APPLICATION NOTE

DRINKING AND WASTE WATER TREATMENT

The problem

Water destined for distribution into the public water system is extracted from a number of sources. Each of these sources needs to be treated in a specific way to remove suspended material, viruses and bacteria and humic acids which colour the water.

EEC drinking water regulations applied in 1989 and higher expectations of water quality worldwide mean that traditional methods of treatment and control are inadequate to ensure that recommended contaminant levels are never exceeded.

Water clarity is measured by monitoring the turbidity. This is useful to check the effectiveness of the treatment process, but is no use in controlling dosing or investigating the source of a problem if one arises.

The answer

New control processes are needed which rely on the fundamental parameter controlling flocculation, the zeta potential. The Malvern Zetasizer makes the measurement of zeta potential simple, fast and reproducible.

A typical water treatment plant is shown in fig. 1. The process involves altering the pH, adding salts or polyelectrolytes, or a combination of these. This flocculates the contaminants which will then sediment or are filtered out.

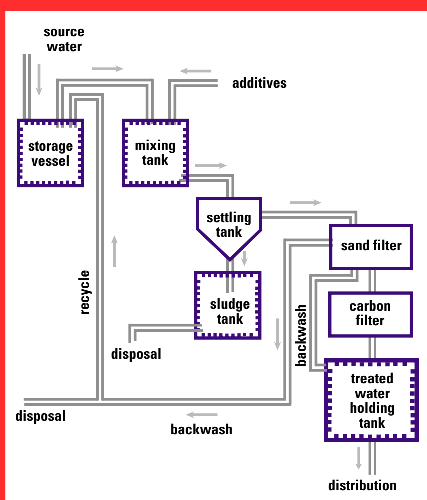

fig 1

Theory

These treatments work by altering the zeta potential of the suspended material. Maximising the efficiency of additive addition and control of flocculation can be done by routine measurement of the zeta potential (Ref. 1). To destabilize a suspension or increase the rate of flocculation the zeta potential must be reduced.

The zeta potential is the parameter that determines the electrical interaction between particles, a high value prevents flocculation, reducing the value allows particles to approach each other and flocculate (fig2), the fastest rate of flocculation being the point of zero zeta potential (pzzp). The rate of flocculation can also be associated with the compactness of the floc which affects the rate of filtration. (Ref. 2)

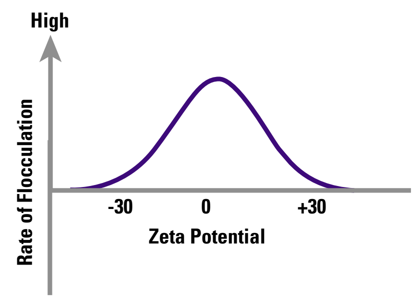

fig 2

The theoretical basis for the concept of zeta potential is described by the DLVO theory: (Ref 3 and 4).

This demonstrates how colloid stability is determined by the balance between the Van der Waals attractive forces and electrical repulsive forces (zeta potential) between particles. Plotting zeta potential over a range of electrolyte concentrations allows the critical coagulation concentration (CCC) to be determined. Below this value the suspended material will not flocculate but may sediment slowly, forming a dense deposit. Above the CCC there will be flocculation; the material will

MALVERN INSTRUMENTS

sediment more quickly and form a lower density deposit. (Ref. 5)

Contamination

Mineral oxides form a significant proportion of the suspended material in ground water. The point of zero zeta potential (pzzp) for many mineral oxides is between 7 and 9 and H^+, OH^- are potential determining ions. This means that pH will be one of the main factors determining zeta potential.

