/month year round. The system size is 5 kW rated, and electricity in the region costs $0.12 per kWh. What is the value of the output from the system per year? Ignore inverter losses downstream from the PV array.

Answer: $828

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Problem 24 (ME405f15h1 / ME436s16h1)

It is reasonable to expect that given growing wealth, the emergence of a middle class, access to modern conveniences, etc., the “emerging” countries of the world may experience exponential growth in energy consumption over the short to medium term. These countries consumed 136 EJ of energy in 1990 and 198 EJ in 2004. Use these data points and the exponential curve to predict energy consumption in the year 2020. Discuss the implications of this prediction.

Hint: The exponential equation is: $E(t) = A\, e^{B\,t}$.

Answer: 304.2 EJ

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Problem 25 (ME405f16h1)

A 400 MW electric power plant with an overall efficiency 38 % uses bituminous coal, which contains 70 % carbon, 2 % sulfur with the rest being volatile matter and ash. The heating value of this coal is 26 500 kJ/kg. Determine:

(a) how much chemical energy the plant needs annually, if it operates continuously;

(b) how much of this coal the power plant uses daily and annually; and

(c) how much CO_2 and SO_2 the power plant produces annually.

(d) Comment on the results.

Answer: (a) $CE_{in} = 3.32\ 10^{10}$ MJ/year

(b) m_{coal} = 1 252 860 tons/year m_{coal} = 3432 tons/day

(c) CO_2 released = $3.22\ 10^{6}$ tons/year SO_2 released = $9.19\ 10^{4}$ tons/year

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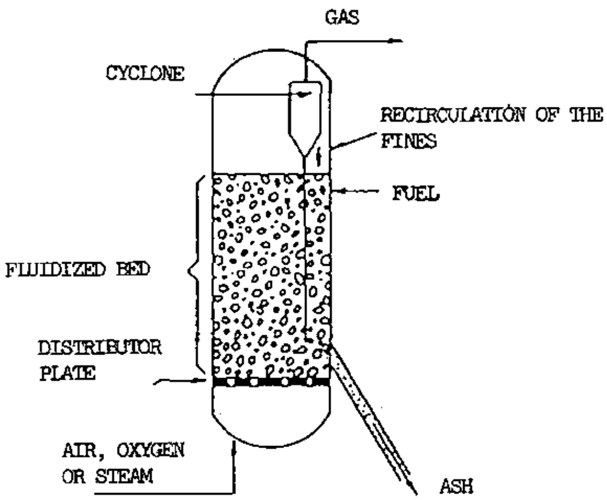
Problem 26 (ME436s17q1 / ME436s18q2 / ME405s18q2)



Three Fluidized Bed Reactors (FBR's) consume bituminous coal with 65 % carbon, 2.3 % sulfur by weight and heating value 24 000 kJ/kg. The FBR's supply with heat power to a 600 MW_e coal power plant with 42 % overall thermal efficiency. Determine:

(a) How much heat the set of FBR's produce annually;

(b) How much coal they consume; and

(c) How much $Ca(OH)_2$ must be supplied to the FBR's in order to remove the SO_2 produced?

Answer: (a) $Q = 4.51\ 10^{13}$ kJ/year

(b) $m_{coal} = 1.88\ 10^{9}$ kg/year

(c) $Ca(OH)_2 = 4.99\ 10^{7}$ kg/year

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Problem 27 (ME436s18q1 / ME405s18q1)

To compare the efficiency of a microwave oven with the efficiency of an electric kettle, Ayşe placed 50 mL of water into each. She calculated the energy required to boil the water, which was 4.64 Wh. The kettle which had a power rating of 1300 W, took 14.2 s to boil the water. The microwave had a power rating of 900 W and took 27.5 s to boil the water. Which is more efficient? (Note 3600 s in 1 h)

Answer: The kettle

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Problem 28 (ME436s18h1 / ME405s18h1)

Determine the m^3 of natural gas that could be saved per year in Turkey if all of the undeveloped potential for hydropower were utilized. Assume electrical conversion efficiencies of 36 % and 84

% for natural gas and hydropower, respectively. Use an average heating value of 34,000 kJ/m^3 for natural gas (Russian). Be sure to explain any assumptions and equivalencies.

