Control of Water Effluent or Process Quality

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Determining Optimum Coagulant/Polymer, pH/OH conditions for best plant performance, lowest chemical, energy and operational costs and sustained optimum water quality

Control of the coagulation and flocculation of the incoming raw water (or sludge liquors or effluents) is critical for ensuring good water quality and control of the treatment process. Many factors influence the optimum coagulation set point and flocculation of the materials to be removed from the raw water source.

Influencing factors on the raw water include:

- Raw COLOUR (of which HUMIC and FULVIC acids, HPO, HPI and HMW components)
- Organics, NOM (Including BDOM & AOC)
- pH/OH (Balance with dose and Alkalinity for Coagulation Process)
- Process FLOW
- TURBIDITY - Active and Latent (Activity and varying demand of turbidity compounds and matter on the coagulation process)
- TDS & SS
- Temperature (affects agglomera tion and influences pH/OH set point)
- Mixing (Quality, Design, Location and Performance of Existing)
- Dosing (Quality, Condition of Chemical Dosing Pumps and System, Pipelines etc)
- Transportation (Flocculation Assembly Design, Suitable for all Waters? Speed of Flocculation, Heavy Flocc / Light Flocc?)

Jar tests have been used for years to "ballpark" coagulant dose. Jar tests have limitations in that they are time consuming, intermittent, and are subject to variations in operator's visual observations. To help improve coagulant demand calculations, zeta meters (ZM) have been used to improve jar tests results with good results. Zeta potential is a measure of particle surface charge. Prior to the advent of electro-kinetic potential monitors, zeta meters were the primary instruments for measuring electro-kinetic properties as related to coagulant dose. Both instruments measure charge, but use very different methods.

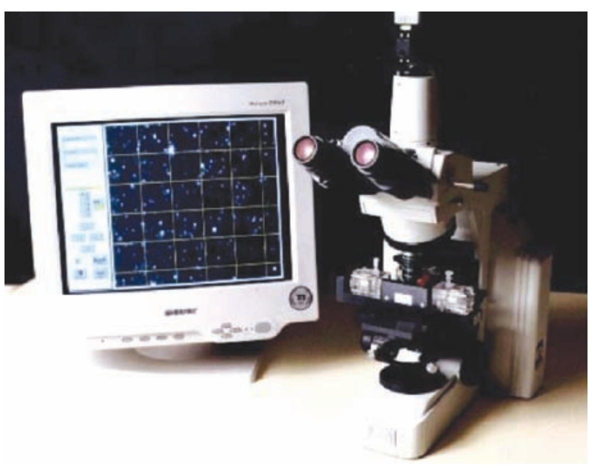

Figure 1

THE TECHNOLOGY and APPLICATION

The zeta potential system (Figure 1) uses a stereoscopic microscope to observe particle movement through a glass cell called an electrophoresis cell. Electrodes in each end of the cell create an electric field. Particles possessing a positive charge (+) will move toward the anode (-), and negative particles (-) toward the cathode (+), Particle speed and direction are related to its zeta potential (ZP). The ZP corresponding to optimum coagulant dose varies from plant to plant. It is important to understand that a ZP of zero is hardly ever the optimum value! The goal is to lower repulsive forces to the point where particle collisions causes agglomeration, and achieves the optimum particle size/density resulting in the best flocculation, sedimentation, and filtration. This "net charge" value could be negative, zero, or positive, but usually negative. ZP is normally expressed in millivolts. An optimum charge might be from -10 to -5 millivolts, for example.

