Experimental evaluation of thermal performance of selected oils in Uganda for indirect solar domestic cooking applications

Benard Tabu
Msc. Physics (MUK)
Dept. of Physics, Gulu University (Uganda)

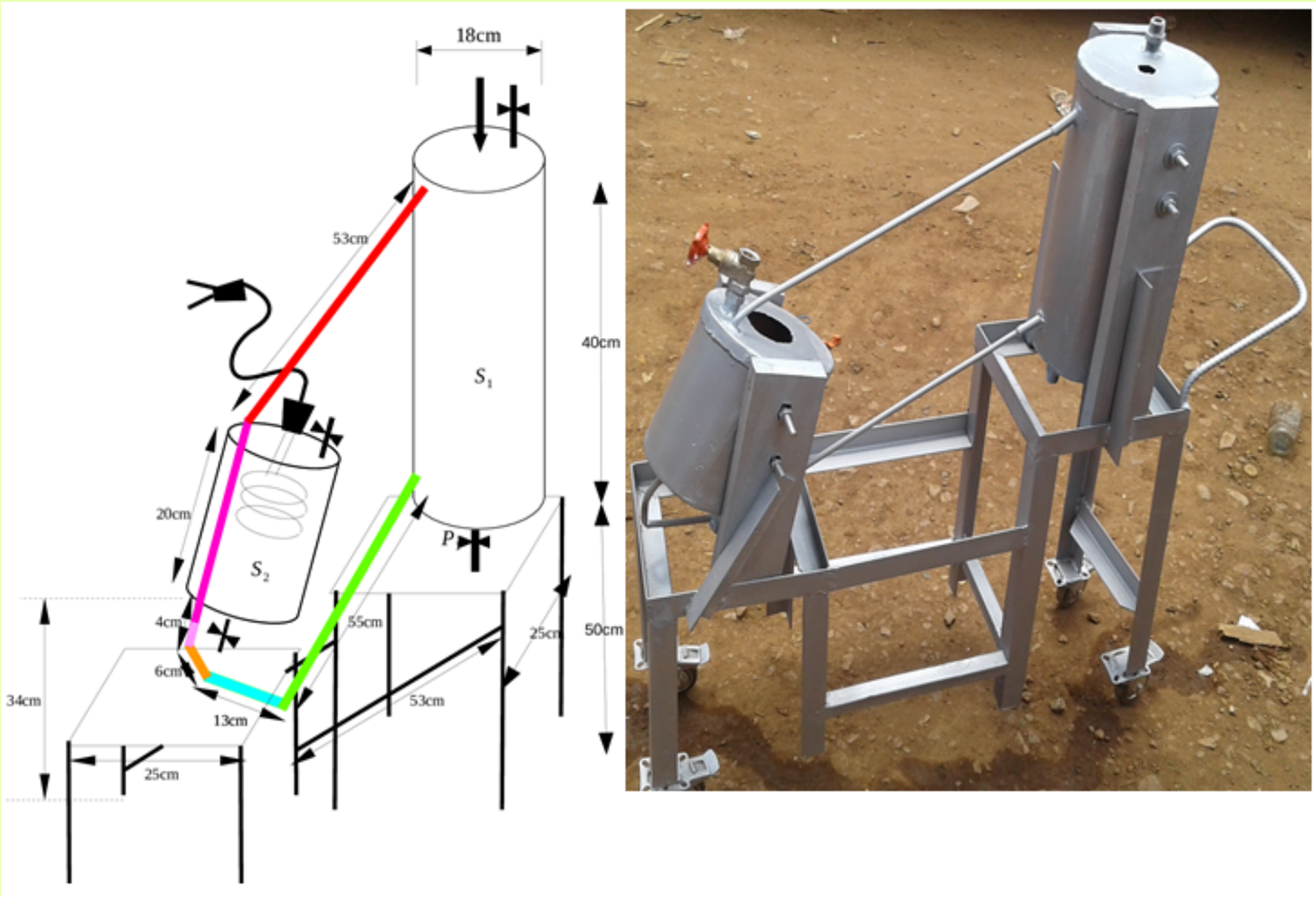
PAUWES
Research 2 Practice Forum 2018
Energy, Water Security and Climate Change in Africa
Tlemcen, Algeria

Introduction

Need for solar cookers with thermosiphon TES system

- In developing countries, firewood and charcoal are the major source of energy for domestic cooking.
- Deforestation, soil infertility, low agricultural productivity, extreme weather changes, and loss in biodiversity.
- Uganda's solar potential is good ($5 - 6kW/m^2/day$).
- The available solar cookers are without TES; work only during sunshine hours.
- Oils act as the heat transfer and storage fluid at higher temperatures.
- Thermosiphon is cheap.

