Electronic Supplementary Material (ESI) for RSC Advances.

Understanding viscosity reduction of a long-tail sulfobetaine viscoelastic surfactant by organic compounds

Lionel Talley Fogang[1], *Abdullah S. Sultan*[1,2*], *Muhammad Shahzad Kamal*[2]

[1]Department of Petroleum Engineering, King Fahd University of Petroleum & Minerals, 31261 Dhahran, Saudi Arabia

[2]Center for Integrative Petroleum Research, King Fahd University of Petroleum & Minerals, 31261 Dhahran, Saudi Arabia

***Corresponding Author:** Abdullah S. Sultan

Email: sultanas@kfupm.edu.sa

Supporting Information for Publication

Table S 1. Estimated values of crossover frequency and relaxation time of the pure surfactant solution

Temperature (°C)	η_0 (Pa.s)	G_0 (Pa)	ω_c (rad/s)	τ_R (s)	ξ (nm)
30	186.09	4.59	2.47×10^{-2}	40.5	97.0021
60	138.07	4.05	2.93×10^{-2}	34.1	104.375

Table S 2. Estimated differences in zero-shear viscosities between the surfactant solutions with the oils and the pure surfactant solutions at test temperatures

Concentration (wt %)	n-decane		Crude oil		EVOO		Octa-decane
	30°C	60°C	30°C	60°C	30°C	60°C	60°C
0.9	6.72×10^{2}	5.50×10^{4}	1.43	2.08×10^{1}	1.17	9.65×10^{1}	1.39×10^{1}
2	1.58×10^{5}	2.06×10^{5}	2.12	5.62×10^{3}	2.33	3.33×10^{3}	2.26
3	1.63×10^{5}	2.05×10^{5}	2.62	1.92×10^{4}	9.57	6.59×10^{3}	8.13

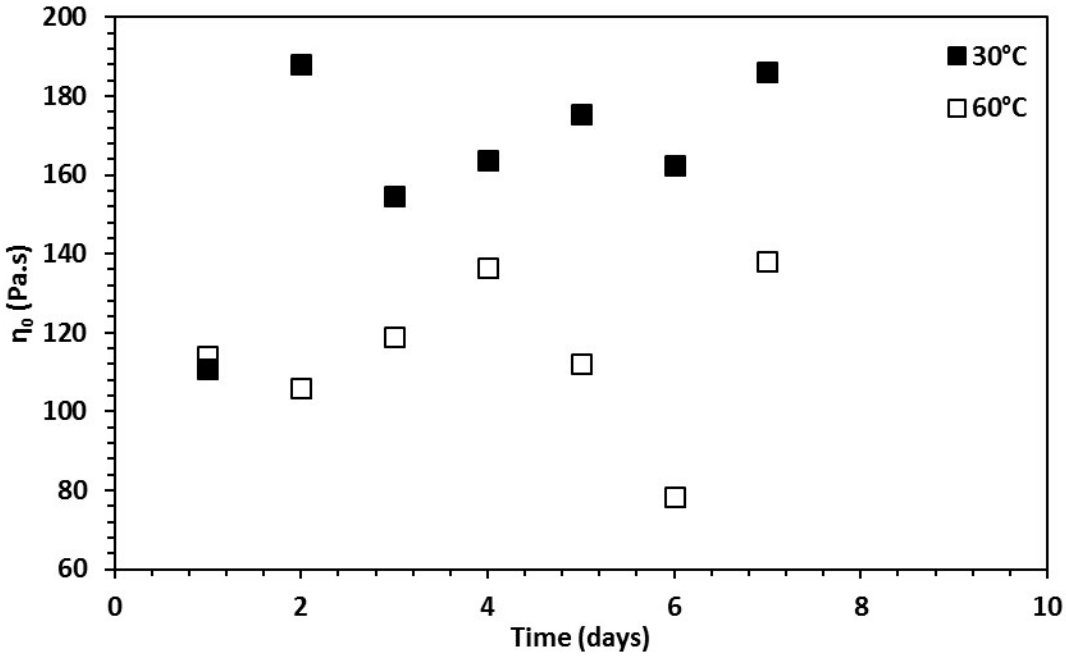

Figure S 1. Zero-shear viscosity of surfactant solution with time

Figure S 2. Cryo-TEM image of 3.96 wt % surfactant solution at 30°C diluted in ethyl acetate. The black curves represent the edges of the micelles

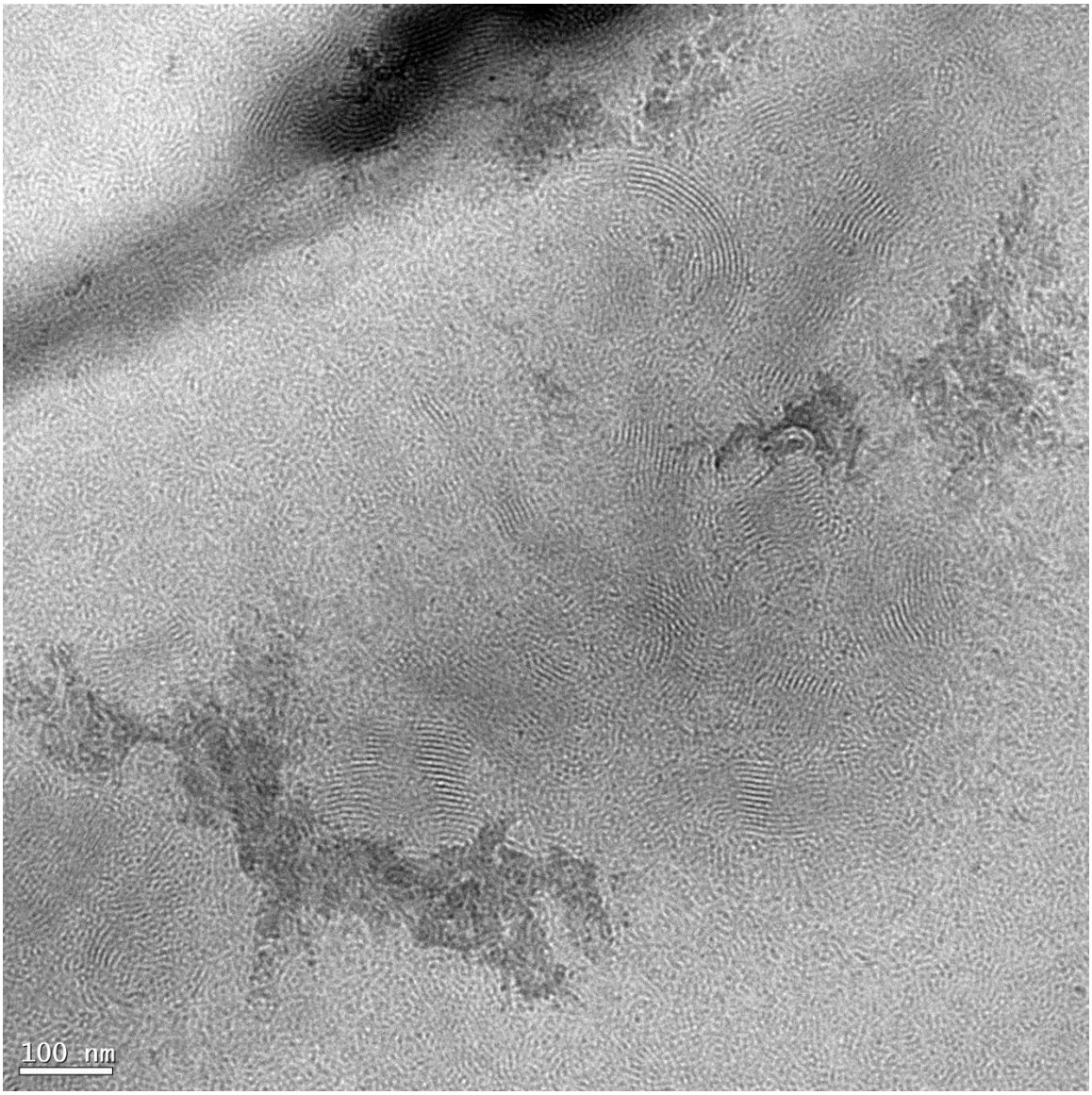

Figure S 3. Cryo-TEM image of 3.96 wt % surfactant solution at 30°C diluted in ethyl acetate. The black curves represent the edges of the micelles

