Popular Science Summary

Chasing unexpected results in the particle size analysis of oil droplets.

Imagine that 90% of the results given by the most popular particle size distribution determination technique are unreliable and a large scientific community have been using these results over the past years without critically thinking about them.

In the engineering world, accuracy and precision are two concepts that are extremely important to consider when measuring the efficiency of any process. In the food industry as well as in many applications, the need to measure small particles has led to different technologies. Some of them used in a major extent compared with others. Together with advances in laser and light technology, especially after the increasing interest of nanoparticles by the pharmaceutical industry, several techniques have been developed in order to improve the accuracy and reliability of the small particle measuring techniques.

Automatized laser diffraction (LD) techniques are the most used and popular instrument to measure particle size distributions. Its high popularity is due to its outstanding broad measuring range capability and its easy-to-use and high reproducibility. These instruments utilize the principle of laser technology. Together with a complex mathematical algorithm the technology interprets the signal and in an indirect way measure macroparticles, microparticles, nanoparticles and mixtures of those. This makes it an all-purpose technique. However, this technique has its problems and limitations, which are not easy to overcome. These are quite often overseen, underestimated or simply unknown to the user.

Having a deeper understanding under which conditions the instrument can give precise, accurate and reliable results will be highly beneficial for most of the scientific community interested in micron and submicron particle populations. For example, product developers, process engineers, food scientists, just to mention some. However, there are some conditions under which the LD technique shows unexpected results in the form of unexpected peaks. To tackle this problem, this study was started.

In this master thesis, conditions are studied under which unexpected peaks appear or do not appear while measuring oil droplets on commonly used LD equipment. A comparison between two commonly used LD models is presented in order to highlight significant differences in volume PSD and the occurrence of unexpected peaks.

Experiments were preformed using primarily pasteurized milk. However, since milk is such a complex system a model emulsion was studied, which is a more basic system to analyze. This also provided insights to discard some of the hypotheses that might cause the appearance of the unexpected peaks. In order to evaluate the accuracy and detection capability of LD equipment, a technique using dynamic light scattering was used as a complementary technique.

Furthermore, this thesis describes usage recommendations and best practices in detail. This can provide insights in how such equipment should be operated to limit the incidence of unexpected peaks and how to interpret the unexpected peaks when they do occur.