

Optimization of a solar-driven hydraulic pump system for surface water treatment

Tatenda A. Kajau^{*1}, Bhekile B. Mamba¹, Nomcebo H. Mthombeni², A. R. D. Verliefde³, Machawe M. Motsa¹



¹Institute for Nanotechnology and Water Sustainability (iNanoWS), School of Science, Engineering and Technology, University of South Africa, Florida Campus, P.O. Box 392, Pretoria 003, South Africa.

²Department: Civil and Chemical Engineering, School of Engineering, College of Science, Engineering and Technology, University of South Africa, Florida Campus, P.O. Box 392, Pretoria 003, South Africa.

³Department of Green Chemistry and Technology, Faculty of Bioscience Engineering, Ghent University, Sint-Pietersnieuwstraat 25, 9000 Ghent, Belgium

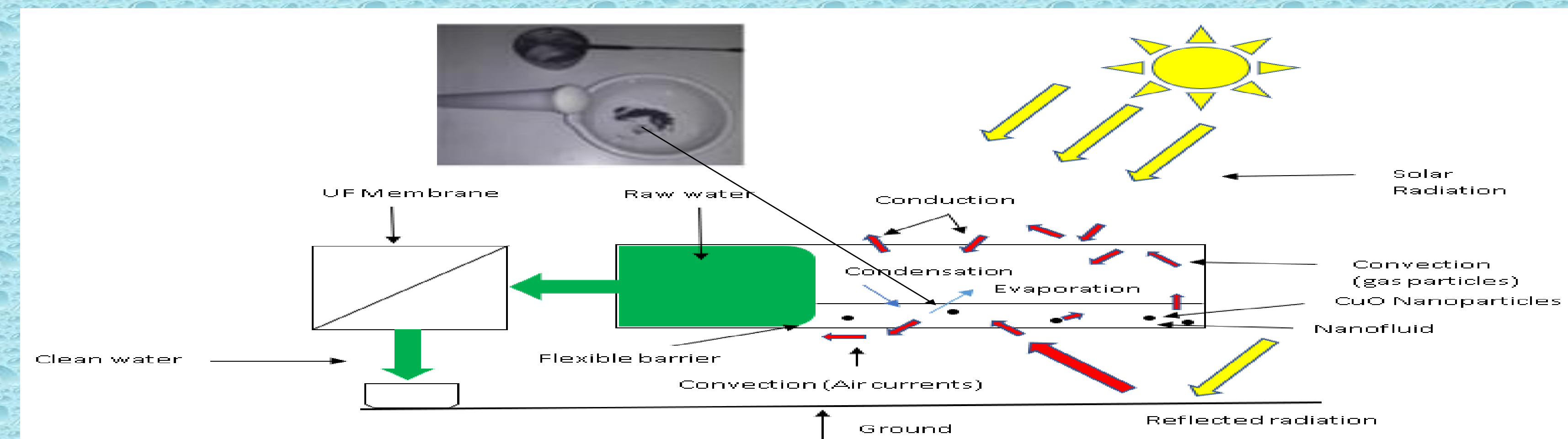
*Corresponding author: Tel.: +27 11 670 9339, E-mail: motsamm@unisa.ac.za or alfredkajau@gmail.com



Introduction

South Africa is classified as a water-stressed country and suffers from widespread water scarcity and to address this problem, there is a need to implement wastewater treatment and water reuse strategies. Membrane technology is a viable water treatment technique. Solar energy has been proven to be effective in providing energy to drive membrane filtration systems and its utility in South Africa is very viable due to the abundance of solar insolation.

Method



Sampling
& water
analysis

Preparation of
UF membrane
and CuO
nanoparticles

Preparation of CuO
nanofluid

Characterization of membrane
and nanoparticles
ATR-FTIR spectroscopy
SEM, AFM, TGA
Contact angle & SFE
Zeta potential, Size

Nanofluid tests
Stability
Thermal conductivity
Pressure

Evaluation and optimization of hydraulic pump
performance
Statistical analysis of flux performance