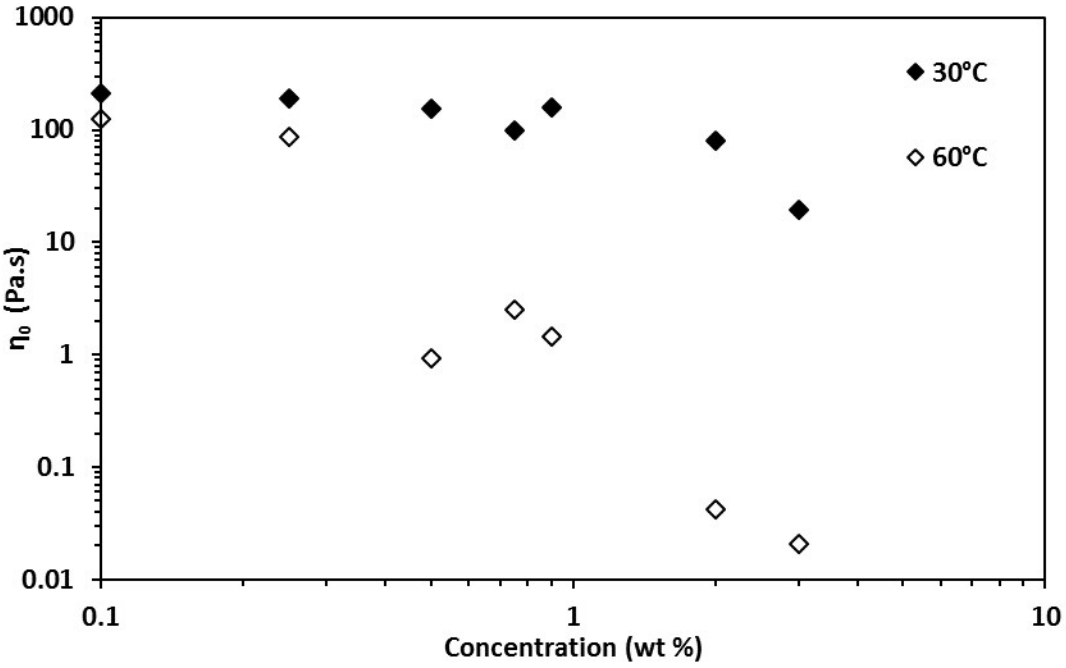

Figure S 4. Estimated zero-shear viscosity of 3.96 wt % surfactant solution with different EVOO concentrations

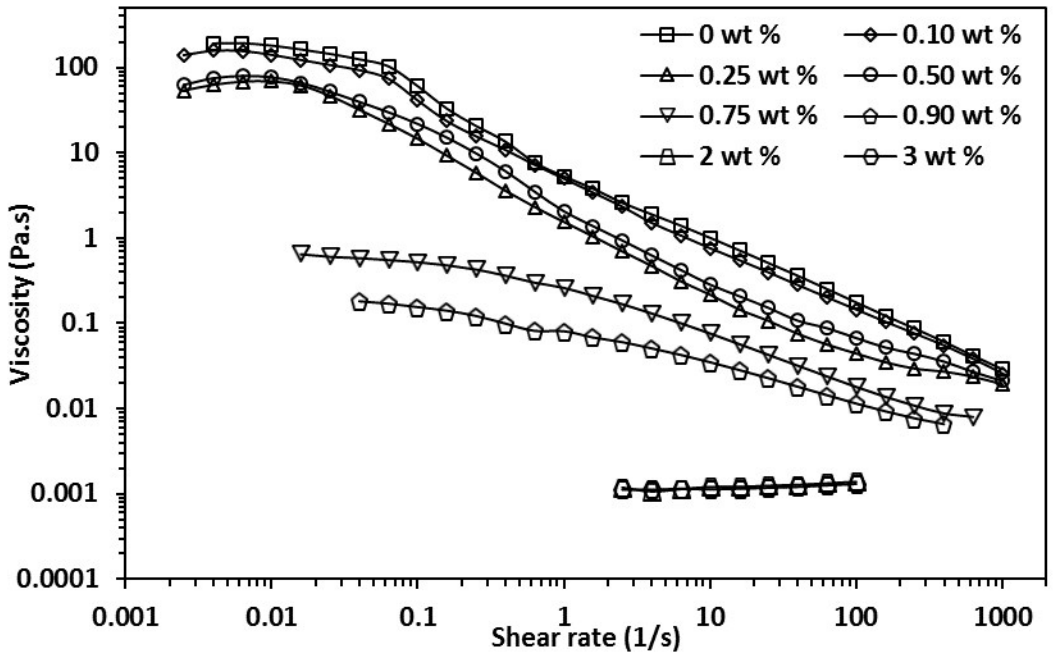

Figure S 5. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of n-decane at 30°C

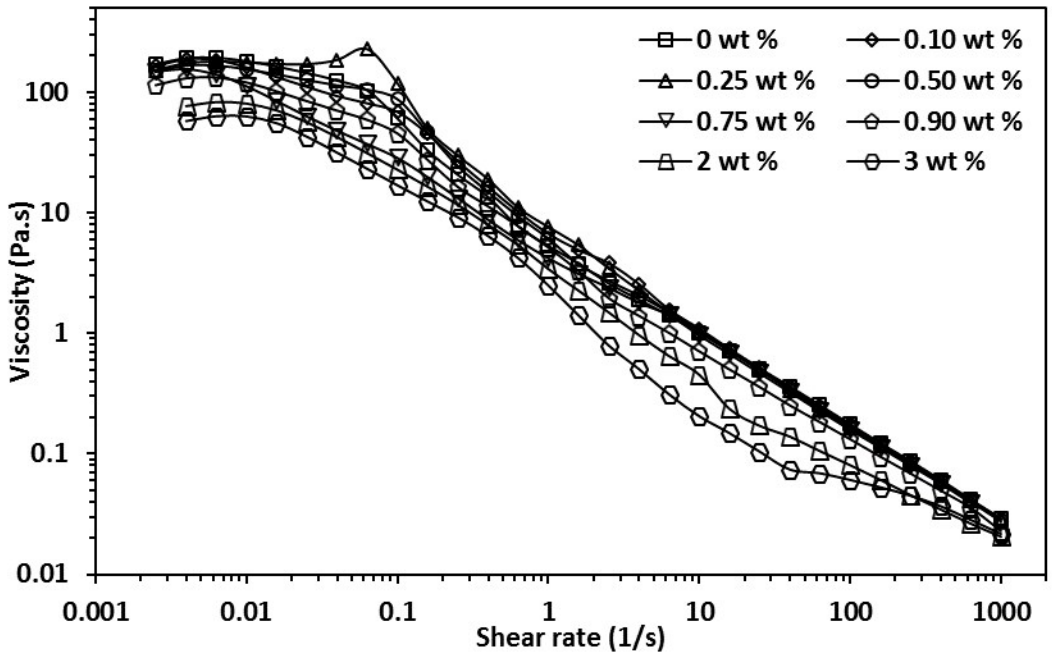

Figure S 6. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of crude oil at 30°C

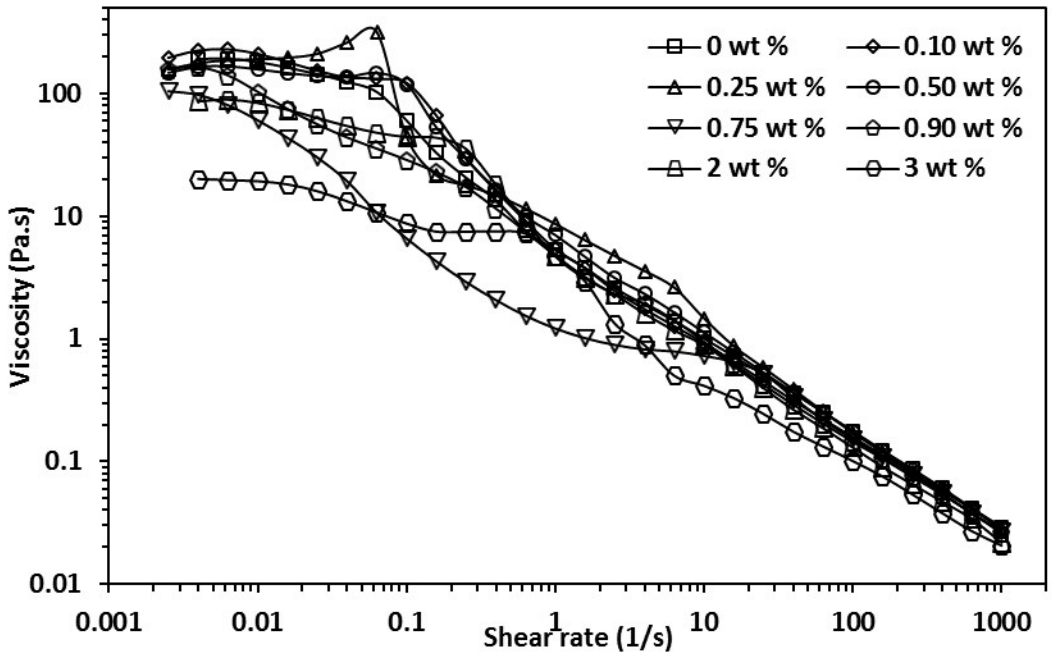

Figure S 7. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of EVOO at 30°C

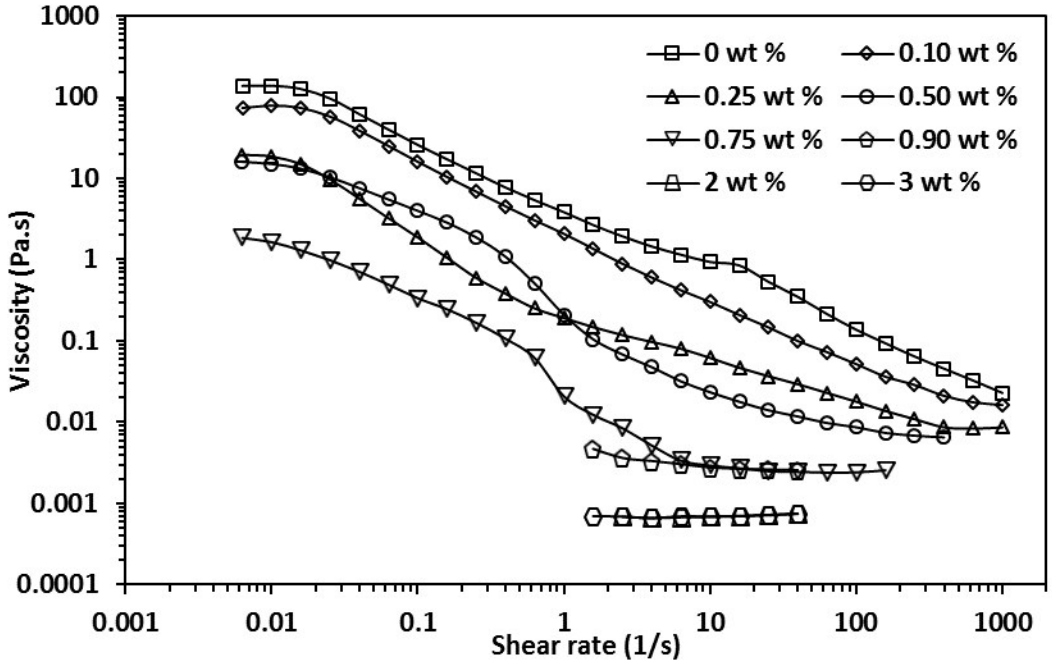

Figure S 8. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of n-decane at 60°C

