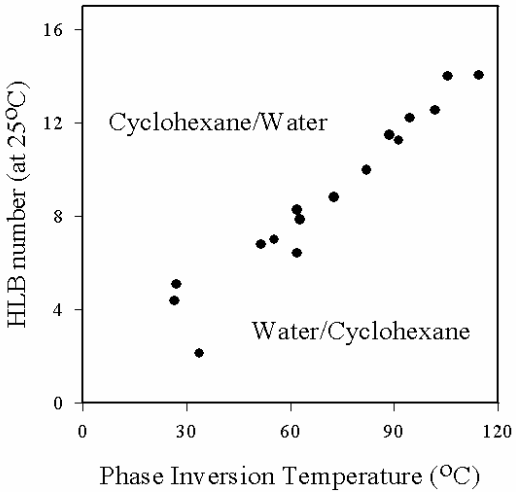
Question: How do we develop a margarine that can resist the (Brazilian) temperatures (22 ^{o}C – 40 ^{o}C) without refrigeration?

Answer:

A quick look in Wikipedia turns up the interesting fact that in 1869 Emperor Louis Napoleon III of France offered a prize to anyone who could make a satisfactory substitute for butter, suitable for use by the armed forces and the lower classes. Margarine was the answer!

A good place to start is to look in a terrific book by McClements[1] where we learn that margarine is a water in oil (W/O) emulsion (p. 2). When oil is the continuous phase, we now know that the emulsifiers will have a low HLB (hydrophile-lipophile balance) number, that is, be more soluble in oil than in water.[2] Further, because margarine should be "spreadable" the continuous oil phase will contain some re-enforcing network, sometimes aggregated fat crystals. (p. 194, 222, 230, 263) The formation or loss of fat crystals will be temperature sensitive. Above a certain temperature, the fat crystals melt, the strength of the oil phase drops, and the water drops can sediment and separate. You need to determine whether this is a significant factor or not.

A second factor is the temperature dependence of the emulsifiers. The HLB scale can be complemented by the PIT (phase inversion temperature) scale. The PIT is the temperature where the emulsion inverts, that is changes between O/W and W/O. You will often see both an HLB value and a PIT value for an emulsifier. Interestingly they are correlated.[3]



[1] McClements, D.J. *Food Emulsions: Principles, practice, and techniques*; CRC Press: Boca Raton; **1999**.

[2] Morrison, I.D.; Ross, S. *Colloidal dispersions: Suspensions, emulsions, and foams;* John Wiley & Sons: New York; **2002**; pp 429 – 432.

[3] ibid., pp 432 – 434.

This figure shows a good correlation between the HLB and PIT. Don't pay too much attention to the exact temperature because the PIT will change with the composition of the oil. The figure serves as a guide. Margarines are water in oil emulsions so that if you wish to keep the emulsion stable over the range of temperatures 22 ^{o}C – 40 ^{o}C then you need to use as low an HLB as possible. Those are the values where the emulsion remains W/O as the temperature changes. In general surfactant suppliers can provide both HLB and PIT values for their products.

If course, this is only a start, an idea to narrow the search. But it should help.