Thermosiphon design



Experimental setup.

Temperature profiles of the boiler during the charging

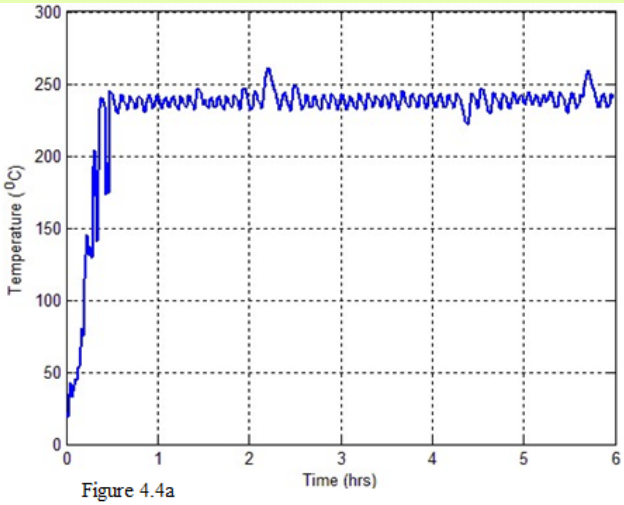


Figure 4.4a

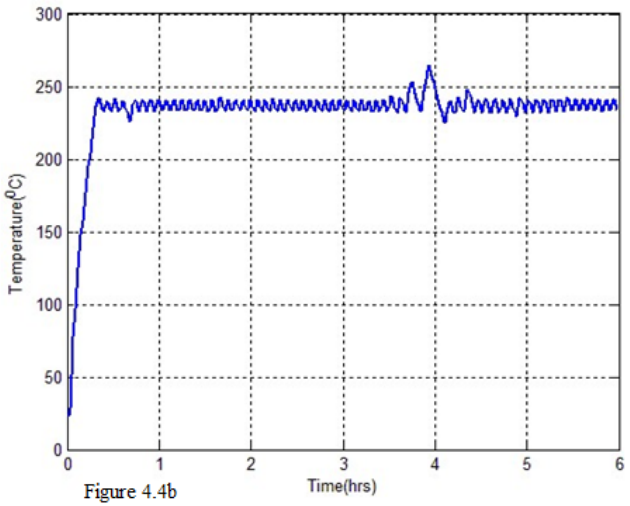


