Enhanced Solar Thermal Evaporation of Ethanol–Water Mixtures, through the Use of Porous Media

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Introduction

❑The harness of solar energy could be accelerated through heat localization in porous media which may then be used for applications ranging from enhanced evaporation of water to distillation schemes involving desalination.

Aim

❑Investigate the efficiency of the water-ethanol binary mixture evaporation,
with respect to:

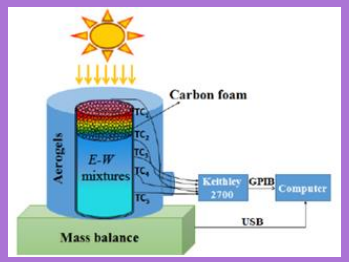
- Carbon foam (CF)
- Physical properties (vapor pressure, viscosity, surface tension, density)

Materials & Methods

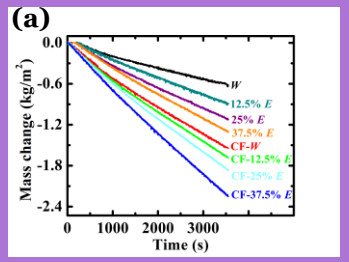
❑Evaporative characteristics of three particular E-W mixtures (i.e., 12.5 vol %E, 25 vol %E, and 37.5 vol %E) subject to an input solar radiation power (Ps) of 1700 ~ W/ m^2 is investigated.

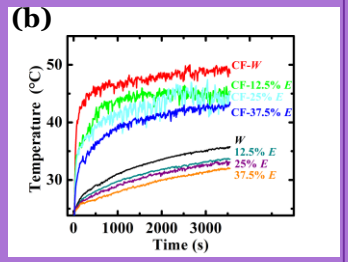
❑CF is reticulated vitreous and 97 % porous.

Results & Discussion



❑ Experimental setup: related to solar radiation mediated evaporation of ethanol (E)-water (W) mixtures.





❑Experimental results: (a) The mass change/loss as a function of time of water and ethanol water mixtures with and without CF (b) The observed variation of top surface temperature (TC1) as a function of time corresponding to the mass change with and without CF.

❑Nondimensionalization :

$$m^{'} = \frac{dm}{dt} = m^{'}(\mu, \sigma, P_{vap}, \rho) = \mu^{a}\sigma^{b}P_{vap}^{c}\rho^{d}$$

$$\frac{dm^{'}}{m^{'}} = Z(2\frac{d\mu}{\mu} - 2\frac{d\sigma}{\sigma} + 1.5\frac{dP_{vap}}{P_{vap}} - 0.5\frac{d\rho}{\rho})$$

	$Z_{average}$
Water	-1.24
Water +CF	-0.60
12.5% Ethanol+CF	-0.79
25% Ethanol+CF	-0.88
37.5% Ethanol+CF	-0.69

Conclusion

❑We have shown enhanced evaporation of ethanol-water mixtures through the use of CF based porous media which could find many applications, ranging from phase separation to distillation.

❑It was developed that evaporation rate is a function of 4 physical parameters which are P_v, μ, σ and ρ. Total effect of P_v and μ on evaporation rate is found as ~ 96%.