Answer: 919.8 10^9 m^3/year

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Problem 29 (ME436s19q1 / ME405s19q1)

You are shopping for an air conditioner and the salesman tells you that the more expensive model (4400 TL) is a "much better buy" than the less expensive model (2750 TL). Both remove heat at a rate of 6000 Btu/hour but the former does it with a COP of 6. The COP of the latter is only 4.

(a) Is the salesman right?

(b) How long will it take you to recover the investment in the more expensive model if electricity costs 0.75 TL/kWh?

Notes: 1 Watt = 3.412 Btu/hour

Coefficient of Performance (COP) of a heat pump, refrigerator or air conditioning system is the ratio of useful heating or cooling provided to work required.

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Problem 30 (ME436s19h1 / ME405s19h1)

Determine the kg of fuel oil that could be saved per year in Turkey if all of the undeveloped potential for hydropower were utilized. Assume electrical conversion efficiencies of 36 % and 84 % for fuel oil and hydropower, respectively. Use an average heating value of 45 000 kJ/kg for fuel oil. Be sure to explain any assumptions and equivalencies.

Suggested reference:
http://www.geni.org/globalenergy/research/renewable-energy-potential-of-turkey/100-re-for-turkey-2020.pdf.

This reference gives the following information:

"Turkey has a hydro power potential of 433 GW. With today's technology, only 125 GW of that is economically viable. By the commissioning of new hydropower plants which are under construction, 34% of the economically usable potential would be tapped by 2020."

You may use your own choice of reference and year.

Note that the key items in an official report are: 1. Full list of references given at the end (as an appendix); and 2. Reference to these documents within the text

Answer: 69.5 106 tons of oil per year

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Problem 31 (ME436s19h2 / ME405s19h2)

A 1000 MW_e power plant is being planned for a city in Turkey. Consider two possible options for the plant: lignite and solar fueled. The total system should have a capacity factor of 90 %.

(a) What is the average daily amount of lignite, in kg/day, consumed to power the plant? Assume the combustion of 1kg of lignite provides 16 000 kJ/kg. Use a typical conversion efficiency for the power plant.

(b) If an advanced solar photovoltaic plant is to be used, with the best available solar flux-to-electricity conversion efficiency of 15 %, what is the total land area required to provide the needed power? You may assume that the land needed is 2 times the flat panel area. The daily total (direct and diffuse radiation) solar energy flux near that city has an annual average of 6 kWh/m^2.day on a properly oriented surface. Assume that the solar plant will have to also store sufficient energy during the day to meet an equivalent demand at night.

List all the necessary engineering assumptions that you have to make during calculations.

Answer: (a) 13 886 tons of lignite per day

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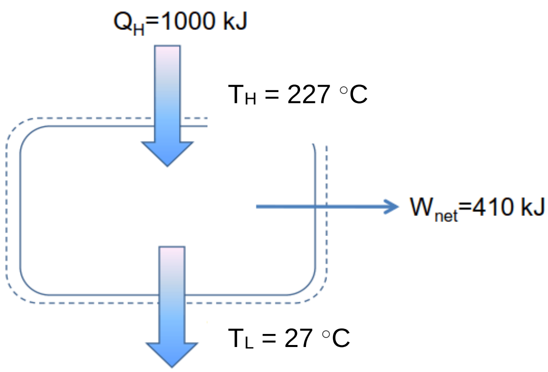
Problem 32 (ME436s19m1-2 / ME405s19m1-2)



An inventor claims to have developed a power cycle capable of delivering a net-work output of 415 kJ for an energy input by heat transfer of 1000 kJ. The system undergoing the cycle receives heat from a source of 227 °C and rejects heat to a sink of 27 °C. Determine if this is a valid claim.

Answer: Not a valid claim

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Problem 33 (ME436s20q2 / ME436s21q2 / ME405s21q2)

The amount of energy the world needs to generate in a year is about 5.6 10^{20} Joules. How much fuel is needed to meet the demand when the fuel is (a) coal, (b) oil (c) gas, and (d) nuclear.

Assume the following: Burning coal (lignite) releases about 23 10^6 J/kg

Burning oil (gasoline) releases about 46 10^6 J/kg

Burning gas (LNG) releases about 54 10^6 J/kg

Burning uranium (U-235) releases about 80 10^{12} J/kg

Disregard efficiency of conversions.

Comment on whether any of the renewables (biomass, hydro, geothermal, wind, solar) can be a replacing alternative with today's technology.

