

Comparing three zeta potential analyzers for pulp characterization - Stabino® comes out first for titration and size range

Pulp is a fibrous material resulting from the chemical decomposition or mechanical separation of cellulose fibres from wood or plants. Pulp is one of the most important raw materials for the paper industry. A typical light microscope image of plant fibres is shown in Figure 1.

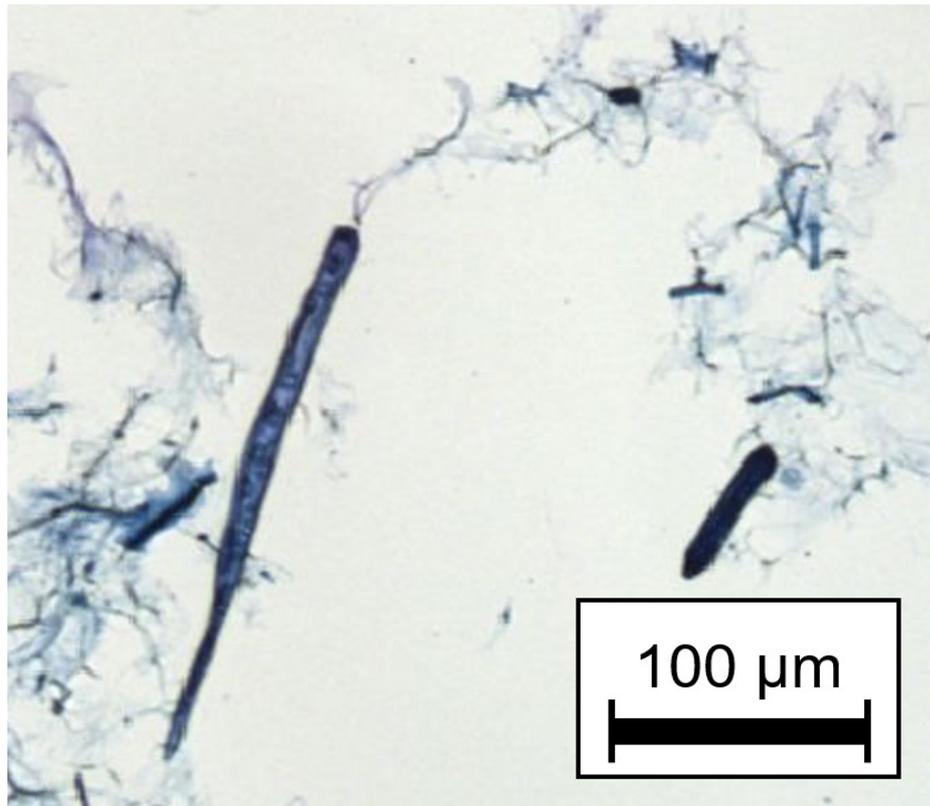


Figure 1: Optical image of typical fibres in pulp.

Courtesy to TU Graz, Prof. W. Bauer

Zeta potential measures the interaction between charged surfaces

In the world of paper making, zeta potential is important to understand the interactions between cationic retention, fixing aids and the anionic charged surface of fibres. Damaging substances such as lignin sulfonates will interact within the water circuit of a paper machine with expensive, cationic-charged fixing or retention aids producing deposits (coacervates).

The measurement of zeta potential is a useful analytical parameter to provide a better insight and understanding of the complex colloidal mechanism within the finish of the fibres.

Technology for characterization



Stabino®



ZetaView®

Figure 2: Particle Metrix particle characterization systems.

Stabino® is a streaming zeta potential titration system that provides a fast electric response to study the changes of zeta potential. It is well suited to perform rapid charge titrations. Most samples can be analysed at their original concentrations. For more detail, please have a look at this webpage:

→ <https://www.colloid-metrix.de/en/products/stabino-charge-titration.html>

ZetaView® is based on individual particle tracking in a laser light scattering video microscope, working at concentrations between 10^5 and 10^8 particles per ml. It works on the first principles micro-electrophoresis and can be used to calibrate other instruments for size and zeta potential. Please find more details on the following webpage:

→ <https://www.particle-metrix.de/en/products/zetaview-nanoparticle-tracking.html>

Both the Stabino® particle charge titration system and the ZetaView® Particle Tracking Analyzer (PTA) are made for high sample throughput.

