HORIBA Scientific

Application Note

Zeta Potential Analysis of Refinery Wastewater and Its Treatment

AN202

Manipulating the surface charge of suspended particles significantly improves wastewater treatment efficiency. Lowering the magnitude of surface charge allows particles to aggregate and therefore more quickly flocculate or settle/cream. This is often achieved by adding inorganic coagulants and polymeric flocculants. Zeta potential measurements with the SZ-100 determine the effect of different coagulants and concentrations, and thus ensure the greatest impact for the lowest cost. In this note, the effect of coagulant concentration on the treatment of suspended solids in refinery wastewater is analyzed.

Introduction

Suspended solids are a common impurity in wastewater from industrial and mining operations. Safety and aesthetics dictate that all water be essentially free of suspended matter. In order to meet requirements for water clarity for reuse or discharge, the suspended solids are often allowed to settle to the bottom or float (cream) to the top of large tanks. The duration of these processes is a strong function of the particle size, e.g. larger particles settle/cream faster. Thus, if particles can be made to aggregate, the settling process is shorter and therefore the treatment operation is faster and therefore less expensive.

Particle flocculation can be an energetically favored process; as particles flocculate, the total particle surface area is decreased and the system is more stable. However, flocculation cannot occur if particle collisions are suppressed by electrostatic interactions. That is, if two particles have the same charge (positive or negative), they will repel each other.

Aggregation is enhanced through charge neutralization by the addition of additives. In order to minimize costs, the optimal amount of additive must be determined. One widely used class of additives is known as coagulants. These are salts with (generally) polyvalent ions that modify the particle surface potential. Unfortunately, in many systems, addition of too much coagulant will actually change the sign of the surface charge, and therefore restabilize the suspended solids defeating the purpose of adding the coagulant.

The zeta potential is related to the surface charge of suspended particles. Therefore, its measurement using the HORIBA SZ-100 Nanoparticle Analyzer (Figure 1) can be used to monitor the effect of coagulant addition.

Figure 1: SZ-100 Nanoparticle Analyzer.

Materials and Methods

Refinery wastewater was obtained and initially diluted in 1 mM NaCl. This small amount of NaCl serves as a background electrolyte to keep the suspension ionic strength constant and suppress variations in results due to dissolved gases such as CO_2.

The effect of a proprietary coagulant was studied by adding known quantities to the suspension, and then using the SZ-100 to perform a zeta potential measurement.

Results and Discussion

The zeta potential value of the wastewater suspension as a function of added coagulant is plotted in Figure 2 below. As is common in this analysis, the added quantities are varied on a logarithmic scale.

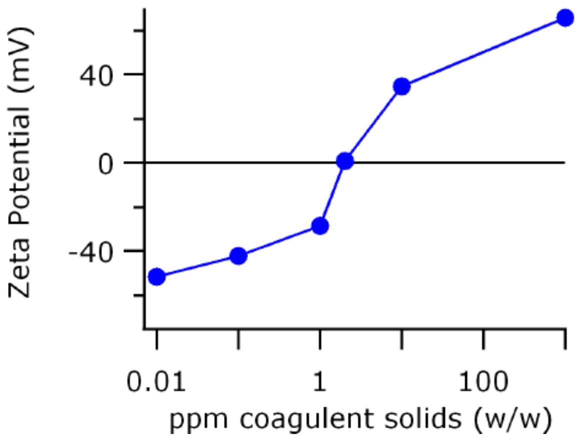

Figure 2: Zeta potential of suspended solids as a function of added coagulant. Note that the zeta potential data allows one to rapidly discern the optimum coagulant choice for clarifying this waste stream.

As coagulant is added, the zeta potential approaches zero. There is an additional, and for this application, critical point in the data shown here. As additional coagulant is added, the zeta potential reaches zero, also known as the iso-electric point. Then, it crosses zero and the net charge on the particle becomes positive. Too much coagulant restabilizes the suspension but now with the opposite charge. The danger in adding too much coagulant is not merely the additional cost in reagents, but also that the treatment process will become ineffective.

Conclusions

The results of these measurements show that the SZ-100 can be used to rapidly identify the correct quantity of coagulant to use in the treatment process. Zeta potential analysis can provide a basis of optimizing operation of wastewater purification. Data from the SZ-100 can guide decision making to ensure that the least expensive treatment options are chosen while protecting the environment.

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