Renewable Energy Resources

EN 216 & EN 301 (/M)

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Energy Classification

(1) 1° Energy 2° Energy. (2) Renewable and non Renewable

(3) Commercial and non commercial.

Total World Delivered Energy Consumption by sectors and Fuels

TABLE 1-1 Total World Delivered Energy Consumption by End-Use Sector and Fuel in 2017 (EIA, 2018)

All values are in Quad Btu (quadrillion Btu). (1 quadrillion Btu = 1×10^{15} Btu = 0.95×10^{15} kJ)

Fuel	Total	Electricity	Residential	Commercial	Industrial	Transportation	All End-Use Sectors
Oil*	196.7	6.7	8.5	3.9	69.7	106.7	188.8
Natural gas	130.7	44.0	20.6	8.8	53.2	4.1	86.6
Coal	159.8	90.5	4.3	1.6	63.5	0.0	69.4
Nuclear	26.9	26.9	—	—	—	—	—
Electricity	—	—	21.0	16.8	35.1	1.6	74.5†
Renewables	74.9	55.5	1.3	0.2	17.9	—	19.4
Total	589.0	223.6†	55.7	31.3	239.4	112.4	438.8

*The values given for oil also include other nonpetroleum liquid fuels such as ethanol, biodiesel, coal-to-liquids, natural gas liquids, and liquid hydrogen.

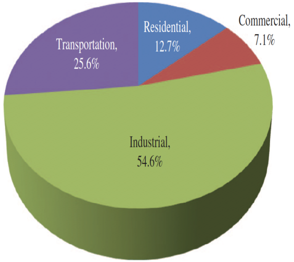

Figure 1-1 Percentages of global energy use by end-use sectors in 2017 (*EIA, 2018*).

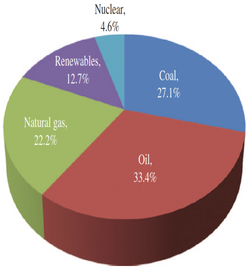

Figure 1-2 Percentages of total world primary energy supply by fuel in 2017 (*EIA, 2018*).

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1) Energy lost?

2) amount of Electricity in kWh

3) Overall thermal efficiency.

Problem 1

In table 1-1, the total energy consumption by different energy sources is given to be 589.0 Quad Btu while the total energy use by all end-use sectors is 438.8 Quad Btu. using the table data calculate the total amount of energy lost during the production of electricity by all energy sources. Also calculate the amount of electricity produced in kWh and the overall thermal efficiency of electricity production by all energy sources.

1) → Energy loss = $(223.6 - 74.5) = 149.1$ Q.Btu

→ Energy loss = $(589.0 - 438.8) = 150.2$ Q.Btu

difference in loss = $(150.2 - 149.1)$

= 1.1 Q.Btu.

transmission losses

2)

Electricity produced

$$= \left(74.5 \times 10^{15} \text{ Btu}\right)\left(\frac{1 \text{ kJ}}{0.95 \text{ Btu}}\right)\left(\frac{1 \text{ KWh}}{3600 \text{ kJ}}\right)$$

$$= 2.18 \times 10^{13} \text{ KWh.}$$

3) $\eta_{thermal} = \dfrac{\text{Energy Produced}}{\text{Energy Consumed}} = \dfrac{74.5}{223.6} = 33\%$

- Ton of Oil equivalent (toe) is an amount of energy unit commonly used to express large amount of energy. It represents the amount of energy released by burning 1 ton (1000 kg) of crude oil. One toe is taken equal to 42 GJ.
- The power plant in the USA generated 4.05×10^{9} MWh of electricity in a year. According to table 1.1, 74.5 quad Btu of electricity is produced. Express these values in the toe unit. Also determine the percentage of global electricity generation that occurred in the USA.

Electricity Generation in USA $= (4.05 \times 10^{9}\ \cancel{\text{MWh}}) \left(\dfrac{1000\ \cancel{\text{kWh}}}{1\ \cancel{\text{MWh}}}\right) \left(\dfrac{3600\ \cancel{\text{kJ}}}{1\ \cancel{\text{kWh}}}\right) \left(\dfrac{1\ \cancel{\text{GJ}}}{1 \times 10^{6}\ \cancel{\text{kJ}}}\right) \left(\dfrac{1\ \text{toe}}{42\ \cancel{\text{GJ}}}\right)$

A

$= 0.35 \times 10^{9}$ toe

Electricity Generation in World

$= (74.5 \times 10^{15}$ ~~Quad~~ Btu$)$

$= 1.87 \times$ Mtoe $\quad = \cancel{22.6 \times 10^{6}}$ toe

1.685×10^{9} toe

% electricity $= \boxed{20.34\%}$

Review of Thermal Sciences

Sp. heat

Air
m=1kg

300-301K

0.718 kJ.

