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Review on difficulties and probable solutions for different types of energy producing sources

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Abstract: *In the present paper, through reasoning and analysis, the difficulties and probable solution, on production of electricity using thermal power plants by burning of coal by running the steam engine, solar cells, lithium ion batteries, thermoelectric cells, Solid oxide fuel cells have been presented. The thermal power plants are cost effective when compared to solar cells (5 $ per watt of solar cell which is equal to 815 INDIAN rupees per watt of solar cell). The global warming is not due to CO_2, this is due to thinning of ozone layer which needs focus. The CO_2 is the air coolant and is food of plants and trees which gives oxygen to breathe in by living beings. The lithium ion batteries cost $5*10^4$ INDIAN rupees for 2 kWhr power produced which is not sufficient to run the home appliances for longer times. To charge lithium ion battery (2 kWh) to run the 200W TV for one year (219 kWh) it costs 100*10=1000 INDIAN rupees. The charging of lithium ion battery is not possible for one year due to degradation resulting by number of charging and discharging times (possibly it needs 100 times recharging and discharging per year) and also to run it for one year due to thermal degradation. The efficiency of SOFC's is very lower due to high input thermal energy (1000ºC to 1500ºC). Instead of SOFC's steam engines operating at 300ºC can be operated to produce the electricity and to run the vehicles. In the present paper SOFC's operating at room temperature using ozone and H_2 gas have been presented. This is one advantage of SOFC's using ozone and H_2 gases. One can also study Ozone and NaCl based electrolytic solar cell as it is cost effective when compared to inorganic, organic and polymer based solar cells. The probable mechanism of ozone and NaCl based electrolytic solar cell is presented in this paper. The probable other electrolytes instead of NaCl is also presented in this paper. The thermal power plants are the advantageous energy producing sources when compared to solar cell with respect to cost and power output. Then next to thermal power plants, ozone and NaCl based solar cell is the probable alternative energy producing source with respect to cost and power output.*
Keywords: *Thermal power plants; Solar cells; Lithium batteries; thermoelectric; solid oxide fuel cells.*

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I. Introduction:

The thermal power plants are used to produce electricity by burning of coal and this generates the heat of 500ºC. The heat generated is used to produce the steam and this steam is used to run the steam turbines or engine and this in turn produce electricity. The steam engine or turbine produces pressure equivalent to 1.38 MPa to 1.5 MPa to run the steam turbine or engine. The bigger steam turbine produces power equivalent to 150 MW per unit. It is said that the coal is becoming shortage. Therefore the researchers are using the solar cells to produce the electricity using sun's energy. Over the last many decades the research on solar cells is carried out on the different type of inorganic materials using Si, GaAs, CdTe, CIS, CIGS, GaN and CZTS with power conversion efficiency for these solar cells varying from 8 to 40% [1-9]. But the solar cells are very costly when compared to the thermal power plants to produce electricity. The cost of solar cell for 1 W of power is around 5 $. This is most expensive. If there is a shortage of coal then this problem can be solved using the dried garbage as there is huge amount of garbage is produced daily. There are also many electricity producing devices such as lithium ion battery, thermoelectric devices and solid oxide fuel cells [10, 11]. The cost of lithium ion battery with power 2 kWh is around $6*10^4$ INIDAN rupees which is expensive. The thermoelectric materials and solid oxide fuel cells are operated at higher temperatures which is the drawback of it. Considering the high input thermal energy the efficiency of thermoelectric devices and solid oxide fuel cells is very lower. In the lithium ion batteries there is also thermal degradation problem. In the present manuscript review on difficulties and probable solutions on the production of electricity using thermal power plants by burning of coal to run the steam engine, solar cells, lithium ion batteries, thermoelectric cells, and Solid oxide fuel cells are presented. In the present study Solid oxide fuel cells operating at room temperature using the ozone and H_2 gas is presented. In the present study Ozone and NaCl based electrolytic solar cell is also presented.

