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Carbon Dioxide Recycler Using Nano Solar Technology

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***Abstract*— In these days, two of the most intimidate problems facing the world are climatic changes and energy substitutes. The notion of "carbon dioxide recycler using nano solar cells" is to address these interconnected challenges by developing a technology or producing nano solar fuels that is underpinned by deep scientific understanding. A guiding principle is that the technology must be both scalable to the magnitude of the problem and economically viable. Our vision is captured by one deceptively simple chemical equation:**

Solar Energy + x CO_2 + (x+1) H_2O → C_xH_{2x+2} (liquid fuel) + (1.5x+1.5) O_2

The conversion of CO_2 and H_2O to CO and H_2, which are the universal building blocks for synthetic fuels, should serve as the basis for this revolutionary alternative and that the sunlight should be used in the form of heat. More specifically we advocate accomplishing the conversion via a nano solar-driven two-step metal oxide thermochemical cycle. A thermochemical cycle can be visualized as an engine that converts heat to chemical work.

In this talk the basic principles of thermochemical cycles will be introduced and progress made towards implementation of these principles will be discussed. It was recently demonstrated by scientists that solar-driven conversion of CO2 to CO. Advances in characterizing and understanding the remarkably dynamic behaviour of the active metal oxide materials and how use of nano technology in solar cells can improve the efficiency of reactor (which is the core of this system) will be discussed in this paper.

***Index Terms*— nano solar-energy, conversion of CO_2 and H_2O to CO and H_2, nano technology in solar cells.**

I. INTRODUCTION

Solar-powered thermochemical water & CO splitting produces hydrogen using water, heat from the sun, and chemicals that are completely re-cycled(fuel), so that only hydrogen and oxygen are exhausted to atmosphere which is safer. Here only water and solar thermal energy are consumed in the cycle. All known thermochemical cycles face obstacles that could include extremely high temperature, difficult separations of chemicals during sequential cycle steps, multiple reaction steps necessary to close the cycle etc.. Many of these barriers can be solved, but generally at the expense of energy efficiency, consumption of feed stocks other than water and possibly much higher temperature to drive reactions upto completion. Also these measures add cost to the product, inhibit acceptable production rates, or prevent the realization of plant designs with acceptable lifetimes.

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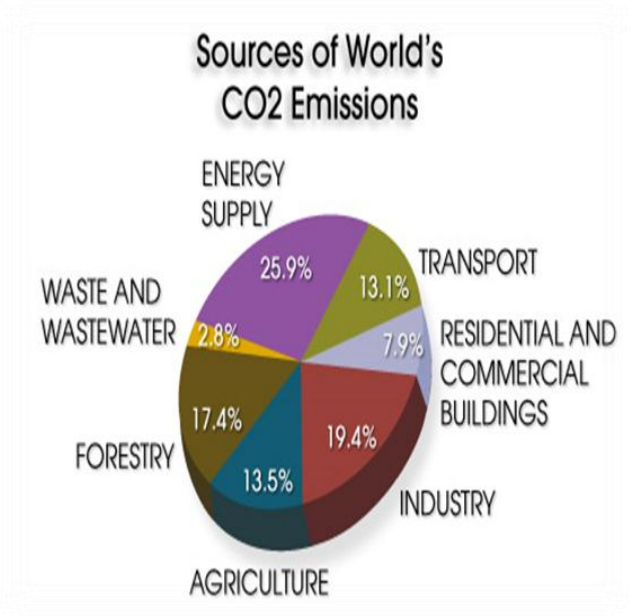
Overcoming these barriers is made even more difficult by turning to solar radiation for the driving energy source, primarily because of its transient nature and relatively low power density. The low power density characteristics of solar power requires large collector areas and efficient concentrators to drive energy-intensive process. This problem can be overcome by using nano solar cells instead of conventional solar cells. The ultimate success of nano solar thermochemical hydrogen production is contingent on developing suitable reactive materials and on incorporating these materials into an efficient nano solar thermochemical reactor.