Results

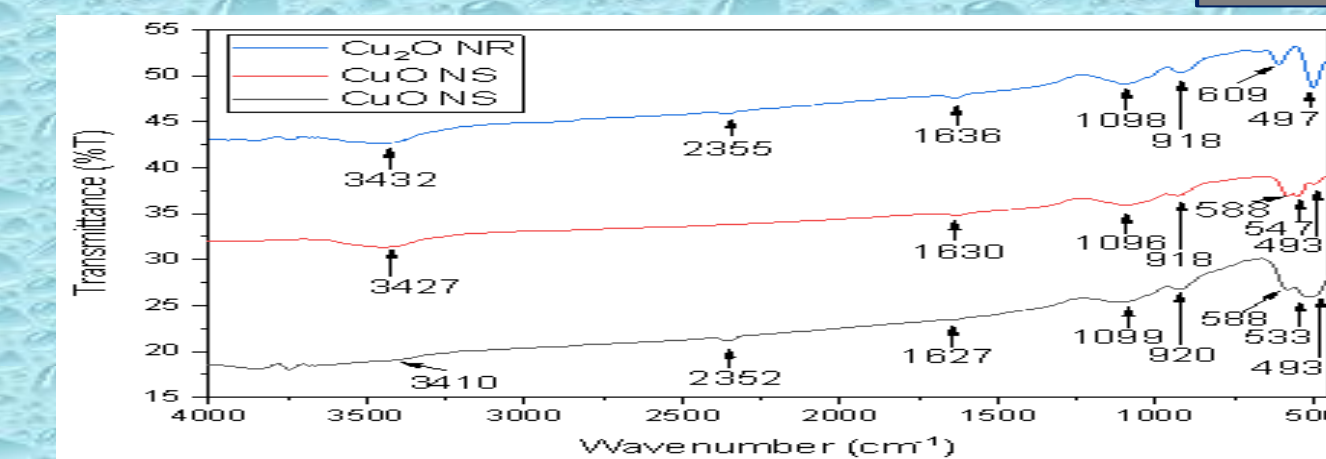


Fig 1: ATR-FTIR spectra of CuO nanoparticles

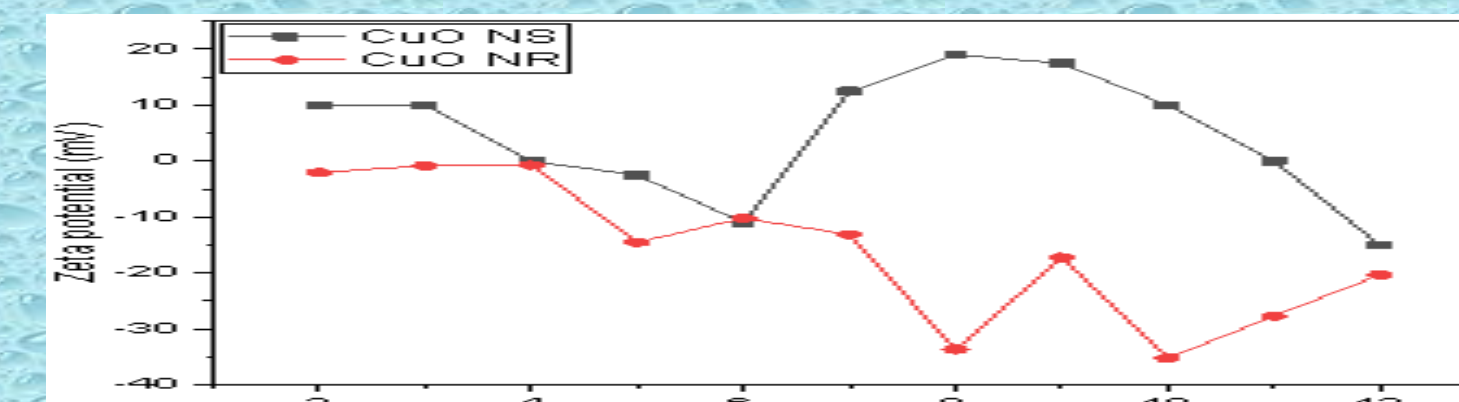


Fig 2: EDS Spectra of CuO nanoparticles

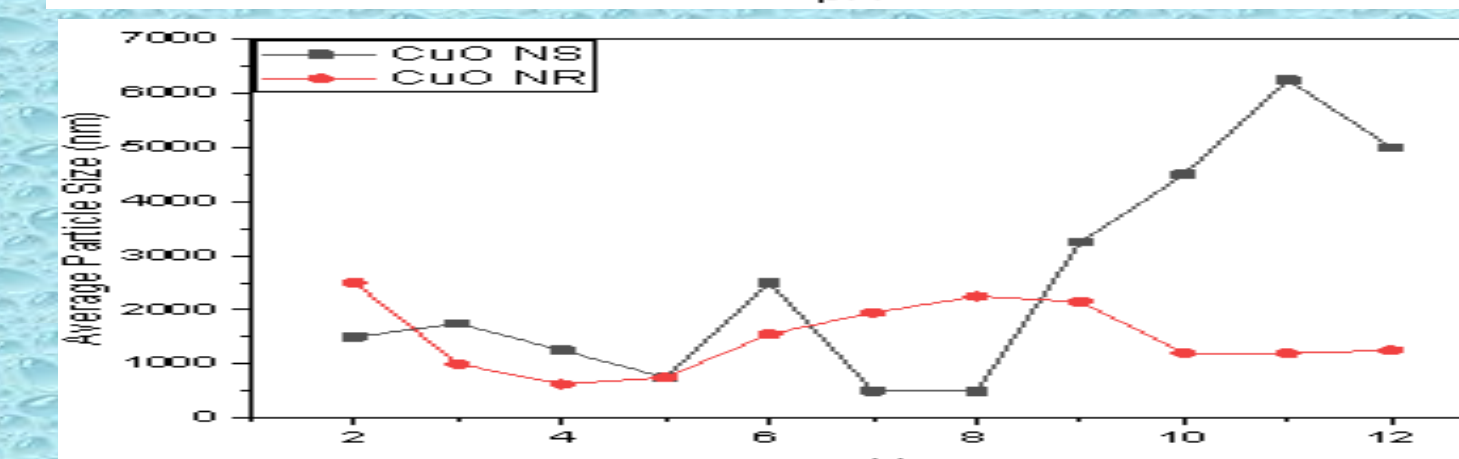


Fig 3: SEM images of UF membrane (i) Surface, (ii) Cross-section, and CuO nanoparticles

Fig 5: FTIR spectra of UF membrane.