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Problem 34 (ME405f22q4)

As a new engineer, you are given the task of determining the mechanical efficiency of a pump driven by an electric motor. The test setup has an inlet and outlet diameter of 8 cm and 12 cm, respectively. The test fluid is an oil having a density of 800 kg/m^3. At a flow rate of 0.15 m^3/s, the pressure rise across the pump is 170 kPa and the motor (90 % efficient) draws 35 kW of electric power. What is the mechanical efficiency of the pump?

Answer: $\eta_m = 0.81$

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Problem 35 (ME436s20h1)

Determine the kg of lignite that could be saved per year in Turkey if all of the undeveloped potential for hydropower were utilized. Assume electrical conversion efficiencies of 35 % and 84 % for lignite and hydropower, respectively. Use an average heating value of 23 000 kJ/kg for lignite. Be sure to explain any assumptions and equivalencies.

Suggested reference:
http://www.geni.org/globalenergy/research/renewable-energy-potential-of-turkey/100-re-for-turkey-2020.pdf.
This reference gives the following information:
"Turkey has a hydro power potential of 433 GW. With today's technology, only 125 GW of that is economically viable. By the commissioning of new hydropower plants which are under construction, 34% of the economically usable potential would be tapped by 2020."

You may use your own choice of reference and year.

Note that the key items in an official report are: 1. Full list of references given at the end (as an appendix); and 2. Reference to these documents within the text

Answer: 140 10^6 tons/year

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Problem 36 (ME436s21q1 / ME405s21q1)

A certain engine is filled with gasoline that contains chemical energy, and when the engine is started, it begins transforming that chemical energy into mechanical energy. Over the course of a few seconds, the engine transforms 7000 J of chemical energy, but 5000 J of that energy is 'wasted' in the form of thermal energy.

a) How much energy does the engine transform into useful mechanical energy during these few seconds?
b) Calculate the efficiency of this engine.

Answer: Useful Energy = 2000 J ; η = 29 %

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Problem 37 (ME436s21h1 / ME405s21h1)

Write a short essay (about a page long) on Pareto efficiency (or Pareto optimality), giving at least one example.

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Problem 38 (ME436s21h2 / ME405s21h2)

Write a short essay (about a page long) on the use of renewable energy resources (such as solar, wind, geothermal, and hydro) as alternatives to fossil fuels. Include: facts, possibilities, and short comings.

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Problem 39 (ME436s22h1 / ME405s22h1)

It takes about 560 kW to run a typical diesel locomotive at speeds around 175 km/h. Magnetically levitated, or MagLev, trains, on the other hand, require substantially less power because the magnetic levitation eliminates energy loss to friction. The worst MagLev system requires 270 W to levitate the train and 780 W total to move it at 160 km/h (fast MagLevs can make closer to 480 km/h). The number of passengers each train can hold is comparable. How much less energy does it take to travel one kilometer in a MagLev train as opposed to one kilometer in a train pulled by a diesel locomotive?

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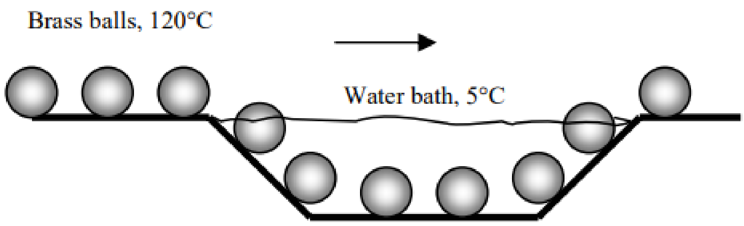
Problem 40 (ME436f22q1)

A number of brass balls, diameter 5 cm, are to be quenched in a water bath at the specified rate of 100 balls per minute. Determine the rate at which thermal energy needs to be removed from the water in order to keep its temperature constant.



Assumptions:

1. The thermal properties of the balls are constant: ρ = 8522 kg/m^3 and c_p = 0.385 kJ/kg.°C.
2. The balls are at a uniform temperature before and after quenching: 120 °C and 74 °C, respectively.
3. The changes in kinetic and potential energies are negligible.

Hint: Apply the first law of thermodynamics.

Answer: 16.49 kW

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Problem 41 (ME405s23q2)

What do you think about the use of nuclear energy for electricity generation in Turkey?

