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Review article

Solar ponds â˜†

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Abstract

This report provides the background to, and the current status of, solar ponds as proven viable large-area collectors capable of providing both low-cost thermal energy and mechanical or electrical energy using state-of-the-art low-temperature turbo-generators.

After a short background statement giving the history and motivation to create a viable large-area collector with built-in storage, the basic theory of salt-gradient solar ponds is sketched. (More detailed-theory is available from the given references, particularly two recently published handbooks.) NaCl and $MgCl_2$ are two common and low-cost salts suitable for solar ponds. A number of problems such as the adverse effect of wind, leakage, foulingâ€”and their solutionsâ€”are indicated as are some fundamental constraints (Section 8) that limit the sites suitable for solar ponds. Practical details include how ponds are built and filled and how the heat is extracted. Section 7 presents a condensed account of solar pond experience in a number of countries.

Practical operating temperatures of 90Â°C are obtained with collection efficiencies usually between 15 and 25 per cent: this permits a number of practical applications as discused in Section 10, i.e. heating and cooling, power production and desalination.

Realistic pond cost figures indicate thermal energy costs equivalent to US$41 per ton of fuel for a sunny climate (using a conservative 11.7 per cent annual charage on capital): such low-cost calories permit thermodynamic conversion to power: although the conversion efficiency is low, the solar pond power station (SPPS) is viable in many cases. Bus-bar power costs, for a sunny climate, vary from a high of US13.5 cents/kWhâ€"using present technologyâ€"to a low 5.3 cents in sizes of 20 GWhr(e) per annum or larger.

A 150-kW SPPS has already been built and successfully operated in Israel since December 1979 and a 5000-kW unit is due for completion in the next 2 yr.

The ability of a solar pond to store heat even from summer to winter greatly increases its usefulness in almost all applications: for power production, the SPPS canâ€"like a hydro-electric plant, provide peaks of power, on demandâ€"far in excess of the pond mean capacity. The estimate that SPPS costs flatten out at 20â€"40 MW is of interest to developing countries that could install generating capacity in relatively small steps as demand grows.

[a] This survey paper on salt-gradient solar ponds was prepared at the request of the U.N.â€ as part of the preparatory process in connection with its Conference on New and Renewable Energy Sources to be held in August 1981â€"whose permission to reprint here is gratefully acknowledged.

This paper was prepared for a specific audience and does not attempt to reference all the works reported. (SERI is currently preparing a comprehensive bibliography on solar ponds.)

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