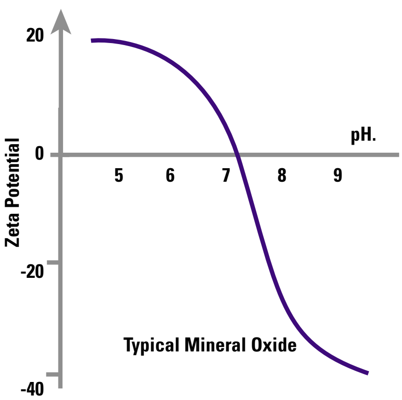

fig 3

The effect of different treatments

pH

Source water will be typically pH5 to 6, adding alkali will reduce the zeta potential of most contaminants and increase the rate of flocculation. pH adjustment is not usually used on its own, but in conjunction with other treatments to increase their effectiveness.

Electrolytes

The effect of adding salts to a dispersion, if they are not specifically adsorbed, is to reduce the zeta potential of the suspended particles. Aluminium sulphate is often used as a flocculate because aluminium is a trivalent cation.

This is important because the suspended material in water is negatively charged and the flocculating effect is proportional to the sixth power of the valency of the positively charged ions added.

Investigation of the correct pH for use of these ions is essential because the adsorption efficiency of the metal ions onto an oxide surface can vary from 0 – 100% over a pH range of less than 1. Adsorption efficiency is directly related to the reduction in the zeta potential. (Ref. 6)

Polyelectrolytes

Polyelectrolytes are charged polymers which naturally adsorb onto particle surfaces. The polymer is of opposite charge to the particle so adsorption reduces the zeta potential. The quantity added and the rate of addition both affect the rate of flocculation. (Ref. 7)

Waste water

Water used in the paper or mineral processing industries has to be treated before re-use or discharge into rivers etc. The same principles for domestic supply water treatment apply to waste water and ground water contaminated with toxic metals, insecticides and herbicides. (Ref. 8)

Conclusion

Using the Malvern Zetasizer enables the measurement and control of the zeta potential of suspended material in water in a treatment plant. This will improve water quality and increase plant throughput.

List of references

Ref. 1: Riddick T M (1968) Control of Colloid Stability through zeta potential.

Ref. 2: A Elaissari and E Pefferkorn, J. Chem Phys 95(4) 1991, 2919

Ref. 3: Verwey E J W and Overbeek J Th. G (1948) "Theory of Stability of Lyphobic Colloids" Nth Holland Amsterdam.

Ref. 4: Deryagen B V and Landau L D (1941) Acta Physico Chim SSSR 14, 633

Ref. 5: Hogg R et Al (1966) Transfaraday Soc. 62, 1638

Ref. 6: James R O & Healy T W (1972) J Colloid Interface Sci. 40, 42, 53, 65.

Ref. 7: E Pefferkorn + A Elaissari. J Colloid Interface Sci. Vol 138 No. 1 187 (1990).

Ref. 8: Higgins T E and Romanow S (1987) Haz Waste 4, 4, 307 Treatment processes for contaminated ground water.

Malvern Instruments Limited
Enigma Business Park
Grovewood Road
Malvern
Worcs
WR14 1XZ
U.K.
Tel: +44 (0)1684 892456
Fax: +44 (0)1684 892789

Malvern Instruments S.A.
Parc Club de L'Université
30, Rue Jean Rostand
91893 Orsay Cedex
France
Tél: +33 (1) 69 35 18 00
Fax: +33 (1) 60 19 13 26

Malvern Instruments Inc.
10 Southville Road
Southborough
MA 01772
U.S.A.
Tel: +1 (508) 480-0200
Fax: +1 (508) 460-9692

Malvern Instruments GmbH
Rigipsstraße 19
71083 Herrenberg
Germany
Tel: +49 (0) 7032 97770
Fax: +49 (0) 7032 77854

Malvern Instruments (Asia Pacific)
Penthouse 21-11
The Boulevard
Mid Valley City
Lingkaren Syed Putra
59200 Kuala Lumpur
Malaysia
Tel/Fax: 603 2283 6139

Malvern Instruments Nordic AB
Box 15045, Vallongatan 1
750 15 UPPSALA
Sweden

APPLICATION NOTE