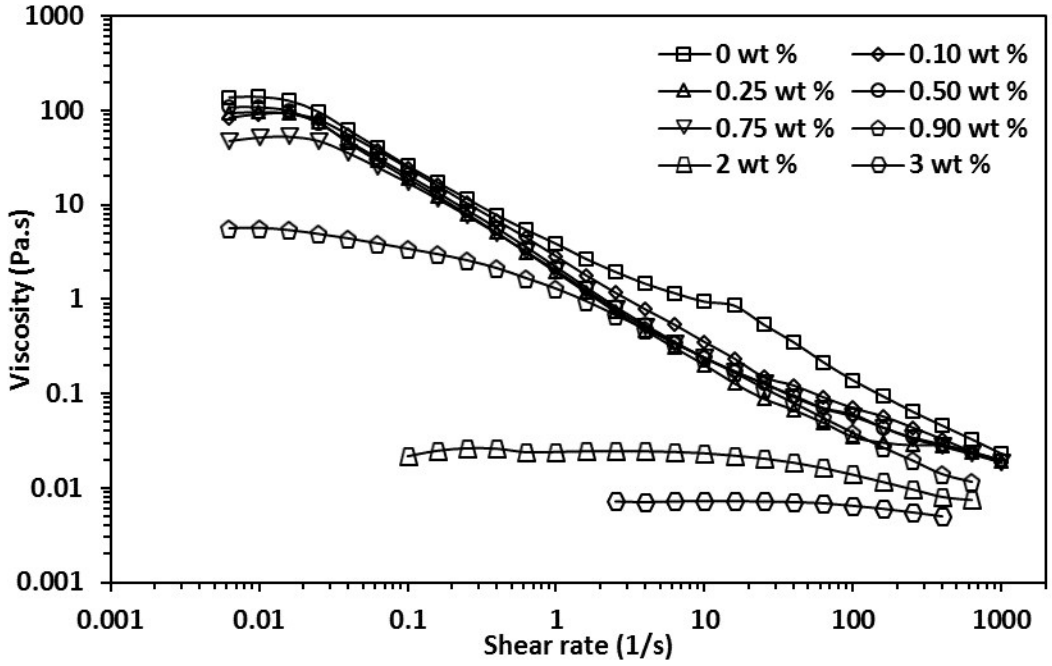

Figure S 9. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of crude oil at 60°C

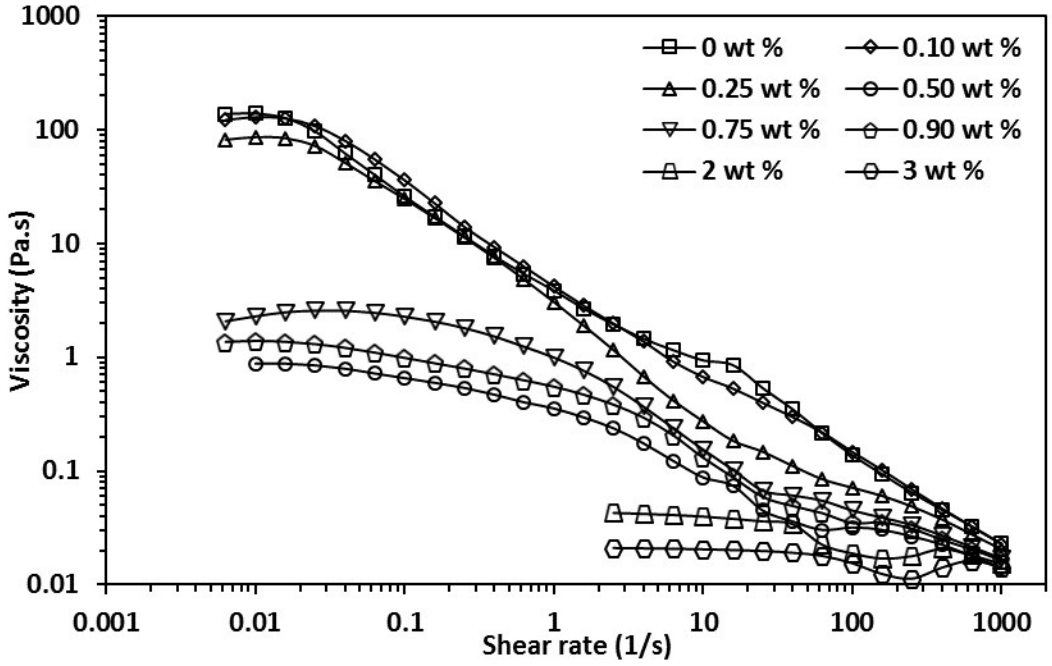

Figure S 10. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of EVOO at 60°C

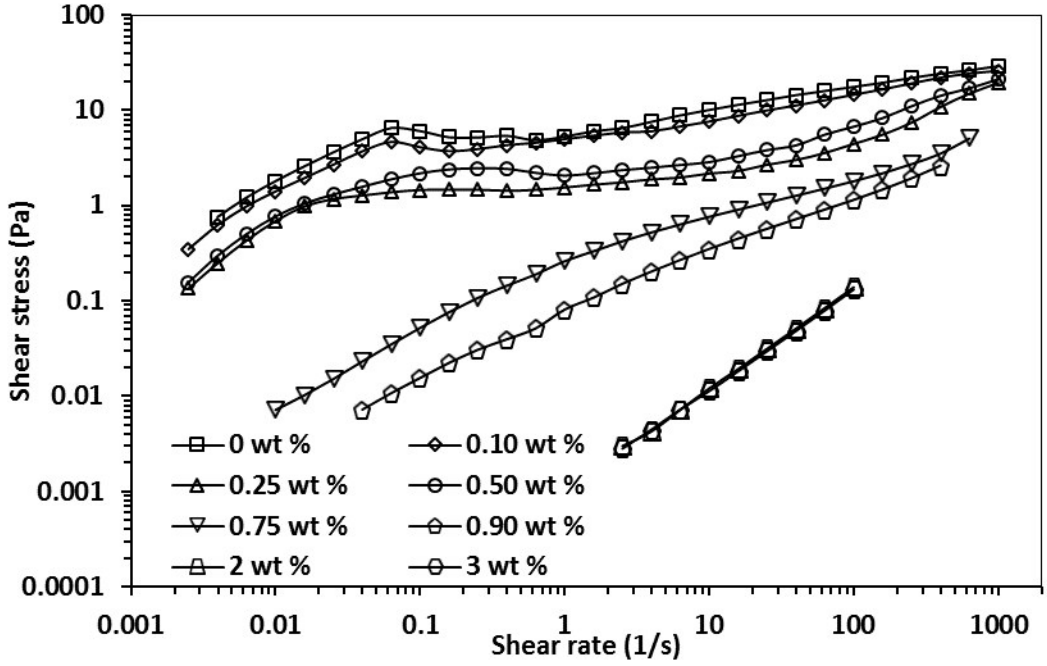

Figure S 11. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of n-decane at 30°C

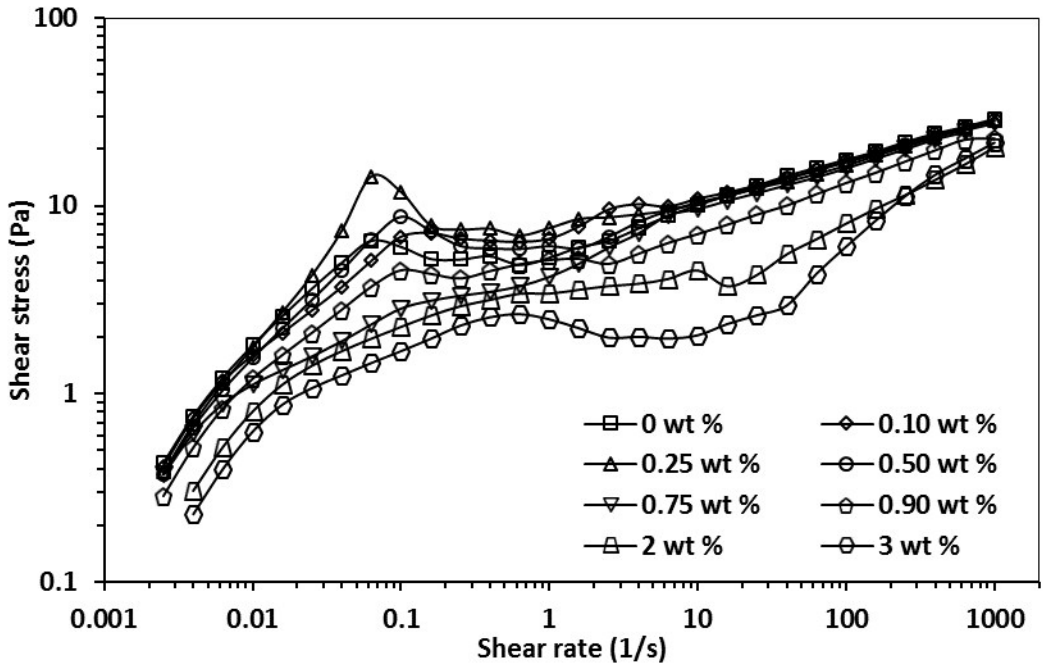

Figure S 12. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of crude oil at 30°C

