

SOLAR ENERGY – ITS USE IN DENTISTRY

Abstract:

The global demand for energy is currently growing beyond the limits of production. To meet future energy demands efficiently, an effective renewable energy solution should be investigated. Although many renewable sources of energy are available, yet solar energy is one of the promising option as it is abundantly available to be tapped. Through this paper, an attempt has been made to review the potential use of solar energy in dentistry.

Keywords: Solar energy, dentistry

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Date of Submission : 16/1/16

Date of Acceptance : 24/2/16

INTRODUCTION

In a country like India, where majority of the people are residing in the rural areas in which electricity is one of the major problem, so to overcome the issue of the electricity an alternate source of energy need to be investigated for providing electricity to the people residing in those areas. Renewable energy sources need to be explored. Solar energy is one such source, as an amount of solar/sun energy which strikes the earth surface is greater than annual global energy consumption.⁽¹⁾ It has been estimated that the solar energy which is being received by the earth surface is more than 1500 times the world's commercial energy

consumption and 100 times more the world's coal, gas and oil reserves. Moreover, the solar energy is available all the day along to be tapped by anyone and that too free of cost.⁽²⁾

Solar energy is produced by thermonuclear process leading to production of heat and electromagnetic radiations. Approximately 650,000,000 tons of hydrogen is converted into helium every second.⁽³⁾ In spite of this, the solar radiation energy coming to earth is some 200,000,000 billion kWh. On a clear sunny day, between 800-1000 W/m² (global radiation) reaches the ground as some of the radiations are lost while penetrating the atmosphere.⁽⁴⁾ These solar radiation thus can be converted into electricity by means of

Photovoltaic cells.

Now a days, the solar energy is finding its way in day to day use not only in urban areas but also in rural areas and far away places where availability of electricity is a problem.

Solar energy driven products provides a compelling solution for remote and off-grid communities, particularly rural areas of the developing countries, which may not have reliable access to consumables such as gas or may have only very expensive gas.⁽⁵⁾

This article intends to review the potential usage of solar energy in dentistry which ranges from mobile dental vans, dental instruments, oral hygiene maintenance, sterilization of instruments, electricity for lights and air conditioners.

Solar Powered Toothbrush

A mechanical toothbrush powered by the sun. First invented by Dr. Yoshinori Nakagawa (Japan) and first manufactured in the year 1980. Dr. Kunio Komiyama, a dentistry professor emeritus at the university of Saskatchewan, designed the first model of solar powered toothbrush. Newer model of light-activated toothbrush, (Soladey-J3X) is incorporated with a TiO₂ semiconductor and a solar panel. It does not work in the dark, though the brush needs about as much light as a solar-powered calculator would to operate.⁽⁶⁾

Mechanism of action of Soladey-J3X Ionic toothbrush (Fig. 1)

When exposed to any light source (a fluorescent bathroom light, a plain light bulb, or sunlight), the photosensitive titanium rods inside Soladey-J3X converts light into negatively charged electrons (ions). The rods release these ions, which blend with saliva to attract positive (hydrogen) ions from the organic acid in the dental plaque causing its decomposition. The reaction could also have an effect on plaque formation.⁽⁷⁾ There is also evidence that the powdered TiO₂ semiconductor irradiated with visible light has a bactericidal effect against Escherichia coli and streptococcus mutans.⁽⁸⁾

Advantage of Using Soladey⁽⁶⁾

- The Ionic Process is activated simply by light and water
- Titanium dioxide rod produces ions to break down plaque
- Requires little or no toothpaste
- Works on tough dental stains, encourages whiter teeth
- Convenient to keep in your car, bag, and child's lunchbox so ideal for travel or where water is unavailable
- Cleans and refreshes dentures and braces
- No electrical cords or batteries
- More effective for plaque removal than an ordinary toothbrush
- Ionic action in the saliva is naturally antibacterial and continues after brushing
- Brush handle and titanium dioxide rod can last a lifetime
- Uses economical changeable brush heads.

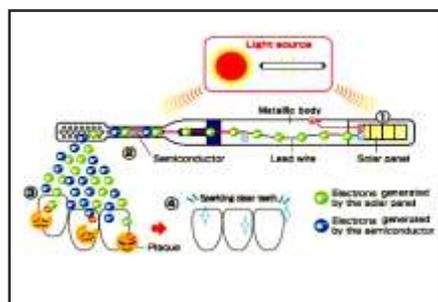
Solar Powered Portable Dental Kit (Fig. 2)

Is a self contained portable dental system which is powered by solar energy. This helps a dental professional to provide services in remote rural areas(as the kit contains chargeable battery for micrometer-handpiece and foot control), high in Himalayas or Amazon jungles. With this system, there is almost a minimal use of electricity as the power is supplied by solar panels and there is no use of wall plugs. It is in use by the US Army and US marine corps since 1995 and many humanitarian organizations.⁽⁹⁾

Solar powered Autoclave

Mechanism of action :

Solar energy operated autoclaves are being developed which make use of broadband light absorbing particles



Legend to Fig. 1

Mechanism of action of Solar Powered Toothbrush
Source: <http://www.connect-green.com/tag/solar/>