Figure 4.4b

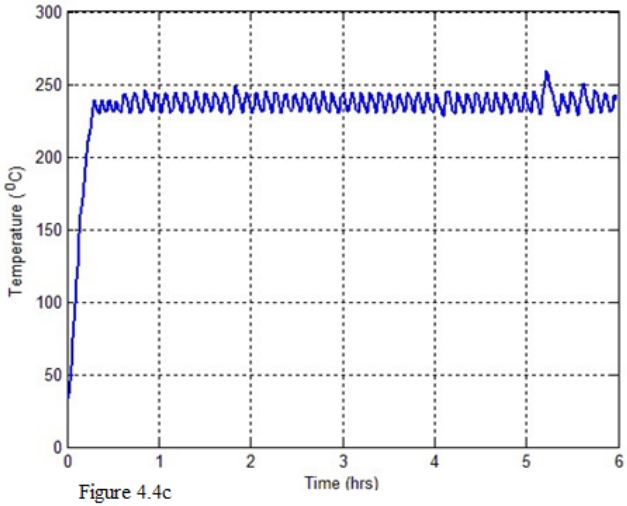
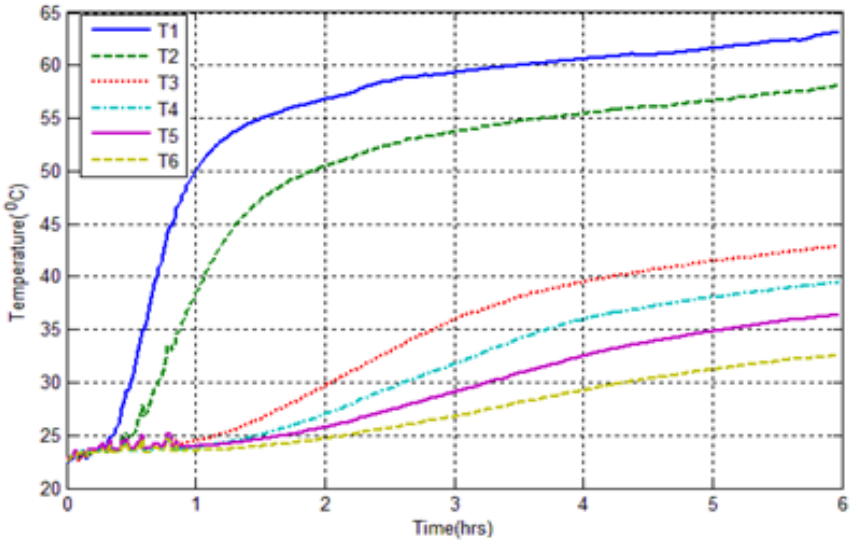
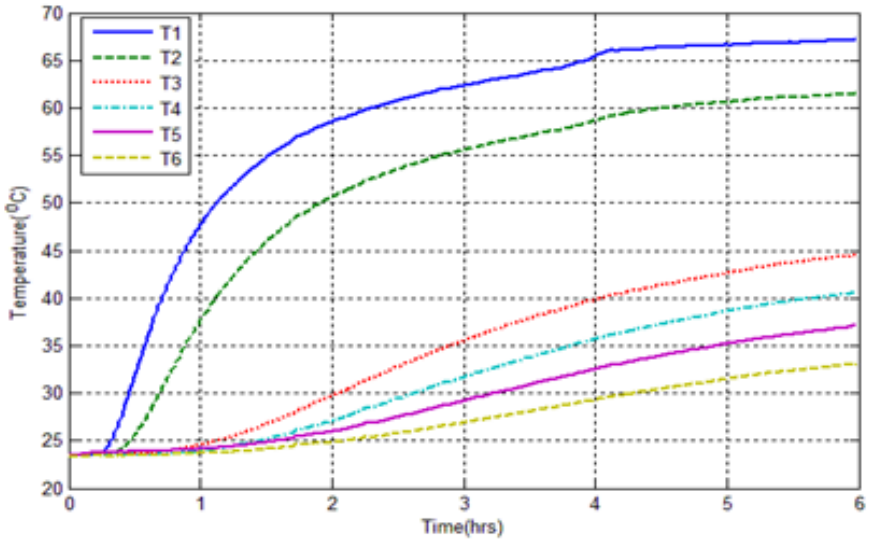
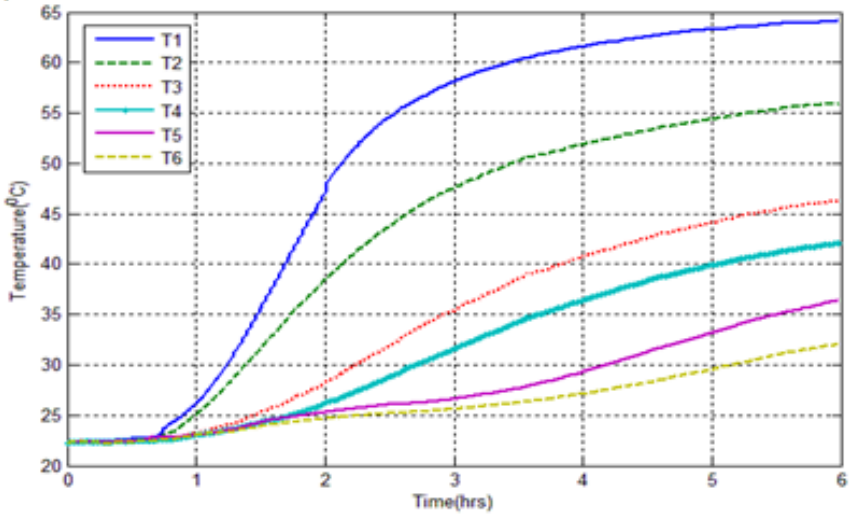