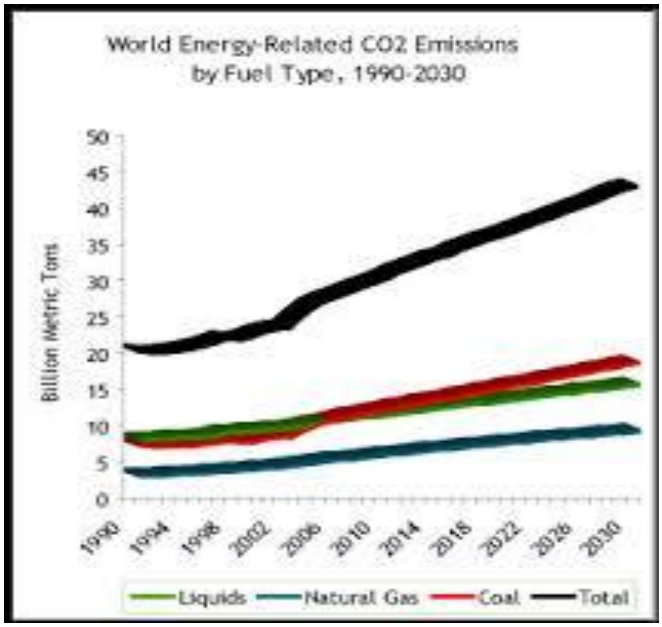
II. PRIOR ANALYSES:

Several conventional methods have been adapted to recycle and to reduce the concentration of carbon dioxide in the atmosphere. These actions are necessary since Co_2 is the largest source of green house gas. It is found that a portion of approximately 72 %of global warming is because of CO_2.Carbon dioxide and other green house gases are collected in the atmosphere as a thick blanket, trapping the sun's heat and causes the planet to warm up. Coal-burning power plants are the largest source of carbon dioxide which produces nearly 2.5 billion tons every year. Automobiles, the second largest source, create nearly 1.5 billion tons of CO_2 annually. Now let us know about some CO_2 emission analysis across the world



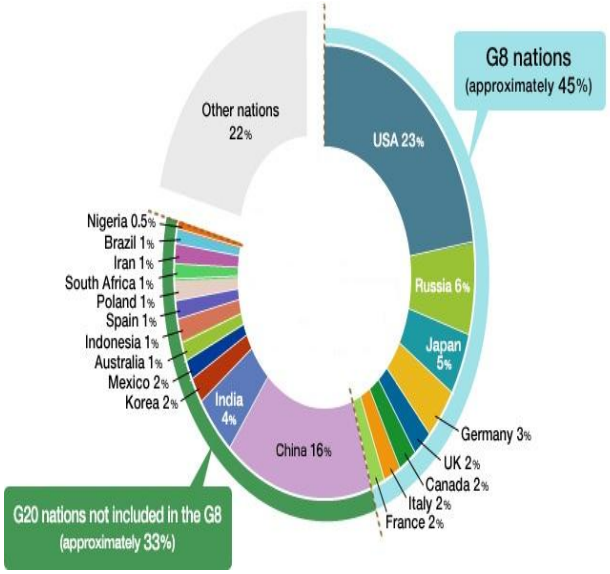
1.The energy supply plays vital role in Co_2 supply.

This picture(1) says: nearly quarter part is because emissions through energy supply sources. The minimum contribution is from emissions through waste and waste water. The industries also emits a good number. So the carbon dioxide recycler using nano solar technology combines this three sources which will recycle nearly half of the CO_2 emitted all through the world.



2.CO_2 emissions by various forms of fuels.

In this picture(2), It may be noted that the requirement of coal has been increasing continuously compared to liquids and natural gas. Its due to the fact that coal has its role almost in all fields from industries, power plants to commercial purposes.The liquids and natural gas consumptions remains steadily increasing throught the year.

