Solar Electroplating

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Abstract-Energy is the most urgent need of modern world. Most of the operations in the World around are using non-renewable source of energies. Many companies are working in the Field of electroplating. The current industries are using Low Volt DC (12 V) and High DC Current for electroplating. To achieve this, companies use rectifiers (up to 1000 Amps), which have high losses. Also the current generated is not completely pure DC. The paper here proposes to use solar energy for the process of electroplating. Solar energy would require suns energy to produce Low Voltage DC (12 V) and High DC Current.

Keywords: Electroplating, Solar Energy

I. INTRODUCTION

Solar energy is the most exploited resource compared to all other sources of renewable energy. If statistics are to be believed then 13% of the world's energy requirement is met through the use of renewable energy sources and of these 13% only 1% is supplied using solar energy.

Sun is the most abundant sources of energy and yet its energy is exploited very less hence there is huge possibility to exploit this resource for the betterment of the modern world. The earth globally requires a total of 500 exajoules of energy while the global energy received by the earth from sun in the year 2000 was 1575 exajoules hence sun roughly provides us with an average of three times the energy required by us but we are capable of harnessing only 1% of our total energy requirement from the sun. The need of efficient and quick usage of solar energy is thus the demand of the hour.

Use of sunlight is increasing every day and in various domains of life. Use of solar energy for cooking, for heating water, for producing small amount of energy is practiced in the world extensively now a days. To use sun rays to produce energy using photovoltaic cells has been in practice from 1954. Since sun is such a powerful and huge source of energy its rays could also be used in processes requiring large amount of energy such as ELECTROPLATING [1, 2].

II. ELECTROPLATING

Electroplating is the process of reducing dissolved metal cations using current to from coherent metal coating on the electrodes. Electroplating is also referred to as electrodeposition and is analogous to a galvanic cell working in reverse manner. Electroplating in very basic terms is defined as electrical oxidations of anions onto on a solid substance.

Electroplating and modern chemistry was formulated by Luigi V. Brugnatelli in 1805 and the first industry to use electroplating commercially was 'Norddeutsche Affinerie' in Hamburg in the year 1876. As the science grew its relationship between various metals was established and currently electroplating concept is used extensively in making utensils, for providing a chromium coating on various places like cars, to make inexpensive jewellery, to provide anti rust coating on metals and in other such applications [1].

Most of the current industries do electroplating using Low Volt DC (12 V) and High DC Current. To achieve this, companies use rectifiers (up to 1000 Amps), rectifiers as devices involve various losses in the circuit, an aspect of most rectification is the loss from the peak input voltage to the peak output voltage, caused by the built-in voltage drop across the diodes (around 0.7 V for ordinary silicon p–n junction diodes and 0.3 V for Schottky diodes). Half-wave rectification and full-wave rectification using a centre-tapped secondary produces a peak voltage loss of one diode drop. Bridge rectification has a loss of two diode drops. This reduces output voltage, and limits the available output voltage if a very low alternating voltage must be rectified. As the diodes do not conduct below this voltage, the circuit only passes current through for a portion of each half-cycle, causing short segments of zero voltage (where instantaneous input voltage is below one or two diode drops) to appear between each "hump" [1, 2, 8].

A conventional electroplating method is shown below which is currently used in many industries to produce electricity.

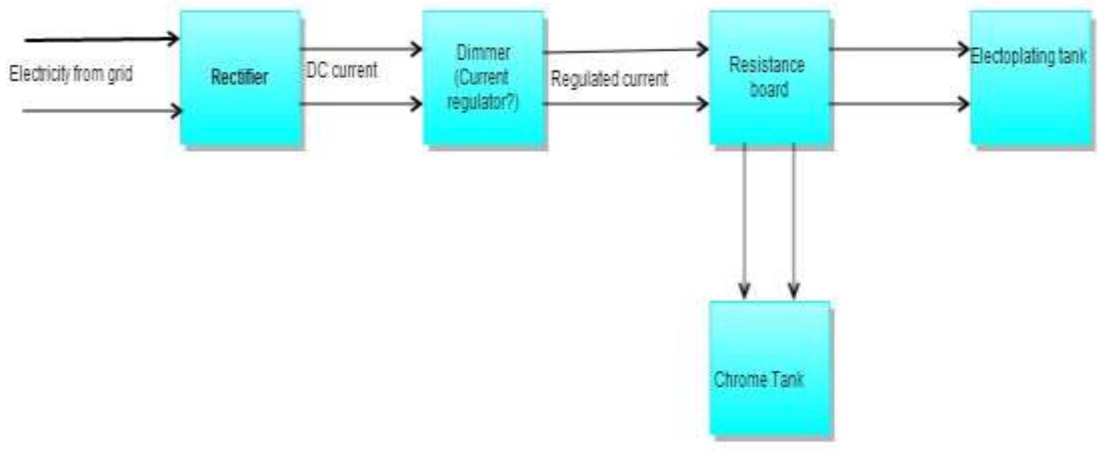

Figure 1: Block diagram of typical electroplating system

The various components used in the mechanism are explained below.

- Rectifier-High voltage AC to Low Voltage DC, current varying from 50 Amp to 2000 Amps
- Resistance board-To control the amount of current needed by changing the resistance, works more like a potentiometer.
- Dimmer-It regulates the amount of current flowing to the electroplating tank.

- Electroplating Tank-the tank in which electroplating is done. Its dimensions can vary according to the component which the industry uses for electroplating [5, 6].