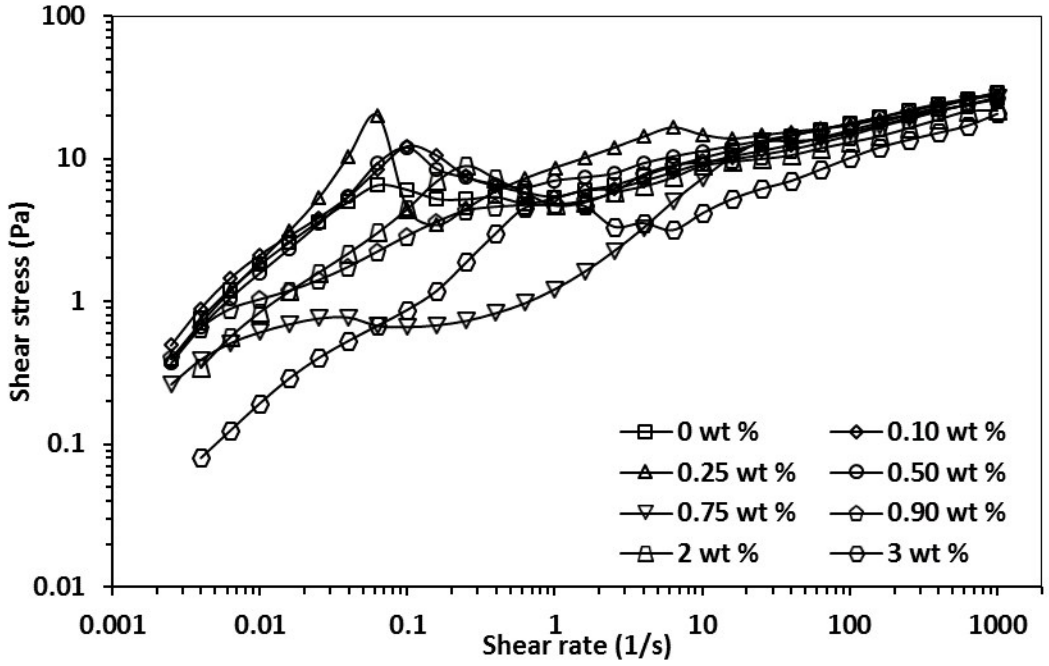

Figure S 13. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of EVOO at 30°C

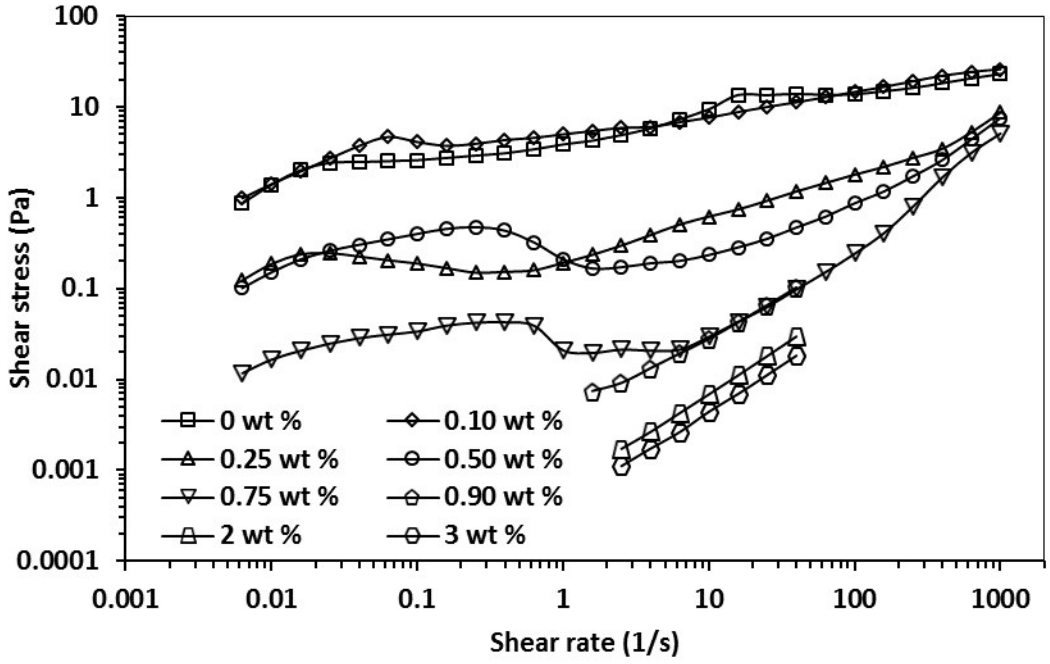

Figure S 14. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of n-decane at 60°C

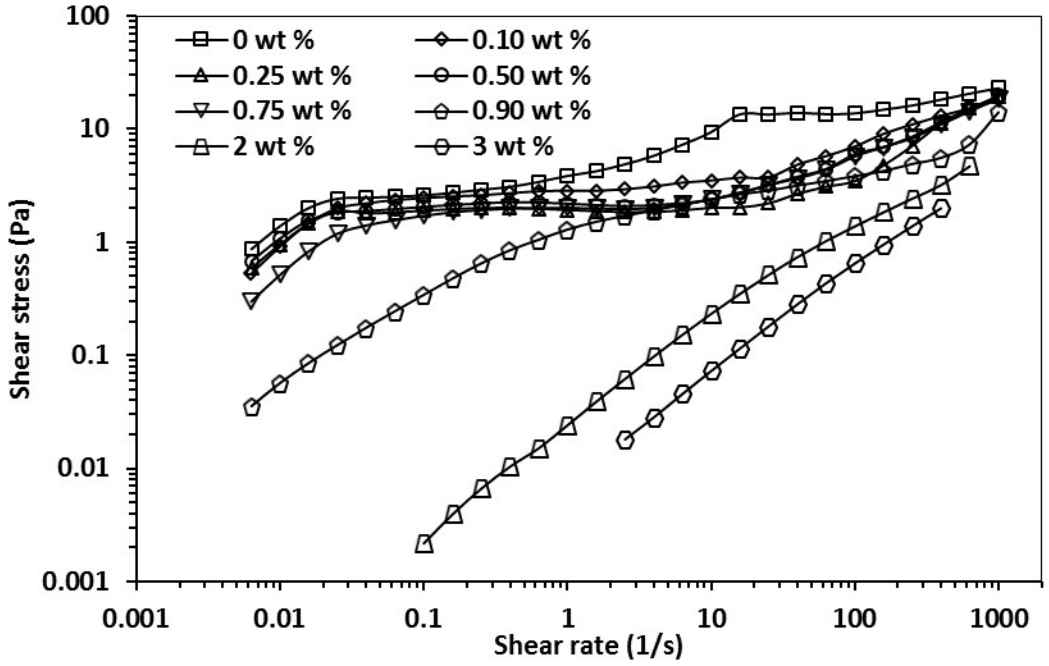

Figure S 15. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of crude oil at 60°C