II. Results And Discussion:

The energy density of coal is 6.7 kilowatt-hours per kg. To power a 100 W bulb for one year it takes 325 Kg of coal for a thermal power plant with 40% efficiency [12]. It takes around amount of coal and garbage as given below to produce the wattage of electricity

100*24*30*12 = 864kWh for 325Kg of coal
100*24*30*12 = 864kWh for 325Kg of garbage
$7.975*10^{10}$kWh = 10^8*30Kg (garbage for one month)

Every day millions of tons (10^8*30 for one month) of garbage are produced in India. The garbage should be dried and should be converted in to hard blocks. These blocks should be sent to thermal power plants to produce electricity by burning it. By using UV lamps to dry the garbage it takes input electrical energy around ($6.15*10^8$ kWh). The output energy produced by burning these dried blocks is 129.67 times more energy when compared to input energy utilized to dry the garbage using UV lamps. Since the coal is running out, for running thermal power plants there is no need of coal again. The thermal power plants can be run by burning the garbage. By burning the garbage power equivalent to extracted energy of $7.975*10^{10}$ kWh can be produced monthly. This is very large to fulfill the total electricity demand of India. Therefore large number of thermal power plants should be established. The waste from the forest can also be utilized to run the thermal plants to produce the electricity.

A 100W UV bulb uses about 0.5 kWh of electricity per year [13]

0.5kWh/12 = 0.041kWh
100 bulbs = 200Kg
1.5e10 = 10^8*30
1.5e10*0.041kWh = 6.15e8kWh
7.975e10kWh/6.15e8kWh = 129.67

The total power demand of INDIA is around 12×10^{13} W.h in one month. The initial investment required to produce the power (12×10^{13} W.h in one month) is around 4.2×10^{16} INDIAN rupees [14] for latest and existing solar cell technology [14]. This calculation is based on the cost of the solar cell which is equal to 5 $ per one watt. To produce the same power using conventional method (hydro and thermal) around is 12×10^{10} INDIAN rupees are required as initial investment. In the case of ozone and NaCl based electrolytic solar cell, it requires around 5.32×10^{11} INDIAN rupees as initial investment.

It is reported in various literature that the running of thermal power plants by burning coal to produce electricity causes liberation of CO_2 and this is the reason of global warming. This is wrongly reported. The global warming is due to thinning of ozone layer and is not due to CO_2. In contrast the CO_2 in air causes cooling of air. This can be elucidated from the use of CO_2 in the soda water and cold drinks. It is known that the CO_2 is the food of trees and plants and they consume CO_2 and liberate fresh air i.e. oxygen and this is inhaled by humans, animals and birds to survive/live. From this it can be elucidated that the running of thermal power plants by burning of coal to produce electricity do not causes global warming instead the thermal power plants are producing enough CO_2 to consume by trees and plants to give fresh air or oxygen to inhale by all type of living beings. Therefore one should operate thermal power plants to produce electricity instead of solar cells. The solar cells are very costly and it cost 5 $ per one watt of power. The thermal power plants are very cheaper when compared to solar cells based on Si, GaAs, CdTe, CIS, CIGS, GaN and CZTS and also when compared to dye sensitized, polymer and organic based solar cells as stated in above paragraph.

It is in new that the DELHI one state of INDIA there is fog of CO_2 due to burning of agricultural waste in nearby states and this fog last for one week to ten days. This means that there is deficiency of number of tress by seven times. If this problem needs to be resolved the government should plant enough trees to make trees consume the CO_2 fog completely. It is necessary to plants the trees to resolve the problem of CO_2 fog in regions where it is observed.

A one Kg of lithium ion battery can store or produce energy equivalent to 150 Watt-hours. A 6 Kg of lead-acid battery can store or produce energy equivalent to 25 Watt-hours [15].

The lithium ion battery (CAML 40 Ah/2k Wh) cost $6*10^4$ INDIAN rupees. The power consumed by TV is 50 to 200 Wh [16]. The power consumed by TV for one year is shown in below table 1.

If 2kWh lithium battery cost $6*10^4$ INDIAN rupees then the total cost to run the TV of 200 W for one year would be 219kWh*$6*10^4$/2k = $6.58*10^6$ INDIAN rupees. This is not feasible and is very costly.