Figure 4.4c

Temperature profiles

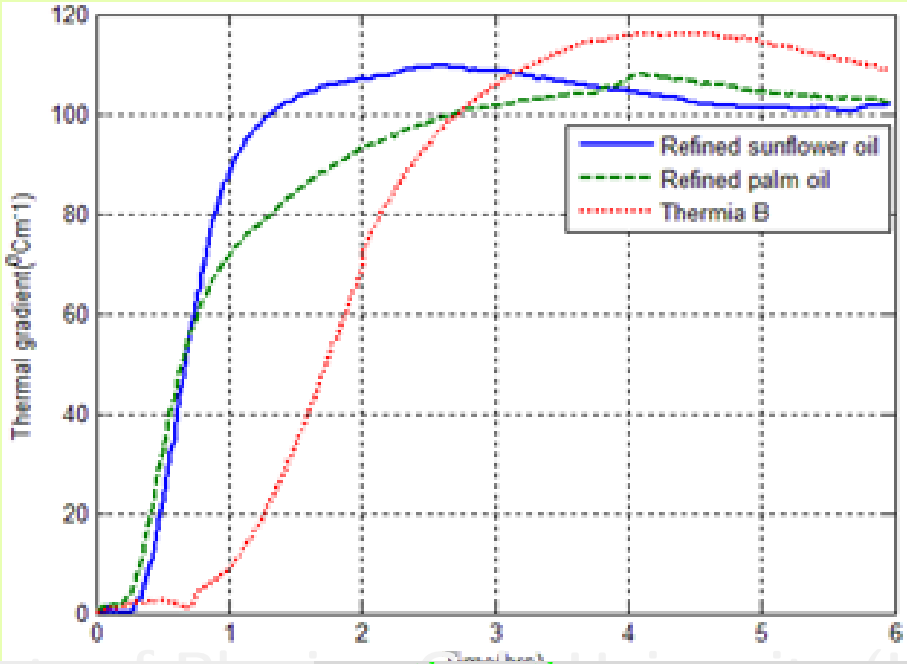






Thermal gradient

- Maximum thermal gradients were 109.6 °Cm^{-1} in 2.4 hours, 107.9 °Cm^{-1} in 4.1 hours and 116.1 °Cm^{-1} in 4.3 hours. Initial increase was due to rapid heat absorption