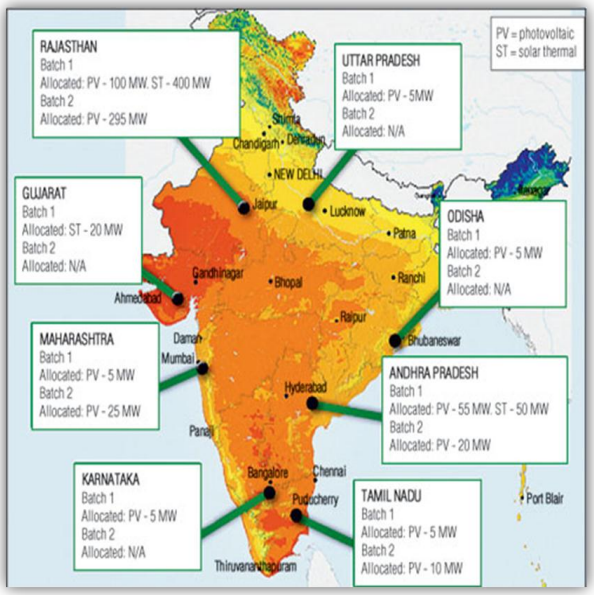


CO_2 emission of G8 nations is comparatively more since the energy requirement is more there.

From the analysis it is clearly shown that how the carbon dioxide emissions through various sources affects the environment by playing major role in green house effect thereby increasing temperature on earth's surface. These problems have a best solution called 'prevention'. But this is limited only as sentence. The increasing population and its requirements make it inconceivable. So it is preferable to recycle the CO_2 produced, which may also increase efficient usage of energy.

The reason for using solar energy as main component in recycling is that it is the most abundant and easily approachable renewable energy.

III. THE DIMENSIONS OF SOLAR ENERGY IN INDIA:



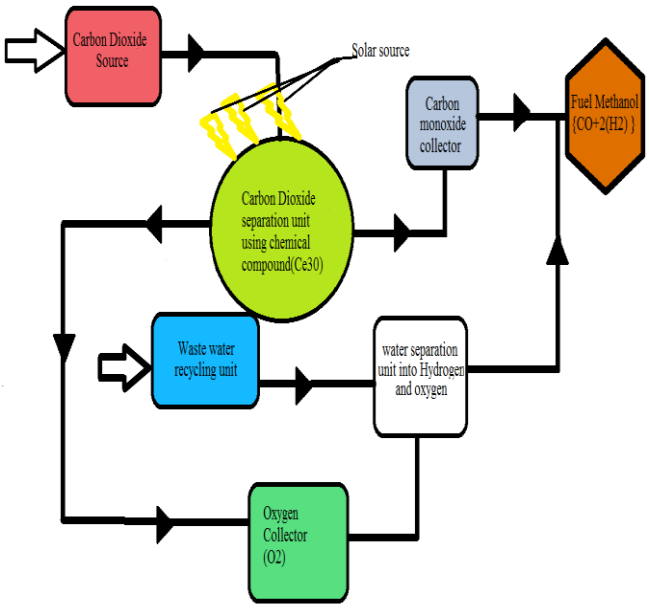
3.The figure represents the distribution of solar energy across India

It may be studied from the above picture (3) regarding the availability of solar power in separate batches and the intensity of distribution across India. The southern and western parts and some parts of central India have abundant solar resource. On the other hand, most of our country's industries and power plants are located in places where solar source is abundant. So if we install this CO_2 recyclers using nano solar technology in these places, it will contribute a considerable amount of development of the country.

IV. CONSTRUCTION:

The reactor consists of CO_2 separation unit, Waste water recycling unit, source and collectors. The CO_2 separation unit consists of two chambers. One will be maintained at lower temperature and the other side will be maintained at higher temperature. It has two vertical conveyors which carries the gas (CO_2) to be recycled. There will be two step reactions which involves two reverse oxidation reaction i.e. reduction reactions. This process is wholly called as thermo-chemical cycle. The waste water recycling unit consists of waste water which will be separated into hydrogen and oxygen. It will then be used for converting collected chemical compound into consumable fuel.

The solar energy is obtained with the use of solar panels having nano solar cells. The advantage of using nano solar cells includes the reduction of area required for installing collectors, acquiring higher temperature in lesser time, increasing panel's efficiency thereby reducing maintenance cost of recycler.



The plant layout shown below has the sketch showing entire process happening inside the plant.

V. PROCESS:

A. Nano solar cells:

Most conventional solar cells are based on silicon, which has proven itself to be versatile and inexpensive. However, it can only absorb part of the spectrum emitted by the sun. Thus it is developed to collect those other wavelengths without making any drastic changes to the basic design of solar panels.

