Malvern | Material relationships

ZETA POTENTIAL

WATER TREATMENT **SOLUTIONS**

INCREASING THE EFFICIENCY AND STABILITY OF WATER TREATMENT PROCESSES

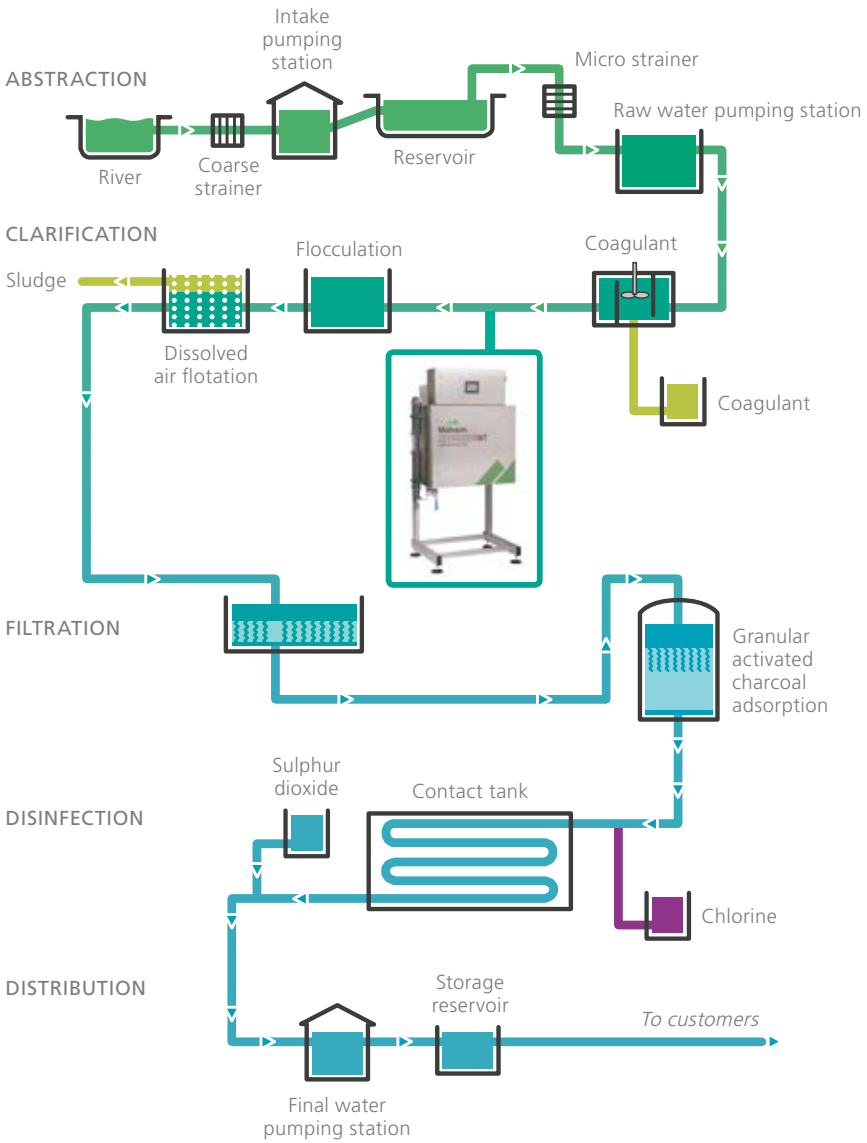
SET A FIRM FOUNDATION FOR SECURE COST-EFFICIENT WATER TREATMENT...

For the water treatment industry, quality is non-negotiable. Consistently demonstrating that regulatory standards are met, while at the same time driving down treatment costs, provides the stimulus for continuous process improvement. Plant stability is the defining operational goal and a primary driver for the adoption of online analytical tools. Complementary aims are to:

- Confidently meet quality targets even when raw water quality changes sharply and rapidly
- Reduce chemical consumption in the face of rising costs and reduced availability
- Automate monitoring and provide clear and consistent information for operational decision making
- Minimize sludge production and associated disposal costs.