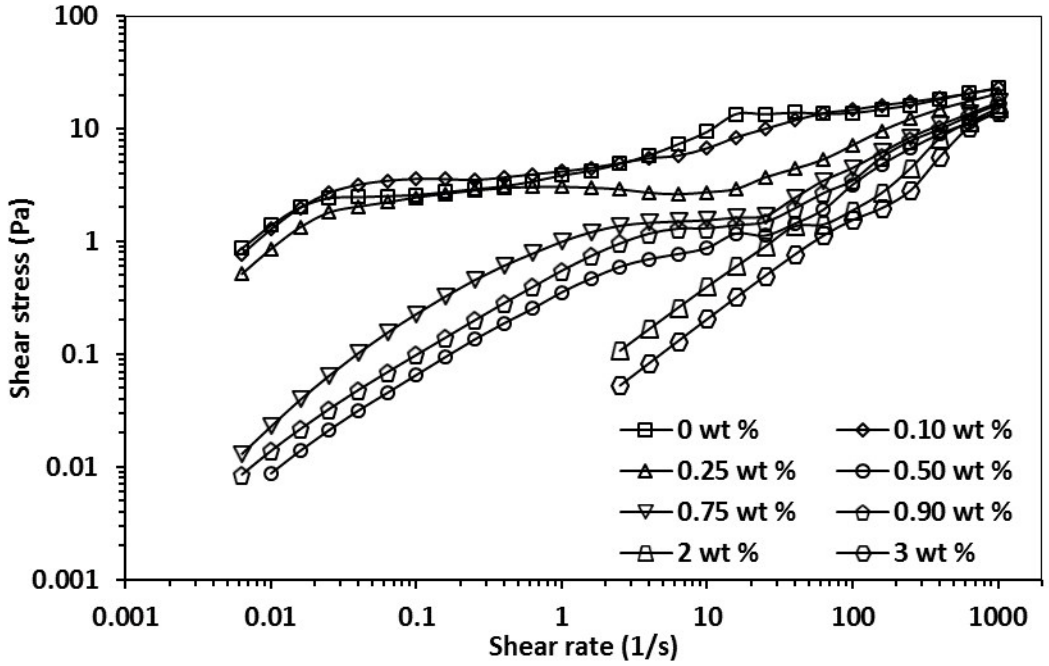

Figure S 16. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of EVOO at 60°C

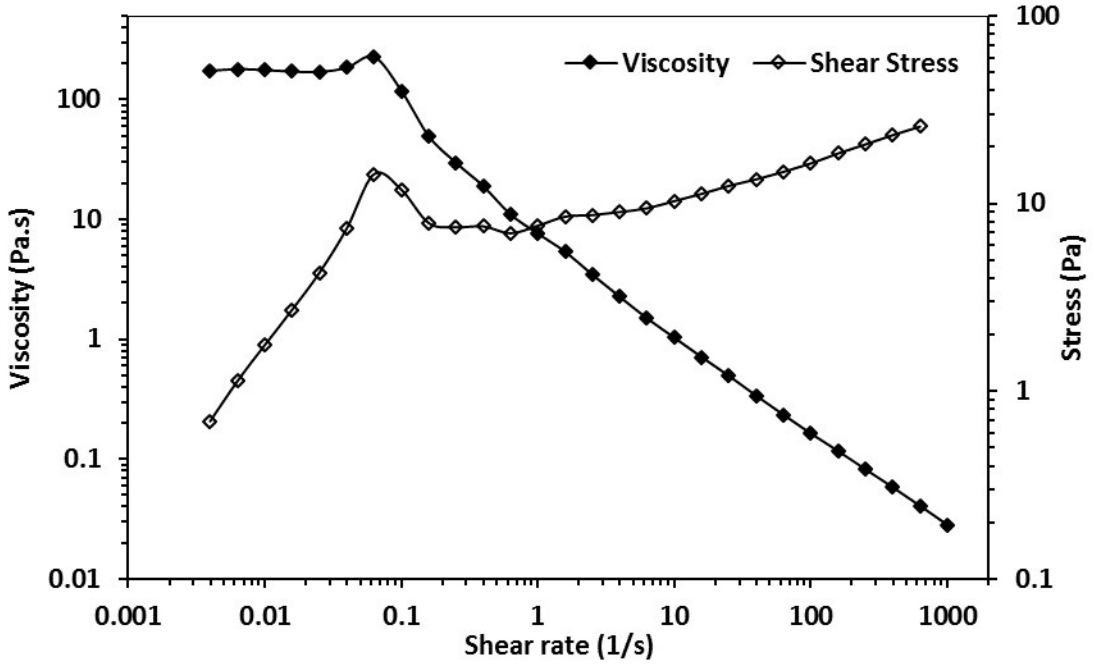

Figure S 17. Viscosity and stress vs shear rate of 3.96 wt % surfactant solution with 0.25 wt% crude oil at 30°C.

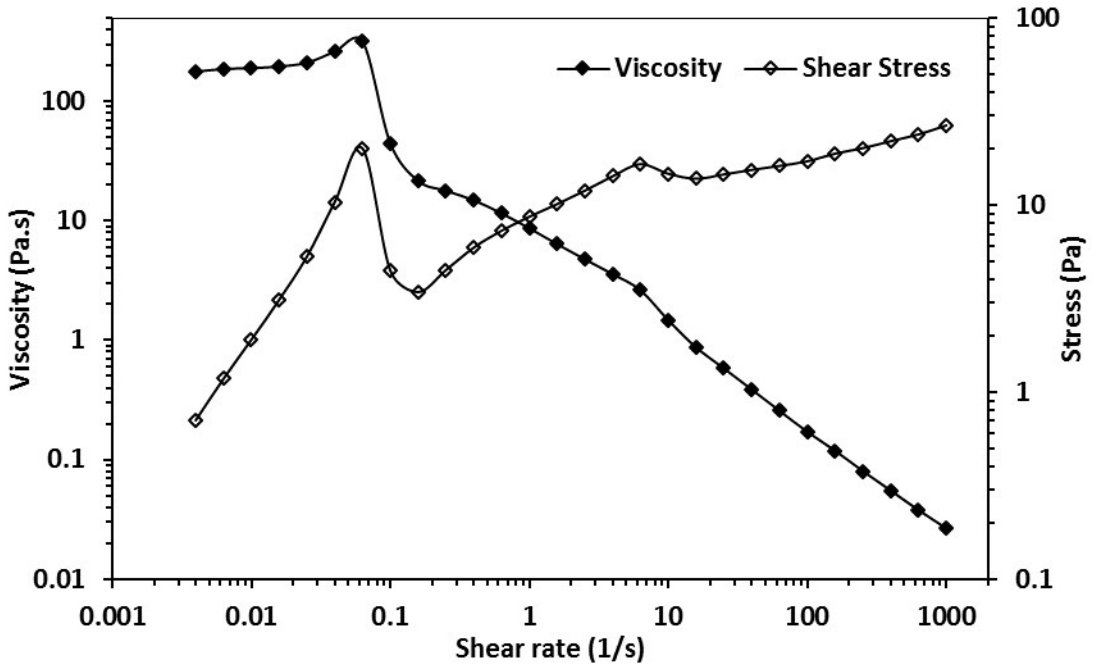

Figure S 18. Viscosity and stress vs shear rate of 3.96 wt % surfactant solution with 0.25 wt% EVOO at 30°C

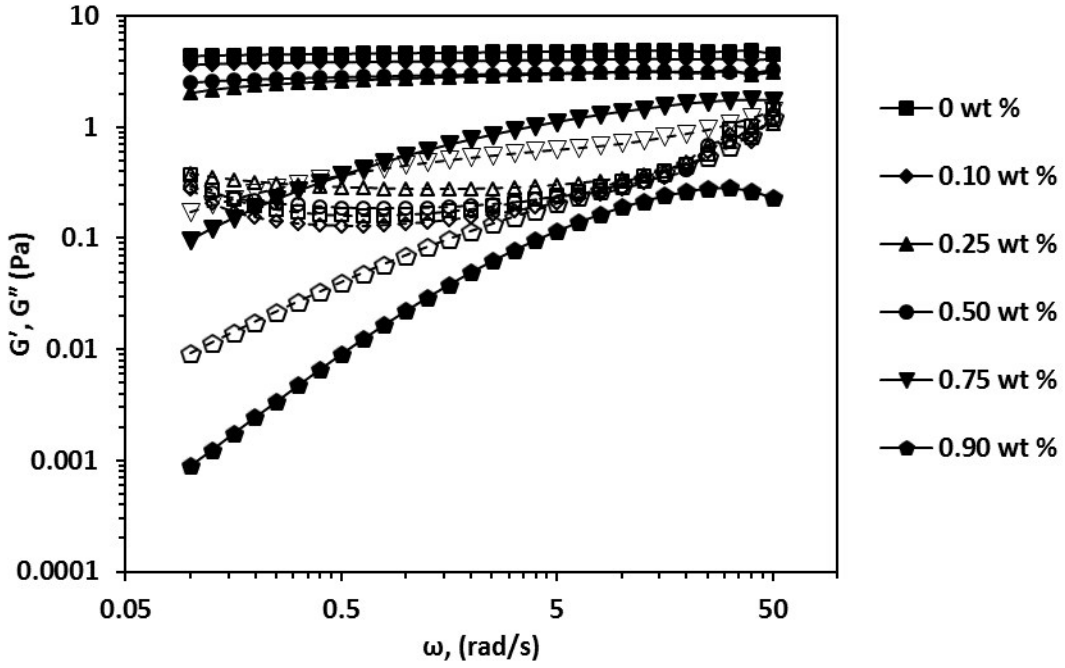

Figure S 19. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of n-decane at 30°C

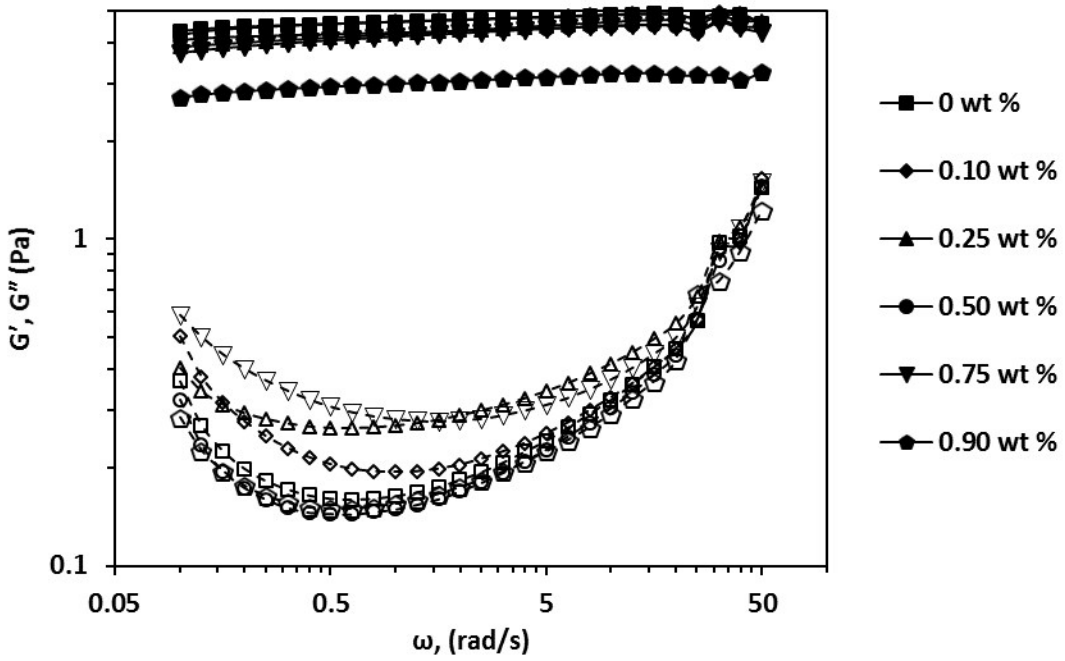

Figure S 20. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of crude oil at 30°C