A photovoltaic material can convert photons into electricity when the energy level of the light matches the material's optical bandgap. Silicon absorbs the infrared end of the spectrum well, but not so well in other places. The key to this new technology is taking all the wavelengths of light that silicon cannot absorb, and absorbing them by some other mean. To fill in the gaps, the researchers used a novel material composed of an array of multi-walled carbon nano tubes and photonic crystals.

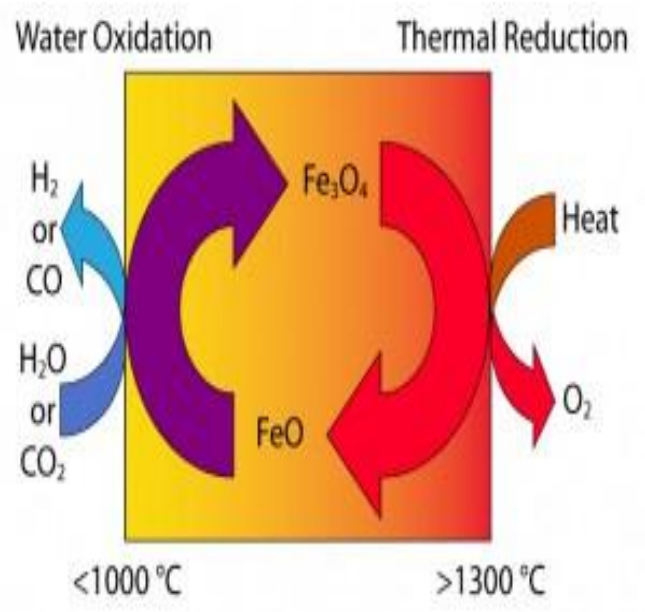
This carbon nanotube absorber is situated as a layer on top of the silicon photovoltaic cell. The absorber is very good at collecting photons from a wide spectrum of light. Unlike a regular solar cell, this process doesn't immediately result in electricity generation. Instead, the absorber material heats up in response to the light and directs that heat energy into the photonic crystal layer, which glows with light at peak intensity right in the middle of silicon's band gap. It is found that by using this technology the theoretical efficiency of this "CO_2 recycler using nano solar technology" is found to achieve around 80%.

B. Thermochemical Process:

Thermochemical process combines heat sources with chemical reactions to split either water into hydrogen and oxygen or Carbon Dioxide into Carbon Monoxide and oxygen. It divides one difficult reaction into two easier reactions at two different temperatures. The following reaction occurs, based on Iron oxide to split Carbon Dioxide

i) $Fe_3O_4 + Heat = 3FeO + 1/2O_2$
(Higher Temperature Oxidation)
ii) $3FeO + CO_2 = Fe_3O_4 + CO$
(Lower Temperature Re-Oxidation)

Net Reaction of (i) and (ii) is,
$CO_2 = CO + ½ O_2$
And
$H_2O = H_2 + ½ O_2$



Layout of carbon separation unit

After splitting the carbon monoxide(CO) will be sent to a separate collector tank. (CO Storage tank).

Meantime, the waste water treated by the action of heat will divide into hydrogen and oxygen molecules. On the other hand, the formation of intial reactant Fe_3O happens due to Re-oxidation.

The splitted by-products hydrogen, oxygen and carbon monoxide will undergo chemical reaction in reactor in the presence of heat. This will form the fuel 'methanol' and 'oxygen'. The oxygen can be released into atmosphere.. The methanol has several advantages in various aspects. Some are:

(i)Transportation fuel
(ii) Waste water Denitrification
(iii) Fuel cell Hydrogen Carrier
(iv) Biodiesel transesterification
(v) Electricity generation
(vi) Chemical Feedstock

This most efficient way of recycling the green house gas helps in the thrive of mother earth.

VI. CONCLUSION:

The modification done in this project improves its efficiency to a considerable level. It is also considered to be an economically stable one. Ongoing work is focused on materials and reactor improvements and on demonstrating a steady state operation and establishing record efficiencies. It is believed to be possible in 7 to 8 years to become as a market ready device. Success will consist of continuously improved generations of prototypes and Carbon Dioxide recycler systems using nano solar technology. A new generation with significant improvements in performance (measured as the amount of solar energy converted into fuel), greater durability and reduced cost is found to be in near future.

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