The crucial first step of removing physical contaminants via clarification provides a foundation for the entire water treatment process. Coagulant overdosing during charge neutralization is common, and often is considered as insurance against process fluctuations stemming from sub-optimal analysis and control. Taking a hit on chemical usage and sludge production is preferable to compromising water quality.

However, overdosing can re-stabilize suspended particles, decreasing filtration efficiency, as well as increasing treatment costs. The ideal is to maintain the process in a relatively narrow operating window, where just enough coagulant is added to form a stable floc. Reaching this level of performance requires sensitive, relevant and timely monitoring.



"Potential coagulant **cost savings** of 22%, generating 10% less sludge production, and more **stable treated water quality**." [1]

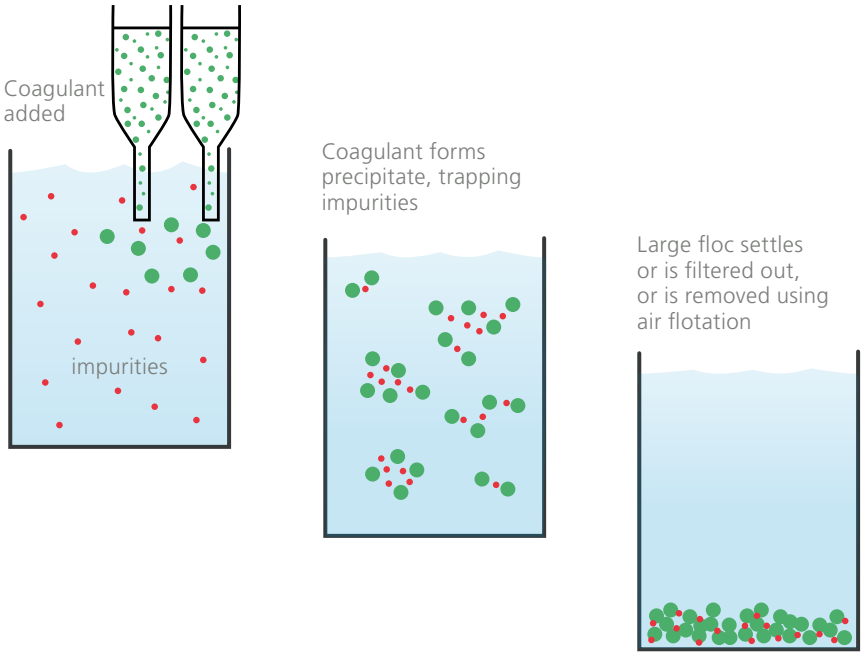
Reference 1. E. Sharp *et al.* 'Zeta potential measurements render the flow test obsolete: Operational experience on a full-scale works.'

The Zetasizer WT is a fully automated online sensor for continuous zeta potential monitoring that enables the proactive, precise and cost-efficient control of charge neutralization processes. By reducing coagulant and sludge disposal costs it delivers a healthy return on investment whilst reducing vulnerability to sharp changes in incoming water quality. Plant stability is more easily maintained in the face of storms, flooding, heavy rain and algae bloom, as well as in response to seasonal events such as snow melt and leaf fall.

...WITH ONLINE ZETA POTENTIAL MEASUREMENT

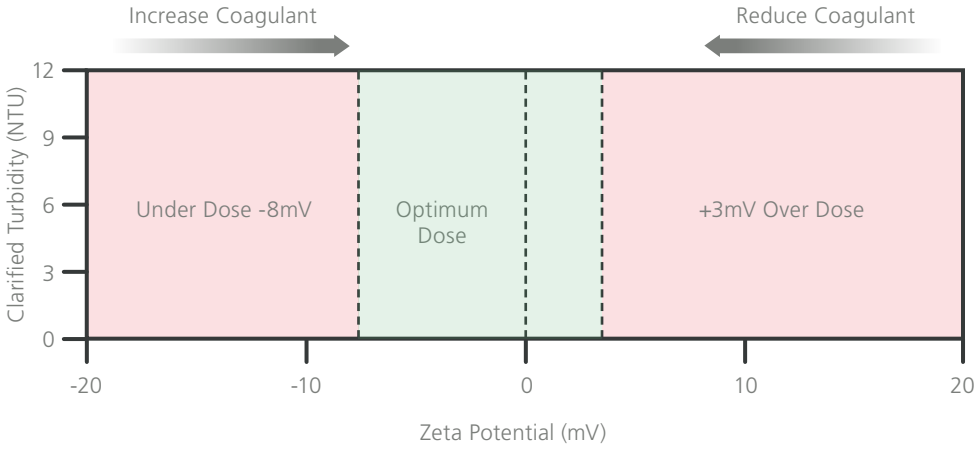
The Zetasizer WT continuously measures zeta potential, a parameter that directly quantifies the likelihood of coagulation. Zeta potential is a well-established, proven parameter for assessing suspension stability and is distinctly different from current density measurements as reported by streaming current meters (SCMs).

