

Effect of humidity on monolayer desorption at the air-water interface

THE effect of atmospheric humidity on the physicochemical properties of lipid monomolecular films at the air-water interface has been thought to be of secondary importance, and has never been studied experimentally. Yet, the physical situation encountered at the air-water interface may be strongly dependent on the humidity in the gas phase^{1,2}. Harkins³, while not specifically investigating this effect, took painstaking measures to ensure saturation of the air above the interface in an effort to suppress any temperature difference between the interior of the aqueous phase and its free surface. Obviously, below the saturation point of the air, the free surface of water is expected to be at a lower temperature than the interior by virtue of the evaporation of liquid. Thus, in some instances, the temperature of the outermost layer of the free water surface was reported to drop by 15°C or more relative to the temperature of the bulk from measurements of the surface tension during evaporation⁴. In other investigations the mean temperature, measured by thermistors, of a thin region immediately below the free surface of a water pool was reported to be several degrees lower than that in the interior during evaporation¹. The data presented here constitute a clear indication of the decisive effect of atmospheric humidity on the kinetics of monolayer desorption from the air-water interface. Figure 1 illustrates the dramatic difference in the observed decrease of the surface pressure of myristic acid monolayers in three different conditions of atmospheric humidity.

Unstable density and temperature gradients may thus be expected along the depth of a water layer undergoing evaporation. The main effect of these gradients is the generation, at a critical value, of the well known convective flows^{5,6} in which liquid at the surface is driven, by buoyancy or surface tension effects, to the interior and replaced by liquid from below. The intensity of these hydrodynamic effects obviously should be a function of the rate of evaporation (or heat flux) and hence, in the case of water pools, of the relative humidity of the air above

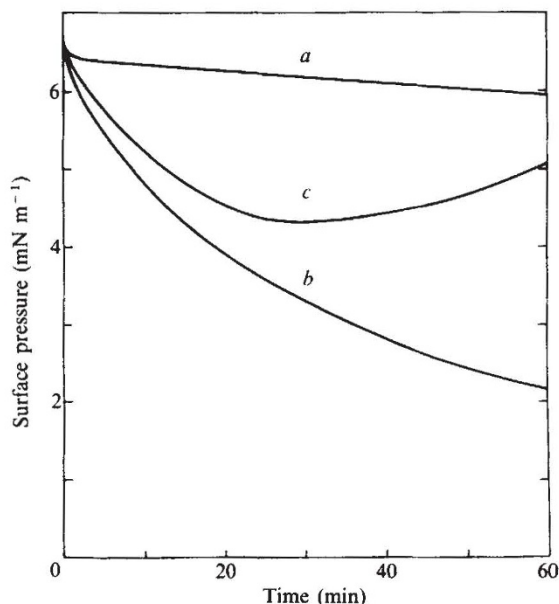


Fig. 1 Monomolecular film behaviour of myristic acid on 0.01M HCl at constant surface area. Relative humidities are 100% (a), 68% (b) and increasing 72 to 84% (c). The surface pressure was measured within 30 s of spreading and compressing the film. Each curve is reproducible to within at least 0.1 mN m⁻¹. Temperature 21.2°C.

the free liquid surface. As the motion of fluid involves exchange of surface liquid for bulk liquid it could, in principle, affect studies of the dynamics of surfactant molecules both along the interface, such as surface diffusion, or across the interface, such as adsorption-desorption phenomena.

The apparatus used in this study consisted of a 1.6-mm deep Teflon trough, a Wilhelmy-type film balance, three thermistor probes for scanning the temperature of both the liquid and gas phases, and small relative humidity probes placed 5 mm above the interface. The entire system was enclosed in a Lucite cabinet, and the experiments were conducted in a controlled environment room. The cabinet was fitted with small pluggable access ports which served two purposes: first, to allow spreading of the monolayer from *n*-hexane through long capillary tubes, thus minimising disturbances of the physical conditions of the system, and second, to allow for adjustment of the humidity levels in the cabinet which also contained moist filter paper. In every instance spreading of the monolayer was accomplished only after complete stabilisation of the temperature and relative humidity. Every effort was made to check for and eliminate experimental artefacts due to film leakage, contact angle hysteresis, and solvent effects.

It is believed that curve *a* in Fig. 1 represents the rate of monolayer desorption in a convection-free aqueous layer (pH 2.0). The increase in the apparent desorption rate at 68% relative humidity (curve *b*) is presumably due to the convective motion in the liquid which causes a more rapid depletion of surfactant molecules from the surface, perhaps even during the spreading process. Interestingly, if the relative humidity is allowed to increase from 72 to 84% (curve *c*), the apparent film pressure first decreases rapidly, due to enhanced surfactant depletion by convection, and then increases gradually as a result of surfactant re-adsorption which could be aided by the well known suppression of convective motion in liquids by the presence of solvent-free monolayers at the surface. The behaviour depicted also was found to persist for lauric acid monolayers in the liquid-expanded state and, except for curve (c), the results for a given surfactant were independent of trough dimensions or construction material.

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Ice elevation map of Queen Maud Land, Antarctica, from balloon altimetry

THE technique and expected coverage of ice elevation mapping using radio altimetry data from the Twerle balloons¹, have already been discussed². We present here preliminary results obtained after analysing 18 balloon traverses, with 1,900 elevation points. A map of the entire continent agrees very well