To charge lithium ion battery (2 kWh) to run the 200W TV for one year (219 kWh) it costs 100*10=1000 INDIAN rupees. The charging of lithium ion battery is not possible for one year due to degradation resulting by number of charging and discharging times (possibly it needs 100 times recharging and discharging per year) and also to run it for one year due to thermal degradation. A Lithium-Ion batteries average life span is 2 to 3 years or 300 to 500 charge cycles. Therefore it is not feasible to run it for longer times and by number of charging and discharging cycles.

Table 1. Power consumed by TV for one year

TV Wattage	Hours Per Year Run	Yearly K Wh Of Electricity
50 W	1,095	54.75 kWh
75 W	1,095	82.13 kWh
100 W	1,095	109.5 kWh
125 W	1,095	136.9 kWh
150 W	1,095	164.3 kWh
175 W	1,095	191.6 kWh
200 W	1,095	219 kWh

A 100-watt ceiling fan will use 100 watts of power per hour (100 Wh). If there is power cut for two hours then the power consumed by ceiling fan is 200 Wh. The lithium ion battery (2 kWh) can run for ten hours but the cost of lithium ion battery is $6*10^4$ INDIAN rupees. This is most expensive. The cost of power generated by thermal power plants is 10 INDIAN rupees per 1 kWh. The cost of lithium ion battery (2 kWh) is $6*10^4$ INDIAN rupees. This is rechargeable battery. This means that the cost ratio of power generated by thermal power plants and lithium ion battery is $6*10^3$ INDIAN rupees. This means that the cost of lithium ion battery is not cost effective considering the life span of lithium ion battery (2-3 years or 300 to 500 cycles).

Thermoelectric materials are used to produce electricity by heating the thermoelectric material at higher temperature. These are studied in bulk form to produce the electricity. Instead one can try using thin films with larger surface area to produce the electricity and by using the thin film one can operate the thermoelectric materials at lower temperatures thereby reducing the cost which means it will be cost effective.

It is in literature it is stated that the solid oxide fuel cells (SOFC’s) are operated at higher temperatures. The type of SOFC’S is low temperature SOFC’s (300ºC-500ºC), intermediate temperature SOFC’s (800ºC-1000ºC) and high temperature SOFC’s (1200ºC-1500ºC). The efficiency of SOFC’s are much lower considering the high input thermal energy. To use the SOFC’s in vehicles, there is one question how the operating temperature is created. It is not wise to use the high temperature SOFC’s as there is problem of creation of operating temperature. Instead of high temperature SOFC’s it is wise to use the steam engine to run the vehicles. This can be operated at 300ºC. It is also not wise to use the SOFC’s in bulk form (Stacked thick films), instead one can use the thin film with large surface area. To use thin film with large surface are for SOFC’s it is not feasible to run the vehicles. Therefore it is wise to use steam turbines to run the heavy vehicle like trains and also to produce the electricity for domestic use.

Instead of high temperature SOFC’s, one can use SOFC’s operating at room temperature using ozone and H_2 gas. SOFC’s using ozone and H_2 gases have advantage over high temperature SOFC’s using H_2 and O_2. SOFC’s utilizing ozone and H_2 is novel idea and needs trial experimentation.

$O_3 \rightarrow O_2 + O^{-2}$ (under sunlight)
$2O^{-2} \rightarrow O_2 + 4e^-$ (at cathode)
$2H_2 + O_2 + 4e^- \rightarrow 2H_2O$ (at anode)
Over all equation are $2H_2 + 2O^{-2} \rightarrow 2H_2O$

One can also try Ozone and NaCl based electrolytic solar cell as it is cost effective when compared to inorganic, organic and polymer based solar cells [14]. The probable mechanism is as follows. **Table 2 & 3** Shows the comparison of different types of energy sources [14].