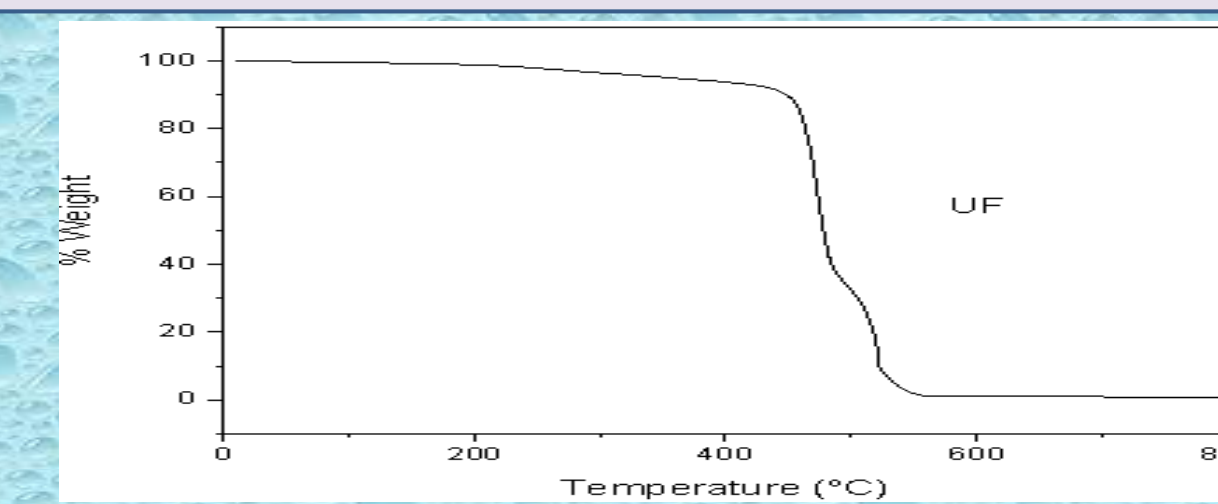


Fig4: TGA thermogram of UF membrane.

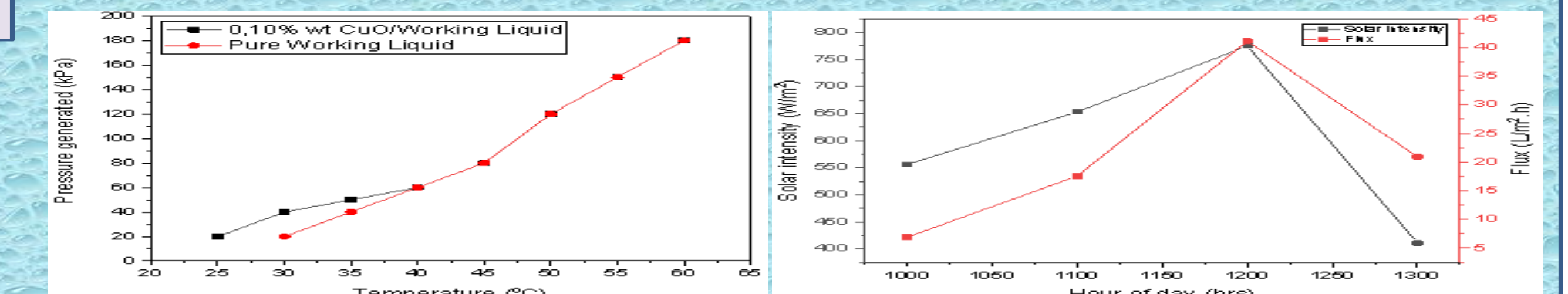


Fig 7: Nanofluid pressure generation and evaluation.

Conclusion

1. Generated pressure was proven to be directly related to both temperature and flux produced.
2. Efficiency of solar pump with nanofluid was 6% larger than for pure working liquid and calculated to be 21,9% from heat transfer calculations. The p-value (Sig. 2-tailed) of the independent sample means t-test is greater than the alpha value of the test, i.e., 0,948 > 0,05, it thus follows that the null hypothesis cannot be rejected. No significant difference between flux of nanofluid and that of pure working liquid.
3. Optimum conditions were established to be a nanofluid composition of 0,1%wt. CuO/Working liquid at a pH of 6, within a temperature range of 25°C – 40°C, and periodic chemical cleaning of membrane with a 0,35% NaOCl solution for 30 minutes on each cleaning cycle.

References

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