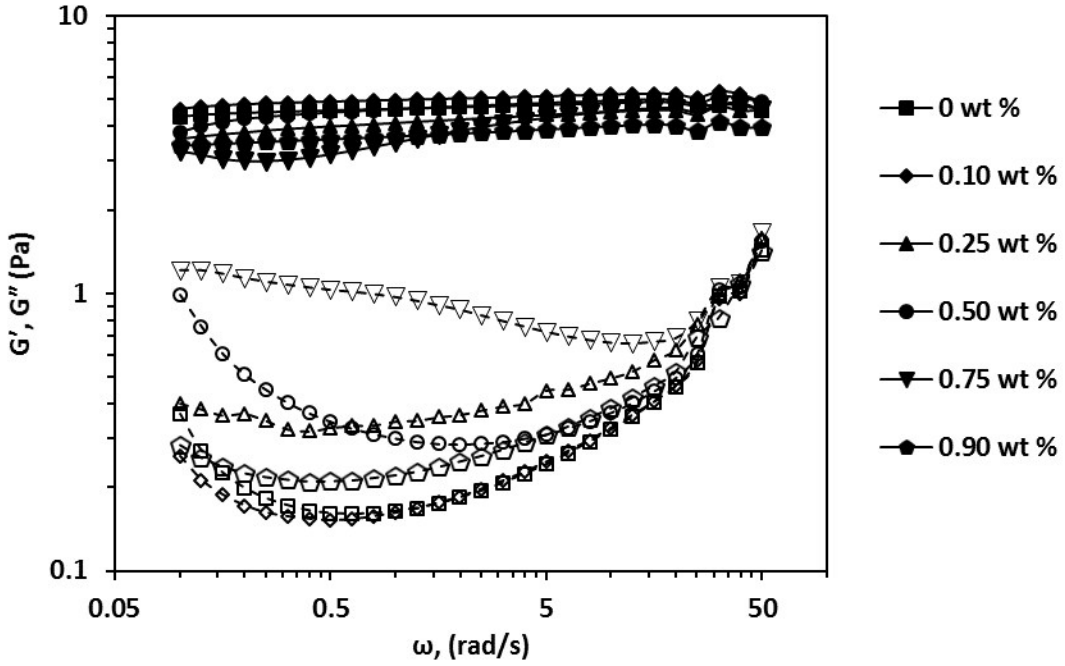

Figure S 21. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of EVOO at 30°C

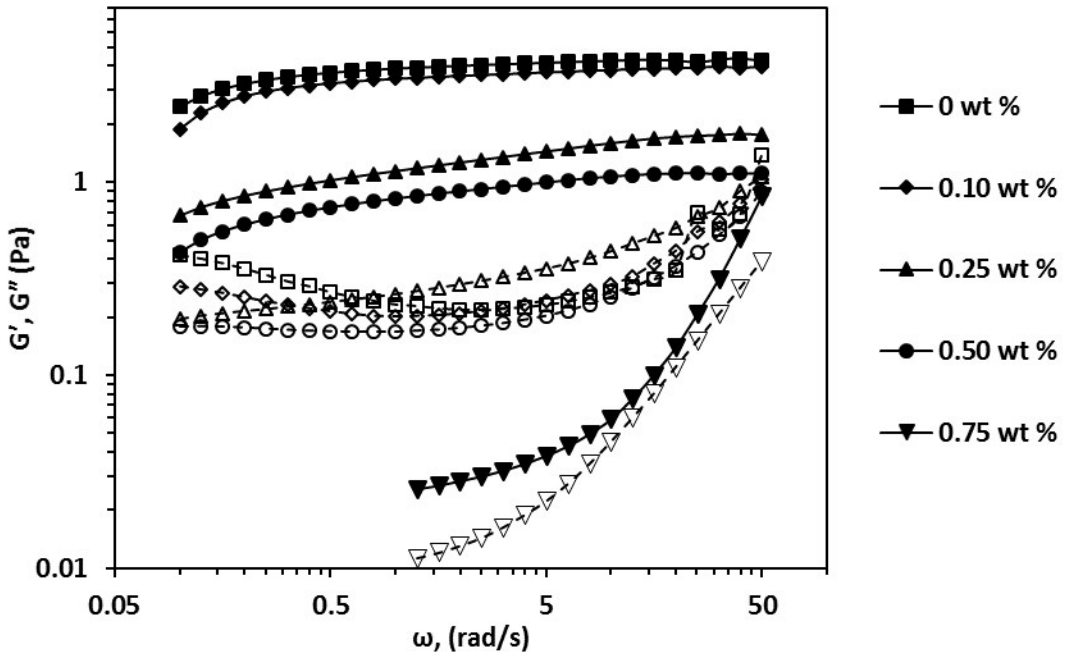

Figure S 22. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of n-decane at 60°C

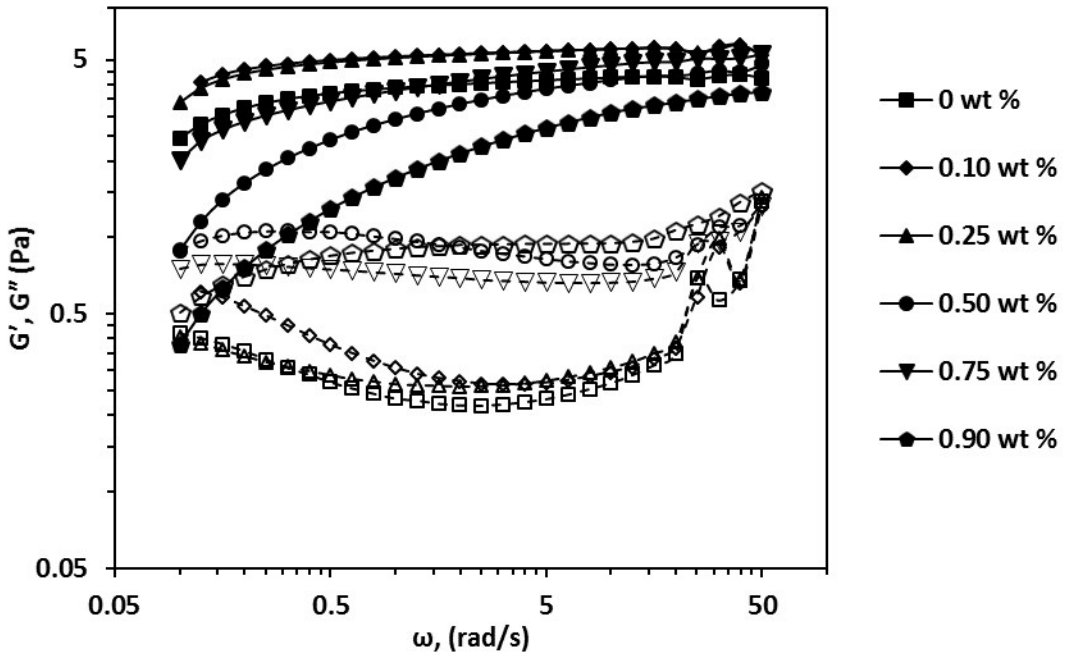

Figure S 23. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of crude oil at 60°C

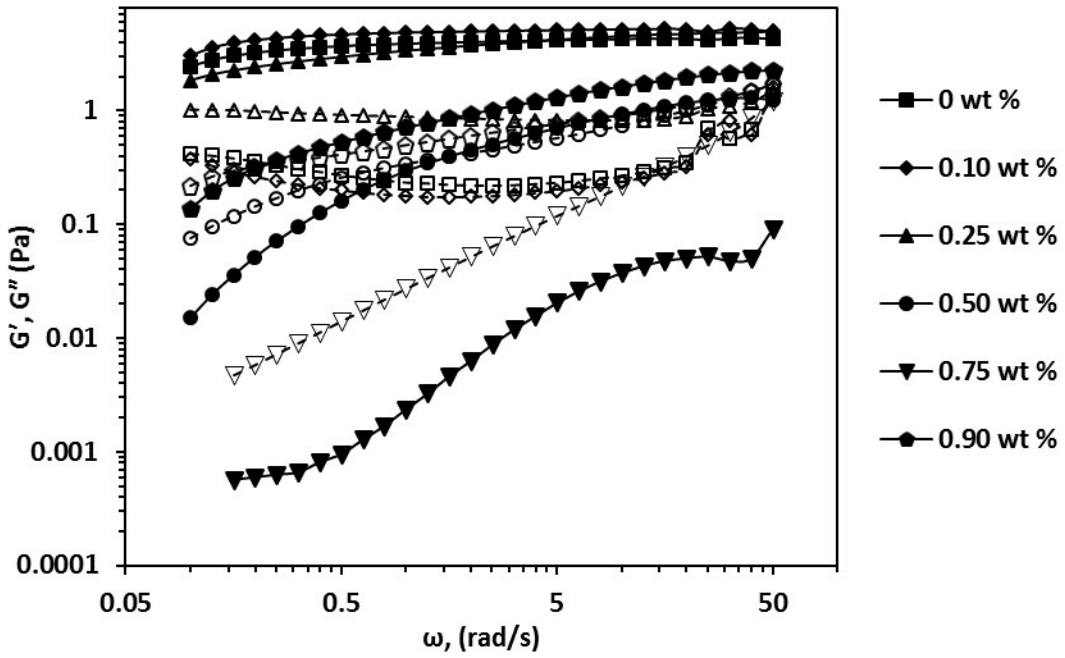

Figure S 24. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant solution with different concentrations of EVOO at 60°C