Trial using NaCl
$O_3 \rightarrow O_2 + O^{-2} + 2e^{-1}$ (at Anode)
$2Cl^{-1} \rightarrow Cl_2 + 2e^{-1}$ (at Anode/Cathode)
$4Na^{+1} + 4e^{-1} \rightarrow 4Na$ (at Cathode)

Trial using NaOH
$O_3 \rightarrow O_2 + O^{-2} + 2e^{-1}$ (at Anode)
$2(OH)^{-1} \rightarrow H_2O + O^{-2} + 2e^{-1}$ (at Anode/Cathode)
$4Na^{+1} + 4e^{-1} \rightarrow 4Na$ (at Cathode)
Instead of NaCl and NaOH one can also probably use KCl, KOH, $MgCl_2$, $Mg(OH)_2$, $ZnCl_2$, $ZN(OH)_2$, $CuCl_2$, $Cu(OH)_2$, $CaCl_2$, $Ca(OH)_2$ solutions. This needs trial experimentation.

Table 2. Comparison of different types of energy sources [14]

Type of energy sources → Parameters ↓	Latest solar cells	Thermal power plants	Ozone and NaCl based electrolytic solar cell
Technology	Complicated	Easy	Medium Easy
Initial investment required to produce 12×10^{13} W.h in 1 month	4.2×10^{16} INDIAN Rupees	12×10^{10} INDIAN Rupees	5.32×10^{11} INDIAN Rupees
Area required to produce 12×10^{13} W.h in 1 month	3×10^{10} Sq. Feet	Data not available	1.08×10^{10} sq. feet
Area Cost @ 2×10^{5} INDIAN Rupees per 100 sq. yard	6.7×10^{12} INDIAN Rupees	Data not available	2.4×10^{12} INDIAN Rupees
Poisonous or inflammable gases used or emitted	SiH_4, PH_3, BH_3 etc.	CO_2 is emitted which is not pollutant as it is food of plants and trees	O_3
Materials used	Inorganic, organic materials	Coal & Steam	O_3 & NaCl O_3 & NaOH

Table 3. Comparison of different types of energy sources

Type of energy sources → Parameters ↓	Lithium ion battery	SOFC using H2 and O2	SOFC using O3 and H2
Technology type	Medium	Complicated	Medium
Cathode	$LiMn_2O_4$	LSM	LSM
Anode	Graphite, Silicon	Ni-YSZ	Ni-YSZ
Electrolyte	$LiPF_6$	YSZ	YSZ
Operating temperature	15 to 35 ^oC	300 to 1500 ^oC	Room temperature (RT)

Gases used	Not applicable	H_2 and O_2	H_2 and O_3 (Galvanic effect)
Cost	Medium expensive	Expensive due to operation at 300 to 1500 ºC	Medium expensive due to operation at RT
Degradation	After many number of cycles	After many number of cycles	After many number of cycles
Rechargeable	Yes	No	No

III. Conclusions:

In the present manuscript production of electricity using thermal power plants by burning of coal by running the steam engine, solar cells, lithium ion batteries, thermoelectric cells, Solid oxide fuel cells have been reviewed with reasoning and analysis. The difficulties and probable solutions are presented. The thermal power plants are cost effective when compared to solar cells which in turn cost 5 $ per one watt of power (815 INDIAN rupees). There is no problem with thermal plants as CO_2 does not cause global warming. The CO_2 is the air coolant and is food of plants and trees which gives oxygen to breathe in by living beings. The lithium ion batteries cost $5*10^4$ INDIAN rupees for 2 kWhr power produced. There is also thermal degradation if the battery if run for longer times or larger cycles. To charge lithium ion battery (2 kWh) to run the 200W TV for one year (219 kWh) it costs 100*10=1000 INDIAN rupees. The charging of lithium ion battery is not possible for one year due to degradation resulting by number of charging and discharging times (possibly it needs 100 times recharging and discharging per year) and also to run it for one year due to thermal degradation. The SOFC's are operated at higher temperature 1000ºC to 1500ºC. The efficiency of SOFC's are much lower due to high input thermal energy. Instead of SOFC's steam engines operating at 300ºC can be operated to produce the electricity and to run the vehicles. Instead of high temperature SOFC's, one can use SOFC's operating at room temperature using ozone and H_2 gas and this is one advantage of it. One can also try Ozone and NaCl based electrolytic solar cell as it is cost effective when compared to inorganic, organic and polymer based solar cells. The probable mechanism of ozone and NaCl based electrolytic solar cell is presented in this paper. The probable other electrolytes instead of NaCl is also presented in this paper.

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