Temperature distribution along the height of the storage tank

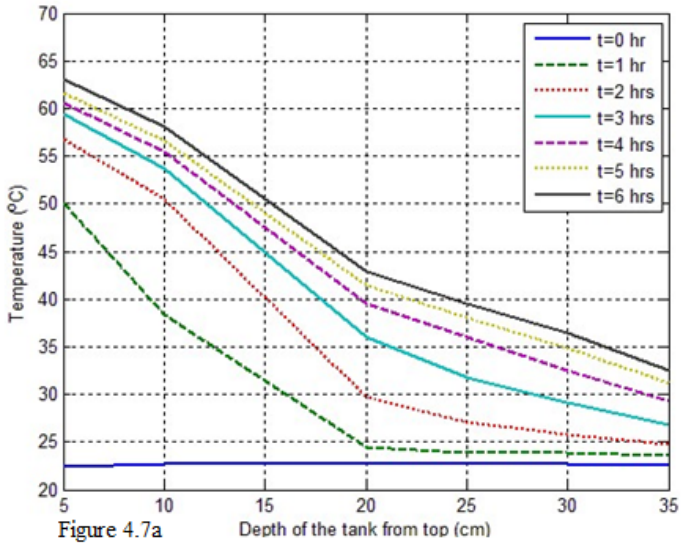


Figure 4.7a

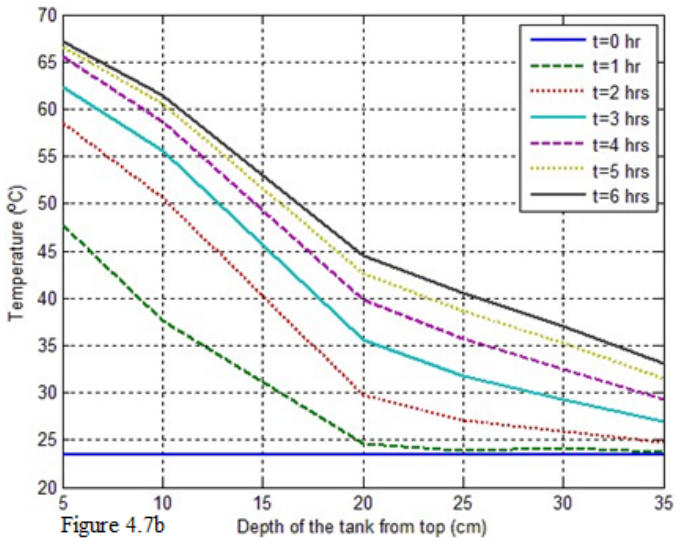


Figure 4.7b

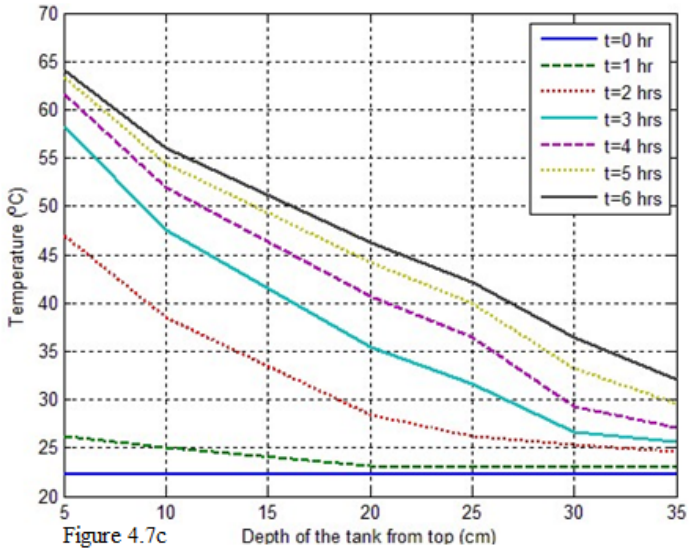
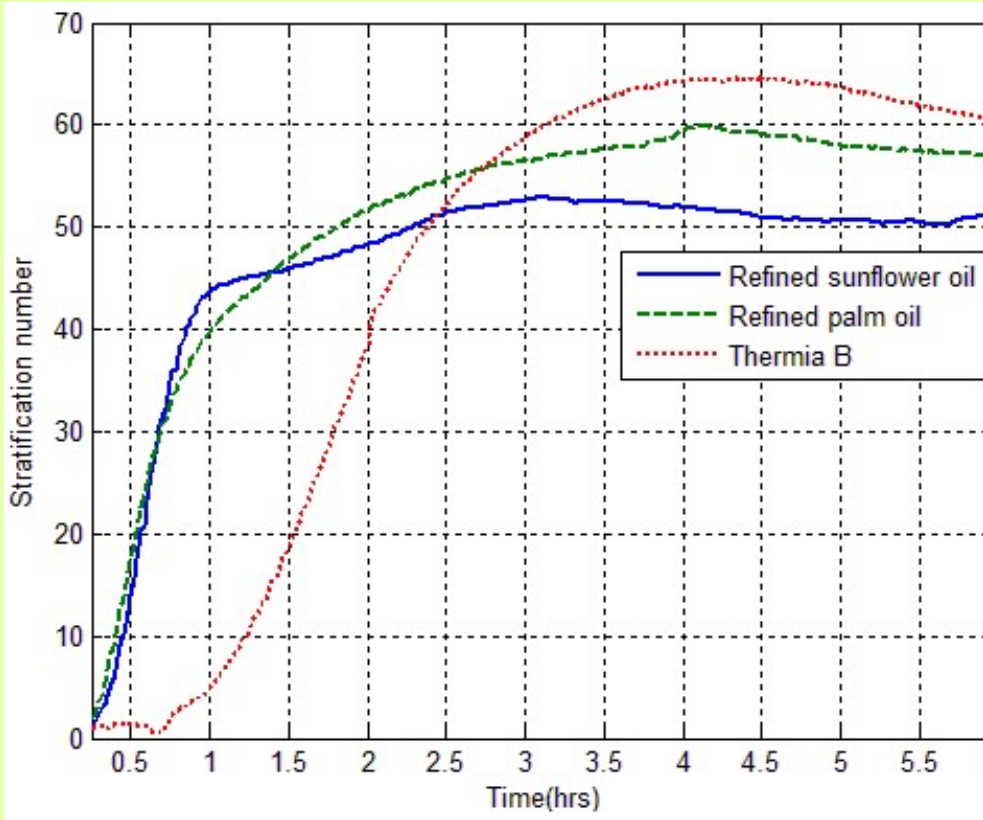


