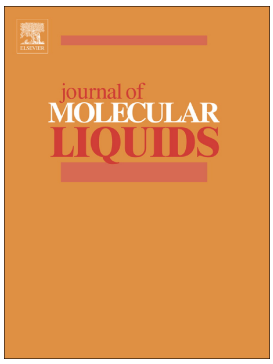

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PII: S0167-7322(18)31483-1
DOI: doi:10.1016/j.molliq.2018.06.069
Reference: MOLLIQ 9267

To appear in: *Journal of Molecular Liquids*

Received date: 20 March 2018
Revised date: 29 May 2018
Accepted date: 18 June 2018

Please cite this article as: Narendra Kumar, Ajay Mandal , Thermodynamic and physicochemical properties evaluation for formation and characterization of oil-in-water nanoemulsion. Molliq (2018), doi:10.1016/j.molliq.2018.06.069

Thermodynamic and Physicochemical Properties Evaluation for Formation and Characterization of Oil-in-Water Nanoemulsion

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Abstract

Kinetically stable nanoemulsion with droplet size less than 500 nm has emerged as an advanced material in wide industrial applications because of its unique structural and physicochemical properties. Nanoemulsions are stabilized by surfactants or emulsifiers by lowering the interfacial tension (IFT) between the dispersed and continuous phases to an ultra-low value. In the present study, surfactants are screened based on their ability to lower the IFT values for proper formulation of stable nanoemulsion. The critical micelle concentration (CMC) of surfactants obtained from the interfacial tension-concentration isotherm curve (IFCV) was used to evaluate surface excess concentration (Γ_{max}), minimum surface area per molecule (A_{min}), adsorption efficiency (pC_{20}), surface tension at CMC (γ_{CMC}), effectiveness of adsorption (Π_{cmc}) along with thermodynamic parameters (ΔG_{mic} and ΔG_{ads}). The experimental results of thermodynamic parameters reveals that adsorption phenomenon predominates over micellization. A meticulous evaluation of derived parameters suggests the suitability of non-ionic surfactant (Tween 80) over ionic surfactants (CTAB and SDS) for formation of stable oil-in-water (O/W) emulsion. In solubilization study, the ultra-low IFT value (10^{-3} to 10^{-5} mN/m) between oil-middle phase emulsion with 0.5 wt. % Tween 80 at varying salinity calculated by Chun-Huh equation indicates the increased solubility of oil in emulsion. Nanoemulsions prepared by high energy method using Tween 80 and n-heptane with droplet size in the range 91.05 to 40.16 nm manifest kinetic stability due to continuous Brownian motion of droplets. The dissolving capacity of crude oil in nanoemulsion was determined by miscibility test. The synergetic effect of silica nanoparticles (NPs) in presence of Tween 80 shows enhancement in stability of nanoemulsion with drop in droplets size from 36.15 to 21.37 nm and surface charge of -59.05 mv. The formulated nanoemulsions show Pseudo-plastic behavior with viscosity in the range of 9-12.5 mPa-s, which is further improved in presence of nanoparticles.