Air
m=1kg

1000-1001

0.855 kJ

$$dU = mC_v\,dT$$
$$dH = mC_p\,dT.$$

$$\Delta U = m\,C_v\,dT$$

Energy transfer.

Heat
Work
in Mass

Steady system.

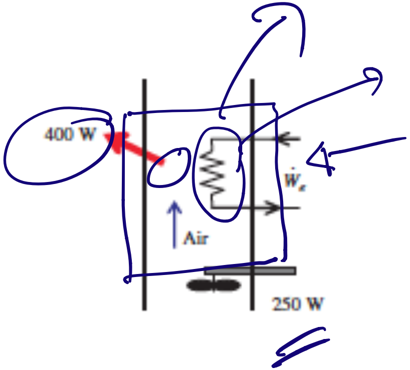
heat
Work
Mass.
mass out

$$\dot{E}_{in} = \dot{E}_{out}$$

closed volume

Tank
Specific

Q. A house has an electric heating system that consists of a 250 W fan and an electric resistance heating element placed in a Duct. Air flows steadily through the duct at a rate of 0.5kg/s and experiences a temperature rise of 7 deg C. The rate of heat loss from the air in the duct is estimated to be 400 W. determine the power rating of the electric resistance heating element. (hint-sp. Heat of air at room temperature is 1.005 kJ/kgdeg C.



$\Delta m_{cv} = 0$, $\Delta E_{cv} = 0$. $\Delta h = c_p \Delta T$

$$\dot{E}_{in} = \dot{E}_{out}$$

$$\dot{W}_{e,in} + \dot{W}_{fan,in} + \dot{m} h_1 = \dot{Q}_{out} + \dot{m} h_2$$

in

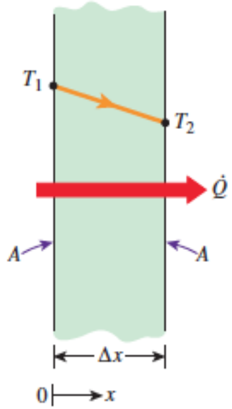
$$\dot{W}_{electric,in} = \dot{Q}_{out} - \dot{W}_{fan,in} + \dot{m}(h_2 - h_1)$$

$$= (400\,W) - (250\,W) + (0.5\,kg/s)(1.005\,kJ/kg\,°C)$$

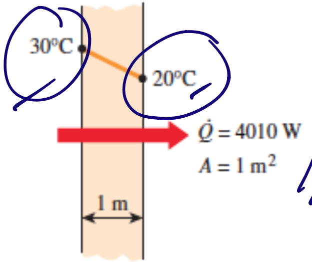
$$= 3.67\,kW$$

Heat Transfer-Conduction, convection and Radiation

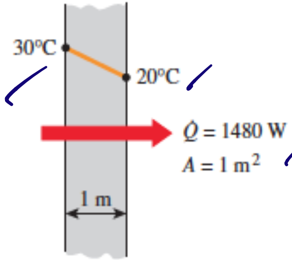
Conduction



$$\dot{Q}_{cond} = kA\frac{T_1 - T_2}{\Delta x} = -kA\frac{\Delta T}{\Delta x}$$



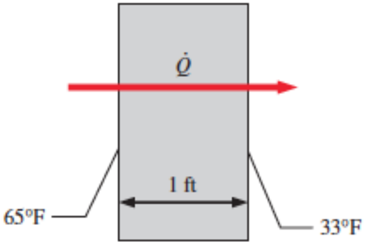
(*a*) Copper (k = 401 W/m·K)



(*b*) Silicon (k = 148 W/m·K)

Q.3

The east wall of an electrically heated home is 15 ft long and 8 ft high, and 1 ft thick and made of brick whose thermal conductivity is k= 0.42 Btu/h.ft degF. On a certain winter night, the temperature of the inner and outer surface of the wall are measured to be about 65 deg F and 33 deg F respectively, for a period of 10 h. determine a) the rate of heat loss through the wall that night and b) the cost of that heat loss to the home owner if the cost of electricity is 7 INR /kwh.



$$\dot{Q} = kA\frac{dT}{dx} \quad L$$

$$A = 15 \times 8 = 120\,ft^2.$$

$$\dot{Q} = 1612.8\ Btu/h. = 0.473\,kW.$$

$$\boxed{1\,kW = 3412.1\ Btu/h}$$

$$Q = \dot{Q} \times h = 0.473 \times 10\,h = 4.73\ kWh.$$

electricity unit

$$= 7\,INR/\cancel{kWh} \times 4.73\,\cancel{kWh}$$

$$= 33\ Rs.$$