The above system comprises many components explained above, but with the introduction to different components there introduces errors and complexities like the chrome tank involves expensive maintenance, the rectifier losses have already been stated above, transmission of dc current invokes various losses in the system, true regulated current is very difficult to obtain and requires expensive corrective mechanism to filter the waves.

Hence owing to so many of the losses above the system involved is quite expensive and becomes further quite expensive for the costumers thus not feasible enough. Cheaper the produced electricity, better it is for the consumer and subsequently better for the nation because more number of people can afford it [7-8].

III. METHODOLOGY

The paper here proposes to use solar energy for the process of electroplating. Solar energy would require suns energy to produce Low Voltage DC (12 V) and High DC Current. The use of solar energy here inculcates many advantages stated hereafter.

- Solar energy can be much cheaper for electroplating as solar panels generate DC at suitable voltage.
- Voltage can be directly utilized here which will give us much higher efficiency.
- Cost of the system will be reduced, as we do not need inverter and batteries here.
- Expected payback period would ideally be around 2 years, thereafter the system will work for minimum another 15 years giving free electricity for 15 years.

Various elements and the amount of various parameters discussed below are shown in tabular format.

Table I: Requirements for electroplating

Materials to be deposited	Temperature of Electrolyte (^{0}C)	Voltage Required (V)	Current Required (Amp)
Ni	50-55	12	600
Cu	50	6	200
Sn	60	12	100
Zn(Cyanide)	30-35	12	500
Zn(Acid)	55-60	6	300

The above diagram indicates the ideal temperatures for the electrolytes to function properly. The ideal temperature for the optimum behaviour of nickel electrolyte as shown above is 50-55^{0}C which is used extensively in electroplating industries.

Zinc on the other hand can behave and exist in two distinct forms which are Zn as cyanide ion and Zn as acidic ion. Both of the ions are used in very large values in industries [8].

Solar energy can now be used easily for the above process as stated and shown.

The use of solar energy in electroplating is explained below through a chart whose components are almost similar to the components explained above.

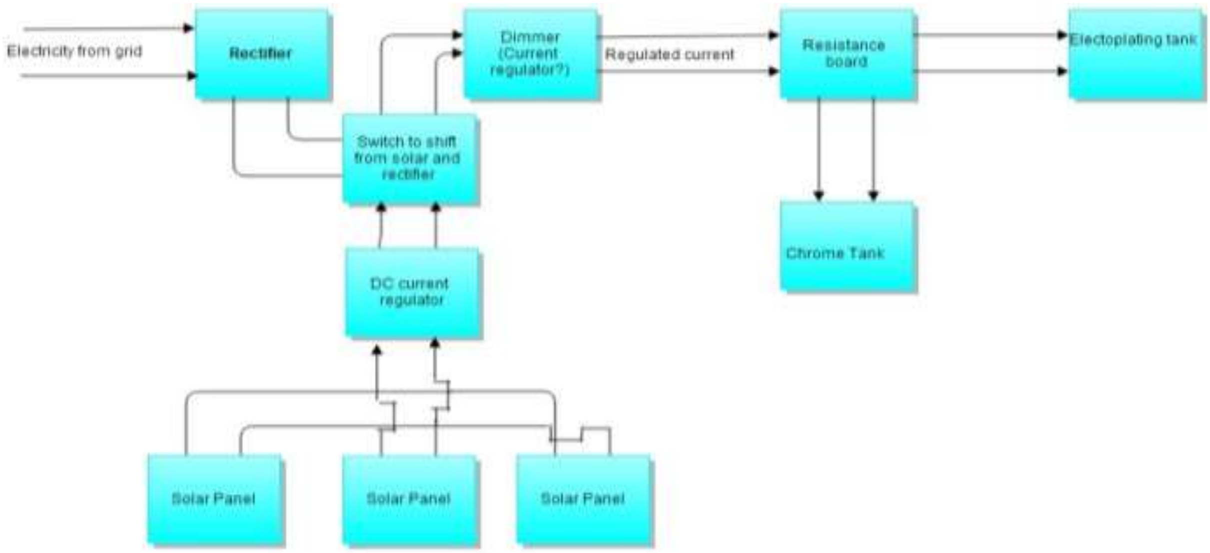

Figure 2: Solar Energy in Electroplating

IV. RESULTS

The mathematical proof to demonstrate the efficiency and proficiency of the above system is explained below.

Suppose we have a solar panel of 240W rated at 24V. It will generate 10A current at STP. Let's consider its average current to be 9A.Then no. of panels needed=500/9=56 (approximately) all connected in parallel.

Cost of panels= Rs. Per watt X Panel Size (in watts) = 55*1000= Rs55,000/-

Wiring=Rs3, 000/-

Mounting Frames= Rs3, 000/-

Switch and other cost=Rs 10,000/-

Total cost of system= Rs71, 000/-

Power Saved per year = per unit rate X per day units generated X sunny days

= Rs 8 X 8 X 300

Estimated return period = 3.4 years.

Now if we compare their existing power source to Solar, then existing rectifiers are about 60-70 % efficient which indicates poor efficiency and also the output is not pure sine wave which can affect the functioning of many devices adversely. Hence the useof Solar is expected to get better electroplating results with about 2 year's payback. The system is expected to payback for at least next 15 years there-after.

V. CONCLUSION

The use of solar energy in this innovative manner is very profitable both for the energy producers and consumers as this method could be very cheap in application which can help in reducing prices of energy generation which is the need of the hour. The method is also very clean has the potential to utilisesuns energy to the maximum and optimum levels very efficiently.

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