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Solar pond – A nonpolluting energy reservoir for heating plating solutions

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This paper reports the feasibility studies on the use of solar pond for low temperature heating applications. Unlike other solar energy technologies, solar ponds can withstand daily fluctuations in solar radiations and can provide low temperature thermal energy on a large scale with cheap materials indigenous to the siting region. In addition, solar ponds share solar energy's advantages, by being nonpolluting and available free of cost.

Key words: Solar pond, nonpolluting energy reservoir, electroplating

INTRODUCTION

Techniques for conserving materials and energy receive great attention during the recent years because of the continued energy crisis and fast depletion of fossil fuels and limited world mineral resources. Electroplating industries are no exception to the conservation measures to be followed in various processing sequences [1–3]. Many electrodeposition processes operate at elevated temperatures and therefore some form of heating must be provided for the electrolyte. Three principal forms of heating are used in the metal finishing industry, namely, electric immersion heaters, steam heating coils or gas heaters. Solar energy may be able to provide a significant amount of this energy and may be particularly attractive because it is a perennial and nonpolluting source of energy. There are a wide variety of solar collector types viz. flat plate collector, concentrator, vacuum tube collector and solar pond. One collector concept particularly attractive for low temperature applications is the solar pond. This paper reports the feasibility studies on the use of solar pond for heating, plating and anodising solutions.

SOLAR POND

Solar energy is an abundant and renewable energy source. The utilization of this energy source has been limited on account of the high cost of collecting solar energy. The intermittent nature of solar radiation is another major drawback. If continuous supply of energy is required, then some form of storage becomes essential. For collecting solar energy on a large scale, conventional flat plate collector becomes impractical on account of the large plumbing cost. A large body of water is potentially an inexpensive horizontal collector of large surface area with provision for energy storage. In a large lake, the solar energy absorbed at the bottom of the lake is transferred to the surface by buoyancy driven convective motion. Heat is lost from the surface by convection, radiation and evaporation. Hence the temperature at the bottom of a large lake is not much higher than the ambient temperature. If the hot fluid at the bottom of the lake is prevented from mixing with the cold fluid at the surface then the temperature at the bottom of the lake can be maintained as high as 60° above the ambient temperature [4–6].

Solar ponds are shallow bodies of salt solution with a black liner, heated by solar radiation, in which thermal convection is prevented by a saline gradient. Solar ponds, which act as a combined heat collector and storage, can provide sufficient thermal energy for many applications requiring heat generation in industrial, commercial or rural community settlings. The depth of the nonconvective or salt gradient solar pond varies from 1 to 3 metres, in which a portion of the pond's depth is stabilised against convective heat motion by dissolved salt with more salt toward the bottom than the top. This salt gradient counteracts the thermal density gradient caused by solar radiation absorbed at the pond's bottom and prevents fluid motion within the gradient layer. This layer serves as both insulation and storage and permits the lower layer of the pond, which does convect, to reach temperature close to the boiling point, while the surface convective layer is near ambient temperature.

At first place, solar ponds are relatively simple in concept, consisting mainly of a shallow pit in the ground, water and some salt. Sodium chloride, magnesium chloride and concentrated sea water are the salts usually used, although many other salts are also possible. In many locations excavation, salt, and water are readily available, resulting in low cost plus the use of ingenuous resources. This gives the solar pond a special attraction for developing countries that are concerned about the export of capital to purchase either fuel or energy producing devices. Solar ponds employ well established technologies for most of the construction and general operation practices. Examples include installation of pond liners, pumping of fluids, and delivery of heat to a load. Control of biological organisms and maintenance of pond transparency also play important roles. Operating costs are expected to be low. While fluid pumping is usually necessary to extract heat from the solar pond, collection and storage are completely passive. In areas of high evaporation, a source of make up water must be provided to keep the pond surface from falling too much. Sea water and many brackish waters have sufficiently low salinity for this purpose.

Solar pond has been already put into use for hot water heatings, space heating, swimming pool heating, grains drying, desalination, solution mining, power generation etc.

COST

Solar pond is considered as one of the inexpensive ways for collection and storage of solar energy. Israelis, who have extensive experience with solar ponds, claim that solar ponds can be built for as little as Rs.100 per m^2 of collection area. This is very low when compared to conventional flat plate collectors whose cost exceeds Rs.2000 per m^2. The following is the breakdown cost for a big solar pond given by Srinivasan [6]: 800 MJ of heat was extracted from a 240 m^2 area pond under Bangalore climatic conditions at 13% thermal efficiency using copper heat exchangers (Table I).

TABLE–I: Cost breakdown for solar pond

1.	Digging, trimming and bunding	...	Rs. 30
2.	Plastic liner	...	Rs. 30
3.	Clay	...	Rs. 80
4.	Salt	...	Rs. 80
5.	Heat exchanger	...	Rs. 50
	Total	...	Rs. 200/m^2

CONCLUSION

Solar ponds collect and store solar energy for use at temperatures below the boiling point of the lower zone brine. Solar ponds have lower cost than conventional flat plate collectors in all locations and much lower cost in favourable locations. Typically the average energy gain per unit area of the pond is comparable to that of a flat plate collector working with the same average storage temperature. Solar ponds have the advantages of lower cost and large intrinsic heat storage capacity. Pond limitations are the impossibility of erecting on roofs or tilting for high altitude use and the heat losses to the earth that make uninsulated small ponds inefficient. On account of these losses, ponds of only a few hundred square meters area for individual house or water heating are not economically competitive.

REFERENCES

1. G F Cubert, *Plat Surf Finish*, **68**-5 (1981) 14
2. T M Mooney, *ibid*, **67**-12 (1980) 12
3. D A Mazzeo and W D Holcombe, *Plating*, **66**-3 (1979) 26
4. A Rabl and C E Nielson, *Solar Energy*, **17**-1 (1975) 12
5. N R Sheridan, *Solar World Congress*, (Ed) S V Saoko lay, Vol. II, Pergamon Press, (1983) p 1009
6. J Srinivasan, *Small Solar Ponds for Low Temperature Process Heating*, KCST Report 86 SP2, Bangalore, India (1986)