For comparison purposes, a third measurement system, the Müttek SZP-04 from BTG, was used to measure zeta potential. The SZP-04 System Zeta Potential measures the surface charge of solid materials suspended in water. The resulting zeta potential is based on a streaming potential measurement after an automatic plug formation of the sample material. The device is widely used in the paper industry and in pigment applications as well as for coating evaluations. These measurements were performed in the group of Professor Wolfgang Bauer at the Institute of Paper, Pulp and Fibre Technology, Graz University of Technology.

Samples

- Sample 1: Softwood bleached kraft pulp (fines), primary fines
- Sample 2: Softwood bleached kraft pulp (fines), primary fines, covalently cationised
- Sample 3: Softwood unbleached kraft pulp (fines), primary fines 1
- Sample 4: PGW fines unbleached
- Sample 5: PGW fines unbleached, covalently cationised
- Sample 6: Softwood unbleached kraft pulp (fines), primary fines 2
- Sample 7: Hardwood (Euka) bleached kraft pulp (fines), primary + secondary fines

Note: The **kraft** process (also known as **kraft** pulping or sulfate process) is a process for conversion of wood into wood **pulp** consisting of almost pure cellulose fibers.

Results

The zeta potential of the seven samples was measured with the Stabino®. The samples were diluted by a factor of 1:10. **Figure 3** shows the zeta potential measurements of samples 1 and 5.

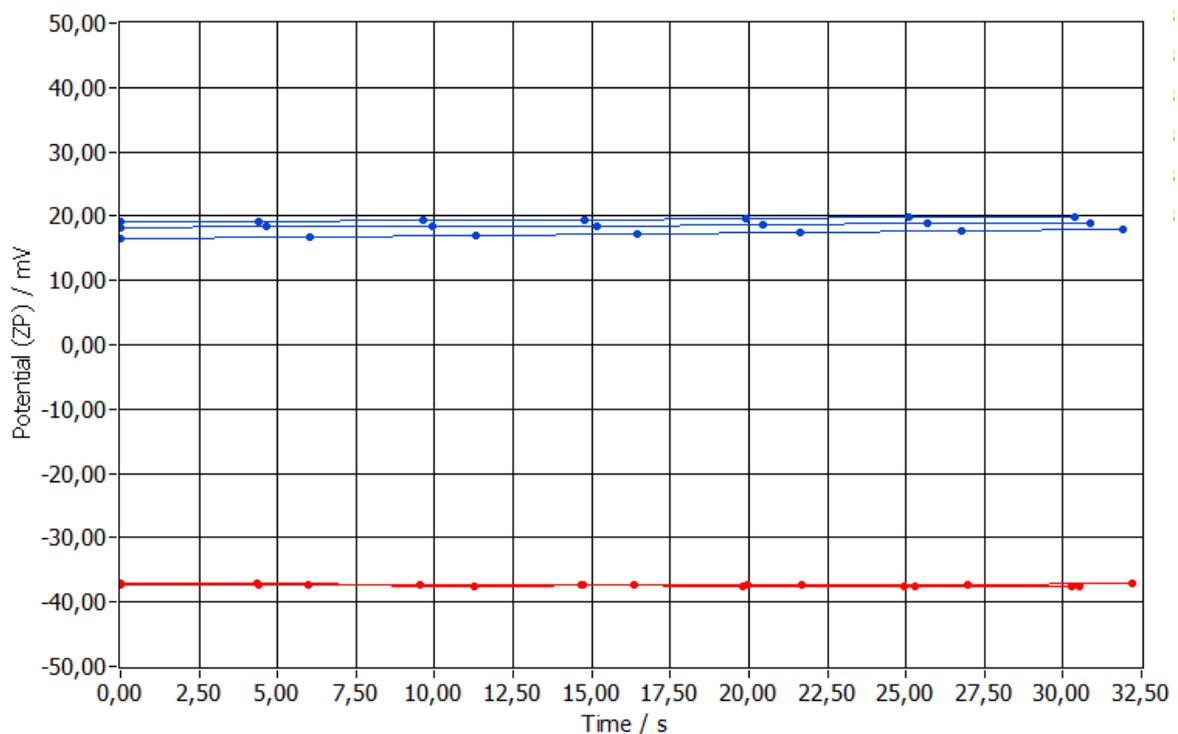


Figure 3: Stabino® Measurement results from sample 1 (red) and sample 5 (blue) in a 1:10 dilution.

