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Emulsification And The HLB-temperature

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Emulsification and the HLB-Temperature

Shinoda, who introduced the HLB-temperature (1-3) as a means to select emulsifiers, has pointed out the importance of the low interfacial tension at the HLB-temperature for obtaining emulsions with small average droplet size and hence good stability. These conclusions have been discussed by Parkinson and Sherman (4) who for some systems could find only insignificant differences in the particle size distribution of emulsions prepared at the HLB-temperature and at other temperatures. It appears possible to resolve this ambiguity by the fact that spontaneous emulsification in the surfactant phase also plays a part for making use of the HLB-temperature for emulsification.

Our results showed spontaneous emulsification to take place when the temperature was reduced from the HLB-temperature. The system water, tetraoxyethylene dodecyl ether, and hexadecane showed a pronounced reduction of droplet size when the temperature was lowered from the HLB-temperature (28°C) with its three-phase (water, oil, surfactant phase) state to 20°C, at which temperature only two phases (water and oil) were present. Figures 1A and B demonstrate the change from a broad distribution with a number average droplet size of 3 μm to a more narrow distribution with an average size of 1 μm after reduction of the temperature.

It is tempting to explain this spontaneous emulsi-

fication as a result of the transport of surfactant across the interface with an accompanying further reduction of the interfacial tension analogous to the formation of kinetically unstable microemulsions (5, 6) and other examples of spontaneous emulsification (7-10), but such an explanation is ruled out by the fact that corresponding emulsions prepared at temperatures in excess of the HLB-temperature and hence with enhanced surfactant transport over the interface *did not* show a reduction of droplet size. The average droplet size was actually increased by the temperature reduction (Figs. 1C and D).

Instead, the reduction of droplet size appeared to be related to the presence of the surfactant phase. When emulsions were prepared containing 0, 20, and 50% of the surfactant phase (Fig. 2), no spontaneous emulsification was observed for the emulsion of only the aqueous and oil phases with no surfactant phase. The distribution remained essentially constant (dashed lines, Figs. 2A-D). Compositions with 20 (Figs. 2A and B) and 50% (Figs. 2C and D) surfactant phases and with a corresponding water/oil ratio of 65/35 gave considerable reduction of the droplet size. The importance of the surfactant phase was also shown by the fact that the surfactant phase itself gave emulsions with extremely small and uniform droplet size when rapidly cooled from 28 to 20°C.

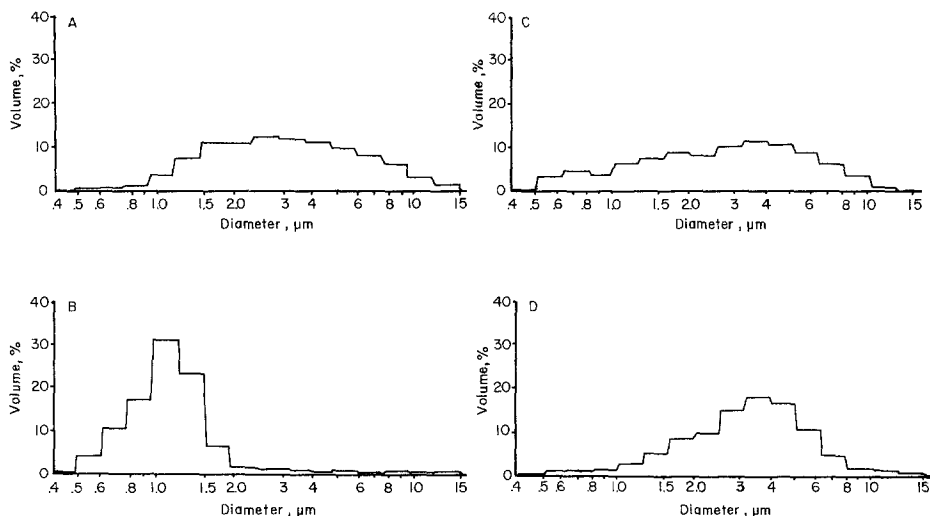


FIG. 1. The droplet size in an emulsion was reduced when it was rapidly cooled from the HLB-temperature (28°C) to 20°C (A and B). Cooling from 30° to 20°C did not produce the corresponding effect (C and D).

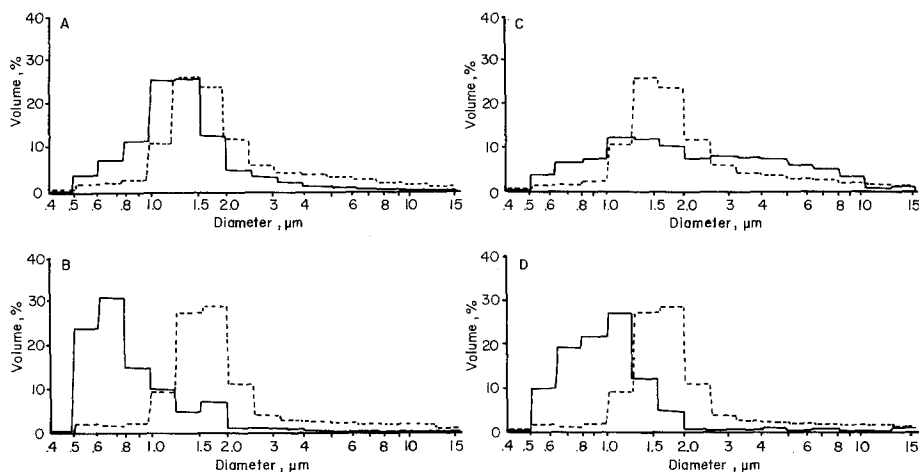


FIG. 2. Compositions at the HLB-temperature but with no surfactant phase (---) gave no spontaneous emulsification. Comparisons (—) with 20 (A and B) and 50% (C and D) surfactant phase gave considerable reduction of the droplet size.

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