Application note

Characterization of additives for cement and concrete through charge measurement

- **Characterization of construction chemicals**
- **Verification of reaction under real conditions**
- **Optimization of additive and admixture**

BACKGROUND

Today the construction chemicals industry produces a multitude of additives for cement or gypsum-based formulations. Some typical examples of these additives are liquefiers, superplasticizers, stabilizers, water retention agents, air-entraining agents, defoamers, accelerators and retarding agents.

By way of chemical or physical interactions, additives are capable of improving the characteristics of construction material systems such as their processability, setting or hardening behavior or their durability.

As a rule, construction chemicals are added in very small dosages. Basically, these additives are highly optimized functional molecules. The dominant products in this field are superplasticizers which come within the groups of polycondensates and polycarboxylates.

EXPERIMENTAL

Two different polycarboxylates were examined with the Mütek™ Particle Charge Detector (in short PCD).

Within the PCD measuring cell a streaming potential is generated serving the titrator as an indicator which automatically adds titration agent until the neutralization point is reached. The volume of added titration agent directly relates to the charge level of the polycarboxylate under test.

Figure 1: Mütek Particle Charge Detector (PCD-05 Travel)

RESULTS

A Mütek Particle Charge Detector was used to identify the anionic charge levels of two different polycarboxylates (PC-A, PC-B). Specifically, the polymers were studied in deionized water, 0.1 M sodium hydroxide solution with a pH of 12.6 and in a cement pore solution. The latter represents the filtrate of a water-cement mix at the usual ratio and which exhibited a pH over 12.5 and high ionic strengths. In addition, the anionic charge was determined in 0.1 M sodium hydroxide solution in the presence of 1 g/l Ca2+ ions.

- Both polymers are identical in molecular weight but differ in their lateral chain lengths and anionic charges. The polycarboxylate PC-A with shorter chains showed, in all tested solvents, a distinctly higher charge level compared to PC-B (see Figure 2).
- As a result of deprotonation, the anionic charges increase in an alkaline medium. In the presence of Ca2+ ions, however, the anionic charges decrease owing to a charge neutralization process (Ca2+ bonding).
- The results obtained in the cement pore solution were found to be comparable to those obtained for sodium hydroxide solution (pH 12.6) with Ca2+ ions added.

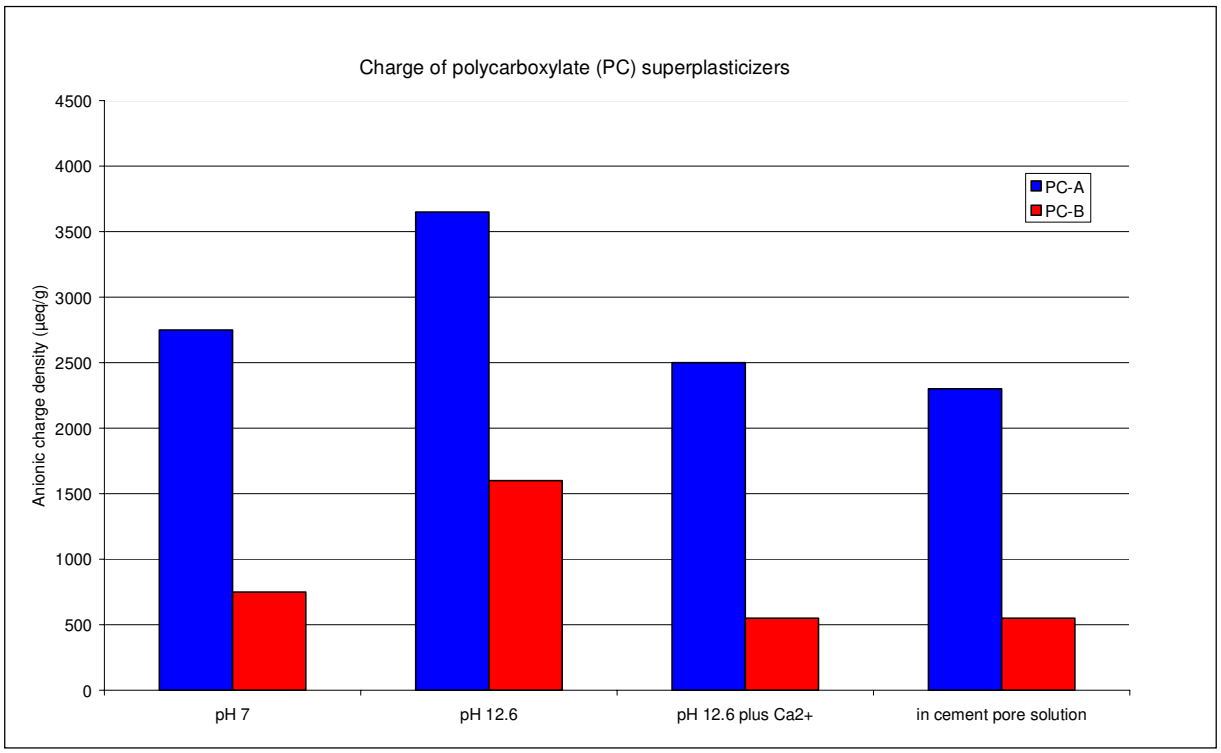

Figure 2: Mütek PCD results of two polycarboxylates. Source: Technical University of Munich, Chair of Construction Chemicals, Prof. Dr. Johann Plank

CONCLUSIONS

The Mütek PCD precisely identifies the anionic charges of different polycarboxylates in a cement pore solution and in other solvent systems. This method enables a determination of the actual anionic charges of these additives as they occur in industrial practice. Accordingly, the system provides information about the adsorption behavior and the resultant dispersion effect of superplasticizers of this kind.

Charge measurements with the Mütek Particle Charge Detector allow for:

- **Characterization of various superplasticizers**
- **Identification of the adsorption behavior and thus the effect of an additive in cement**
- **Information about the adsorption behavior of additive blends**
- **Optimization and new development of additives and additive combinations**