COMMENTS ON "A THEORETICAL ANALYSIS OF EVAPORATING DROPLETS IN AN IMMISCIBLE LIQUID"

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IN A RECENT paper [1], Mokhtarzadeh and El-Shirbini presented an analysis and detailed numerical results on the evaporation process of a droplet in an immiscible liquid. They discussed the mechanical stability of a vapor bubble at a drop surface in Section 3.7.1 in their paper with the aid of the criteria by Moore [2]. The criteria predict that if

$$\sigma_{cv} > \sigma_{dv} + \sigma_{dc} \quad (1)$$

the bubble is expelled into the continuous phase, and if

$$\sigma_{dv} > \sigma_{cv} + \sigma_{dc} \quad (2)$$

the bubble enters into the droplet, where σ_{cv}, σ_{dv}, σ_{dc} are tensions working at continuous-phase liquid/vapor, dispersed-phase liquid/vapor, and dispersed-phase liquid/continuous-phase liquid interfaces respectively (see Fig. 1). Those criteria seem to result from an elementary misunderstanding on the force balance at the three-phase contact line.

The resultant force of three interfacial tensions causes a motion of the three-phase contact line in the same direction relative to the bubble as the said resultant force; in other words, the bubble is moved in the opposite direction to the resultant force. If equation (1) were satisfied, the dispersed-phase liquid would be pulled up on the bubble so that the bubble would be engulfed in the droplet. On the contrary, if equation (2) were satisfied, the continuous-phase liquid would break into the vapor/dispersed-phase liquid interface so that the bubble would be expelled into the continuous phase. Thus the criteria presented by Moore [2] and cited by the authors [1] have to be reversed. It should be also mentioned that the above criteria conflict with those by Selecki and Gradon [3] cited by the authors and with those by the discusser [4]. The observations by Gradon and Selecki [5] and the discusser [6] cited also by the authors showed that a bubble is expelled from a droplet in the case of $\sigma_{dv} > \sigma_{cv} + \sigma_{dc}$ contrary to the criteria.

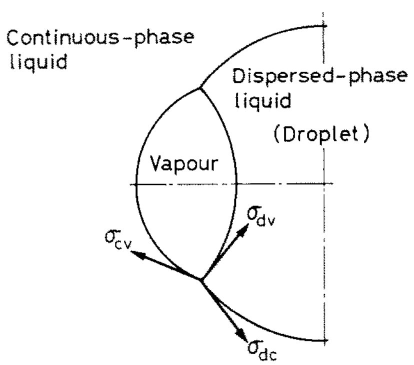

FIG. 1. Vapour lens at the surface of a droplet.

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