The zeta potential of raw water is typically negative, in the region of -25 mV to -15 mV. Adding coagulants neutralizes this negative charge, moving zeta potential towards zero and ultimately into the positive range. Flocculation is typically seen at zeta potentials from -8 mV to +3 mV with particle re-stabilization occurring above +5 mV. Controlling coagulant dosing, either manually or automatically, by directly referencing zeta potential to a set point, therefore optimizes the charge neutralization process. A typical set point will be in the region of -5 mV to 0 mV.



Continuously measuring the zeta potential of water following coagulant dosing:

- Indicates whether more or less coagulant is required
- Enables predictive, rather than reactive control
- Permits a timely response to rapid changes in raw water quality
- Provides the data for automated process control
- Detects a shift in plant operation before it becomes a major problem.



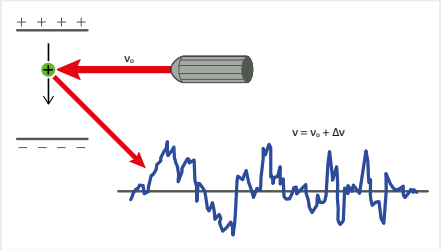
"The online zeta (potential) measurement is a **proactive** tool for preventing treatment problems and keeping water processing plants **operating smoothly**."

Source: Wemlinger Water Treatment Plant, Aurora Water, Colorado, USA.

WHY INFER PROCESS PERFORMANCE...

Traditional techniques used for monitoring particle charge in coagulation and sedimentation processes include the jar test and in some cases SCMs. These techniques have a number of limitations for efficient charge neutralization and clarification control.

Zeta potential measurement directly addresses the issues associated with both techniques. It is fully automated and complete in just a few minutes. Measurements are highly reproducible and repeatable, and sufficiently sensitive to detect a developing plant problem, before it impacts operation. The data delivered reveals whether coagulant addition should be increased or decreased.



Zeta potential measurement using a laser

For these reasons zeta potential is a valuable laboratory analysis. However, a further, critical benefit of the technique is that it can be implemented online, using robust automation technology with a proven track record for reliable process monitoring.

"We've been using zeta potential in the lab for some time now so we're really excited to be able to put it online."

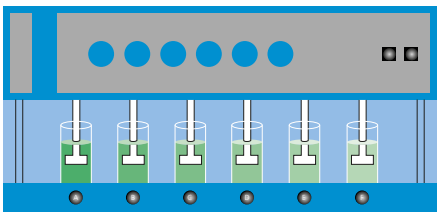
Source: Green River Water Treatment Plant, Tacoma Water

Jar test

Jar tests are a traditional method for optimizing coagulant dosing and give a direct view of the flocculation process. Disadvantages include:

- A failure to exactly mimic conditions in the plant
- Time to perform analysis
- Requirement for operator interpretation

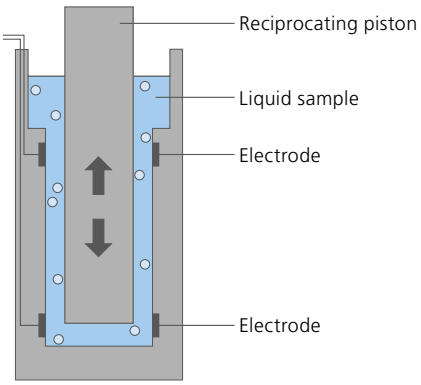
The time delay between sampling and results is a significant limitation for responsive plant control.