THE COAGULATION CONTROL SYSTEMS

Figure 2a – EKA 2000 Portable

In addition to the fully on-line automatic coagulation control system Achromatic has now available an advanced portable or laboratory electro-kinetic monitor (figure 2a) and the fully automatic on-line system (figure 2b). These are coagulant/polymer dose analysers that utilize electro-kinetic potential that measure the total "load" within the water / sludge / effluent / influent etc to be trea ted and/or including the polymer/s or coagulants so added. The system analyses the net ionic and colloidal surface charge (positive and negative) in the sample being tested. Electro-kinetic potential is related to zeta potential by the formula:

I □ ZD/N

Where i = electro-kinetic, Z = zeta potential, D = dielectric constant, and N = viscosity of the fluid. The treated sample flows into the analyser chamber where it is drawn into the analyser cell assembly. Particles in the sample are temporarily immobilized inside the analyser cell chamber annulus and probe assemblies. As the water is oscillated under controlled conditions, mobile counter-ions surrounding these particles are moved downstream to the analyser cell assembly detection and monitoring electrodes. This controlled oscillation of like charges causes an alternating current to be generated that is defined as "electro-kinetic potential." This current is amplified through the appropriate electronics and displayed a value representing the current electro-kinetic potential of the sample. This is then

Figure 2b – ICCS 2000 Fully On-line Automatic Coagulation System

directly related to the sample load and/or demand and/or over or under-dose on the coagulant and sample. The analysis is very accurate and occurs almost instantaneously in real time, which enables superb continuous direct control of the dosing pumps.

Electro-kinetic charge monitoring is actually another method to measure ZP. However, the measured numerical values are not the same. A ZP of -10 MV, for instance, is not -10 electro-kinetic potential units. This presents no problem in actual use since the optimum treatment program is always empirically determined for each plant. As previously stated, in turbidity removal, the goal is to achieve optimum particle size/density. For organics removal, in "enhanced coagulation," optimum dosage may not even be related to particle collisions and flocculation development. This provides an advantage over zeta potential that relies on visual observation of particles.

LARGE COST SAVINGS & PROCESS OPTIMISATION

"Optimum" coagulation chemistry is generally defined as "the lowest dosage of all chemicals that results in the desired removal of contaminants with the lowest total operating costs." The ultimate goal is to be able to add just enough coagulant and no more to achieve the breakdown of the energy barrier that exists. (Figure 3) the problem is that this is virtually impossible to achieve manually in real time. To dose so close manually to the "breakthrough" point would leave the plant susceptible to carry over, high turbidity, oocysts contamination and high coagulant in the filtered water. The on-line electro-kinetic potential system can provide this optimization when properly installed, maintained, and interpreted. The Achromatic on-line ICCS2000 fully automatic coagulation & flocculation dosing control system typically has returned between 25-30% chemical & polymer cost savings once installed and set up.

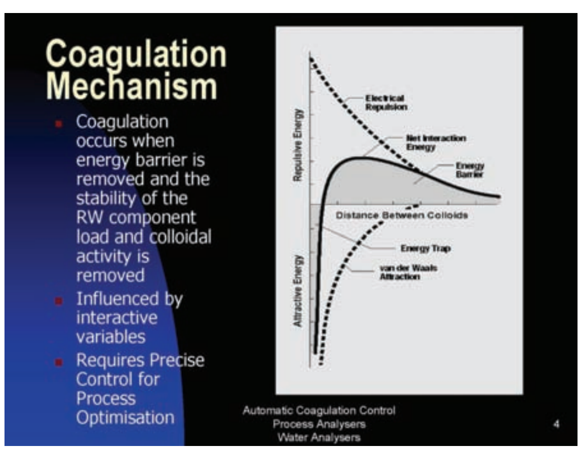

Figure 3

HOW THE AUTOMATIC COAGULATION CONTROL SYSTEM ICCS 2000 & THE ELECTRO-KINETIC POTENTIAL SYSTEM EKA 2000 ARE USED

ACHROMATIC ICCS 2000 (See Figure 2b)

The ICCS 2000 is more than just a group of monitoring and controlling instruments and controllers. Every ICCS 2000 installation is different and is set up according to each plants' own individual water conditions and process characteristics. Many years experience and knowledge has gone into the design and integration of the ICCS 2000 system. The operational software has multiple programmable inputs and outputs with individual process tuning capability for each and every process condition or sample or stream and interactive variables. Cognition of the plant characteristics, design and operational layout and conditions can be taken into consideration and tuned into the system. Achromatic carries out a full process survey prior to installation and/or can advise site staff accordingly.