For **Particle Tracking Analysis – zeta potential (PTA-ZP)** in ZetaView®, the samples were diluted 1000 times in distilled water to adjust concentration. A typical PTA image (**Figure 3**, left) shows presence of large and small objects. The finding is consistent with optical microscopy (**Figure 1**) hence sample preparation was representative. ZetaView® measures zeta potential distribution at high resolution.

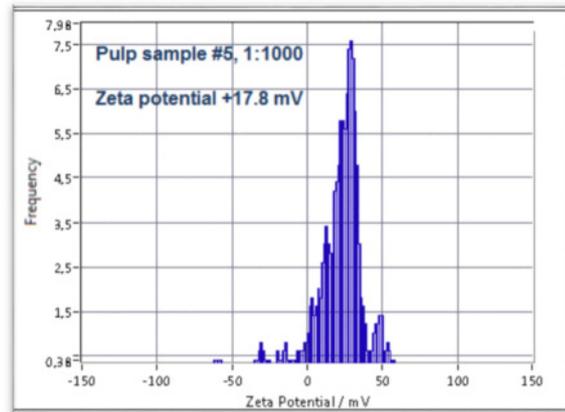
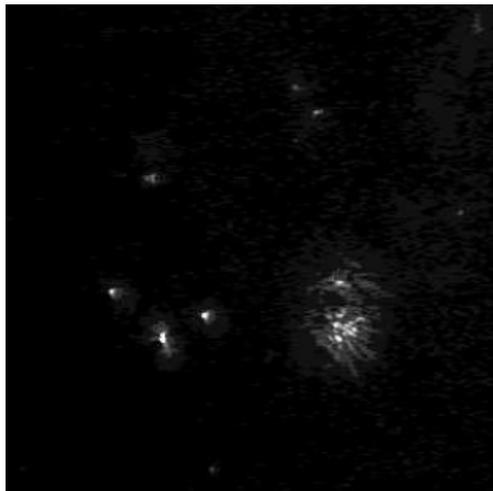


Figure 4: Video image (left) and high-resolution zeta potential distribution (right) from Nano Particle Tracking Analysis with zeta view potential option (PTA-ZP) – ZetaView®.

Table 1 and **Figure 5** show zeta potentials measured with Stabino®, ZetaView® and Mütek SZP-04. The measurements with the SZP-04 were performed at their original concentration.

Analyzer	Zeta potential average of samples						
	1 / mV	2 / mV	3 / mV	4 / mV	5 / mV	6 / mV	7 / mV
ZetaView®	-28.5 ±2,1	+3.5 ±2.1	-21.0 ±0.0	-34.5 ±0.7	21.5 ±0.7	-29.5 ±0.7	-30.5 ±0.7
Stabino®	-37.4 ±0,0	18.7 ±1,3	-21.5 ±0,2	-33.8 ±0,1	18.5 ±0,6	-37.9 ±0,1	-24.2 ±0,1
SZP-04	-23	+20	-22	-28	10	-25	-16

Table 1: Overview of all measured zeta potentials with Stabino®, ZetaView® and Mütek SZP-04