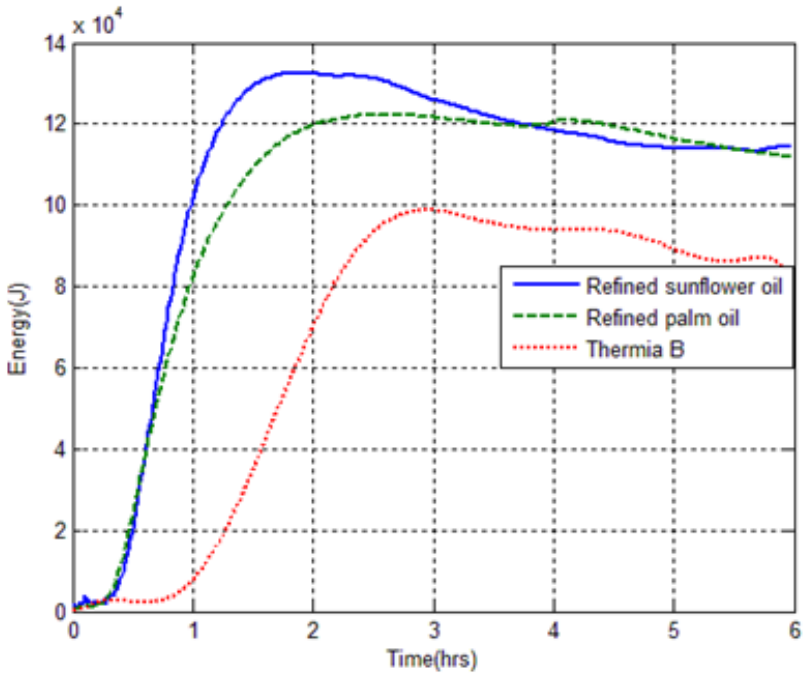
Figure 4.7c

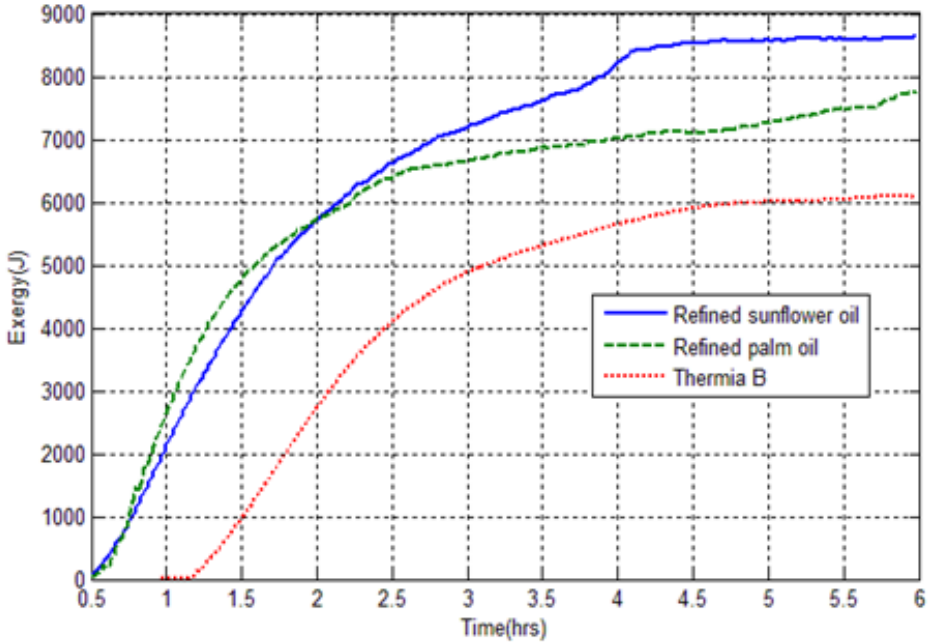
Stratification number

- Rapid increase within first 2 hours; peak values of 60 in 4.1 hours, 52.9 in 3.1 hours, and 64.5 in 4.4 hours.Initially, large absorption of heat. Agrees with Oró et al. (2013)



Energy and exergy distribution of TES system





Conclusion

- Refined sunflower oil generally has better thermal stratification during the first one hour as compared to refined palm oil and thermia B.
- Stored energy for refined sunflower oil was generally higher than that of refined palm oil and thermia B
- Both refined sunflower oil and refined palm oil are recommended for TES, though refined sunflower oil is preferred
- Optimization of thermosiphon TES system to be investigated.

Cooperation with PAUWES

- Conferences.
- Common interest identification.
- Training.
- On site field visit.

From research to practice

- Prototype of solar cookers incorported with TES.
- Field demonstrations in public places like schools.

Acknowledgment

- My supervisors: Dr. Denis Okello and Dr.Nyeinga Karidewa.
- Prof.Tom Otiti.
- Sida-Makerere Bilateral Scholarship program.
- ENPE Project.
- PAUWES/PARTNERS.

Thank you for listening