Jar Test

Streaming current meter

SCMs can be installed online for continuous monitoring but have a number of drawbacks including:

- Poor sensitivity at low charge conditions observed during coagulation
- Difficulty indicating the required change in coagulant dose due to non-absolute reading
- Measurements are influenced by changes in water conductivity and deposits on the sensing surface.



SCM

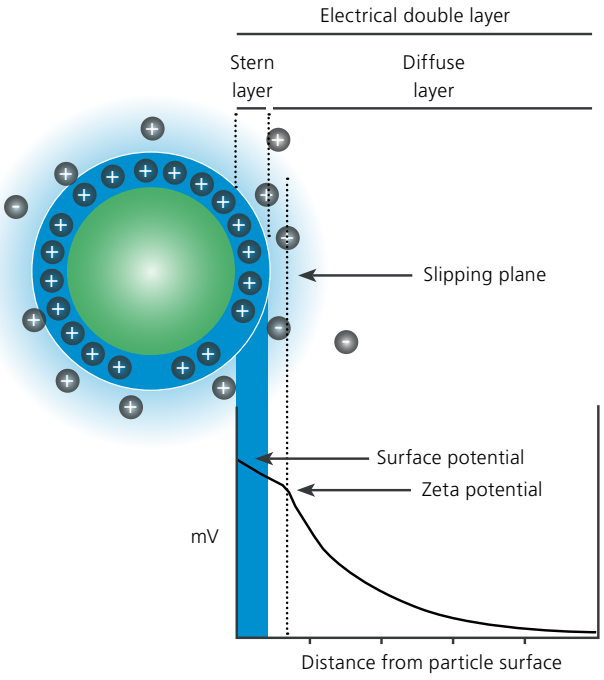
SUMMARY OF DIFFERENCES IN TECHNIQUES

Streaming current	Electrophoretic Light Scattering
Measures a proportion of particles that adsorb onto cell walls	Measures all particles, organics and minerals directly
Calibration of output required	Absolute technique, no calibration required
The low concentration of particles in feed water leads to a very low signal, so insensitive to small changes	Can measure at very low concentrations
Signal depends on the sample conductivity, which varies as the nature of the sample changes	Zeta potential is reported directly

...WHEN YOU CAN CONTINOUSLY AND DIRECTLY MONITOR IT?

The Zetasizer WT is an automated sensor for the online measurement of zeta potential. An aliquot of water is captured as it passes through the Zetasizer WT and an electric field is applied. This field influences the mobility of the particles which is dependent on the surface charge on the particles themselves. The mobility is analyzed using Electrophoretic Light Scattering (ELS), which is an absolute technique eliminating the need for calibration. A NIST traceable standard is available for verification if required.
The measurement is performed in a temperature controlled cell and is insensitive to factors not impacting particle charge. Results are delivered at a user defined frequency of up to one measurement every two minutes.

The Zetasizer WT therefore delivers a continuous, time relevant measure of particle charge that can be used to drive predictive and/or automated control.



ZETA POTENTIAL IS THE CHARGE AT THE POINT WHERE SUSPENDED PARTICLES INTERACT

Zetasizer WT is easily installed at various water treatment facilities without the need for specialist equipment, requiring only a:

- Standard plant power supply (110/240V)
- Pumped water sample supply
- Minimal footprint

Because sample is pumped to the analyzer it can be situated some distance from the clarification process. A local human machine interface (HMI) simplifies routine operator interactions, but the Zetasizer WT can also be interfaced to a plant control system for remote/integrated monitoring and automated control.

The Zetasizer WT has been developed specifically to meet the needs of the water industry, from Malvern's Zetasizer Nano, which has patented technology for robust, accurate measurement and is the world's most widely used system for zeta potential measurement.

Key features include:

- High system uptime - the system runs 24/7 with minimal maintenance required
- Low cost replacement of cell and tubing (every 2-4 weeks, requiring only 10 - 20 minutes of non-operation)
- Automatic restart after any power interruption
- Programmable measurement frequency, typically one complete measurement every two minutes
- Easily integrated within existing control platforms via OPC, Modbus TCP/IP or 4-20 mA signals.