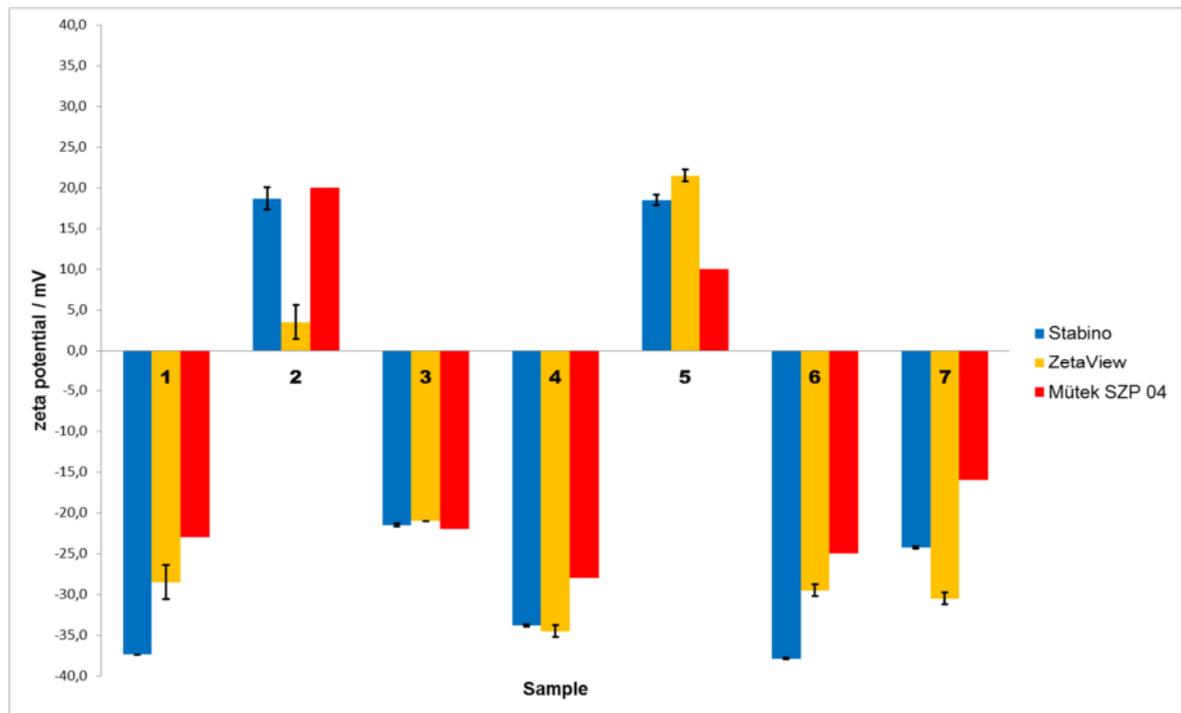


Figure 5: Comparison of zeta potential results from Stabino®, ZetaView® and Mütek SZP-04

The measurements with Stabino® and ZetaView® show small differences. Overall, the results showed good agreement.

With Stabino®, it is possible to perform polyelectrolyte -, pH- and conductivity titrations. **Figure 6** shows titrations on samples 1 and 5. Sample 1 is anionic and was titrated with cationic 0.0025 N P-DADMAC up to the zero point of charge (ZPC). Sample 5, a cationic material, was titrated to the ZPC with PVS.

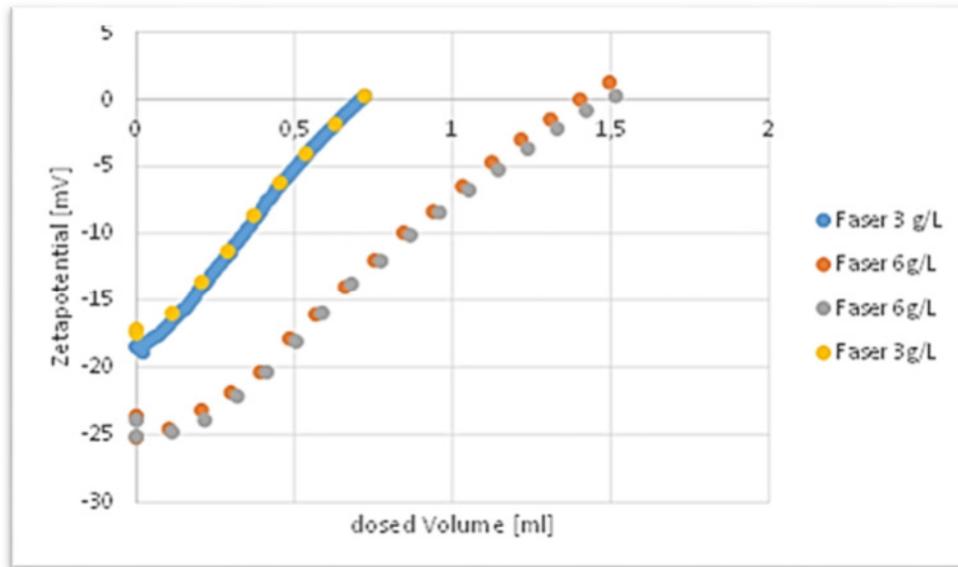


Figure 6: Zeta potential titration with Stabino® on 3g/L and 6g/L pulp at TU-Graz. Titrand: fixing aid

Conclusion

The zeta potential measurements compared well between all three instruments. With Stabino® and SZP-04, it was possible to measure at the original concentration. The outstanding benefits of Stabino® are clear. They offer a broad size range and the ability to perform charge titrations. It is capable of analyzing particles over the widest size range, from macromolecules and colloidal nanoparticles up to fibers and particles in the sub-mm size. Furthermore, Stabino® offers automated titrations with polyelectrolyte-, pH and salt solutions for particles of multiple sizes.

Stabino® is a universal, multi-parameter charge titration system. As our users say, it is also easy to operate.

Acknowledgments

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