Diffusion coefficients of quinine in supercritical CO_2

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It is widely recognised that the increase in atmospheric CO_2 levels due to industrial activity is the main cause of climate change. One idea is that, under the right conditions, it could be used industrially as a solvent. In its gaseous form, CO_2 is essentially a non-solvent but, in the supercritical fluid state above its critical point (T_{cr} = 31.1°C and P_{cr} = 7.38 MPa), the density and solvation capabilities of CO_2 change dramatically compared with the gas. The key physico-chemical properties of a supercritical fluid such as density, diffusivity and dielectric constant can be easily controlled by changing the pressure and/or temperature.

Another advantage of using supercritical CO_2 ($scCO_2$) in extraction is the fact that it can easily be separated from the product by processes like adsorption, absorption or evaporation. This offers good product purity as none of the above separation processes can be detrimental to the product.

One of the ideas of using $scCO_2$ as a solvent is to extract quinine, which has been used since the 16th century to treat malaria. Quinine is not only an antimalarial medication, but it is also used for the treatment many other diseases. It is also widely used in beverages such as tonic water. Usually, the strong acids or petrochemical-derived solvents (e.g. as hexane) are used for the extraction of quinine and the final product is not clean. The use of $scCO_2$ is most promising as it does not require no pre-treatments or post purification processes. However, this application is impacted and even governed by the diffusion process but there is a lack of knowledge about transport properties of quinine in $scCO_2$.

Our objective is to investigate the diffusive properties of quinine in supercritical CO_2, and how they depend on pressure and temperature. To conduct the investigation, a dedicated experimental setup has been developed, comprising a Taylor dispersion instrument working at high pressure [1]. The solid quinine is first dissolved in ethanol and then is injected into supercritical CO_2. For this reason the first task of the study is focused on the analysis of the diffusion of pure ethanol in $scCO_2$. The second part is aimed at the diffusion of the (quinine + ethanol) solution in $scCO_2$ at different pressures and temperatures.

References

[1] S. Ancherbak, C. Santos, J.-C. Legros, A. Mialdun, V. Shevtsova: *Development of a high-pressure set-up for measurements of binary diffusion coefficients in supercritical carbon dioxide.* Eur. Phys. J. E **39**, 111 (2016).