A COMPUTER SYSTEM FOR CHARACTERIZING STABILITY OF SURFACTANT FOAMS

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Abstract

Foam is a dispersion of gas bubbles into a liquid. Like other dispersions, foam is thermodynamically unstable: it changes in structure with time. Foam stability can be quantified by different methods but the great majority of them are invasive methods that alter more or less the equilibrium foam microstructure during sampling and test preparation. That is why non-invasive and destructive methods are wanted. Ultrasound-based methods being non-invasive are very promising for foam characterisation. That is why non-contact and non-destructive method for characterization of surfactant foams is proposed in this manuscript.

The proposed method in the manuscript is based on using ultrasonic emitter and receiver which detect the reflected signals from the irradiated object. Two surfactant foams (shave foams sample 1 - uniform foam, and sample 2 - coarser foam) were evaluated in terms of stability over time (0 - 60 min). The results were processed by spectral analysis of signals method - discrete wavelet transform (DWT) of Haar implemented with fast conversion. The results obtained by the ultrasound method were compared and validated by image analysis of the resulting foam microstructure taken with a light microscope equipped with a digital camera.

Discrete wavelength spectra were obtained for the approximating and the detailing coefficients of the two foams. The increase over time of the second detailing coefficients at level of decomposition m = 8 for both tested samples was approximated to a linear function with the slope being indicator about their stability. When comparing the linear growth of the detailing wavelength spectra coefficients over time it was evident that the sample with initial coarser microstructure (sample 2) had lower stability compared to the initially more uniform foam microstructure of sample 1 which corresponds to the results obtained by image analysis of their equilibrium microphotographs. The image analysis of the two surfactant foams with different initial microstructure parameters – median diameter of the bubbles (d50) and the mean Sauter diameter of the bubbles (d32) indicated linear growth of both d50 and d32 with time but with different kinetics (higher kinetics for sample 2). The results obtained by the two methods were compared and identical conclusions were drawn.

The obtained results indicated high sensitivity and adequacy of the proposed non-destructive ultrasound method for analysis of the foam stability over time compared to the commonly used invasive microscopic method based on image analysis of foam microstructure.

Key words: *Characterization, Classification, Surfactant foams, Foam stability, Ultrasound, Wavelets.*