

NMR Relaxation of Suspensions of Mixed Particles

Many formulations contain more than one type of particulate material. These particles may compete for adsorption of polymers which enhance stability. Optimizing stability of these mixed suspensions can be challenging. The importance of the process of dispersion and its profound effect on the economics and quality of the subsequent product has long been recognized; the economic impact of incorrect mixing can be considerable. Understanding particulate suspension structure is, essential to optimize product performance.

Surface particle analysis using NMR relaxation is well-established. It is known that the magnitude of the relaxation depends very much on the specific material under investigation. For example, the relaxation rate of an alumina suspension is much shorter than that for a silica suspension of the same particle size and concentration because the former element is quadripolar.

In the example shown below, the NMR relaxation rate of two different nanoparticulate silica suspensions was measured separately and then mixed together and measured again. The first was a typical pure SiO₂, the second alumina-modified SiO₂. Both materials are used extensively in a wide variety of applications.

Both unmodified SiO₂ (black) and the Al-modified SiO₂, (blue) show the expected linear behavior for relaxation rate versus particle concentration. The Al-modified SiO₂ suspension has a steeper slope. The red line then shows the result of adding increasing amounts of the unmodified SiO₂ to a fixed amount of the Al-modified SiO₂ suspension. Clearly relaxation rates are additive. If the concentration of one of the particle suspensions is known then the other can be measured.

Note the range of concentration measured. NMR measurements can prove very useful since they can be made using undiluted suspensions; they are also independent of particle size and shape. These data also emphasize another advantage of NMR relaxation measurements in that detailed surface chemistry can be probed, for example that of alumino-silicate clays. Here the surface chemistry can vary widely; it critically depends on the clays prehistory and so care must be taken when comparing data on clays from different sources.