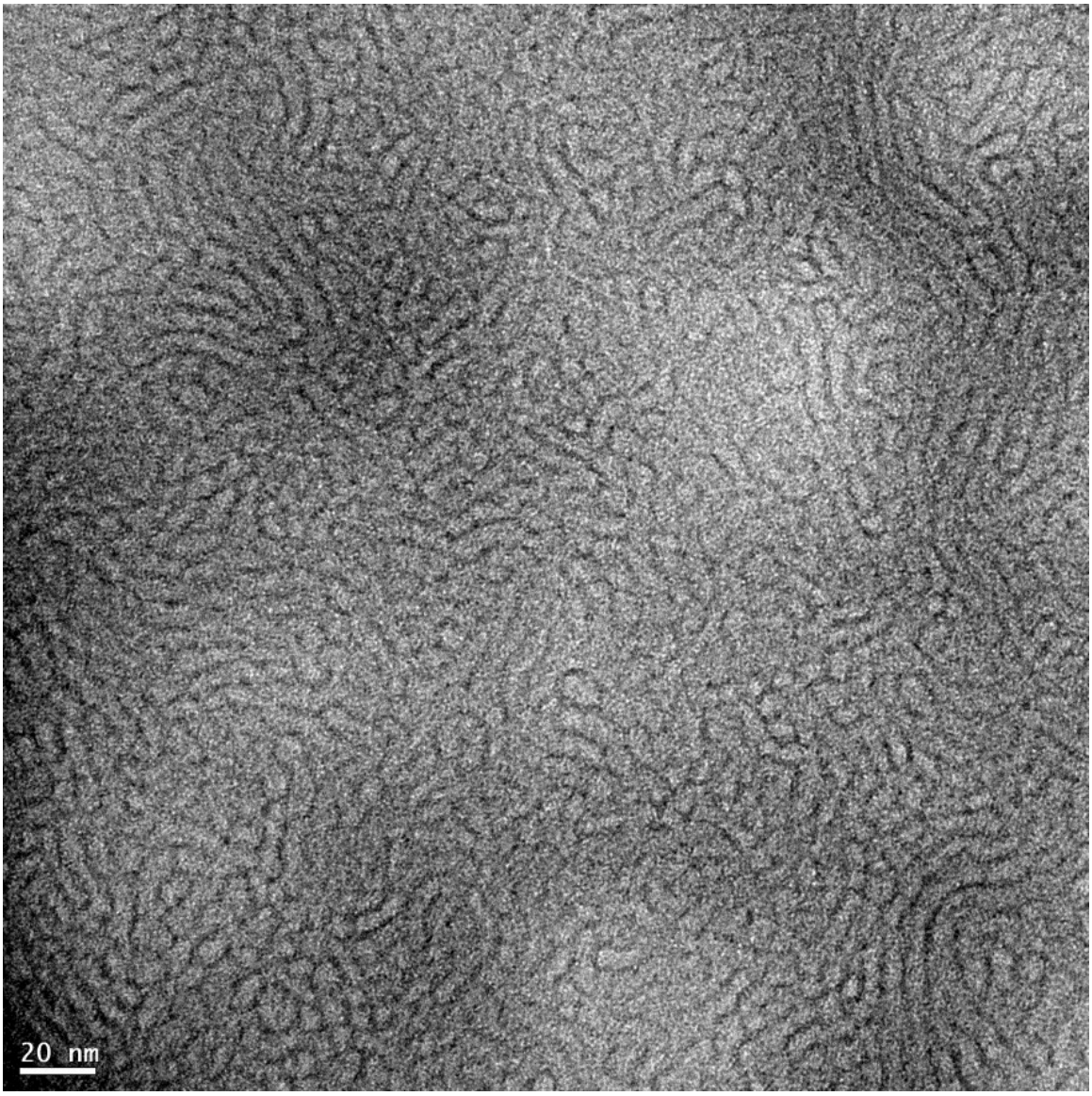

Figure S 25. Cryo-TEM image of 3.96 wt % surfactant solution with 3 wt % EVOO at 60°C. The black lines represent the micelle edges.

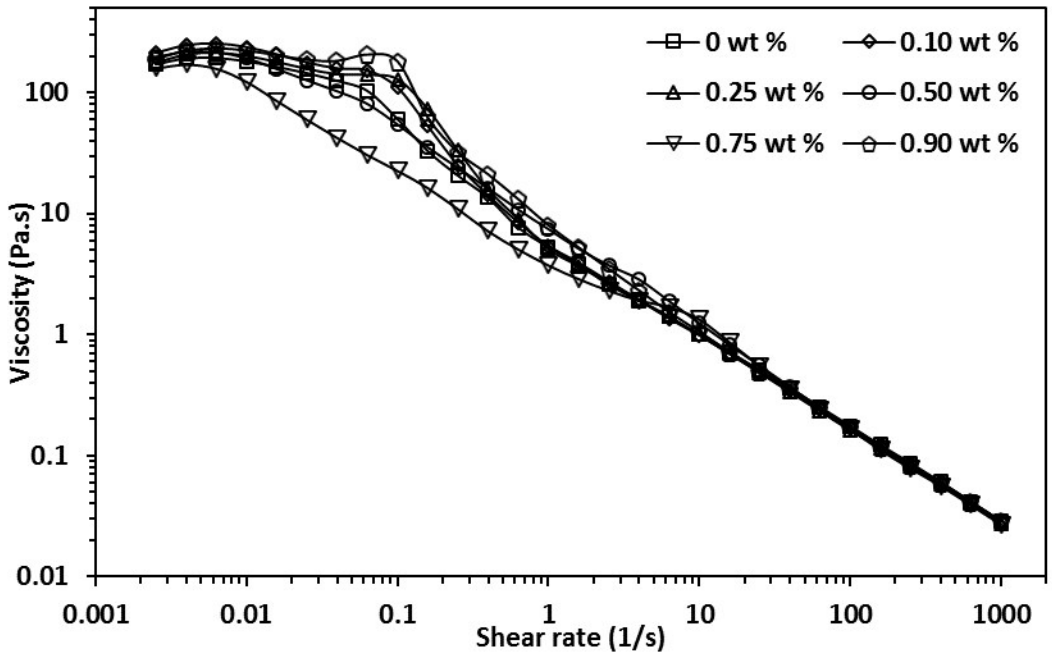

Figure S 26. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of PGA at 30°C

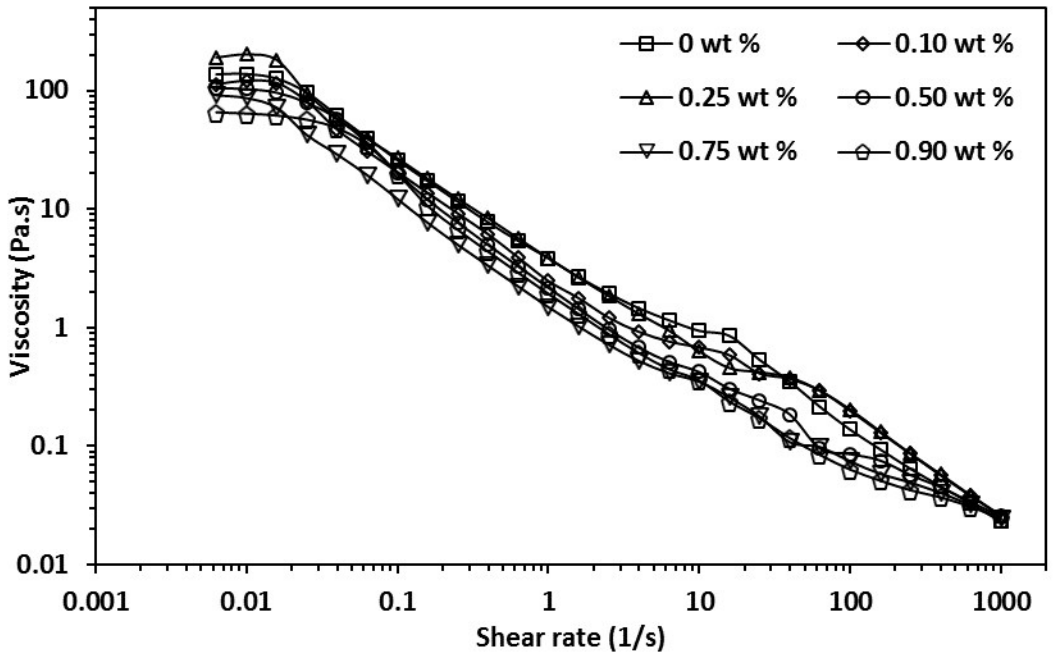

Figure S 27. Viscosity vs shear rate of 3.96 wt % surfactant solution with different concentrations of PGA at 60°C