Legend to Fig. 2

Solar Powered Dental Kit
Source: Brochure Bell dental products



Legend to Fig. 3

Solar powered dental van
Source: Dental Tribune; the world's dental newspaper South African Edition – Oct 2013

(Nanoparticles) such as metallic nanoshells, nanoshell aggregates, and conductive carbon nanoparticles. These nanoparticles when dispersed in aqueous solution and illuminated by sunlight, have been shown to convert absorbed solar energy to steam at an efficiency of just over 80%, where less than 20% of the energy contributes to heating the liquid volume. In the solar steam generation process, broadband light-absorbing nanoparticles create a large number of nucleation sites for steam generation within the fluid. As the light is absorbed by a nanoparticle, temperature difference between the nanoparticle and the surrounding fluid is established because of a reduced thermal conductivity at the metal-liquid interface: this local temperature increase may become sufficient to transform the liquid in the direct vicinity of the nanoparticle into vapor. On sustained illumination, the vapor envelope surrounding the nanoparticle grows, eventually resulting in buoyancy of the nanoparticle-bubble complex. When this complex reaches the surface of the liquid, the vapor is released, resulting in a vigorous non equilibrium steam generation that does not require the bulk fluid temperature to have reached its boiling point.⁽¹⁰⁾

With nanoparticle dispersants, temperatures of both the liquid and the steam increases far more rapidly than the temperature of pure water, with the liquid water reaching 100°C more rapidly with nanoparticle dispersants than water without nanoparticles. Using a solar concentrator (Fresnel lens or dish mirror) to deliver sunlight into the nanoparticle-dispersed aqueous working fluid, this process is capable of delivering steam at a temperature of 115–135°C into a 14.2-L volume for a time period sufficient for sterilization.⁽¹¹⁾

Solar powered mobile dental and medical clinic (Fig. 3)

The seven-meter solar powered mobile dental truck is designed to provide crucial health services to the people living in rural areas and far off places of Africa. The truck has compartments that help health professionals provide hearing diagnostics as well as eye and blood tests. It even has a small dental clinic. The truck's dental clinic has a dental chair, an x-ray unit, a water distiller and a needle incinerator. Solar panels on the truck charge the truck's lighting and the TV that shows public information, videos to patients as they queue for medical services. It also relies on an inbuilt generator to help power the truck's other equipment. Apart from providing health service, it also helps in providing education to the people. This is done through a 12-meter solar-powered internet school that can accommodate at least 21 people. Twenty four solar panels provide nine hours of power a day to this mobile classroom. It is equipped with laptops and even a 50-inch electronic board.⁽¹²⁾

Solar powered electricity

Solar powered electricity is the direct conversion of sunlight into direct current (DC) electricity. Before it can be used in homes and business (Clinic), it has to be changed into alternating current (AC) electricity using an inverter. The inverted/ changed current then travels from the inverter to the building's fuse, and from there to the appliances that need it. Energy storage (battery) is needed for night use when no sunlight is there. PV panels use the photovoltaic effect to turn the sun's energy directly into electricity, which can supplement or replace a building's usual supply. To generate as much electricity as possible, PV panels need to spend as much time as possible in direct sunlight. A sloping, south-facing roof is the ideal place to mount a solar panel.⁽¹³⁾

Solar Hybrid Air Conditioner

This refers to air conditioning (cooling) system that uses solar energy or off grid power supply. An air-conditioning system utilizing solar energy (absorption cooling systems) would generally be more efficient, cost wise, if it was used to provide both heating and cooling requirements in the building it serves.⁽¹⁴⁾ Solar energy heats a fluid that provides heat to the generator of an absorption chiller and is re-circulated back to the collectors. The heat provided to the generator drives a cooling cycle that produces chilled water. The chilled water produced is used for cooling. Solar thermal energy can be used to efficiently cool in the summer, and also heat domestic hot water and buildings in the winter. Efficient absorption chillers nominally require water of at least 190°F (88°C).⁽¹⁵⁾

Sensitive dentistry clinic in Port Charlotte, Florida, United States, became the first dental clinic to use solar energy system as cooling method. The five ton hybrid air conditioning unit was installed, which comes with a rooftop solar panel. With a typical air conditioning system, the compressor accounts for most of the energy consumed. The hybrid system uses its solar panel to collect the sun's heat, which is converted to energy that refrigerates and warms the air, allowing it to completely bypass the compressor. It also uses heat pump rather than the standard electric coils. Unlike a photovoltaic solar panel system, solar air conditioner doesn't require constant direct sunlight and can run for four days on just four solid hours of sun.⁽¹⁶⁾

Solar powered production of Plaster of Paris

Solar power is also finding its way in the production of plaster of paris. Solar energy provides the required heat for the calcination process. The plaster of paris produced with the help of solar energy is of much superior quality (in term of whiteness and setting time) as the one produced in which

heat source is wood, coal and diesel. This superior quality of plaster of paris will be very useful product in dentistry.⁽¹⁷⁾

Conclusion

Solar energy is an important part of life and has been since the beginning of time. It is capable of producing the raw power required to satisfy energy needs of the entire planet with the advantage of being one of the least destructive energy source. Use of solar energy in dentistry has proven to be promising. However, further studies are required to explore the hidden potential of solar energy in this field.

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