EFFICIENT WASTEWATER CLEANUP WITH CLAY BASED FLOCCULANTS.

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ABSTRACT

Contaminated industrial wastewater frequently contains oily emulsions, latex and heavy metals. The standard treatment is precipitation and the use of polymers for coalescence and flocculation of the oil and suspended solids. The end product is a liquid, gooey sludge that is difficult to remove and that has to be disposed of as a liquid waste. It does not pass TCLP tests. For smaller wastewater streams (50,000 gpd max), another batch treatment method that is gaining acceptance is employing bentonite-based flocculants that consist of bentonite or organoclay, polymers, various dry acids and bases and other ingredients. The flocculant powder is added in one step, one tank, most of the time, in which process the emulsion is broken, the solids coagulated and the metals are removed by both precipitation and/or ion exchange onto the bentonite. The bentonite platelets form a matrix in which the oil droplets are fixated or encapsulated. This matrix then forms a floc, which settles to either the top or the bottom of the tank. By passing the wastewater through a filter or belt press, a filter cake results that contains some 20-49% solids. Often a pozzolanic reaction takes place over time. This filter cake usually passes the TCLP test and is disposed of as a solid waste into landfills at about $25.-/ton plus freight. The process takes place in less than 10 minutes. Sufficient shear must be applied to make sure the bentonite disperses in the water. The remaining wastewater can either be discharged into the sewer, or by post polishing with an organoclay/carbon adsorption system, it can be cleansed to such low concentrations of oils, solvents and metals that recycling is possible, saving on water/sewage discharge costs.
This presentation describes in detail how such systems work, including how emulsions are broken, and some of the equipment.

INTRODUCTION

Bentonites, which are the main ingredient of these flocculants, are composed of volcanic ash, which has been chemically altered after it was deposited in lakes and oceans. The clay mineral montmorillonite from the smectite family is the main ingredients. The remainder consists of quartz, feldspar, goethite, shale, and sometimes gypsum flakes.

Clay minerals are electrically charged, they have ion exchange capacity. Due to defects in the internal structure, charge deficiencies are regulated on the surface of the clay platelet by the adsorption of metallic cations of every stripe. The predominant ones are sodium, calcium, magnesium, and potassium. If the ash was deposited in fresh water, calcium predominates, which results in a bentonite with very limited swelling capacity. However, if the ash was deposited in salt water, sodium is the predominant exchangeable ion. Since sodium swells when it comes in contact with water, the entire clay swells up to sixteen times its volume. This is the mechanism that creates a floc when it is inserted into wastewater. The exchangeable ions are easily replaced with heavy metals present in the wastewater. By adding electrolytes to the dry bentonite, oil and other organics are trapped and encapsulated in a matrix of bentonite flakes. Such a system is used for wastewater that contains up to 3% oil. Precipitation can be encouraged by adding precipitation agents. Addition of dry acids or bases results in a lowering or increasing of the pH, depending on the desired end result.

Organoclays are sometimes used if the oil content has to be reduced to non-detect. An organoclay consists of a bentonite which has been chemically modified with a quaternary amine by ion exchange with sodium and calcium. This reaction results in a bentonite that is organophilic and hydrophobic. It is able to remove oil, grease and other organics by partition.

FLOCCULATION

Oils, greases, fats are frequently found in wastewater, deriving from material removal treatment of metals such as vibratory deburring, vehicle wash water, food processing, tanneries, stamping plants and others. Such wastewaters often contain 2-3% of oil. Skimming may not be applicable because the oil may coat sediments, or it may be chemically emulsified.

When such wastewater is treated in a batch tank, the first step is to split the emulsion, either by adding an electrolyte such as alum, or by lowering the pH, and then adding a coagulant such as an organic polymer. Adding an anionic polymer then flocculates the oil droplets that form in this manner. This method is usually much cheaper then having it hauled away.

Bentonite based flocculents, in many cases, can be designed in a manner that allows for the entire process to be performed in one step. What is crucial is not just to guess which ingredients to blend, but the ratios of these ingredients. The resulting sludge that is formed after the treatment process is often disposed of as a solid waste.

CASE HISTORIES

The wastewater sample has a brown to opaque color, a petroleum odor, a medium to low viscosity, and contains some settled sediments and some froth on the surface. The pH did not require adjustment. The sample was diluted with water by 4:1, and 2.65 lb of flocculant were used per 100 gallon of wastewater.

RESULTS:

Parameters	Pre-Treatment	Post Treatment
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Suspended Solids	5,200 ppm	17ppm
Turbidity	7,300 FTU	13 FTU
Color	25,200 PTCO	67 PTCO
F.O.G.	1,220 ppm	16.1 ppm
PH	6.9	8.95

A full floc with good reduction was formed.

Another wastewater from a die caster showed the following results:

Parameter	Pre-Treatment	Post Treatment
Color	milky due to oil	clear
F.O.G mineral oil	904.0 ppm	9.0 ppm
Animal/vegetable oil	40	19
Copper	0.67	0.15
Cadmium	0.14	0.05
Iron	5.42	0.79
Nickel	0.15	0.10
Lead	13.35	0.56
Chromium (Hex.)	0.11	0.05
Zinc	3.38	0.34

By passing the treated water through a granular organoclay filter, this water can be cleaned to the point of allowing recycling.

EQUIPMENT

The ideal equipment consists of a system that performs the entire flocculation operation in one step. These are batch systems that can treat anywhere from 200, 500, to 1200 gallons per hour. Many of today's type of equipment are fully automatic. Dilution of the wastewater is preprogrammed, as are pH adjustment. Such systems are PLC controlled. The only additional step may include removal of free oil. Belt filters retain the sludge, as water drains off. These systems treat wastewater with both organic and inorganic items. Laboratory testing before treatment determines which flocculant is to be used, and the amount required.

CONCLUSION

This brief description of the treatment of small wastewater streams shows that the use of bentonite based flocculants, it the appropriate equipment, is an economic and easy method of treatment. Recycling of wastewater is feasible if post treatment with organoclay is included. The resulting sludge usually passes the TCLP test, and can be disposed of as a solid waste in a landfill.