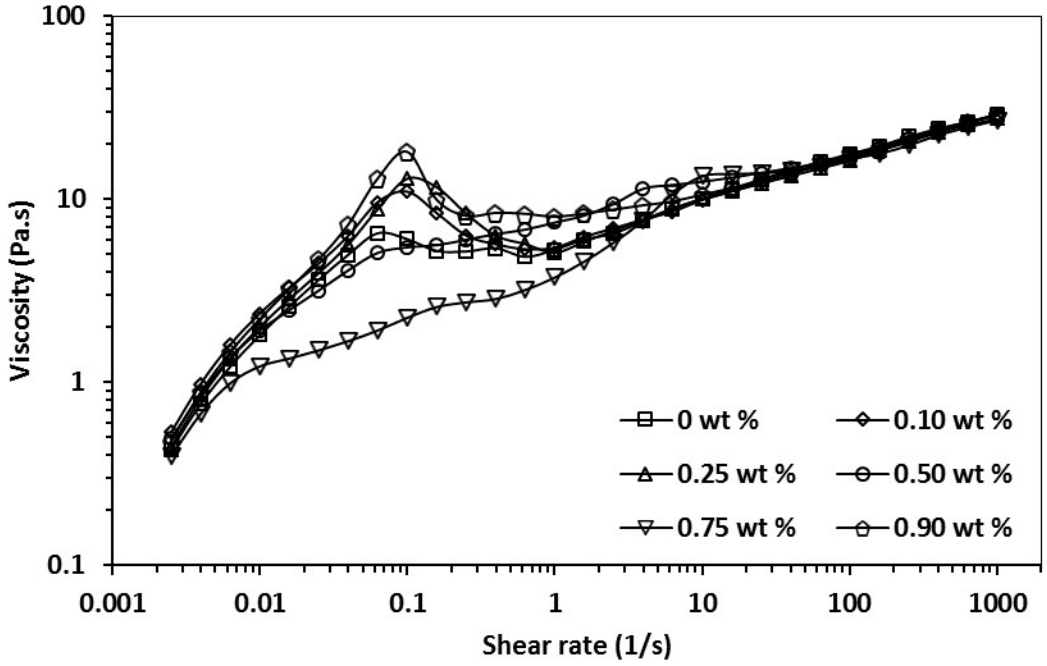

Figure S 28. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of PGA at 30°C

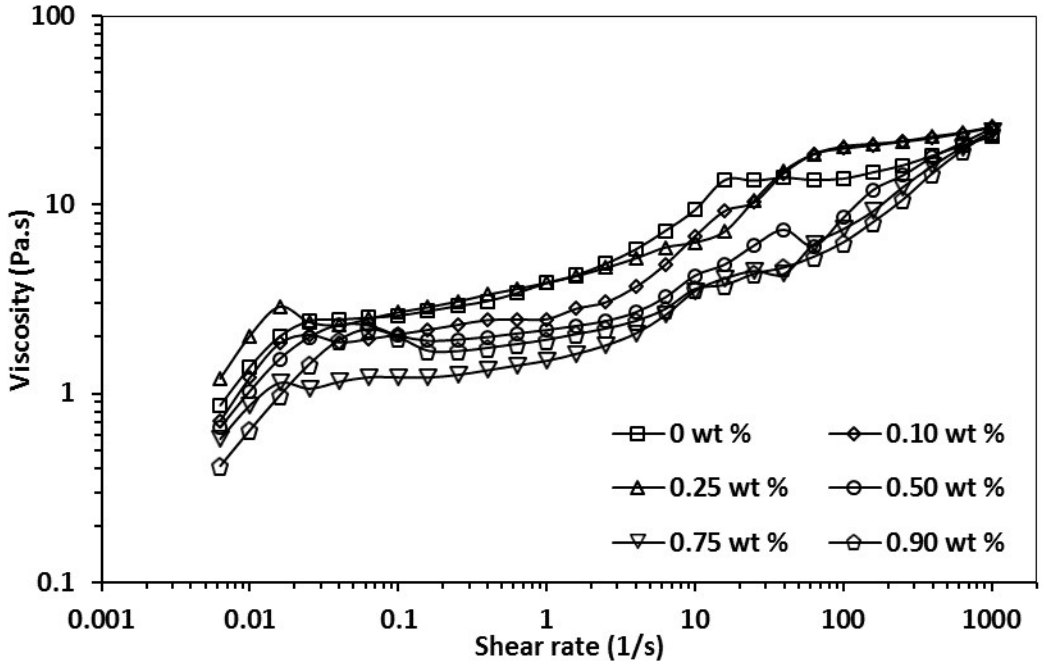

Figure S 29. Shear stress vs shear rate of 3.96 wt % surfactant solution with different concentrations of PGA at 60°C

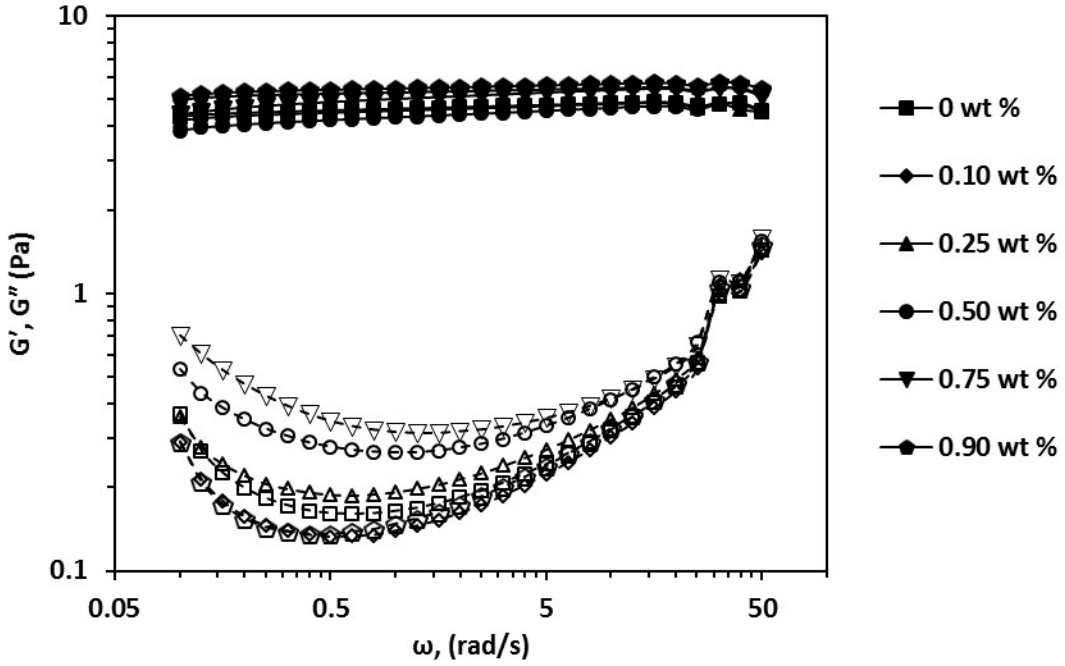

Figure S 30. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant with different concentrations of PGA at 30°C

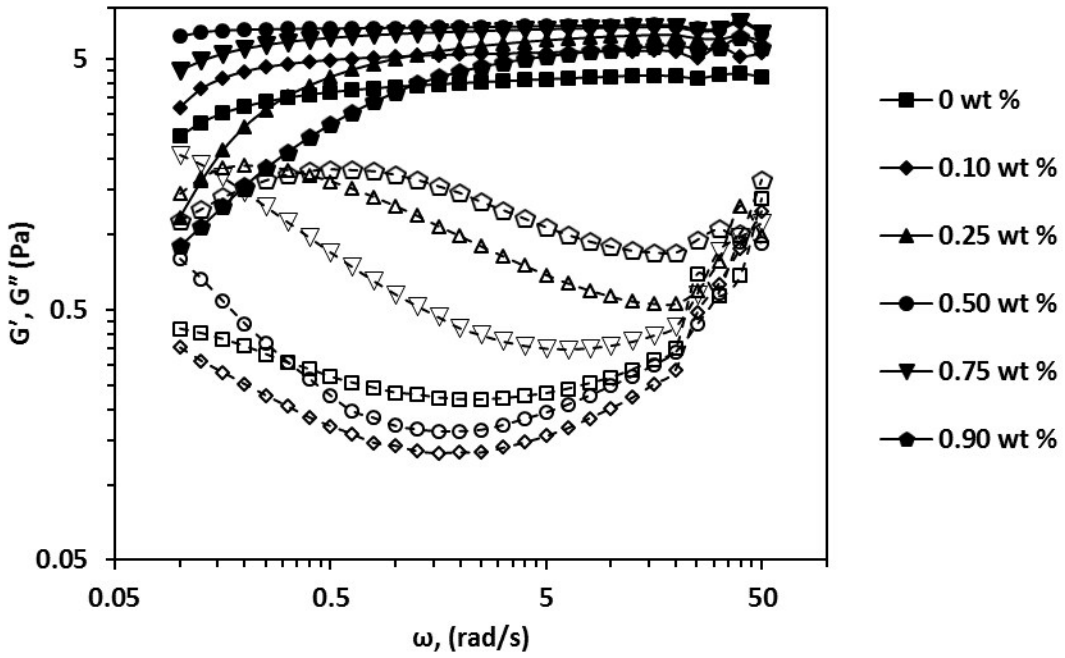

Figure S 31. Storage modulus (filled symbols) and loss modulus (open symbols) of 3.96 wt % surfactant with different concentrations of PGA at 60°C