Excerpt from the Web site, https://en.wikipedia.org/wiki/Akkuyu_Nuclear_Power_Plant:

The Akkuyu Nuclear Power Plant is the only large nuclear power plant in Turkey and is under construction at Akkuyu, in Büyükeceli, Mersin Province. It is expected to generate around 10% of the country's electricity when completed.

In May 2010, Russia and Turkey signed an agreement that a subsidiary of Rosatom would build, own, and operate a power plant at Akkuyu comprising four 1,200 MWe VVER1200 units. Construction of the first reactor has commenced in April 2018. In February 2013, Russian nuclear construction company Atomstroyexport (ASE) and Turkish construction company Özdoğu signed the site preparation contract for the proposed Akkuyu Nuclear Power Plant. The contract includes excavation work at the site.

The official launch ceremony took place in April 2015, and the first unit is expected to be completed in 2023.
It is expected to be the first build-own-operate nuclear power plant in the world.

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Problem 42 (ME405s23h2)

“The words "sustainable" and "renewable" are often used to describe certain sources of primary energy, often interchangeably. However, these words have very different meanings. Not everything renewable is sustainable, and in turn not everything which is sustainable is necessarily renewable.”
Briefly explain, with examples, why you agree (or do not agree) with the above statements.

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Problem 43 (ME405f23q1)
A kettle has a power rating of 1000 W. It takes the kettle 4 minutes to heat 600 mL of water from 22 ^{0}C to 100 ^{0}C. If it uses only 54.4 Wh of energy to heat the water, what is the efficiency of the kettle?

Answer: η = 81.6 %

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Problem 44 (ME405f23q2)
When electric power is to be transmitted over long distances, such as several hundred kilometers or more, the voltage is first increased to very high values, perhaps as high as 750,000 to 1,000,000 Volts. This is done even though it must ultimately be reduced to as low as 220 to 240 volts before entering a residence. Explain why the voltage is increased to these high values and why it is beneficial to do so.

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Problem 45 (ME405f23h1)

Efficiency and Effectiveness are the two words which are most commonly juxtaposed by the people; they are used in place of each other, however they are different. While efficiency is the state of attaining the maximum productivity, with least effort spent, effectiveness is the extent to which something is successful in providing the desired result.

Briefly explain the two heat transfer concepts, fin efficiency and fin effectiveness.

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Problem 46 (ME405f23h2)

"Load" refers to the amount of power in an electricity distribution grid of a country. The load must be balanced so that supply continuously meets demand levels which are subject to variations and changes that impact the grid. Thus, load is separated into base load, and peak load. Give brief explanations of both and how they are met.

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Problem 47

Einstein won the Nobel Physics Prize in 1905 for explaining the photoelectric effect, in which light incident on a surface can lead to the emission of an electron from that surface with energy

$$E = h\,\upsilon - \phi$$

where h is the energy of a photon of light and v is a property of the surface.

(a) What are the main differences and similarities between the photo electric effect and the photovoltaic effect?

(b) Discuss how, if at all, the photoelectric effect could be used to yield useful energy.

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Problem 48 (ME405f24q1)

The famous dirigible Hindenburg had a volume of approximately 199 000 m^3. It was filled with hydrogen to give it buoyancy. Assume that the pressure inside was 100 kPa and that the temperature was 15 °C.

(a) How much hydrogen did the Hindenburg contain, in kg?

(b) How much energy (kWh) would it take to produce that hydrogen by electrolysis of water, assuming an electrolyzer efficiency of 65 %?

(c) How long would it take to produce that hydrogen using 1.5 MW turbine, operating at full power?

39.4 kWh energy is needed to electrolyze one kg of hydrogen.

Answers: (a) m = 16 754 kg; (b) E = 1 016 000 kWh; (c) t = 677 h

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Problem 49 (ME405f24q2)

Suppose you have an electric range in your home for cooking your food. Suppose also that the electricity supplied to your range is generated at a dam constructed for that purpose. Identify the principal forms of energy manifest in the overall chain of events from the water standing motionless behind the dam to the heat cooking your food.

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Problem 50 (ME405f24h1)

Efficiency and Effectiveness are the two words which are most commonly juxtaposed by the people; they are used in place of each other, however they are different. While efficiency is the state of attaining the maximum productivity, with least effort spent, effectiveness is the extent to which something is successful in providing the desired result.

Give one example on each of the four cases below:

(a) Something effective but not efficient;

(b) Something efficient but not effective;

(c) Something neither effective nor efficient; and

(d) Something both effective and efficient.

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