Performance of a element plane reflector augmented flat plate collectors for solar water pasteurisation

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Abstract

Access to safe and adequate water supply and improved sanitation is a fundamental need and a basic human right vital for health and dignity of all people. The situation has therefore called for concerted effort which has been expressed in the global commitments reiterated in the Millennium Development Goal (MDG), to reduce to half the population of people who lack access to safe and adequate water supply by 2015 and provide safe and adequate water for all by the year 2025. There are various techniques that have been used ,to disinfect water and make it safe to drink. These include: chlorination, ultra-violet disinfection, use of ozone gas, pasteurization and mixed-oxidant gaseous systems which is the most recent technology. Conventional water treatment methods rely heavily on chemicals, high energy consumption, use of expensive equipments and huge capital investments. Although they are suitable where large amount of water is required, they are not suitable for most rural settings existing in Kenya today that are normally scattered making centralized system a very expensive venture. Direct application of heat is one of the oldest and most reliable method of water disinfection. This study has pursued the concept of heating water using solar thermal energy to kill disease causing organisms, mainly E. coli which is one of the major indicator of fecal pollution in water. The direct heating of water was investigated using a 2m2 flat plate collector with a 2- element plane mirror reflector used to concentrate solar radiation from an aperture area of 4m2. Two experimental collectors were investigated; one having 20mm diameter galvanized pipe with a 26 gauge stainless steel absorber sheet and the other with 18mm diameter copper pipe with a 32 gauge aluminum absorber sheet. In both investigations, collector without reflectors was used as control experiment. Thermal performance tests have been conducted using continuous flow operation at controlled flow-rate (30±31/hr and 40±31/hr) and using pasteurization tests with thermostatic valve installed with a valve opening temperature of 82°C. In both the experimental systems under investigation it was observed that the use of mirror increased the day average instantaneous efficiency by up to 10% during continuous flow operation and up to 100% in output of pasteurized water discharged via the thermostatic valve. Water quality tests were done for both raw and pasteurized water samples using presumptive test for total coliform and Eijkman test for confirmation of E. coli in water. There was no E. coli found in pasteurized water. Data analysis was done using both descriptive and inferential statistic. An economic analysis of the solar pasteurization system has indicated an annual saving of up to 5tonnes of wood for collector with reflectors and an aperture area of 4m2 having a daily pasteurization output of up to 1001iters for a day under clear sky condition with an average solar radiation

of 720W/m2, ambient temperature of 28°C and average wind speed less than 2m/s. Thus, the adoption of this study would not only reduce the number of uses of water borne diseases such as cholera and typhoid which have been identified as major cause of morbidity in Kenya by the Health Sub-sector Strategic Plan (19992004) but also lead to a reduction in environmental degradation, green-house gas emissions and health effects associated with inhaling smoke.