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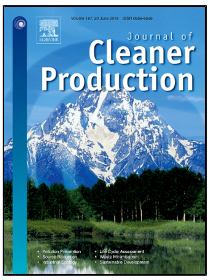

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Effects of nanoparticle-enhanced phase change material (NPCM) on solar still productivity

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Abstract

This paper investigates the effects of nanoparticle-enhanced phase change material (NPCM) on solar still operation and performance. Technical and economic aspects were considered, to show an advance on earlier works using virgin phase-change materials (PCM). Three types of nanoparticle (TiO_2, CuO and GO) were impregnated individually at 0.3 weight% in paraffin to form NPCM-1, NPCM-2 and NPCM-3 respectively. Experiments were conducted with four solar stills (SS) each of 0.5 m^2 area using respectively paraffin (SSPCM), paraffin-TiO_2 (SSNPCM-1), paraffin-CuO (SSNPCM-2) and paraffin-GO (SSNPCM-3). There was observed an increase in thermal conductivity and a reduction in melting and solidification temperatures, with NPCM compared to PCM. The effects of NPCM on water temperature, storage temperature, hourly and annual productivity were determined. SSPCM, SSNPCM-1, SSNPCM-2 and SSNPCM-3 yielded 3.92, 4.94, 5.28 and 3.66 l/m^2/day respectively, corresponding to 26 and 35% increases in productivity of SSNPCM-1 and 2 respectively over SSPCM. Economic analysis showed cost per liter (CPL) of water of \$0.035, \$0.028, \$0.026 and \$0.13 for SSPCM, SSNPCM-1, 2 and 3 respectively. Considering the advantages in productivity and CPL, SSNPCM-2 can be recommended as the best solar still compared to SSPCM, SSNPCM-1 and 3, providing clean water at less than half the cost of bottled water in India.