The system continuously monitors the total incoming demand or load of the water to be treated and the coagulant or polymer being used as the primary coagulant. The system is able to see very precisely any under dose or overdose from the coagulation set point.

As the system has near instantaneous analysis of the process stream, is highly sensitive and accurate, it is therefore possible to tune the dosing to an optimum level that would be impossible to achieve manually. This is where the significant operational cost savings can be achieved.

In addition to controlling the main coagulant pumps the system can also control many other parameters such as the coagulation pH set point and associated dosing pumps and polymer dosing pumps for example. (See figures 4 & 5 & 6)

Figure 4

OVERVIEW OF ICCS 2000 FULLY AUTOMATIC COAGULATION AND DOSING CONTROL SYSTEM

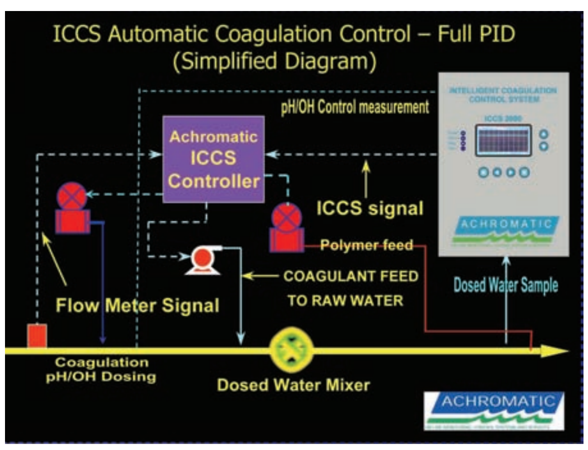

Figure 5

Figure 6 – Achromatic Typical Coagulant Pump Installation

ACHROMATIC EKA 2000

Using a simple titration procedure, the Electro-kinetic charge analyser (EKA) is used to correlate "best jar" with a quantified charge value and optimum plant performance. This provides a quick, easy and visible way for operators to understand the relationship between water quality and EKA value. Once this correlation is established, jar tests usually becomes less frequent or unnecessary. If the plant has an on-line EKA, the portable/laboratory unit serves as a periodic verification of its operation just like a laboratory pH meter, or turbidity meter does for on-line instruments. The portable/laboratory EKA can also be a useful tool for comparing strength/activity of different coagulants/polymers prior to full-scale trials.

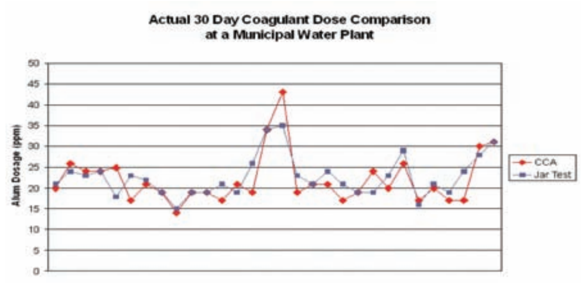

Figure 7

Figure 7 shows actual comparative results using the Achromatic EKA system in a Water treatment works. This provided the following conclusions after their purchase of a laboratory EKA

- The Achromatic EKA system is a very effective tool for verifying jar tests required by a changing river water source. The unit also helped operators rapidly (less than five minutes) determine the optimum coagulant dose for their secondary river water source
- The laboratory unit verified operation of the plant's on-line electro-kinetic monitors that automatically controls the plant's coagulant feed pump.
- The plant reduced total chemical usage during the evaluation
- Operators found the laboratory unit easy to use and a great help during high turbidity excursions and when switching between two different water sources.

Conclusion

From an operator's perspective, the ICCS 2000 electro-kinetic analyser system provides the best on-line tool for optimizing and controlling coagulant dose. With the ICCS 2000 on-line system full optimization of the process may be achieved, with corresponding lower operation costs and sustained improved water quality. With the development of the Achromatic EKA 2000 laboratory unit, operators can verify on-line operation and determine coagulant dose quicker than performing jar tests. The combination of on-line and laboratory units help to define the best coagulation for a changing water source.