PERFORMANCE EVALUATION OF A SOLAR POWERED SOLID ADSORPTION REFRIGERATOR UNDER A TROPICAL HUMID CLIMATE

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ABSTRACT

A solar powered intermittent cycle solid adsorption refrigeration system was developed and tested in Akure, Nigeria (Latitude 7.25^o N, Longitude 5.08^o E). The system utilized granular 70% $CaCl_2$ + 10% activated carbon + 20% $CaSO_4$ / NH_3 as an adsorbent/adsorbate pair. Initial and final condensate liquid volume, evaporator surface temperature, evaporator water temperature, adsorber plate surface temperature and ambient temperature were measured during adsorption. The adsorber plate surface temperature, condenser water temperature, condensate volume and ambient temperature were recorded during the generation of adsorbate. The data collected were reduced, using appropriate physical equations, to determine the Coefficient of Performance (C.O.P) of the Solar Refrigerator. Ambient temperatures during adsorption and generation ranged over 24^o – 29^{o}C. Performances of 1123.09 - 1186.2 kJ/m^2 per day of available cooling were obtained. The best cooling obtained was 438.57 kJ/m^2 per day of collector-exposed area. The refrigerator had an overall C.O.P of 0.021 - 0.033 whilst its daily ice production was 0.49 – 0.63 kg/m^2. The C.O.P and the daily ice production were higher than those reported in the literature for systems with solar collector plates coated with black paint and which utilized $CaCl_2$/NH_3 as working pair.

Keywords: Intermittent-cycle, solid-adsorption, solar-refrigerator, cooling, adsorbent, adsorbate, coefficient of performance, climate.