

Experimental comparison of two specialised cooking pots during partly cloudy conditions using parabolic dish solar cookers

Ashmore Mawire¹, Sunita Mahavar^{1,2}, Oyirwoth P. Abedigamba^{1,3}, Patrick Tsopbou Ngueagni¹, and Katlego Lentswe^{1,4}

¹Material Science, Innovation and Modelling (MaSIM) Research Focus Area, North-West University (Mafikeng Campus), Private Bag X2046, Mmabatho 2735, South Africa

²Solar Energy Research Laboratory, Department of Physics, University of Rajasthan, Jaipur 302004, India

³Department of Physics, Kyambogo University, P.O. Box 1, Kyambogo, Uganda

⁴School of Electrical, Electronic and Computer Engineering, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa

Abstract

Solar cookers perform well during sunny days, but their performance during cloudy periods is poor. Most of the solar cooking tests presented in recent literature, including the test protocols, are for ideal clear sky sunny conditions with little or no clouds. Very little work has been reported on solar cookers in partly cloudy conditions. This work compares two specialised cooking pots using 1.5 m parabolic dish solar cookers to evaluate their performance during partly cloudy conditions. A 4-litre pressure-cooking pot is compared to a 4-litre heavy base cooking pot under partly cloudy conditions to see if it is possible to boil water in variable high and low solar radiation conditions caused by cloud cover. With an average partly cloudy solar radiation value of 549 W/m² for the heating period up to boiling, the pressure-cooking pot can boil 4 litres of water in 1.1 hrs. This is faster than the 1.3 hrs the heavy base pot takes at an average solar radiation of 570 W/m². The average thermal (water heating) efficiency is 33 % for pressure-cooking, greater than the heavy base pot of 26 %. Two additional experimental tests performed with 2.0 and 4.0 kg of water also show better performance for the pressure-cooking pot than the heavy base pot. The results obtained support the use of the pressure-cooking pot during partly cloudy conditions.

Keywords: Experimental; Partly cloudy conditions; Parabolic dish solar cookers: Specialised cooking pots; Thermal efficiency

1. Introduction

To reduce the use of fossil fuels for cooking in developing countries, which have negative health impacts on humans, solar cookers without greenhouse emissions can be used (Aramesh et al., 2019; Arunachala et al., 2020; Paneru et al., 2024; Alonso et al., 2025; Adavi et al., 2025). Solar cookers are devices that capture solar radiation and use it to cook food. Solar cookers can be used to improve the livelihood of women in the developing world since more time can be allocated to other activities instead of searching for firewood, which is detrimental to their health since greenhouse gases are emitted when using firewood for cooking (Padonou et al, 2022). The most common types are solar box cookers, panel cookers, and concentrating solar cookers. Concentrating solar cookers like parabolic dish solar cookers are the most efficient type of cookers, achieving high temperatures in short time intervals for almost all types of cooking such as roasting, baking, frying, and boiling (Lentswe et al., 2021; Abedigamba et al., 2023; Mawire et al., 2024; Gil et al., 2025; Mahmoudi et al., 2025). However, concentrating solar cookers perform poorly during cloudy periods and cannot be used efficiently. Options to improve their