"It provides better sensitivity and is a sharper indicator that the process has changed"

Source: Wemlinger Water Treatment Plant, Aurora Water, Colorado, USA.

TRANSLATE MULTIPLE BENEFITS...

With a Zetasizer WT in place, dosing can be controlled to maintain optimum conditions for coagulation and sedimentation at all times. By continuously tracking the zeta potential of water during the coagulation process the operator can instantly see and respond to changes in the charge neutralization process to achieve stable operation. Fully automated control becomes feasible.

Automated measurement and improved dosage control delivers valuable benefits that translate directly into confident, stable plant operation to regulatory standards, whilst reducing chemical costs.

Greater plant stability and improved water quality consistency

The ability to take preventative action in response to changing conditions before a significant event occurs

A reduction in coagulant usage and a corresponding decrease in sludge production

More productive use of all available manpower

Fast and efficient troubleshooting - faster problem detection and better operational decision-making

Extended time between filter backflush cycles as a result of lower sludge production and steady operation

"Severn Trent Water have been using the Malvern Zetasizer technology for over 5 years and currently use zeta potential to optimize the coagulant dose at several of our water treatment works. I am a firm believer in this technology and have welcomed the opportunity to work with Malvern Instruments and to support this transition into an online arena - which has the potential to revolutionize coagulation control within the Water Industry in the future."

Source: Emma Sharp, Water Treatment and Quality Lead, Severn Trent Water, UK

...INTO GREATER EFFICIENCY AND A SUBSTANTIAL ECONOMIC RETURN

Case study: Wemlinger Water Treatment Plant, owned by Aurora Water.
This company operates three facilities for water treatment in the Denver-Aurora area and has a reputation for US industry leadership. An early access online zeta potential system was installed at Wemlinger in 2012-2013.

Since installation the sensor has:

- Recorded data that are in close agreement with laboratory measurements
- Been welcomed by the operational team as useful and practical
- Proven more sensitive and informative than alternatives such as an SCM
- Demonstrated a sharp response to process changes
- Enabled proactive response by the plant team
- Delivered good reliability.

The Wemlinger team manually adjust chemical dosage rates to maintain zeta potential close to zero, within the range +3 mV to -3 mV.

This has proven to be an effective strategy for coagulation control. If zeta potential becomes negative then dosage rates are increased to restore it to around zero and likewise chemical additions are reduced if zeta potential shifts towards the positive.

Continuous measurement has proven revealing to the experienced operating team allowing it to:

- Reduce chemical dosage costs by around 20% (compared to costs prior to use of zeta potential)
- Optimize the process to enhance overall performance
- Extend filter operating times
- Control the process with greater confidence.

"The on-line zeta potential measurement is helping us to achieve a more cost-efficient water facility, and be more proactive in our treatment"

Source: Wemlinger Water Treatment Plant, Aurora Water, Colorado, USA.

SPECIFICATIONS

Sample requirement	
Sample flow rate (fast loop)	100 - 350 LPH
Sample flow rate (measurement)	0.5 - 2 LPM
System	
Measurement parameter	Zeta potential
Measurement principle	Laser Doppler micro-electrophoresis
Measurement	
Result output frequency	3 minutes typical, programmable
Operation	24 hr continuous
Range of zeta potential measurement	+/-500 mV (+/-90 mV on HMI interface)
General	
Size of molecules and particles that can be measured	3.8 nm to 100 µm
Enclosure rating	IP54, indoor use. Limited capability to NEMA 4X
Power	90-132 VAC, 180-264 VAC, 50-60 Hz, 6 A
Dimensions (W,D,H)	855 x 686 x 1720 mm
Weight	160 kg
Compressed air purge (optional)	1.5 LPM, 6-10 bar, ISO 8573-1:2010 [0.7.2]
Operating environment	
Temperature range	0°C to 40°C
Humidity range	5-95% non-condensing
Maximum sample pressure	6 bar

Malvern

Malvern Instruments Limited
Grovewood Road, Malvern,
Worcestershire, UK, WR14 1XZ

Tel +44 1684 892456
Fax +44 1684 892789

www.malvern.com

MRK 2254-01