Comparative characterization of magnetic nanodispersions

T. Sobisch\textsuperscript{1*}, N. Buske\textsuperscript{2}, D. Lerche\textsuperscript{1*}

\textsuperscript{1}LUM GmbH, Rudower Chaussee 29 (OWZ) 12489 Berlin
\textsuperscript{*}e-mail: info@lum-gmbh.de
\textsuperscript{2}MagneticFluids, Köpenicker Landstraße 203, 12437 Berlin

Functional dispersions based on magnetic nanoparticles are promising candidates for a broad range of biotechnological and medical applications. This requires methods for in-depth characterization but also for a fast screening. Besides the magnetical properties the physical background of particle interactions, the redispersibility of agglomerated particles, primary and hydrodynamic size, the composition of the carrier fluid and the absence of oversized particles is of importance.

Sedimentation analysis using multisample analytical centrifugation with photometric detection is a rather simple but powerful method to characterize the dispersed state and particle size distribution of magnetic nanodispersions. In comparison to this method the hydrodynamic size and zeta potential was determined by light scattering technique (Zetasizer).

Magnetite particles were prepared by the precipitation method. The samples were stabilized by different approaches.
A Magnetite hydrosols (pH 3 – 6) the particles are electrostatically stabilised, having a positive zeta potential.
B Water based nanodispersions with sterically stabilised particles with a primary double layer of dodecanoic acid, fixed on the particle surface, and a secondary layer of a non-ionic surfactant.
C Water based nanodispersions with mainly electrostatically stabilized particles using citrate as a shell component. These particles have a negative zeta potential at a pH of 7.

Transmission profiles are shown below for representative samples belonging to these different groups.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{transmission_profiles.png}
\caption{Transmission profiles obtained during centrifugation at 2300 \textit{g} for samples differently stabilized}
\end{figure}

The double layer particle dispersion (B) is the most stable exhibiting only a small change in profiles. Both A and C exhibited relatively fast separation (large spacing between profiles). However, the shape of the profiles reveals marked differences in dispersion quality. (A) shows a gradual decline of transmission along the sample towards the bottom, i.e. individual particles and aggregates sediment with different velocities according to differences in
hydrodynamic size. (C) exhibits the typical sedimentation behaviour of a space filling particle network (zone sedimentation – particles separate with the identical velocity).

To be presented in more detail the method delivers direct information on the colloidal stability of the dispersed particles and on the degree of particle aggregation. In this respect the method delivers far more detailed information than single values obtained for zeta potential and hydrodynamic size.